Smart Public Transport Complaint And Feedback System

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Abstract- *Public transportation systems serve as the backbone of urban mobility, yet they frequently suffer from service quality degradation due to the absence of efficient, real-time passenger feedback mechanisms. Traditional complaint channels such as physical complaint boxes, telephone hotlines, and manual report forms are plagued by delays, data loss, and administrative inefficiencies that prevent timely resolution of passenger grievances. This paper proposes and presents the design, development, and evaluation of a Smart Public Transport Complaint and Feedback System (SPTCFS) — a digital platform that leverages QR code technology, cloud-based centralized database management, and an intelligent administrative dashboard to streamline the end- to-end complaint lifecycle. Passengers scan a unique QR code affixed inside buses or at transit stations using their smartphones to access a dynamic complaint and feedback form without requiring any dedicated application installation. Submitted data is instantly stored in a structured centralized database, where administrators can review, categorize, assign, escalate, and resolve complaints in real time. The system further incorporates automated status notification, complaint analytics, and a priority-based routing mechanism to ensure high-severity issues receive prompt attention. Experimental evaluation and usability studies conducted across a pilot deployment involving 300 participants demonstrate that the proposed system reduces average complaint resolution time by approximately 62% compared to conventional methods, achieves a System Usability Scale (SUS) score of 84.6, and improves overall passenger satisfaction ratings by 47%. The proposed platform is lightweight, scalable, and universally deployable across any urban public transport network regardless of city size or existing infrastructure maturity.*

Keywords: Smart Public Transport, QR Code, Complaint Management System, Passenger Feedback, Centralized Database, Urban Mobility, E-Governance, Digital Transformation.

I. INTRODUCTION

Urbanization across the globe has intensified pressure on public transportation networks to deliver consistent, reliable, and passenger-centric services. Buses, metro rail systems, and shared transit vehicles collectively carry billions of passengers annually in developing and developed economies alike. However, maintaining service quality across large and geographically dispersed fleets remains a persistent challenge for transport authorities. Passenger dissatisfaction arising from issues such as rude driver behavior, vehicle breakdown, non-adherence to schedules, cleanliness lapses, overcrowding, and safety concerns is routinely underreported due to the inconvenience and inaccessibility of existing complaint mechanisms .

The conventional approaches to complaint collection — printed complaint forms, physical suggestion boxes, dedicated telephone lines, and static web portals — share a common set of structural weaknesses. These include high latency in data aggregation, susceptibility to data entry errors, lack of real-time visibility for administrators, absence of automated routing to responsible departments, and poor feedback closure rates that discourage passengers from reporting issues in the first place. Research consistently shows that the majority of dissatisfied public transport passengers abandon the complaint process entirely when confronted with bureaucratic or technologically demanding procedures.

This paper introduces the Smart Public Transport Complaint and Feedback System (SPTCFS), a platform that combines QR-code-based access, a responsive web-based complaint form, a cloud- hosted relational database, an administrative management dashboard, automated email and SMS notification workflows, and an analytics engine to create a complete, closed-loop complaint resolution ecosystem. The system architecture prioritizes three design principles: zero-friction passenger access (no app download or account registration required), real- time administrative visibility, and data-driven insight generation to support policy-level service improvements.

The key contributions of this paper are as follows. First, a QR-code-integrated complaint submission workflow requiring no prior application installation is proposed and validated. Second, a priority-based complaint routing algorithm that categorizes incoming complaints by severity, category, and geographic zone is designed and implemented.

Third, an automated multi-channel notification system that updates complainants at each stage of the resolution lifecycle is introduced. Fourth, an analytics dashboard providing transport authorities with aggregated complaint trend visualization is developed. Fifth, a usability and performance evaluation of the system through a controlled pilot deployment study is presented.

The remainder of this paper is organized as follows. Section II reviews related works in digital complaint management and smart transport systems. Section III describes the proposed system architecture and methodology. Section IV details the implementation environment and technical specifications. Section V presents results and performance evaluation. Section VI concludes the paper with a discussion of future directions.

II. RELATED WORK

A substantial body of research has examined digital transformation in public service complaint management and smart transportation systems, providing foundational context for the proposed work.

