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InfraFix: An AI-Powered Crowdsourced Infrastructure Maintenance Platform

Prof. Monali P. Mahajan
Department of Computer Engineering
K. K. Wagh I.E.E.R., Nashik, India
mjmetkar@kkwagh.edu.in

Alfaiz Naeem Shaikh
Department of Computer Engineering
K. K. Wagh I.E.E.R., Nashik, India
anshaikh370122@kkwagh.edu.in

Samwad Pohare
Department of Computer Engineering
K. K. Wagh I.E.E.R., Nashik, India
sspohare370122@kkwagh.edu.in

Barkat Sultan
Department of Computer Engineering
K. K. Wagh I.E.E.R., Nashik, India
barkatsultan370123@kkwagh.edu.in

Abstract—Abstract—InfraFix is an artificial intelligence pow- ered plat form designed to address infrastructure challenges such as pot holes, broken streetlights, and community project needs in urban and rural areas. The system provides an integrated web and mo bile application through which users can report problems by up loading photos, descriptions, and geolocations. Leveraging AI, InfraFix evaluates the severity of reported problems on a five-point scale and displays them on a 'Trending Issues' feed that allows citizens to vote and priori- tize local problems. Proximity-based recommendations promote localized problem solving, while the platform's crowdfunding feature allows communities to finance initiatives such as park renovations or road repairs. Registered contractors can bid on active projects, with AI modules verifying their identities, assessing bid reasonableness, and analyzing past work per- formance. Community administrators monitor project statuses (Active, Pending, Completed) and validate contractor bids to ensure transparency and accountability. Overall, InfraFix em- powers communities to collaboratively identify, prioritize, and resolve infrastructure issues efficiently and transparently, thus fostering civic engagement and sustainable development. Index Terms—AI-powered infrastructure reporting, community-driven problem solving, contractor bidding, crowdfunding for public projects, smart issue prioritization

Index Terms—AI-powered infrastructure reporting, crowd-sourcing, contractor bidding, smart issue prioritization, crowd-funding

I. Introduction

Urban infrastructure plays a vital role in the socioeconomic development of cities, directly impacting quality of life, safety, and mobility. However, in many developing regions, main tenance of public infrastructure remains reactive rather than proactive. Problems such as potholes, damaged streetlights, overflowing waste bins, and deteriorating public amenities are often reported late or not at all due to inefficient com munication channels between citizens and municipal bodies. Traditional reporting systems, including helplines and in per-son complaints, are time-consuming, lack transparency, and offer little feedback to the community. Consequently, cities face increasing backlogs of unresolved maintenance issues that degrade civic trust and slow sustainable development. The advent of digital technologies and the proliferation of smartphones have opened new opportunities for real-time civic engagement. Crowdsourcing, in particular, enables the collective intelligence of citizens to identify and report local issues as they occur. By integrating crowdsourced data with artificial intelligence (AI), municipalities can analyze, priori tize, and address problems more efficiently. Several smart city initiatives worldwide have adopted participatory platforms to involve citizens in governance, yet many of these solutions remain fragmented or limited to basic complaint registration without automation or accountability

To address these gaps, InfraFix introduces an AI-powered platform that unifies community-driven reporting, automated analysis, and transparent resolution tracking. The system al lows users to submit issue reports with images, descriptions, and geolocations through a simple web or mobile interface. An AI module then classifies each issue, assesses its severity on a scale from one to five, and determines its urgency level. Issues are displayed in a "Trending" feed where users can upvote items, helping local authorities and residents collec tively identify high-priority problems. Furthermore, InfraFix integrates a unique crowdfunding mechanism that empowers communities to fund small-scale improvement projects, such as park renovations or road patching, when government re sources are constrained Another innovative feature of InfraFix is its contractor man agement system. Verified contractors can bid on open projects, and AI algorithms evaluate their bids based on fairness, histori cal performance, and authenticity. This fosters competition, ac countability, and quality assur-ance in public works execution. Community administrators oversee and approve each project phase—Active, Pending, or Completed—ensuring transparent progress tracking. In doing so, InfraFix creates a trusted digital ecosystem that connects citizens, administrators, and contractors within a single unified framework for infrastructure improvement

II. Related Work

Recent research in smart city development has emphasized the significance of citizen participation, crowdsourcing, and artificial intelligence for effective infrastructure governance.

