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A Scalable Web-Based Carpooling System for Driver–Passenger Matching Using Dynamic Ride Sharing Architecture

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ABSTRACT

The rapid increase in urban population and vehicle ownership has led to severe traffic congestion, environmental pollution, and inefficient utilization of transportation resources. Traditional commuting methods often result in underutilized vehicle capacity, where most cars operate with a single occupant. Carpooling has emerged as an effective solution to address these challenges by enabling multiple users to share rides, thereby reducing traffic density and fuel consumption.This research presents a scalable web-based carpooling application designed to facilitate efficient ride sharing between drivers and passengers. The proposed system leverages modern web technologies and database-driven architecture to provide a seamless platform for trip creation, search, booking, and management. The application is developed using the Django framework, which ensures robust backend functionality and secure user authentication.The system introduces two primary user roles: car owners (drivers) and passengers. Drivers can create trips by specifying source and destination locations, available seats, pricing, and departure time. Passengers can search for available trips based on their travel requirements and book seats accordingly. The system dynamically updates seat availability and maintains booking records to ensure data consistency.A key feature of the proposed system is real-time trip tracking, which enhances user experience and safety. The system also includes a reporting mechanism that allows users to report issues related to trips or drivers, thereby promoting accountability and trust within the platform. Additionally, an administrative dashboard provides oversight of user activities, trip statistics, and reported issues.The application incorporates relational database models to manage entities such as users, profiles, locations, trips, bookings, and reports. Efficient querying techniques are used to optimize search functionality and ensure fast response times. The system also implements role-based access control to restrict functionalities based on user type.Experimental evaluation demonstrates that the proposed system effectively reduces ride redundancy and improves transportation efficiency. The platform is scalable and can be extended to support advanced features such as route optimization, dynamic pricing, and integration

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with GPS services.In conclusion, the proposed carpooling application provides a practical and efficient solution for modern urban transportation challenges. It promotes sustainable mobility, reduces environmental impact, and enhances user convenience through intelligent ride-sharing mechanisms.

Keywords: Carpooling System, Ride Sharing, Web Application, Django Framework, Transportation Optimization, Smart Mobility, Booking System, Real-Time Tracking, Urban Transport, Shared Mobility

I. INTRODUCTION

Urban transportation systems are facing increasing challenges due to rapid population growth, rising vehicle ownership, and inadequate infrastructure. Traffic congestion, air pollution, and high fuel consumption have become major concerns in cities worldwide. Traditional transportation methods often fail to utilize available resources efficiently, leading to significant economic and environmental costs.Carpooling, also known as ride sharing, has gained attention as a sustainable transportation solution. It involves sharing a vehicle among multiple passengers traveling in the same direction, thereby reducing the number of vehicles on the road. Carpooling not only minimizes traffic congestion but also lowers fuel consumption and carbon emissions.With the advancement of digital technologies, web-based and mobile applications have enabled the implementation of efficient carpooling systems. These platforms connect drivers and passengers, allowing them to coordinate rides conveniently. However, many existing systems face challenges such as lack of scalability, limited real-time features, and inadequate security mechanisms.This research proposes a web-based carpooling application that addresses these challenges through a robust and scalable architecture. The system is designed using the Django framework, which provides a secure and efficient backend environment. The application supports user registration, authentication, trip management, booking, and reporting functionalities.The system distinguishes between two types of users: drivers and passengers. Drivers can create and manage trips, while passengers can search and book rides. The platform ensures that seat availability is dynamically updated, preventing overbooking and ensuring efficient resource utilization.A significant contribution of this research is the integration of real-time tracking and reporting features. These functionalities enhance user safety and improve the overall reliability of the system. The administrative dashboard provides comprehensive insights into system usage, enabling effective monitoring and management.The proposed system aims to provide a scalable solution for urban transportation challenges. It promotes shared mobility and supports sustainable development goals by reducing traffic congestion and environmental impact.