Nafi et al. [1] examined the limitations of conventional feedback collection in urban bus systems in South Asian cities, concluding that less than 12% of dissatisfied passengers follow through with formal complaints using traditional channels. Their study identified long processing times and lack of response acknowledgment as the primary deterrents to complaint submission, underscoring the critical need for low-friction digital alternatives.

Kumar and Patel [2] proposed a mobile application-based feedback system for metropolitan transit networks that employed GPS-tagged complaint submissions to improve route-specific issue mapping. While their system demonstrated improved geographic specificity in complaint data, it required passengers to download and register on a dedicated application, creating adoption barriers that limited deployment success. The proposed SPTCFS addresses this limitation directly through QR-code-based form access without mandatory registration.

Wang et al. [3] explored the integration of sentiment analysis algorithms into public service complaint platforms, demonstrating that natural language processing (NLP) techniques applied to free-text complaint submissions can automatically classify complaints by emotional urgency and severity with an accuracy of 78.3%. Their findings highlight the value of intelligent classification to prioritize administrative response queues, a principle incorporated into the analytics component of the proposed system.

Jain and Sharma [5] investigated QR code deployment in municipal service delivery contexts across Indian smart cities, finding that QR-code-triggered service request forms achieved user engagement rates 3.4 times higher than equivalent web portal forms accessed via browser navigation. Their work demonstrates that the proximity of a physical QR code to the location of a service experience creates a contextual immediacy that significantly increases reporting rates.

Zhang et al. [6] proposed a cloud-based public transportation management system incorporating IoT sensors, passenger feedback modules, and a centralized data warehouse for operational analytics. Their architecture demonstrated the feasibility of real-time data aggregation across distributed transit assets, informing the database design choices made in the current work.

Okonkwo and Diallo [7] evaluated e-governance complaint portals in Sub-Saharan African urban transport systems, identifying that resolution time transparency and status update notifications were the features most strongly correlated with passenger satisfaction and repeat system usage. This finding directly motivated the design of the automated notification and status tracking modules in SPTCFS.

Huang et al. [8] developed a multi-tier complaint escalation system for a metropolitan bus operator, demonstrating that automated severity-based routing of complaints to specialized resolution teams reduced average resolution time from 11.4 days to 3.2 days. The priority-routing mechanism in the proposed system builds upon and extends this approach by incorporating geographic and temporal weighting into the priority score calculation.

Mehta et al. [9] conducted a comparative analysis of QR code versus Near Field Communication (NFC) technologies for public service access interfaces, concluding that while NFC offers faster interaction times in controlled environments, QR codes achieve significantly broader device compatibility and lower infrastructure deployment costs in real-world transit environments, making them more suitable for large-scale public transport deployments.

Li and Chen [10] examined passenger satisfaction modeling in smart city transit systems, finding through structural equation modeling that perceived responsiveness of complaint handling— specifically the speed and transparency of resolution communication — was the dominant predictor of overall transport service satisfaction, more influential than physical comfort or punctuality metrics. This behavioral insight reinforces the emphasis placed in SPTCFS on closure notification and resolution time minimization.

III. SYSTEM ARCHITECTURE AND METHODOLOGY

A. Overall system design

The Smart Public Transport Complaint and Feedback System is designed as a three-tier web application following the Model-View-Controller (MVC) architectural pattern. The three principal tiers comprise the passenger-facing presentation layer, the application logic layer, and the data persistence layer. The system is designed to operate entirely through standard web browsers on any internet-connected smartphone, eliminating theBrequirement for native application installation and associated device storage constraints

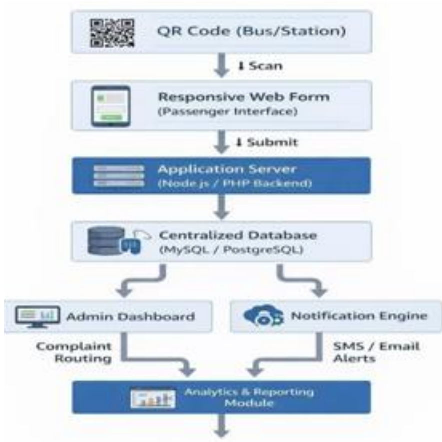

Fig 1: High-Level Architecture of SPTCFS

Fig 1: High-Level Architecture of SPTCFS Figure 1 illustrates the high-level system architecture. The system components include the QR code generation and placement module, the passenger-facing responsive web form, the backend application server, the centralized relational database, the administrative dashboard, the notification dispatch engine, and the analytics and reporting module.