Early studies such as Bott and Young [1] discussed the role of crowdsourcing in improving transparency and accountability in public administration, demonstrating how digital engage ment can enhance responsiveness in governance. Praharaja et al. [2] further highlighted the influence of the 100 Smart Cities Mission in India, showcasing how information and communication technology (ICT) platforms enable citizens to co-create and monitor urban services. Srivastava and Mostafavi [3] explored participatory planning and crowdsourcing in ur-ban infrastructure systems, identify ing both the opportunities for citizen empowerment and the challenges related to data validation, coordination, and long term sustainability. Chaves et al. [4] analyzed crowdsourcing in emergency and urban management contexts, proposing typologies for integrating citizen reports with institutional responses. These works col-lectively illustrate the potential of human-in-the-loop systems that blend social engagement with digital automation. In parallel, mobile crowdsensing has emerged as a key enabler for scalable data collection. Capponi et al. [5] provided a comprehensive survey of mobile crowdsensing architectures, highlighting challenges in privacy, trust, and incentive mecha nisms. Such frameworks support the type of geotagged, image based reporting adopted by InfraFix, where user submissions become structured datasets for automated analysis. While ex-isting systems such as FixMyStreet, OneService, and NYC311 allow users to report civic issues, they largely de pend on manual inspection and lack AI-assisted prioritization or community-driven funding models. InfraFix builds upon these foundations by integrating automated image classifica tion, bid evaluation, and crowdfunding within a unified ecosys tem. By merging AI analytics with participatory sensing, the platform advances prior work toward a more intelligent, transparent, and self-sustaining model of civic infrastructure maintenance.

III. Literature Survey

A considerable body of research has focused on leveraging information and communication technologies (ICT), crowd sourcing, and artificial intelligence (AI) to improve civic infrastructure management. Traditional maintenance systems rely heavily on manual inspections and citizen complaints, which often result in delayed responses and limited account ability. To overcome these challenges, researchers have pro posed participatory and technology-driven solutions that utilize community involvement and data analytics to improve urban governance.

Bott and Young [1] were among the first to examine the use of crowdsourcing in governance, emphasizing its potential to enhance public transparency and citizen empowerment. Their study highlighted how the integration of online participation platforms can democratize problem reporting and policy feed back. Building on this perspective, Praharaja et al. [2] analyzed India's 100 Smart Cities Mission and demonstrated how digital participation tools help bridge the gap between citizens and authorities, ultimately strengthening service delivery and civic accountability.

Srivastava and Mostafavi [3] explored the application of participatory planning and crowdsourcing in developing in frastructure systems for smart cities. They noted that citizen generated data can significantly improve decision-making ac curacy but warned of limitations related to scalability, data verification, and privacy. Chaves et al. [4] extended this idea to emergency management, categorizing different forms of urban crowdsourcing and highlighting the importance of trust, incentives, and institutional collaboration in successful deploy-ments. Mobile crowdsensing (MCS) has further advanced the con cept of distributed citizen participation. Capponi et al. [5] provided a comprehensive overview of MCS systems, describ ing how smartphones can collect real-time environmental and infrastructural data. They outlined critical design challenges, including energy consumption, data credibility, and reward mechanisms, which directly influence user engagement and the quality of collected data. Existing civic reporting plat-forms—such as FixMyStreet in the United Kingdom, OneSer-vice in Singapore, and NYC311 in the United States—allow users to report issues related to sanitation, roads, or light-ing. However, these systems primarily function as complaint repositories and depend on manual triage by authorities. They lack AI-based prioritization, pre dictive analytics, and finan-cial collaboration mechanisms. InfraFix distinguishes itself by integrating crowdsourced reporting with AI-driven image analysis, severity assessment, and contractor bidding. Unlike prior systems, it introduces a crowdfunding component that empowers communities to co f inance and monitor small-scale development projects. The literature therefore under-scores both the feasibility and neces sity of intelligent, citizen-centric systems like InfraFix, which combine participatory governance with data-driven automation to achieve sustainable infrastructure maintenance. The system follows a three-tier design (Fig. ??): • Frontend: React-based user interface for report creation and viewing. • Backend: Node.js REST API with Prisma ORM con nected to SQLite/PostgreSQL. • AI Service: Vision model that classifies and annotates images. Secure authentication is implemented using JWT. Data in tegrity and privacy are maintained through controlled access and encrypted storage

IV. Proposed Method

The proposed system, InfraFix, is designed as an AI powered crowdsourcing platform that enables citizens, local authorities, and contractors to collaboratively identify, priori tize, and resolve public infrastructure issues. The system ar-chitecture integrates multiple functional modules—data acqui sition, AI-based image analysis, issue prioritization, contractor management, and crowdfunding—to create an efficient and transparent maintenance ecosystem. Figure ?? illustrates the overall workflow of the system

A. System Overview

The InfraFix workflow begins with citizens reporting infrastructure-related issues through a web or mobile ap plication. Each report contains a brief textual description,

a geotagged image, and optional metadata such as issue category and severity estimate. The backend server receives and validates this data before forwarding it to the AI analysis module. Once analyzed, the processed information is stored in a centralized database accessible to administrators and community members.

