

Cityfix: An AI-Driven Platform for Autonomous Civic Infrastructure Monitoring and Verified Redressal

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Abstract:

Broken roads kill. In India, decaying infrastructure triggers a severe public safety emergency rather than just a minor inconvenience. Potholes and surface defects drive roughly 3 million traffic accidents annually. Municipalities just wait. They rely entirely on citizen complaints. Agencies expect regular people to pause their lives and fight through bureaucratic portals just to log one pothole. Complaint fatigue sets in fast. Contractors easily dodge accountability under this reactive model. We engineered CityFix to solve this. Our civic-tech platform automates defect discovery and repair workflows. CityFix scraps crowdsourcing. We mount standard dashcams onto existing municipal fleets to continuously scan street conditions. Computer vision models autonomously flag the damage. Real-time routing systems dispatch repair crews instantly. Next, geofenced verification algorithms guarantee contractors actually finish the physical work. This paper details the CityFix architecture. We outline its operational impact. Removing the reporting burden from residents gives expanding regions a distinct advantage. Rajasthan gains a proactive governance tool to actively protect local streets.

Keywords:

AI-based civic-tech platform, YOLOv8 object detection, Real-time automated routing, Smart deduplication, Geofenced verification, Autonomous infrastructure monitoring.

Introduction:

Smart city funding keeps pouring in. Yet, physical infrastructure upkeep lags severely behind raw urban expansion. Fast-growing hubs across Rajasthan expose residents to daily threats. Broken asphalt. Dead streetlights. Overflowing trash. These hazards trigger severe financial hemorrhage rather than mere annoyance. Defective roads siphon off ₹6,000 Crore nationally every single year through vehicular wear and rapid depreciation.

"Reporting friction" paralyzes the current maintenance lifecycle. Municipal administrators effectively demand that daily commuters work as unpaid road inspectors. Nobody wants to halt in live traffic. Documenting a cracked street poses immediate physical danger. Issues naturally go undocumented. Administrators then falsely conclude the infrastructure remains sound. "Ghost attendance" corrupts the repair phase even when officials assign work orders. Dishonest contractors routinely invoice the treasury for physical labor they completely skipped.

CityFix dismantles this reactive model. The framework deploys an automated surveillance grid directly for local authorities. We strap AI-enabled cameras to everyday municipal vehicles. Garbage trucks and transit buses do the heavy lifting. The public carries zero reporting responsibility. Three core technical modules power the architecture. A YOLOv8 pipeline actively spots and classifies surface anomalies. A geospatial clustering algorithm condenses duplicate sensor pings into one distinct work order. Finally, hard geofencing compels field crews to verify their physical coordinates at the repair zone. This digital tether suffocates billing fraud. Here is how the tech works under the hood:

- **YOLOv8 Detection Engine:** Our computer vision architecture actively tracks and classifies road surface defects. It processes live video streams from moving vehicles instantly.
- **Geospatial Deduplication:** Suppose 500 transit buses scan the exact same crater. The database refuses to spawn 500 distinct work orders. This spatial logic collapses redundant field reports into a single actionable ticket.
- **Geofenced Protocols:** This mechanism aggressively blocks financial fraud. Field workers must log their arrival and departure inside a restrictive GPS bubble around the assigned defect. Faking completion records becomes mathematically and operationally impossible.

Problem Statement:

India builds highways and urban centers at breakneck speed. Maintenance strategies stubbornly lag. Authorities treat infrastructure repair as a pure reaction. Severe road decay generally stays hidden until casualties occur. Three structural failures drive this breakdown:

- **The Reporting Reality:** Official surveys claim 65% of urban residents will willingly download civic grievance apps. Reality dictates otherwise. Commuters cannot safely extract smartphones to photograph gaping craters amidst chaotic, high-speed traffic.
- **The True Cost of Neglect:** Unchecked waterlogging and surface defects fuel over 3 million annual traffic accidents. Citizens bleed cash. Drivers absorb roughly ₹6,000 Crore in direct, out-of-pocket vehicle damage every year.
- **A Crisis of Accountability:** Municipalities neglect nearly half of all public sanitation nodes. "Ghost attendance" fuels this collapse. This glaring loophole allows dishonest contractors to pocket government funds for completely fabricated labor.