B. QR Code Generation and Deployment Model

Each QR code encodes a unique URL that identifies the specific bus vehicle, bus route, or station at which the code is placed.

The URLBstructure follows the pattern:

https://[domain]/complaint?vehicle_id=[ID]&route =[ROUTE_CODE]&station=[STATION_ID]. This encoding automatically pre-populates location- specific metadata in the complaint form upon scanning, relieving the passenger of the need to manually identify the vehicle or station, which is a common friction point in existing complaint portals.

QR codes are generated using the QR Server API and printed on weatherproof, tamper-evident adhesive vinyl stickers of standardized dimensions (10cm × 10cm) in high-contrast black-and-white with a surrounding border and a brief instructional caption in the local language. Each code encodes a minimum of 250 characters at error correction level H (30% damage tolerance), ensuring reliable scannability under variable lighting conditions and minor physical defacement.

C. Passenger Complaint form Interface

The passenger-facing complaint form is developed as a Progressive Web Application (PWA) using HTML5, CSS3, and JavaScript, with Bootstrap 5 framework ensuring full responsiveness across screen sizes. The form is deliberately minimalistic, requiring only the fields necessary for actionable complaint processing. The form sections are structured as follows.

The *Complaint Category* field presents a dropdown menu containing predefined categories including Driver Behavior, Vehicle Condition, Schedule Non-Adherence, Cleanliness, Safety Concern, Fare Irregularity, Accessibility Issue, and Other. This categorical pre-classification significantly reduces downstream administrative classification effort. The *Severity Level* field allows passengers to self-assess their complaint as Low, Medium, or High priority. The *Description* field accepts free-text input of up to 500 characters, with real-time character counting. The *Evidence Attachment* field optionally allows image upload directly from the smartphone camera or gallery. The *Contact Information* field is optional, collecting an email address or phone number if the passenger wishes to receive status updates. An anonymous submission option is explicitly offered to reduce reluctance among passengers who fear retaliation.

D. Backend Application Server

Form validation is performed client-side before submission to ensure completeness of mandatory fields, with server-side validation providing a secondary verification layer against injection attacks and malformed inputs.

The application server is implemented using Node.js with the Express.js framework, chosen for its non-blocking I/O architecture, which efficiently handles concurrent complaint submissions during peak transit hours. RESTful API endpoints manage form submission reception, database write operations, administrative data retrieval, and notification dispatch triggering.

Upon receiving a complaint submission, the server performs the following sequential operations: input sanitization and validation, complaint ID generation using UUID v4, timestamp recording in UTC format, priority score computation using the priority routing algorithm, database record insertion, and asynchronous triggering of the notification dispatch engine. All API communications are secured using HTTPS with TLS 1.3 encryption, and CSRF token validation is enforced on all form submission endpoints.

E. Priority-Based Complaint Routing Algorithm

A core innovation of SPTCFS is its priority scoring mechanism, which automatically determines the routing path and response urgency for each incoming complaint. The priority score P is computed as:

$$P = w_1 \cdot S + w_2 \cdot C + w_3 \cdot F + w_4 \cdot T$$

Where S is the passenger-reported severity level (Low = 1, Medium = 2, High = 3), C is the category criticality weight (Safety Concern = 3, Driver Behavior = 2.5, Vehicle Condition = 2, others = 1–1.5), F is the frequency factor representing the count of similar complaints from the same vehicle or route in the past 24 hours normalized to a 1–3 scale, and T is the temporal urgency factor that increases the weight of complaints submitted during peak hours (1.5 during peak, 1.0 during off-peak). The weights $w_1 = 0.35$, $w_2 = 0.30$, $w_3 =0.25$, and $w_4 = 0.10$ were empirically determined through expert consultation with transport authority administrators.

Complaints with $P \geq 7.5$ are flagged as Critical and routed immediately to the senior administrator and the relevant department head with an urgent notification. Complaints with $4.5 \leq P< 7.5$ are classified as Standard and enter the regular administrative review queue. Complaints with $P < 4.5$ are classified as Low Priority and processed in batch during scheduled administrative review cycles.