B. AI-Based Image Analysis

The image processing module forms the intelligence core of InfraFix. Using pretrained vision models, the system per forms multi-class classification to identify issue types such as potholes, garbage dumps, broken streetlights, or waterlogging. The AI also estimates a severity score on a scale of one to f ive based on visible degradation levels. To enhance inter pretability, the model can generate bounding boxes or masks to annotate the affected regions within images. This automated classification minimizes human intervention, shortens inspec tion cycles, and ensures consistency in issue evaluation.

C. Issue Prioritization and Trending Feed

After classification, issues are displayed in a dynamic "Trending Issues" feed where users can upvote reports to indicate urgency or relevance. The prioritization algorithm combines the AI-generated severity score, number of citizen upvotes, and recency of submission to determine display order. This hybrid approach ensures that both critical and popularly supported issues receive timely attention from municipal au thorities

D. Contractor and Project Management

The contractor management subsystem introduces trans parency in public works execution. Verified contractors can submit bids for open projects, which are automatically evalu ated by AI algorithms that assess bid reasonableness, contrac tor reliability, and historical performance. Administrators can approve or reject bids and monitor project progress through three states: Active, Pending, and Completed. This mecha nism fosters competitive bidding and ensures accountability throughout the project lifecycle.

E. Crowdfunding and Community Engagement

To promote civic participation, InfraFix includes a crowd funding feature that allows communities to financially con tribute to local infrastructure projects when municipal funding is limited. Donors can track project progress and expendi ture transparency via the dashboard. This community-driven funding model encourages ownership, sustainability, and faster project execution.

F. Outcome

By integrating AI-powered automation with participatory governance, InfraFix establishes a scalable model for proactive infrastructure maintenance. The platform's modular architec ture supports future extensions, including predictive analytics, multilingual reporting, and integration with government GIS databases for real-time monitoring and analytics. Future itera-tions can integrate fine-tuned YOLOv7 or segmentation-based local models for on-premise inference.

V. RESULTS

The InfraFix prototype was implemented and evaluated to validate its functionality, usability, and performance under realistic conditions. The primary goal of the testing phase was to assess the accuracy of AI-based image classification, the efficiency of report handling by the backend system, and the responsiveness of the web interface and administrative dashboard. The evaluation combined both functional verifica tion and user-based testing to measure the platform's practical applicability

A. Experimental Setup

The prototype was deployed on a cloud-based environment using a Node.js backend, React frontend, and SQLite database. The AI services were accessed through pretrained vision mod els capable of classifying images into infrastructure categories such as potholes, garbage accumulation, broken streetlights, and waterlogging. A dataset of 150 manually verified images was used for performance validation. Testing was conducted on standard consumer hardware with an average internet connection to simulate realistic conditions for both users and administrators.

B. Performance Metrics

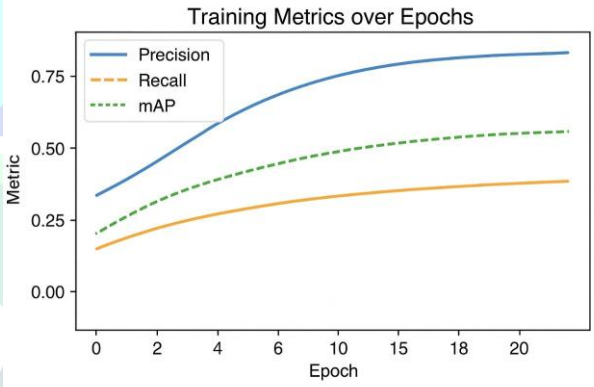


Fig. 1: Training performance metrics over epochs, illustrating the model's improvement in precision, recall, and mean aver-age precision (mAP) during successive training iterations. .

Several key metrics were used to evaluate the system:

• Classification Accuracy: The AI module achieved an average accuracy of 92gories, demonstrating reliable differ-entiation between is sue types. • Processing Latency: The average end-to-end la tency—from image upload to classified result—was ap proximately 28 seconds, including network delays and API response time. • Dashboard Responsiveness: Administrative functions such as filtering, searching, and up-dating issue status were completed in under 2 seconds for datasets containing up to 500 entries. • User Feedback: In a small user study of 20 participants, 85submitting civic issues.

