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Crowdsourced Civic Issue Reporting and Resolution System

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Abstract: *Urban municipalities across rapidly growing cities face persistent difficulties in managing civic infrastructure complaints. Conventional grievance channels — telephone helplines, physical offices, and paper-based registers — are characterised by opacity, delayed response cycles, and an absence of citizen feedback, causing defects such as potholes, waterlogging, broken streetlights, and uncollected waste to remain unresolved for extended periods. This paper presents CivicFix, a crowdsourced civic issue reporting and resolution system developed under Smart India Hackathon 2025 (Problem Statement SIH25031) for the Government of Jharkhand. The platform empowers citizens to submit geo-tagged, media-rich complaints through a Progressive Web Application (PWA) supporting voice input in multiple regional languages. A Convolutional Neural Network (CNN) engine auto-categorises reports, which are routed through a four-tier administrative hierarchy enforced by a Service Level Agreement (SLA) escalation engine. Real-time notifications are delivered via Socket.io, and every administrative action is immutably logged on a blockchain audit trail. Pilot evaluation demonstrates a 66.7 percent reduction in average resolution time, a 2.3-fold increase in complaint submissions, and a mean citizen satisfaction score of 4.1 out of 5.0, confirming the system as a scalable, accountable, and citizen-centric model for digital urban governance.*

Keywords: Crowdsourcing, Civic Issue Reporting, Smart City, Geographic Information Systems (GIS), Progressive Web App (PWA), Urban Governance, Blockchain Audit Trail, AI Categorisation

I. INTRODUCTION

Rapid urbanisation has placed mounting strain on civic infrastructure management across the developing world. The United Nations Department of Economic and Social Affairs (2022) projects that 68 percent of the global population will reside in cities by 2050, intensifying demands on roads, drainage systems, waste management, and public lighting. Despite the scale of these challenges, municipal authorities in many emerging economies continue to rely on outdated complaint mechanisms — telephone helplines, in-person visits, and paper registers — that are inherently slow, opaque, and disconnected from citizens.

India's Smart Cities Mission (2015) catalysed the adoption of digital grievance platforms, yet operational deployments such as CPGRAMS and city-specific apps have consistently underperformed due to siloed architectures, absent real-time tracking, and low citizen retention. A 2020 study of Bengaluru's BBMP Sahaaya application found that fewer than 30 percent of submitted complaints received status updates within the promised service window [1]. These systemic gaps underscore the need for a more sophisticated, participatory approach to civic issue management.

CivicFix addresses these shortcomings by integrating crowdsourcing, artificial intelligence, geospatial analytics, and blockchain-based accountability within a unified, cloud-native platform. Developed for the Government of Jharkhand under SIH25031, the system reframes the citizen as an active co-producer of civic intelligence. This paper details the system's architecture, methodology, comparative evaluation, and projected societal impact.

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II. LITERATURE REVIEW

Existing research establishes a strong theoretical and empirical foundation for technology-mediated civic participation. Fix My Street (UK) demonstrated that hyperlocal, map-based complaint routing can dramatically reduce municipal response times [2]. SeeClickFix (USA) showed that integrating citizen-submitted data with government CRM systems produces measurable bidirectional accountability [3]. Linders (2012) proposed a three-part typology of citizen-government crowdsourcing, identifying the networked governance model — in which citizens and authorities co-produce service outcomes — as most applicable to infrastructure reporting [4].

On the technical dimension, Maas et al. (2020) reported 87 percent accuracy in automated road-defect classification from smartphone photographs using CNNs [5], directly validating CivicFix's AI categorisation module. Schweitzer (2014) found that gamified engagement features increased citizen retention on civic platforms by a factor of 3.2 [6]. Kshetri (2017) demonstrated that blockchain-based audit logs significantly improve perceived institutional trust in e-governance deployments [7], motivating the immutable ledger component of the proposed system.

Despite these contributions, the reviewed literature reveals persistent gaps: limited multilingual voice accessibility for low-literacy populations, absence of SLA-driven auto-escalation mechanisms, and insufficient integration of real-time push notifications with administrative workflows. CivicFix is designed specifically to close each of these gaps.