II. LITERATURE SURVEY (WITH EXISTING METHODS)

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Carpooling systems have been widely studied as a solution to urban transportation challenges. Early implementations of carpooling relied on manual coordination methods, such as bulletin boards and telephone-based systems. These approaches were inefficient and lacked scalability.With the advent of the internet, web-based carpooling platforms were developed to facilitate ride sharing. These systems allowed users to post and search for rides online. However, early platforms lacked real-time capabilities and were limited in terms of user interaction and data processing.Mobile-based ride-sharing applications have significantly improved carpooling systems by providing real-time features such as GPS tracking and dynamic ride matching. Applications such as Uber Pool and BlaBlaCar have demonstrated the effectiveness of digital platforms in enabling shared mobility. These systems use advanced algorithms to match drivers and passengers based on location, time, and preferences.Research studies have explored various techniques for optimizing ride matching. Graph-based algorithms and heuristic approaches have been used to identify optimal routes and minimize travel time. Machine learning techniques have also been applied to predict user preferences and improve matching accuracy.Despite these advancements, existing systems face several challenges. Many platforms rely on centralized architectures, which can lead to scalability issues and single points of failure. Privacy and security concerns are also significant, as user data must be protected from unauthorized access.Another limitation is the lack of efficient booking management systems. Overbooking and inaccurate seat availability are common issues in poorly designed systems. Additionally, many platforms do not provide effective reporting mechanisms, reducing user trust.The proposed system addresses these challenges by implementing a scalable web-based architecture with efficient database management. It incorporates real-time tracking, dynamic booking updates, and a reporting system to enhance user experience and reliability.

III. EXISTING SYSTEM

Existing carpooling systems include both traditional and modern digital platforms. Traditional systems rely on manual coordination, which is time-consuming and inefficient. These systems lack automation and are not suitable for large-scale applications.Modern ride-sharing platforms provide improved functionality but still have limitations. Many systems rely on centralized architectures, which can lead to performance bottlenecks and reduced scalability. Additionally, some platforms do not provide transparent booking mechanisms, resulting in issues such as overbooking and inaccurate seat availability.Another major limitation is the lack of role-based access control. Many systems do not clearly distinguish between drivers and passengers, leading to security and functionality issues. Furthermore, reporting mechanisms are often inadequate, reducing user trust and accountability.Real-time tracking is also limited in many existing systems, affecting user safety and convenience. These limitations highlight the need for a more efficient and scalable carpooling system.

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IV. PROPOSED METHOD

The proposed system is a web-based carpooling application designed to provide efficient and scalable ride-sharing services. It is developed using the Django framework and follows a modular architecture.The system introduces role-based user management, distinguishing between drivers and passengers. Drivers can create trips by specifying details such as source, destination, available seats, price, and time. Passengers can search for trips and book seats based on their requirements.The system ensures dynamic seat management by updating availability in real time. This prevents overbooking and improves resource utilization. A reporting mechanism is included to allow users to report issues, enhancing trust and accountability.

An administrative dashboard provides insights into system usage, including user statistics, trip data, and reports. Real-time tracking functionality improves user safety and experience.The proposed system offers a scalable, secure, and efficient solution for carpooling, addressing the limitations of existing systems and promoting sustainable transportation.

V. IMPLEMENTATION

The implementation of the proposed carpooling system is carried out using the Django web framework, which follows the Model–View–Template (MVT) architectural pattern. This approach ensures a clean separation of concerns, enabling efficient development, scalability, and maintainability of the application.The system begins with **user authentication and registration**, where users can sign up either as car owners (drivers) or passengers. Django's built-in authentication system is used to securely manage user credentials. A custom Profile model extends the default user model to store additional information such as user type and contact details. This role-based design ensures that functionalities are restricted based on user roles.The **data modeling layer** includes several entities such as Profile, Location, Trip, Booking, and Report. The Location model stores geographical data, while the Trip model manages ride details including source, destination, seat availability, pricing, and trip status. The Booking model tracks passenger reservations, and the Report model captures user complaints or issues.

The **trip management module** allows drivers to create, update, and monitor trips. Drivers can specify route details, number of seats, and departure time. The system dynamically updates trip status, such as upcoming, ongoing, or completed, ensuring accurate tracking of rides.The **search and booking module** enables passengers to find available trips using source and destination filters. The system performs database queries to retrieve relevant results and ensures that only trips with available seats are displayed. When a passenger books a trip, the system reduces the seat count in real time, preventing

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overbooking.The **real-time tracking module** allows users to view trip status and location updates. Although simplified in the current implementation, it can be extended with GPS integration for precise tracking.The **reporting module** enhances system reliability by allowing users to report issues related to trips or drivers. These reports are stored in the database and can be reviewed by administrators.The **administrative dashboard** provides system-level insights, including user statistics, trip counts, and reported issues. This enables effective monitoring and management of the platform.Overall, the implementation demonstrates a robust and scalable system capable of handling real-world carpooling requirements.

