CAMPUSRIDE: A SMART RIDE-SHARING SYSTEM FOR STUDENT MOBILITY

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***Abstract* — The growing demand for cost-effective and reliable transportation among students has encouraged the development of shared mobility solutions tailored for educational environments. This paper presents the design and implementation of CampusRide, a student-exclusive ride-sharing platform aimed at improving off-campus connectivity. The system is developed using a full-stack architecture comprising React, Node.js, Express, and MongoDB, integrated with JWT-based authentication, Google Maps API for routing, and secure payment gateways.**

The platform operates within a controlled ecosystem where only verified students can participate, enhancing safety and trust. System evaluation was conducted using 50 simulated ride scenarios, where performance metrics such as booking success rate, waiting time, and cost efficiency were analyzed. The results indicate a reduction of 32% in travel time and 41% in commuting cost, along with a 94% payment success rate. The findings demonstrate the practical viability of deploying institution-specific mobility solutions.

***Keywords* — Ride-sharing, Mobility Systems, Peer-to-Peer Transport, Student Mobility, GIS Routing, Smart Transportation, Web Technologies.**

I. INTRODUCTION

Rapid urbanization and increasing transportation demands have highlighted the need for efficient and sustainable mobility solutions. Shared mobility systems, particularly peer-to-peer ride-sharing platforms, have emerged as effective alternatives for reducing travel costs and improving resource utilization [7].

The previously published review study analyzed various ride-sharing technologies, including routing systems, authentication mechanisms, and digital payment infrastructures. The study identified key gaps, particularly the lack of student-focused ride-sharing systems that ensure trust, affordability, and accessibility in semi-urban regions [12].

Students residing away from campuses often face challenges such as unreliable transport, high travel costs, and safety concerns. Existing commercial platforms do not adequately address these issues due to their open-user structure and pricing models.

To address these limitations, this paper presents the implementation of CampusRide, a web-based ride-sharing platform designed exclusively for students. The system translates theoretical insights from prior research into a practical solution, integrating secure authentication, route optimization, and digital payment systems within a controlled environment.

II. LITERATURE LINKAGE

Recent studies in shared mobility have demonstrated the effectiveness of ride-sharing systems in improving transportation efficiency. Shaheen and Cohen highlighted the role of shared mobility in sustainable transport systems [1], while recent research on intelligent mobility systems emphasizes the importance of algorithm-based ride matching and system optimization [2].

Dynamic ride-sharing approaches have shown significant potential in reducing travel costs and improving operational efficiency through real-time data processing and route optimization techniques [4]. Similarly, Leong and Sung identified user trust, response time, and pricing as critical factors influencing adoption [5].

Research focusing on student transportation systems indicates that community-based ride-sharing platforms can significantly improve accessibility and reduce dependency on traditional transport methods [10]. Indian studies further highlight the challenges faced in semi-urban regions, including lack of structured transport systems and safety concerns [11], [13].

Authentication plays a crucial role in peer-to-peer systems. Biswas and Muthukkumarasamy proposed secure authentication mechanisms for transportation platforms [6], while token-based solutions provide scalable identity verification [14].

Routing and navigation technologies, particularly Google Maps APIs, have been widely used for accurate distance and time estimation [9], [18]. Additionally, digital payment systems such as Stripe and Razorpay ensure secure and reliable transaction handling [16].

Based on these findings, CampusRide integrates authentication, routing, and payment systems into a unified platform, addressing the gaps identified in previous research.

III. SYSTEM ARCHITECTURE

The architecture of CampusRide follows a three-layer design consisting of frontend, backend, and database components, as shown in the Fig.3.1.