III. PROBLEM STATEMENT

Urban civic infrastructure defects — deteriorating roads, malfunctioning streetlights, waterlogging, broken public utilities — materially degrade the quality of life in cities. Traditional complaint systems exhibit three systemic failures: (i) opacity, as citizens receive no acknowledgment or feedback after submission; (ii) latency, as bureaucratic queues delay field response by days or weeks; and (iii) unaccountability, as responsibility for resolution is diffuse and untraceable across departments.

Municipal authorities simultaneously lack consolidated, real-time visibility into the spatial distribution and severity of reported problems, making proactive resource allocation effectively impossible. A participatory digital platform is therefore required — one that not only digitises complaint submission but also enforces a structured, time-bound, and auditable resolution pipeline accessible to citizens regardless of digital literacy or network connectivity.

IV. PROPOSED SYSTEM

CivicFix is a cloud-native, full-stack Progressive Web Application that routes citizen-submitted civic complaints through a formally specified issue lifecycle until confirmed resolution. The system is structured around four principal components:

- **Citizen Reporting Module:** Citizens authenticate via Google OAuth 2.0 and submit complaints through a GPS-tagged, media-rich form. Voice input in regional languages is supported through the Web Speech API, substantially lowering the accessibility barrier for low-literacy and rural users.
- **AI Categorisation Engine:** Uploaded photographs are processed by a CNN-based image classifier that automatically assigns a category (Pothole, Waterlogging, Waste, Streetlight, Drainage) and severity level. This reduces manual triage overhead by an estimated 40 percent while accelerating issue routing.
- **Administrative Workflow Engine:** A four-tier hierarchy — Super Admin (state level), City Admin, Ward Admin, and Field Worker — governs issue verification, field assignment, and resolution. An SLA timer triggers automatic escalation after 24 hours of administrative inactivity at any tier, ensuring no report remains indefinitely unaddressed.
- **Transparency and Accountability Layer:** Every status transition is cryptographically logged to an immutable blockchain ledger. Citizens receive simultaneous push, SMS (Twilio), and email (Nodemailer) notifications at each lifecycle stage, delivered through a Socket.io real-time event pipeline.

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V. SYSTEM ARCHITECTURE

CivicFix employs a decoupled, four-layer cloud-native architecture. The Presentation Layer consists of a Next.js 14 (React) frontend styled with Tailwind CSS and shadcn/ui components, deployed on Vercel's global CDN with offline capability via a PWA service worker. The Application Layer comprises a Node.js / Express.js RESTful API server hosted on Railway with auto-scaling, enforcing Role-Based Access Control (RBAC) through JWT tokens and managing real-time bidirectional communication via Socket.io.

The Data Layer uses MongoDB Atlas v8.0 on AWS Mumbai (ap-south-1) as the primary document store, with Mongoose providing schema validation. Redis serves as a session cache and Socket.io adapter, while Cloudinary handles media storage with on-the-fly image transformations. The Infrastructure Layer automates CI/CD through GitHub Actions, monitors application health via Sentry and Railway metrics, and enforces TLS 1.3 encryption and DPDPA 2023 compliance across all data flows.

A. Data Flow

A citizen submits a report via the PWA; the Vercel CDN delivers the UI while the API gateway receives the payload. The Issue Service validates and persists the document to MongoDB Atlas, simultaneously invoking the AI classification endpoint. The SLA engine monitors timer state; upon expiry, the Notification Service dispatches escalation alerts through Socket.io, Twilio SMS, and Nodemailer email. Each status transition writes an immutable hash entry to the blockchain ledger, which Super Admins may audit independently.

B. Issue Lifecycle State Machine

Each issue transitions through a formally defined state machine: Submitted → Verified → Assigned → In Progress → Resolved → Closed. Deviation states (Rejected, Escalated, Reopened) handle invalid reports, SLA breaches, and citizen disputes respectively. Citizens receive push, SMS, and email notifications at every transition. If a Ward Admin fails to acknowledge a report within 24 hours, the system auto-escalates to City Admin; a further 48-hour breach escalates to Super Admin.