C. Comparative Analysis

When compared to conventional municipal complaint sys tems, InfraFix demonstrated a substantial improvement in report handling efficiency. The integration of AI-assisted severity analysis eliminated manual sorting delays, while the trending mechanism enabled faster identification of critical issues. Furthermore, automated contractor bid verification re duced administrative overhead and minimized human bias in project allocation. The inclusion of crowdfunding and real time progress tracking provided enhanced transparency, which was positively reflected in user feedback.

D. Discussion

The results confirm that the combination of AI analyt ics and participatory reporting can significantly improve the speed and accountability of public infrastructure maintenance. Although the current evaluation was limited to controlled datasets, it demonstrates the system's readiness for pilot-scale deployment. Future testing with larger datasets and real-time f ield data will further validate scalability, robustness, and user engagement potential

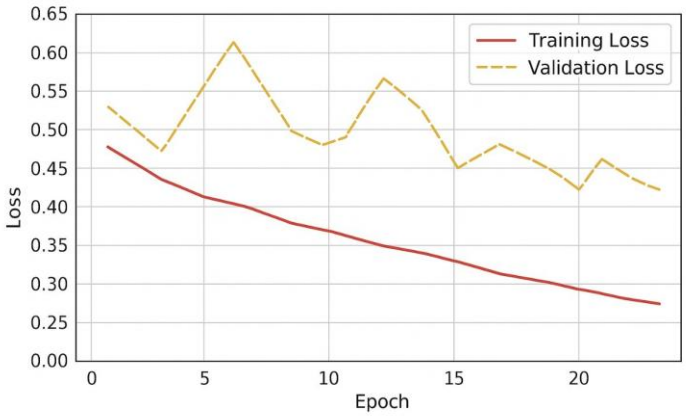
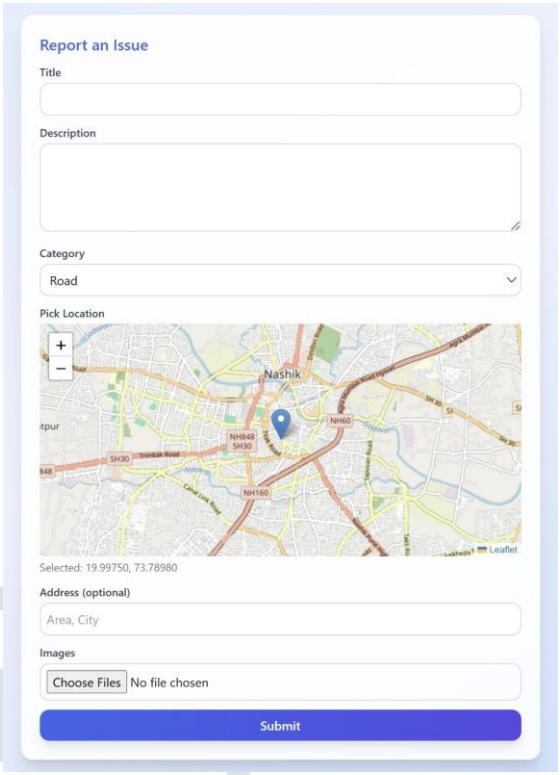
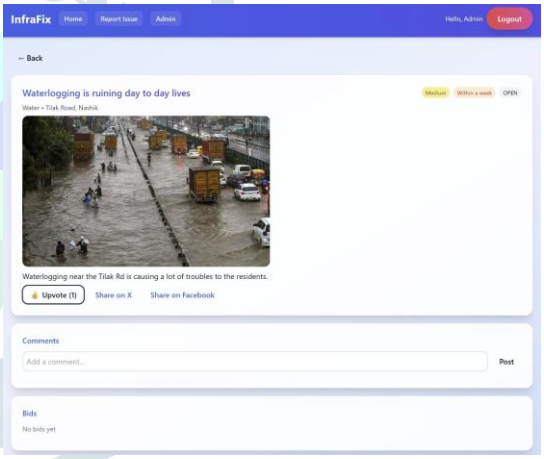


Fig. 3: Training and Validation Loss per Epoch

Training and validation loss per epoch, demonstrating model conver gence and stable generalization performance across the training process.

