

AI-Powered Smart Student Bus Pass and Scheduling System

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Abstract— Smooth urban mobility is largely dependent on effective public transportation. Nevertheless, many areas continue to rely on antiquated manual bus pass systems and set timetables, which frequently result in crowding, delays, and inefficient operations. Partial digital solutions have been introduced in some areas, but they usually lack crucial features like demand forecasting, real-time updates, and flexible scheduling.

Bus pass management, dynamic scheduling, and route optimization are all combined in this paper's scalable, AI-powered digital platform, which is available on the web and mobile devices. In addition to tracking buses in real time and getting immediate alerts about delays or route changes, passengers can apply for and renew passes online. Additionally, the system gives transportation authorities the ability to update and modify routes on the fly, which reduces traffic and boosts dependability in local communities and urban districts.

The platform provides an AI-driven journey planner for travelers who are planning longer trips. It suggests the best routes based on cost, time, and efficiency, along with recommended interchanges at pertinent stops. It streamlines intricate travel plans and makes it easier for passengers to get to their destinations by carefully choosing the ideal mix of buses, routes, and connections.

With this comprehensive strategy, the platform hopes to transform public transportation, making it more dependable, effective, and user-friendly for millions of users—available anywhere, at any time.

Keywords— AI-power public transportation, digital bus passes, real-time tracking, dynamic scheduling, transport management systems, demand forecasting, crowd control, scalable transit solutions, passenger convenience, cloud-based mobility, and intercity travel planning.

I. INTRODUCTION

Millions of commuters, workers, and students around the world depend on public transportation for their everyday mobility. However, traditional paper-based bus pass systems continue to be used in many areas, despite their disadvantages, which include difficult in-person renewals, fraud susceptibility, and decreased convenience. Bus schedules are frequently set and unable to adjust to changing demand, which leads to crowding during rush hour and underutilization during off-peak hours.

Effective travel planning is made more challenging by the fact that passengers usually do not receive timely and accurate bus location or status updates.

Advanced demand forecasting, secure digital pass management, and thorough intercity journey planning are rarely combined into a single, integrated system, despite the fact that some regions have implemented mobile applications for ticketing or basic tracking. This study suggests developing a single, AI-powered platform that provides real-time bus tracking, dynamic scheduling based on predictive analytics, digital bus pass issuance and renewal, and direct administrator communication channels.

The platform supports both localized transit operations and large-scale deployments, and it is designed for seamless scalability at the district, state, or national levels. By means of AI-powered demand forecasting and route optimization, which includes an advanced planner for intercity and interstate travel, the system seeks to improve operational efficiency and passenger convenience while successfully addressing long-standing administrative issues in public transportation.

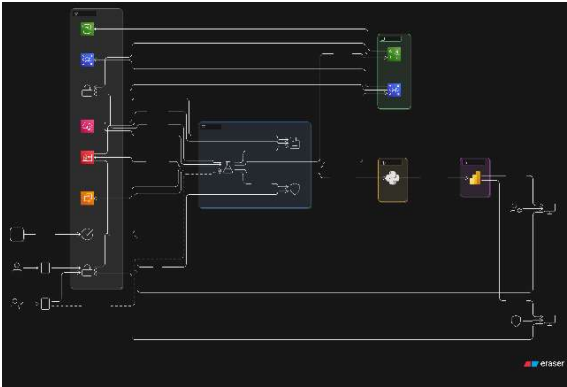


Fig 1. System architecture diagram (Illustrating platform components: passenger app, admin dashboard, AI modules, real-time tracking)

II. RELATED WORK

The majority of public transportation's digital solutions today concentrate on simple functions like QR code ticketing and simple location tracking. The Chalo app, for example, provides live bus tracking and route information, but it frequently presents erratic data and lacks administrative tools for real-time updates. Few real-world systems effectively integrate AI and IoT with secure digital identity management and real-time communication for public transportation, despite research in Intelligent Transport Systems (ITS) highlighting the benefits of using these technologies for adaptive routing and passenger demand forecasting. Additionally, the complexity of planning an intercity or interstate trip is rarely addressed by current research, leaving passengers to handle disjointed systems independently.