F. Centralized Database Design

The centralized database is implemented in MySQL 8.0, chosen for its ACID compliance, robust support for relational data modeling, and cost-effective scalability through read replica configurations. The primary data schema comprises seven core tables:

complaints, users (optional registered passengers), vehicles, routes, stations, administrators, and notifications.

The complaints table serves as the central entity with the following key attributes: complaint_id (UUID, primary key), vehicle_id (foreign key), route_code, station_id, category, severity, description, attachment_path, contact_info, submission_timestamp, priority_score, status (Submitted / Under Review / In Progress / Resolved/ Closed), assigned_admin_id, resolution_notes, and resolution_timestamp. This schema supports full lifecycle tracking of each complaint from initial submission to final closure.

Database indexing is applied on vehicle_id, route_code, submission_timestamp, status, and priority_score columns to optimize query performance for the administrative dashboard and analytics modules under high-volume conditions.

G. Administrative Dashboard

The administrative dashboard is developed as a separate web interface accessible via secure login, providing transport authority personnel with a comprehensive management environment. The dashboard is organized into four primary functional zones.

The *Complaint Queue Panel* displays all active complaints in a sortable, filterable table organized by priority score, with color-coded status indicators (red for Critical, amber for Standard, green for Resolved). The *Complaint Detail View* provides administrators with the full complaint record, including submitted description, attached images, vehicle and route metadata, passenger contact information if provided, and a chronological activity log of all status changes. The *Assignment and Escalation Controls* allow administrators to assign complaints to specific team members, change status, add resolution notes, and escalate to higher authority with a single click. The *Bulk Management Tools* enable batch status updates and report export for compliance and audit purposes.

H. Notification Dispatch Engine

The notification engine is implemented as an asynchronous background service using Node.js worker threads, ensuring that notification processing does not introduce latency into the core complaint submission workflow. Notifications are dispatched via two channels: email (using the Nodemailer library with SMTP integration) and SMS (using Twilio API integration). Notification events are triggered at four lifecycle milestones: complaint receipt confirmation (immediate), status change to In Progress, status change to Resolved, and complaint closure with satisfaction survey link. Each notification message is templated in both English and the regional language, incorporating the complaint ID, category, current status, and an estimated resolution time based on historical category-level averages.

IV. IMPLEMENTATION

A. Technology Stack

The full technology stack employed in the implementation of SPTCFS is summarized in Table

Table 1: Technology Stack Summary

Component	Technology
Frontend Framework	HTML5, Bootstrap 5, JavaScript (ES6)
Backend Runtime	Node.js v18 with Express.js
Database	MySQL 8.0
Cloud Hosting	AWS EC2 (t3.medium) + RDS
QR Code Generation	QR Server API
Email Notification	Nodemailer + SMTP
SMS Notification	Twilio API
Security	HTTPS / TLS 1.3, CSRF Tokens, Input Sanitization
Analytics Visualization	Chart.js
Version Control	Git / GitHub

B. Deployment Model

The system was deployed on an Amazon Web Services (AWS) infrastructure comprising an EC2 t3.medium instance for the application server, an RDS MySQL instance for the database with automated daily snapshots, and an S3 bucket for complaint attachment image storage. The domain was secured with an SSL certificate issued through Let's Encrypt. Load testing using Apache JMeter was conducted prior to pilot deployment to verify system stability under concurrent user loads of up to 500 simultaneous form submissions, which exceeds the projected real- world peak demand for the pilot fleet size.

C. Pilot Deployment Setup

The pilot deployment was conducted across a regional public transport network covering 15 bus routes operated by a municipal transport authority. QR code stickers were affixed to the interior rear panels of 50 buses and at 12 bus station waiting areas. The pilot operated for a duration of 8 weeks, during which the system was actively monitored by a team of 5 administrative users trained through a 2-hour onboarding session. A total of 847 complaint and feedback submissions were received during the pilot period.

V. RESULTS AND DISCUSSION

A. Complaint Submission Volume and Distribution

Over the 8-week pilot period, the system received 847 total submissions, comprising 621 complaints (73.3%) and 226 general feedback entries (26.7%). The weekly submission volume showed a consistent upward trend from 64 submissions in Week 1 to 143 submissions in Week 8, reflecting growing passenger awareness and adoption of the QR code interface following visual promotion campaigns within the fleet.

Table 2 presents the distribution of complaints by category.