VI. METHODOLOGY

The system was developed following an Agile methodology across a 16-week timeline with two-week sprints. User requirements were elicited through structured interviews with eight municipal officers in Jharkhand's urban local bodies and a quantitative survey of 120 residents spanning diverse age groups, income levels, and digital literacy levels. A prototype was deployed at two ward offices for a four-week usability evaluation, with 42 participants providing structured feedback on information architecture, notification frequency, and voice-input accuracy.

GPS coordinate accuracy was verified to within a 4-metre radius under standard network conditions. The CNN image classifier was trained on 12,400 labelled urban-defect photographs and validated on a held-out set of 1,800 images, achieving 89.2 percent classification accuracy. Baseline performance metrics for the incumbent manual ward-round system were independently measured over the same four-week pilot window to enable controlled comparison.

VII. IMPLEMENTATION

The citizen-facing Report module presents a structured form in which the browser Geolocation API auto-populates GPS coordinates. Users select a defect category from a predefined taxonomy, optionally record a voice description (transcribed by the Web Speech API), upload photographic evidence, and submit. On submission, a Mongoose-validated document is written to MongoDB Atlas and the AI classification endpoint is concurrently invoked via an internal HTTP request.

Ward Admins receive an instant Socket.io push notification and access their role-scoped dashboard, which renders a Leaflet.js cluster map grouping nearby unresolved reports to prevent duplicate field deployments. Upon verification and field assignment, each status update writes a cryptographic hash to the blockchain ledger and dispatches citizen

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notifications simultaneously across push, SMS, and email channels. The PWA service worker enables offline report drafting in low-connectivity areas; data syncs automatically on reconnection.

VIII. RESULTS AND DISCUSSION

Benchmarking against the incumbent ward-round system during the four-week pilot yielded the following outcomes. Average time-to-resolution fell from 17.4 days to 5.8 days, a 66.7 percent improvement attributable to automated routing and SLA escalation. Digital submission channels produced 2.3 times the complaint volume of the prior telephone helpline, corroborating findings reported by Desouza and Bhagwatwar (2012). Administrative assignment latency decreased from a mean of 46 hours to 1.9 hours following AI auto-categorisation.

Post-pilot survey responses (n = 42) yielded a mean citizen satisfaction score of 4.1 out of 5.0; 88 percent of participants identified real-time status notifications as the most valued feature. The blockchain audit trail was accessed in 14 percent of resolved cases by Super Admins verifying resolution quality. Gamification elements (points, badges, leaderboard) produced an 18 percent week-on-week increase in voluntary upvote engagement. These results collectively validate CivicFix as a measurably effective model for participatory urban governance.

A. Advantages

- **Instant Geo-Location:** GPS auto-population eliminates manual address entry and enables spatial hotspot analysis.
- **Visual Evidence:** Photo and video attachments provide objective proof of defect severity, reducing disputes between citizens and administrators.
- **Transparent Tracking:** Real-time status updates eliminate the need for follow-up calls and build citizen trust in governance.
- **Immutable Accountability:** The blockchain audit trail prevents data manipulation and creates an independently verifiable record of administrative actions.

IX. CONCLUSION

CivicFix demonstrates that the convergence of crowdsourcing, AI-driven categorisation, SLA-governed administrative workflows, real-time notifications, and blockchain accountability can substantively transform civic complaint management. Pilot results confirm measurable improvements across all key performance indicators: resolution speed, complaint volume, administrative efficiency, and citizen satisfaction. By repositioning the citizen as an active co-producer of civic intelligence and the administrator as an accountable agent operating within a transparent, time-bound pipeline, CivicFix offers a replicable and scalable blueprint for digitising urban governance across India's diverse municipal landscape.

X. FUTURE WORK

Planned enhancements include integration of IoT sensor data for proactive, pre-complaint defect detection; an NLP sentiment model to prioritise reports expressing acute distress or safety risk; cross-departmental issue linking for problems spanning multiple municipal agencies; Augmented Reality (AR) geo-tagging for higher-precision field documentation; and a federated multi-state deployment architecture with a national analytics aggregation layer to enable evidence-based policy learning across India's urban ecosystem.

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