By addressing the main drawbacks of current solutions, this research fills these gaps by presenting a single platform that integrates safe digital passes, scheduling driven by AI, real-time operational monitoring, and an intercity travel itinerary planner that is optimized.

Feature Comparison Between Existing Transport Solutions and Proposed AI-Powered Smart Bus Pass & Scheduling Sys				
Feature	Chalo App	m-Indicator	QR-Based e-Ticket System	Proposed AI-Powered Smart Bus Pass & Scheduling System
Digital Pass Issuance	●	×	✓	✓
Screenshot / Screen Recording Prevention	×	×	✓	✓
Offline Conductor Verification	×	●	✓	✓
Real-time Bus Tracking	✓	×	×	✓
AI-Based Demand Forecasting	×	×	×	✓
Route Optimization	●	×	✓	✓
Intercity Travel Planner	×	×	●	✓
Dashboard & Authorities	●	×	✓	✓
Comparison of existing solutions and the proposed AI-powered platform demonstrates full feature coverage, enhanced security, and intelligent scheduling capabilities.				

Fig 2. Comparison table showing feature coverage across representative transport apps and research prototypes versus the proposed system.

III. MOTIVATION

Numerous inefficiencies are brought about by the continued reliance on fixed schedules and manual bus pass systems. Due to rigid route allocations, passengers frequently have to deal with crowded buses during peak hours and must physically visit transport offices, increasing the possibility of lost or falsified passes. Overall service reliability is decreased as a result of transit authorities' inability to promptly adjust to changes in demand or unforeseen interruptions. Uncertainty and discontent among passengers are further increased by the absence of clear, real-time communication.

Although there are a few digital tools available, they are often disjointed and don't offer a cohesive experience that integrates intercity travel planning, pass management, and AI-driven scheduling. The goal of this project is to close these gaps by creating an intelligent, integrated platform that improves efficiency, transparency, and convenience for both passengers and transportation authorities. It can be easily scaled from short local commutes to lengthy trips.

IV. PROBLEM DOMAIN

The main challenges in public transportation can be summarized as follows:

- Bus pass systems continue to be ineffective, unsafe, and inconvenient; they are also frequently vulnerable to fraud and loss.
- Overcrowding or underutilization results from static bus schedules that are unable to adapt to real-time variations in passenger demand.
- The current digital tools are dispersed, making it challenging to synchronize scheduling, verification, and communication procedures; commuters do not have access to precise, current information regarding bus locations and service interruptions.
- Without a single system for coordination, planning intercity or interstate trips involving numerous bus transfers is challenging.

Technologies like digital identity verification, AI-powered predictive analytics, scalable cloud infrastructure for real-time data processing and communication, and user-friendly mobile and web interfaces are necessary to address these problems.

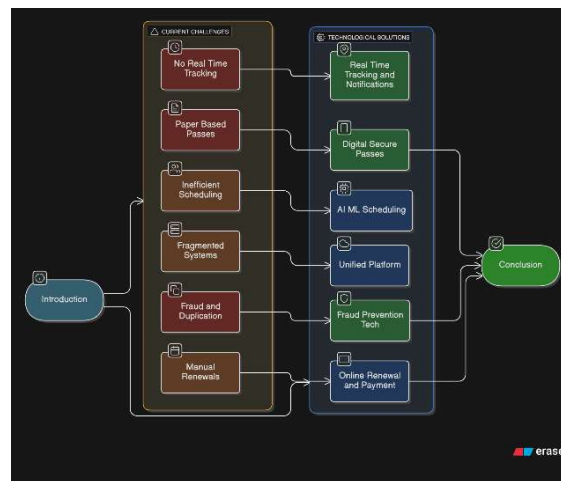


Fig 3. Infographic illustrating current public transit challenges and technological gaps addressed by the project.