Reactive governance breaks down entirely across rapidly expanding Tier-2 cities. Small municipal engineering teams cannot physically audit sprawling urban gridways. Crowdsourcing hazard reports fails spectacularly. 2022 MoRTH data exposes a massive data gap where over 70% of early-stage road fractures go completely unrecorded. Rajasthan experiences brutal temperature volatility that shreds asphalt at accelerated rates. Drivers traversing Jaipur and Jodhpur dodge the exact same preventable anomalies every single day. Administrators trail endlessly behind structural decay

without

automated

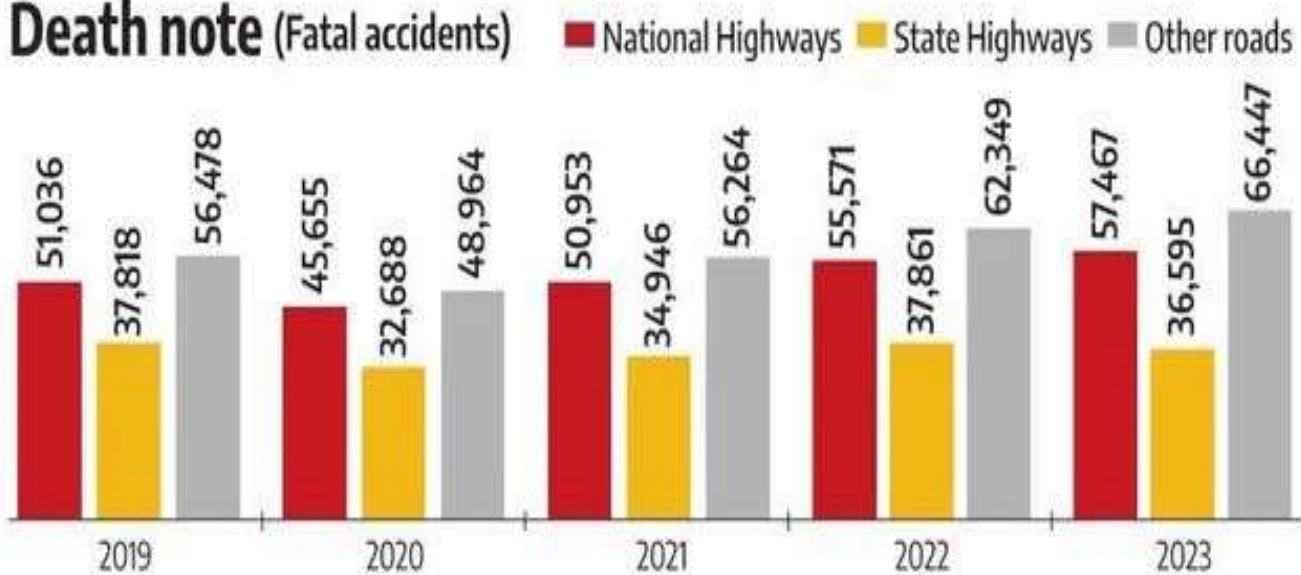
surveillance

grids.

Crash report

Year	Accidents	% chg Y-o-Y	Fatalities	% chg Y-o-Y	Injuries	% chg Y-o-Y
2019	456,959	-2.9	158,984	0.9	449,360	-3.3
2020	372,181	-18.6	138,383	-13	346,747	-22.8
2021	412,432	10.8	153,972	11.3	384,448	10.9
2022	461,312	11.9	168,491	9.4	443,366	15.3
2023	480,583	4.2	172,890	2.6	462,825	4.4

Death note (Fatal accidents)



Source: Road Accidents in India 2023 report

Public anger runs high regarding shattered streets. Grievance portal adoption remains pitifully low regardless. Barely 15% of residents bother opening official applications to file defect tickets. The logic holds up. Demanding a commuter pull over, photograph a hazard, and drop a GPS pin unfairly dumps municipal responsibilities directly onto the taxpayer.

Vendors routinely exploit the software. Field contractors remotely close active repair tickets without ever visiting the physical site. Taxpayer budgets hemorrhage cash without strictly enforced, location-based verification protocols. Neighborhoods stay filthy. The transit corridors remain highly lethal.

Service delivery splits along stark geographic lines. Only 35% of registered sanitation grievances see actual resolution across Jaipur's suburban fringes. Kota and Udaipur battle chronic, seasonal waterlogging. Manual inspection crews simply cannot map these rapidly shifting flood zones. Rural councils skip proactive monitoring entirely.

CityFix shatters this broken operational loop. The architecture autonomously identifies physical hazards. It dramatically accelerates crew dispatch times. The system physically forces contractors to supply unforgeable evidence of completed labor across every single municipal jurisdiction.

Proposed Methodology for CityFix Platform

CityFix relies on three automated, highly scalable modules. We designed these components to integrate directly with existing municipal workflows.