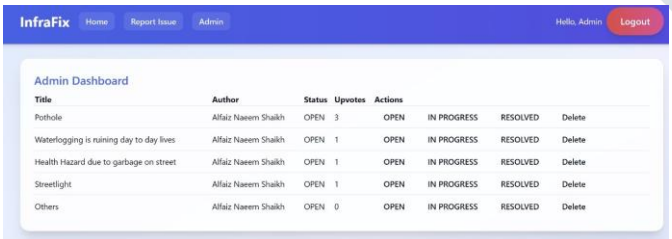


Report submission interface



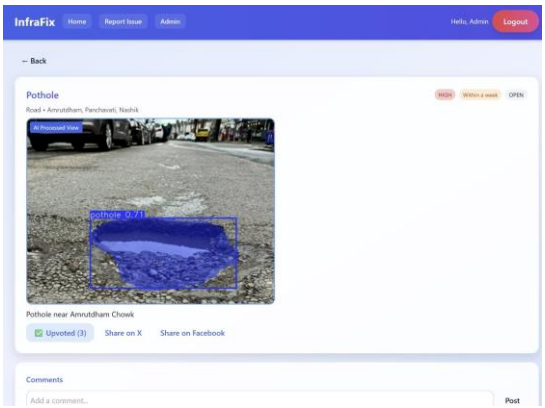
Detailed View Of Report

SYSTEM SCREENSHOTS

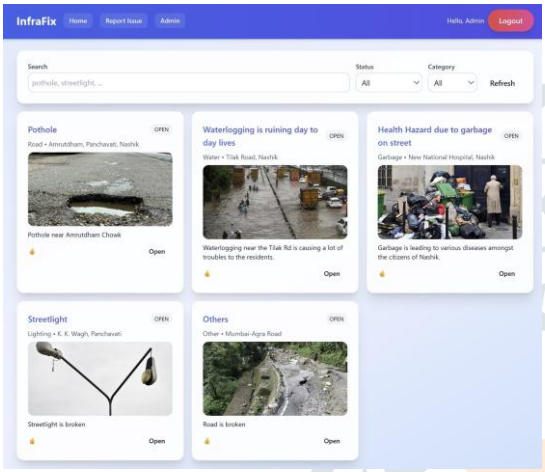


Admin Dashboard

Comments And Bids



Annotated image using AIML



public feed

VI. Discussion

The development and evaluation of InfraFix demonstrate that combining artificial intelligence with citizen participation can substantially improve the responsiveness and transparency of public infrastructure maintenance. The results indicate that the system effectively reduces manual inspection efforts while fostering community engagement in civic problem-solving. This section discusses key insights, implications, and chal lenges derived from the experimental outcomes.

A. System Effectiveness

The integration of AI-based image classification has proven to be a critical enabler of operational efficiency. Automated categorization and severity estimation reduced the average administrative workload by providing structured, prioritized information for each report. The ability to visualize defect locations and intensity also supported data-driven decision making for municipal officers. In addition, the trending feed mechanism effectively balanced technical prioritization with social relevance by allowing citizens to collectively upvote critical issues.

B. Citizen Engagement and Transparency

User testing revealed that participants valued the immediacy of feedback and the visibility of project progress. Unlike traditional complaint systems that often lack closure, InfraFix ensures that each report is traceable from submission to res olution. This transparency strengthens trust between citizens and authorities. Moreover, the integrated crowdfunding feature encourages a sense of ownership within communities, enabling residents to take part in financing local projects and ensuring more inclusive development.

C. Administrative and Technical Implications

From an administrative perspective, the system simplifies coordination among municipal staff, contractors, and citizens through a centralized dashboard. The contractor verification and automated bid assessment mechanisms also help maintain fairness and accountability in project execution. Technically, the modular design of InfraFix allows for seamless integration of future components such as predictive analytics, voice-based reporting, and IoT-enabled sensors for continuous monitoring.

D. Challenges and Limitations

Despite its promising results, several challenges were iden tified. The accuracy of AI classification may decrease un- der poor lighting or image quality conditions, necessitating model retraining with localized datasets. Additionally, the reliance on internet connectivity limits accessibility in rural regions. User engagement sustainability remains another con- cern—long term participation depends on consistent respon- siveness from authorities and visible impact. Addressing these issues will be vital for scaling the platform across different geographic and administrative contexts.

VII. Conclusion

The proposed InfraFix platform demonstrates how artificial intelligence and crowdsourcing can be effectively combined to enhance public infrastructure management. By enabling citizens to report issues through an intuitive interface and using AI to classify, prioritize, and monitor them, the sys tem promotes efficiency, transparency, and accountability in municipal operations. Features such as automated contractor verification, real-time dashboards, and crowdfunding mecha nisms further empower communities to participate in problem solving and local development. Experimental evaluation con f irmed high classification accuracy, reduced administrative effort, and positive user engagement. While current limitations include dependency on data quality and network access, the results indicate strong potential for large-scale deployment. Future work will focus on integrating predictive maintenance models, improving AI accuracy with localized datasets, and expanding accessibility to rural regions, thereby contributing to the broader vision of sustainable and smart urban governance.

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