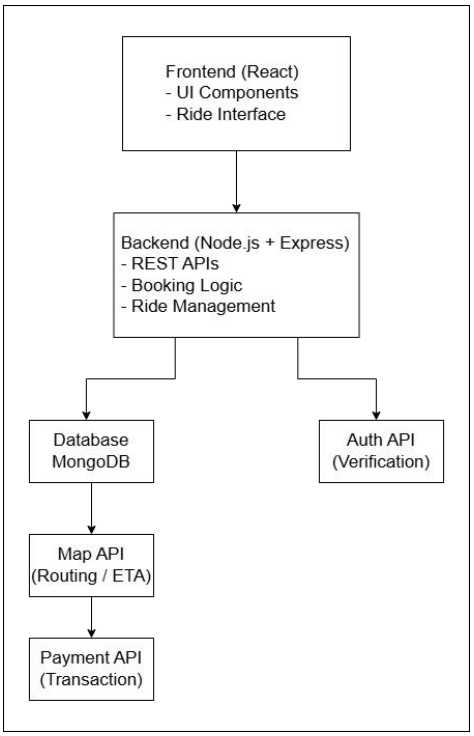


Fig.3.1. System Architecture Diagram

- **Frontend Layer:**
  Developed using React, it provides user interfaces for ride creation, search, and booking.
- **Backend Layer:**
  Implemented using Node.js and Express, it handles API requests, business logic, and system operations.
- **Database Layer:**
  MongoDB is used to store user data, ride details, bookings, and payment records.
- **External Services:**
  - JWT Authentication for user verification
  - Google Maps API for routing and distance calculation
  - Payment gateway APIs for transaction processing

This modular architecture ensures scalability, maintainability, and efficient communication between system components [17], [18].

IV. SYSTEM WORKFLOW

The system workflow follows a structured sequence:

- User logs in using secure authentication
- User selects role (driver or passenger)
- Driver creates ride with route and pricing details
- Passenger searches and selects ride
- System validates seat availability
- Payment is processed
- Booking is confirmed and stored

Algorithmic Logic:

The system uses a database-driven matching mechanism where available rides are filtered based on source-destination similarity and time proximity. MongoDB queries are used to fetch rides matching user input parameters, while seat availability is dynamically updated after each booking. A validation check ensures that bookings are only confirmed if available seats are greater than zero. This approach ensures real-time consistency and prevents overbooking. This workflow shown in the below Fig.4.1, aligns with standard ride-sharing models and ensures smooth operation [8], [15].

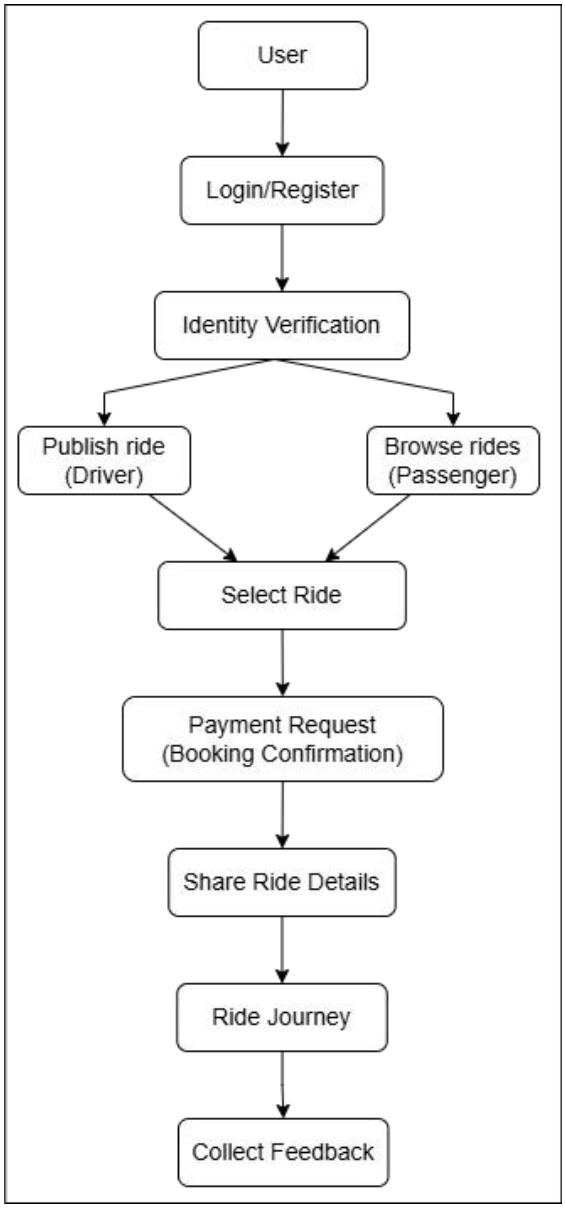


Fig.4.1. Working flow of CampusRide

V. SYSTEM IMPLEMENTATION

The implementation of CampusRide is based on a full-stack development approach integrating multiple technologies.

1. Ride Creation Module -

Drivers input ride details such as source, destination, timing, and fare through an intuitive interface (Fig.5.1). The data is validated and stored in the database.