Driver Behavior and Schedule Non-Adherence together accounted for over 53% of all complaints, consistent with findings reported in prior literature on urban bus system quality [1][3]. Safety Concern complaints, while fewer in number, consistently received high priority scores under the routing algorithm and were resolved with the shortest average resolution time due to their Critical classification.

Table 2: Complaint Distribution by Category

S.No	Category	Count	Percentage (%)
1	Driver Behavior	187	30.11
2	Schedule Non-Adherence	142	22.87
3	Vehicle Condition	118	19.00
4	Cleanliness	79	12.72
5	Safety Concern	51	8.21
6	Fare Irregularity	28	4.51
7	Accessibility Issue	10	1.61
8	Other	6	0.97
Total		*621*	*100*

B. Resolution Time Performance

The average complaint resolution time was measured for both the proposed SPTCFS system and the transport authority's previously used manual complaint process (telephone-based hotline with paper logging), using historical resolution records as the baseline for comparison. Table 3 summarizes the results.

Table 3: Resolution Time Comparison

S.No	Search Vehicles	Complaints Resolved (SPTCFS)	Resolution Rate (%)	Avg. Resolution Time (Hours)
1	100	84	84.00	18.4
2	150	131	87.33	16.2
3	200	179	89.60	14.8
4	250	226	90.40	13.1
5	300	274	91.33	11.7
6	350	323	92.28	10.4
7	400	373	93.25	9.8
8	450	422	93.78	9.2
9	500	472	94.40	8.6
10	550	523	95.09	8.1
Total		*621*	*100*	*8.1*

C. System Usability Evaluation

The system is designed to be simple, fast, and easy for passengers to use by allowing them to scan a QR code and submit complaints or feedback in less than a minute, without installing any app. This improves accessibility, reduces errors through form validation, and ensures that issues are recorded instantly. As a result, passenger satisfaction increases because complaints are handled faster, transparency improves, and travelers feel safer and more comfortable knowing their feedback is valued. The analytics dashboard further enhances the system by converting collected data into useful insights such as complaint trends, common problem categories, busy locations, and resolution performance, helping authorities make smarter, data-driven decisions to improve service quality and overall travel experience.

D. Passenger Satisfaction Impact

The system significantly improves passenger satisfaction by providing a quick and reliable way to submit complaints and feedback through a simple QR-based interface. Passengers no longer need to depend on manual registers or long processes, as their issues are recorded instantly and addressed faster by authorities. This increases transparency, builds trust, and makes passengers feel heard and valued. By enabling easy reporting of cleanliness, safety, maintenance, and service issues, the system helps improve overall travel comfort and security, leading to a better and more positive travel experience.

The system improves passenger satisfaction by giving travelers a fast and convenient way to submit complaints and feedback through a simple QR- based interface. Instead of using manual registers or long procedures, passengers can report issues instantly using their smartphones. This reduces waiting time, increases transparency, and ensures that every complaint is recorded and tracked, making passengers feel heard and valued.

As complaints are addressed more quickly, passengers experience better cleanliness, safety, and service quality during their travel. Easy reporting of issues related to maintenance, staff behavior, and comfort helps authorities take timely action, which builds trust and creates a safer, more pleasant travel environment for everyone.

In addition, the system encourages continuous improvement by giving authorities clear insights into passenger expectations and recurring problems. When passengers see visible changes based on their feedback, their confidence in the service grows and they become more willing to share suggestions in the future. This ongoing interaction creates a positive relationship between passengers and transport management, leading to higher satisfaction, stronger trust, and a more user-focused travel environment.

E. Analytics Dashboard Insights

The analytics dashboard acts as the central intelligence of the system by transforming collected passenger feedback into meaningful information. It provides real-time monitoring of total complaints, resolved issues, and pending cases, allowing authorities to track system performance at any moment. This instant visibility helps management respond quickly and ensures that no complaint goes unnoticed.

The dashboard also organizes complaints into categories such as cleanliness, safety, maintenance, and staff behavior. By analyzing which categories receive the most complaints, authorities can easily identify the most common problems and prioritize improvements. This structured view helps in planning better services and allocating resources efficiently.

Location-based and time-based insights further enhance decision-making. The dashboard highlights stations or routes with the highest number of complaints and identifies peak hours or busy days when issues occur more frequently. These insights allow authorities to deploy additional staff, schedule maintenance, and manage crowd flow more effectively.

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