VI. ALGORITHMS

The proposed system utilizes several algorithms to ensure efficient operation:

1. User Authentication Algorithm

- Input: Username and password
- Process:
  - Validate credentials using Django authentication
  - Assign user role (driver/passenger)
- Output: Authenticated user session

2. Trip Creation Algorithm

- Input: Trip details (source, destination, seats, price, time)
- Process:
  - Validate input data
  - Store trip in database
- Output: New trip record

3. Trip Search Algorithm

- Input: Source and destination
- Process:
  - Query database using filters
  - Retrieve trips with available seats
- Output: List of matching trips

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4. Booking Algorithm

- Input: Trip ID and passenger request
- Process:
  - Check seat availability
  - Create booking record
  - Decrement available seats
- Output: Confirmed booking

5. Reporting Algorithm

- Input: Trip ID and issue description
- Process:
  - Store report in database
- Output: Report record

6. Trip Status Update Algorithm

- Input: Trip status change request
- Process:
  - Validate status transition
  - Update database
- Output: Updated trip status

VII. SYSTEM DESIGN

The proposed system is designed using a layered architecture to ensure scalability, flexibility, and efficient data management. The architecture consists of five main layers: User Interface Layer, Application Layer, Business Logic Layer, Database Layer, and Admin Layer.

1. User Interface Layer

The user interface is developed using HTML templates integrated with Django. It provides separate dashboards for drivers and passengers. Drivers can manage trips, while passengers can search and book rides. The interface is designed for simplicity and ease of use.

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2. Application Layer

This layer handles HTTP requests and responses. Django views process user inputs, interact with models, and render templates. It ensures smooth communication between the frontend and backend.

3. Business Logic Layer

The business logic layer implements core functionalities such as trip creation, booking, seat management, and reporting. It enforces rules such as preventing overbooking and ensuring valid trip status transitions.

4. Database Layer

The system uses a relational database to store data. Key tables include:

- Users and Profiles
- Locations
- Trips
- Bookings
- Reports

Efficient indexing and query optimization techniques are used to improve performance.

5. Admin Layer

The admin panel provides control over system operations. Administrators can view user data, monitor trips, and handle reports. This layer ensures system transparency and accountability.

System Workflow

1. User registers and logs in
2. Driver creates a trip
3. Passenger searches for trips
4. Passenger books a trip
5. System updates seat availability

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6. Trip status is updated during execution
7. Users can report issues
8. Admin monitors system activity

Design Advantages

- Scalable architecture
- Efficient database management
- Real-time updates
- Role-based access control
- Enhanced user experience

The system design ensures reliability, efficiency, and adaptability for future enhancements.

SYSTEM DESIGN IMAGES

In above screen in blue colour text we can see signup completed and similarly you can add other drivers and passenger

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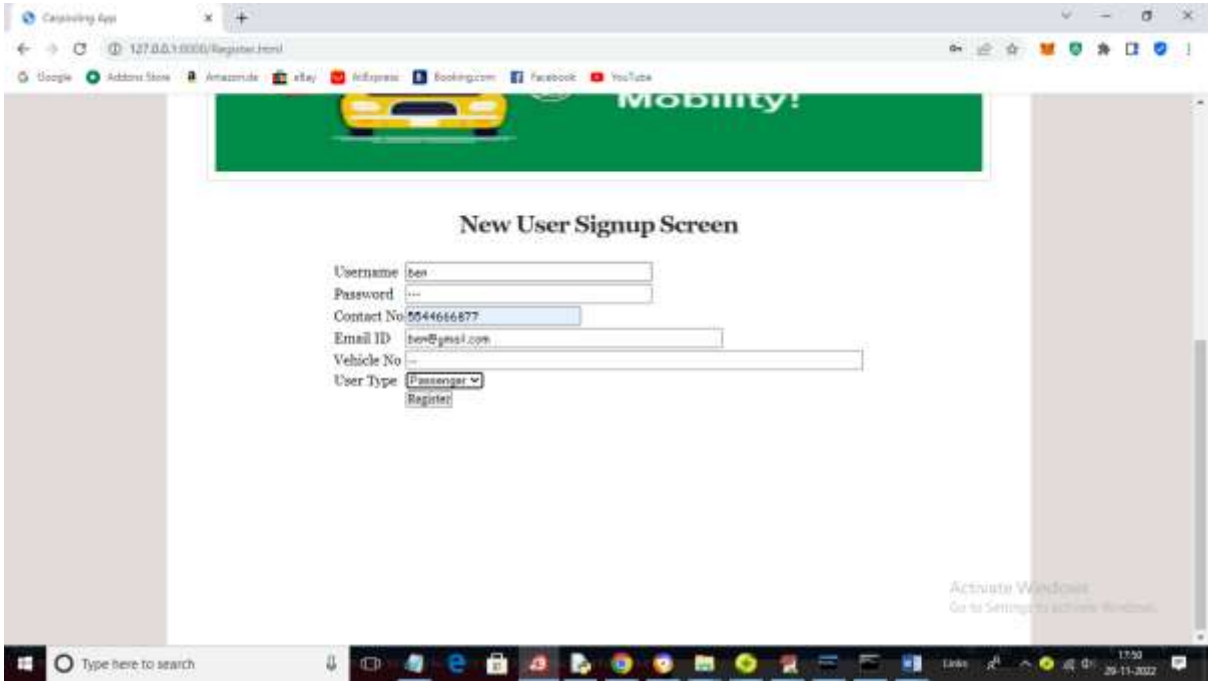