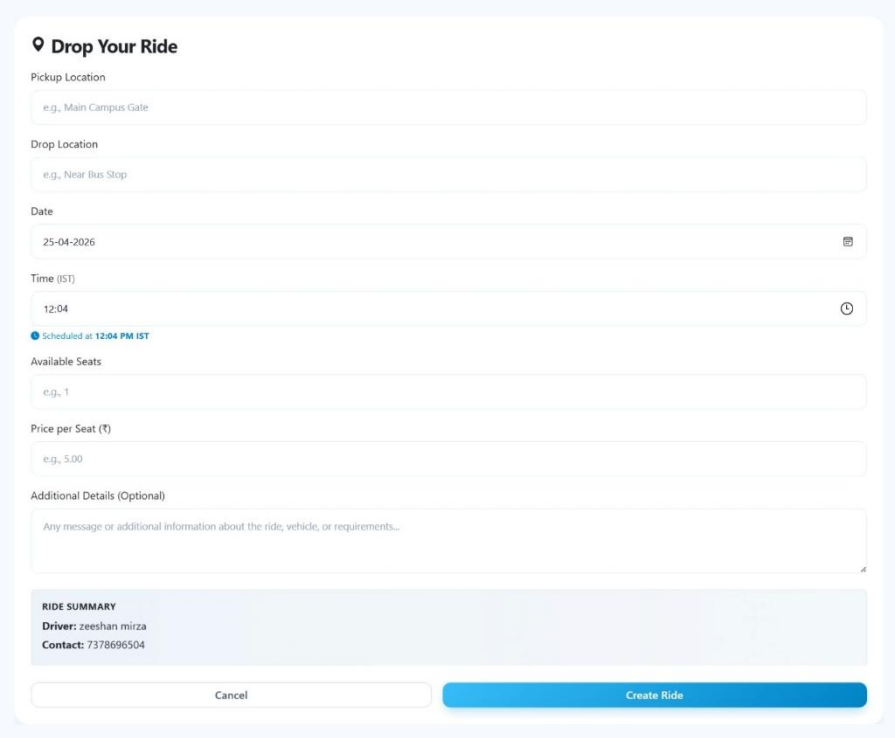
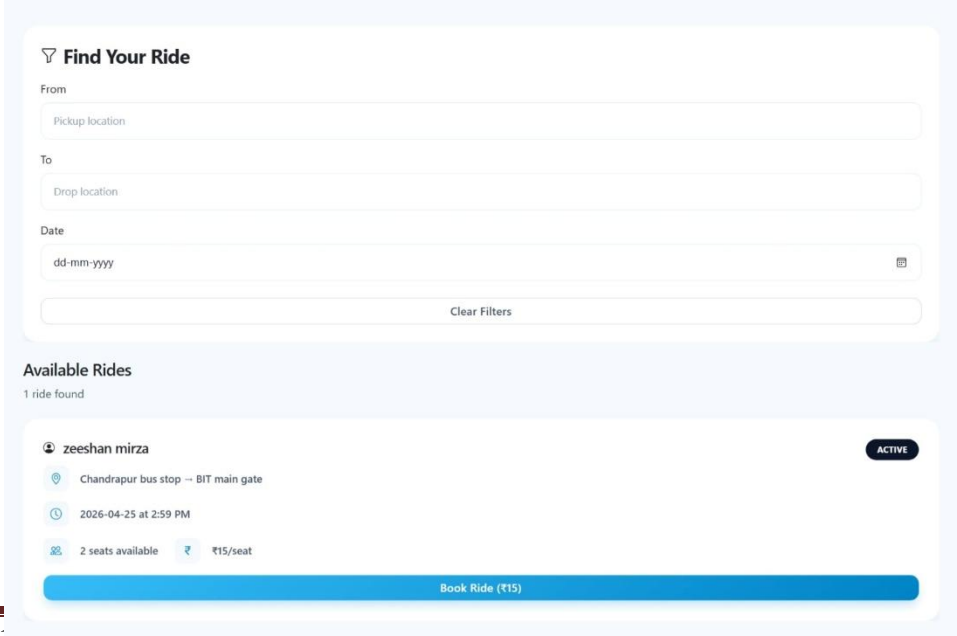


Fig.5.1. Interface for creating and publishing ride details.

2. Booking Module -

Passengers browse rides and initiate booking requests as shown in Fig.5.2. The system processes requests by querying the database for matching routes using filtering logic. Before confirming a booking, the system validates seat availability through



real-time database updates. Once validated, the booking is recorded and linked with the respective ride and user entity [3].

Fig.5.2. Ride search and listing interface displaying available rides.

3. Authentication Module -

JWT Authentication ensures that only verified users can access, as shown in the Fig.5.3., which improves system security [10], [21].