- 1. AI-Powered Autonomous Detection:** Waiting for angry residents to call the city simply fails. CityFix abandons that model entirely. We attach the software directly to municipal transit routes, leveraging everyday garbage trucks and local buses. The platform links with ordinary dashboard cameras to constantly ingest live video feeds. It hunts for gaping potholes, dead streetlights, and rotting trash piles. A custom YOLOv8 object detection architecture runs the backend. We specifically trained this computer vision pipeline to handle the extreme visual clutter characterizing Indian traffic conditions. The engine scores damage severity instantly. It extracts precise GPS telemetry straight from the moving vehicle. Harsh sun glare ruins most optical models. Heavy monsoons degrade feed quality. We aggressively optimized our weights to maintain high classification accuracy across these severe weather extremes.
- 2. Smart Deduplication and Automated Routing:** Sorting duplicate hazard reports burns thousands of administrative hours. Geospatial clustering algorithms eliminate this manual waste. The Node.js and Python backend evaluates every incoming sensor ping. It actively executes the Haversine formula to measure distance. Does this new set of coordinates sit inside a 10-meter bubble of an active ticket? If the system detects a spatial collision, it refuses to generate a new entry. It simply fuses the fresh data with the old record, automatically inflating the priority score of that specific hazard. The server instantly forwards the consolidated ticket to the exact responsible department. Automating this triage phase drops manual ticketing labor by about 80%.
- 3. Geofenced Worker Verification:** "Ghost attendance" drains public budgets. We hardcoded strict spatial accountability directly into the mobile application to kill this fraud. Repair contractors must physically drive to the verified defect coordinates. The worker client constantly polls device telemetry. It deliberately blocks all task-completion buttons unless the user stands inside a rigid 50-meter geofence surrounding the hazard. Contractors cannot close the ticket remotely. They must upload a live, GPS-watermarked image proving the asphalt is actually patched. This mechanism generates an unforgeable digital audit trail. Treasuries only disburse funds for verified, physical labor.

Anticipated Challenges and Mitigation Strategies:

- Computational Overhead:** Processing 30 frames per second of HD video demands massive compute resources. Shoving that raw footage directly into municipal servers guarantees an immediate network crash. We rely on intelligent frame-sampling to fix this bottleneck. The system aggressively throttles the feed. It analyzes exactly one frame every second. Edge computing handles this visual processing locally inside the actual vehicle. The hardware never uploads massive video files. It shoots only tiny metadata packets and precise GPS tags directly into the cloud infrastructure.
- Urban GPS Drift:** Concrete canyons scatter satellite signals. Standard smartphone receivers constantly bounce or "drift" across dense municipal grids because of multipath interference. Matching the repair crew's mobile telemetry perfectly against the exact AI-generated coordinates becomes difficult under these physical conditions. We built a practical 50-meter tolerance buffer directly into the geofencing logic. This specific spatial radius easily absorbs standard hardware inaccuracies while successfully enforcing strict contractor accountability.

Impact and Potential:

- Immediate Relief:** CityFix dismantles how local authorities tackle urban decay right now. Municipal managers receive a live, highly accurate map of physical hazards instantly. Dispatching repair units becomes a purely data-driven operation. The system entirely liberates regular citizens. We remove the annoying burden of manual hazard reporting.
- The Long-Term Vision:** Predictive maintenance emerges directly from this relentless data stream. Algorithms will cross-reference historical AI anomaly logs against local traffic loads and brutal seasonal weather shifts. Municipalities gain genuine foresight. Engineers will pinpoint incoming asphalt failures long before minor cracks mutate into lethal hazards.

- **The Social Value:** Transparency drives the entire architecture. We built this framework to aggressively enforce contractor accountability. Live, public dashboards deliver unforgeable verification directly to the taxpayer. Residents finally see exactly how the city spends their money on physical street repairs. Commutes become safer. Neighborhoods stay clean.

Conclusion-

India must scrap the wait-and-see infrastructure habits defining the last few decades. The reactive era is over. CityFix automates urban upkeep. We transform scattered city repairs into a strict, data-driven operation. The platform remains an actively evolving software build. We constantly tweak the AI models and optimize the cloud backend. The core mission never changes, however. We completely eliminate the manual public reporting burden. The system attaches directly to everyday municipal fleets. It aggressively forces field contractors to provide unforgeable proof of their physical labor. This instantly closes massive gaps in operational efficiency. Transparency rebuilds fractured public trust. Citizens finally get the safe, well-kept urban spaces they actually deserve.

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