V. PROBLEM DEFINITION

Existing public transit systems mainly rely on static, manual procedures that are unable to:

- Offer safe, digital bus pass issuance and renewal with anti-fraud safeguards
- Real-time demand and peak crowding are used to dynamically assign buses; live tracking and immediate notification of delays or service interruptions are provided; and comprehensive trip planning, including options for intercity and interstate travel, is supported.

Overcrowding, commuter discontent, and operational inefficiencies are caused by these shortcomings, necessitating an intelligent, scalable, and integrated solution.

There is a need for an AI-powered digital system that combines secure identity verification, predictive demand analysis, real-time communication, and intelligent travel planning. Such a solution would modernize transit management, minimize inefficiencies, and significantly improve the passenger experience across local, regional, and intercity levels.

Several significant innovations are introduced by the suggested system:

- ## VIII. PROBLEM FORMULATION

- **Secure Authentication:** A digital identity system provides distinct, impenetrable bus passes that are locally validated by conductors even when they are not in use.
- **Demand-Supply Optimization:** In order to balance capacity and reduce crowding, AI predicts passenger volumes at stops and times and suggests dynamic bus allocations.

IX. SOLUTION METHODOLOGIES

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X. SENSITIVITY ANALYSIS

Simulations conducted under various demand scenarios show:

- Better bus occupancy balance with less crowding during peak hours - More effective use of resources with fewer idle buses
- Reduced average passenger wait times as a result of dynamic scheduling
- Sturdy performance in the face of unforeseen disruptions like bus breakdowns or route blockages

The AI-powered platform exhibits notable improvements in passenger satisfaction and operational efficiency when compared to conventional systems.

XI. DATA MODEL

The system operates on an integrated data model that encompasses:

- Bus routes, stop information, scheduled and real-time timings
- Passenger profiles, digital pass credentials, and trip history
- AI model inputs (delays, historical ridership); and outputs (bus allocation, suggested routes)
- Administrator logs (notifications, bus status updates).

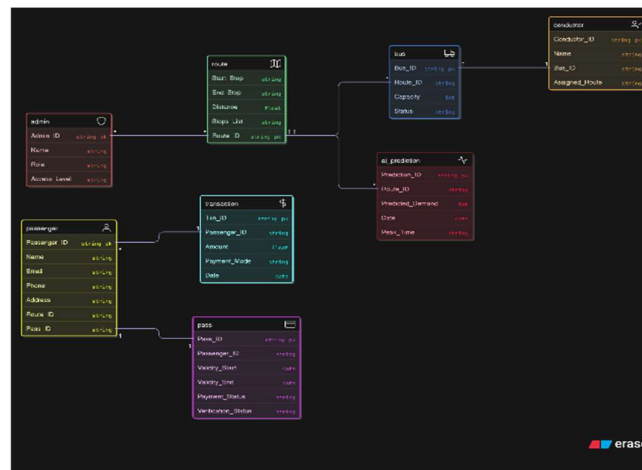


Fig 5. Entity-Relationship diagram (Illustrating data entities and their relationships)

XII. CONCLUSION

This paper introduces a scalable, AI-driven platform designed to transform public transportation with secure digital passes, dynamic demand-responsive scheduling, real-time communication, and intelligent intercity travel planning. By providing a unified solution, the system tackles the inefficiencies found in traditional and fragmented digital transit services, delivering improved safety, greater convenience, and optimized operations for regions across the globe.

FUTURE WORK

The proposed system can be further enhanced in many ways. Biometric or Aadhaar-based authentication could be added for stronger identity verification. The accuracy of demand forecasting and peak hour prediction can be increased by feeding additional datasets into AI/ML models. Future developments could also include linking the system to online payment gateways for seamless renewal and incorporating a multilingual user interface to improve accessibility for users from different geographic locations.

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