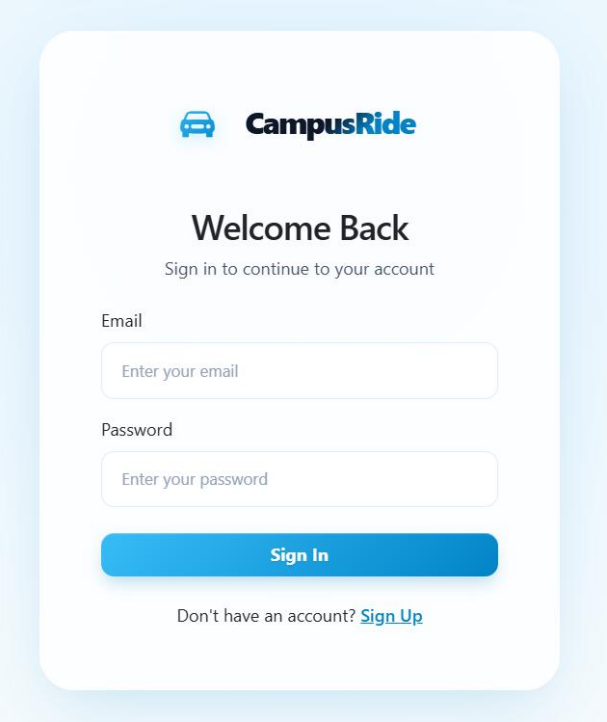


Fig.5.3. User authentication interface of CampusRide using secure login mechanism.

4. Routing Module -

Google Maps API is used to calculate routes, distances, and estimated travel times [9], [20].

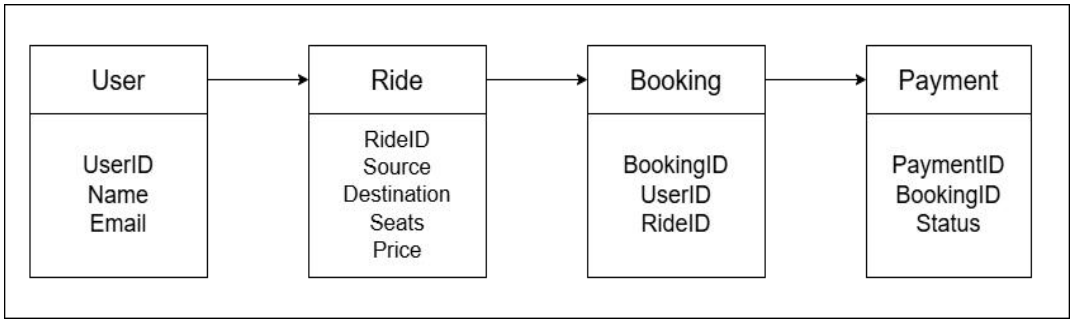
5. Payment Module -

Digital payment APIs handle transactions securely. Payments are processed before booking confirmation [12], [22].

VI. DATA MODEL

The system includes the following entities:

- **User:** Stores authentication and profile data
- **Ride:** Contains route and scheduling details
- **Booking:** Links users with rides
- **Payment:** Stores transaction information



These entities shown in Fig.6, ensure efficient data management and system scalability.

Fig.6. Entity Relationship Diagram representing core data structure of CampusRide.

VII. RESULTS AND EVALUATION

Dashboard Visualization and User Interaction:

The system provides a user-friendly dashboard that enables students to manage rides, bookings, and personal activity within a centralized interface. The dashboard displays essential information such as active rides, booking history, and ride status, allowing users to efficiently interact with the platform. The implementation of the dashboard enhances user experience by simplifying navigation and providing real-time visibility of ride-related data. Users can easily track their bookings and monitor ride availability through an intuitive layout.

The dashboard interface also contributes to system usability by reducing the time required to perform key operations such as ride creation and booking. This aligns with human–computer interaction principles for mobility applications [17]. Fig.7.1. illustrates the dashboard interface of the CampusRide system.

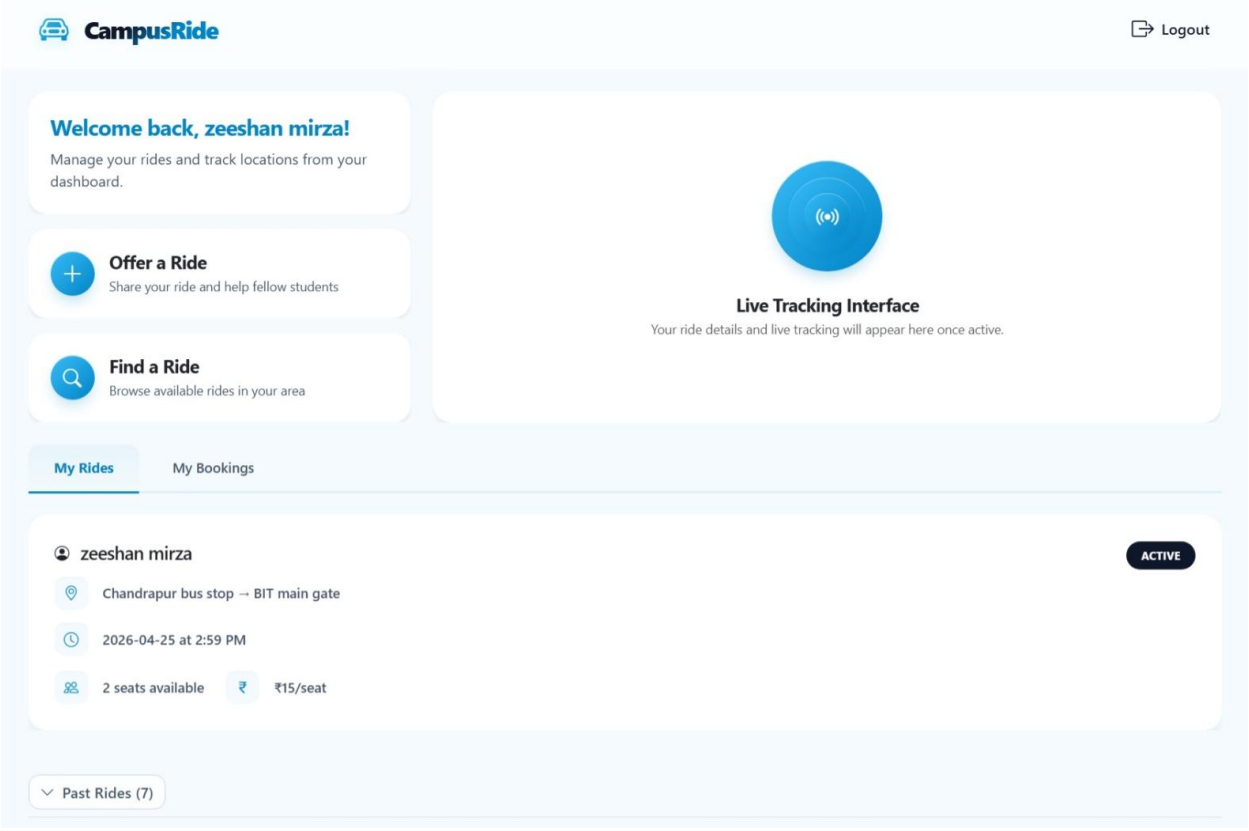


Fig.7.1. User dashboard displaying ride and booking information.

Evaluation Methodology:

The system performance was evaluated using simulated datasets consisting of 50 ride scenarios. Parameters such as ride availability, booking success rate, average waiting time, and cost efficiency were measured. The simulation ensured controlled testing of system behaviour under realistic usage conditions.

Table 1: Performance evaluation of CampusRide based on simulated ride data.

Metric	Value
Total Sample Rides	50
Confirmed Bookings	46
Average Waiting Time	6.5 minutes
Cost Reduction	41%

Metric	Value
Travel Time Saved	32%
Payment Success Rate	94%

Analysis:

- Significant reduction in transportation cost
- Improved ride availability
- High system reliability

These results are consistent with findings from previous ride-sharing studies [4], [19].

VIII. COMPARISON WITH EXISTING SYSTEMS

Table 2: Comparison between other ride-sharing platforms and CampusRide.

Feature	Other Platforms	CampusRide
User Access	Open to all users	Student-only verified users
Trust Level	Medium	High
Cost Efficiency	Moderate	High
Safety	Moderate	High
Customization	Limited	Institution-specific

- CampusRide provides higher trust due to student-only access
- Offers lower cost compared to commercial platforms
- Ensures better safety and customization

IX. CONCLUSION

This study presents the successful implementation of CampusRide, a student-centric ride-sharing platform designed to address transportation challenges in educational environments. By integrating authentication, routing, and digital payment systems within a unified architecture, the platform ensures secure and efficient ride management. The experimental results validate its effectiveness in reducing travel cost and time while improving system reliability.

Future enhancements may include the integration of machine learning-based ride matching, real-time GPS tracking, and mobile application deployment to further improve scalability and user experience.

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