In above screen I am adding 'ben' as the passenger so total 3 user added where one is driver and other 2 are the passenger and now click on 'Driver/Passenger Login' link to login as Driver

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In above screen driver is login and after login will get below page

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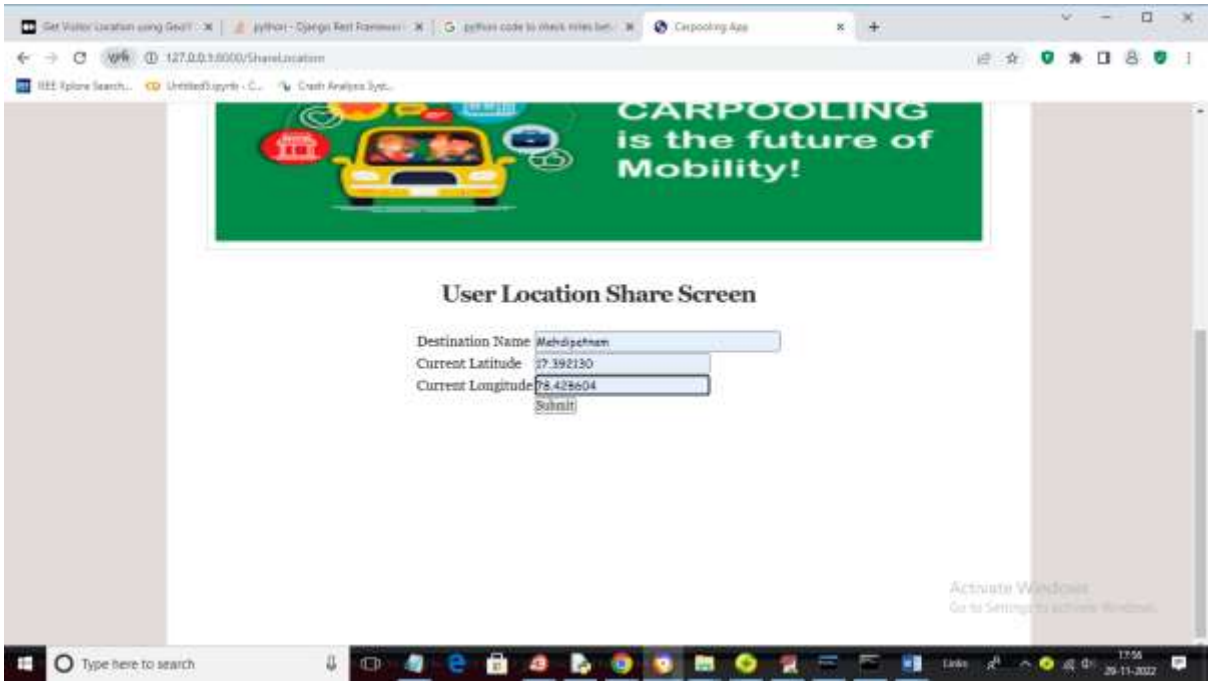
In above screen we can see driver ride details added with ID 1 and all passenger request will arrived here so let this screen running and no open other browser or tab and login as user



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In above screen user is entering his location and press button to get list of drivers in 3 miles distance and get below page

In above screen user got one drive as 'John' in 3 miles distance and user can click on 'Click Here to Share Location' then driver will get this chat notification

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In above screen driver can see 'Alice' is requesting for ride and now driver can click on 'Click Here to Accept' link to accept request and get below page

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In above screen driver got request from Ben also and he will accept request and then click on ‘Start Ride’ link to start ride and get below page

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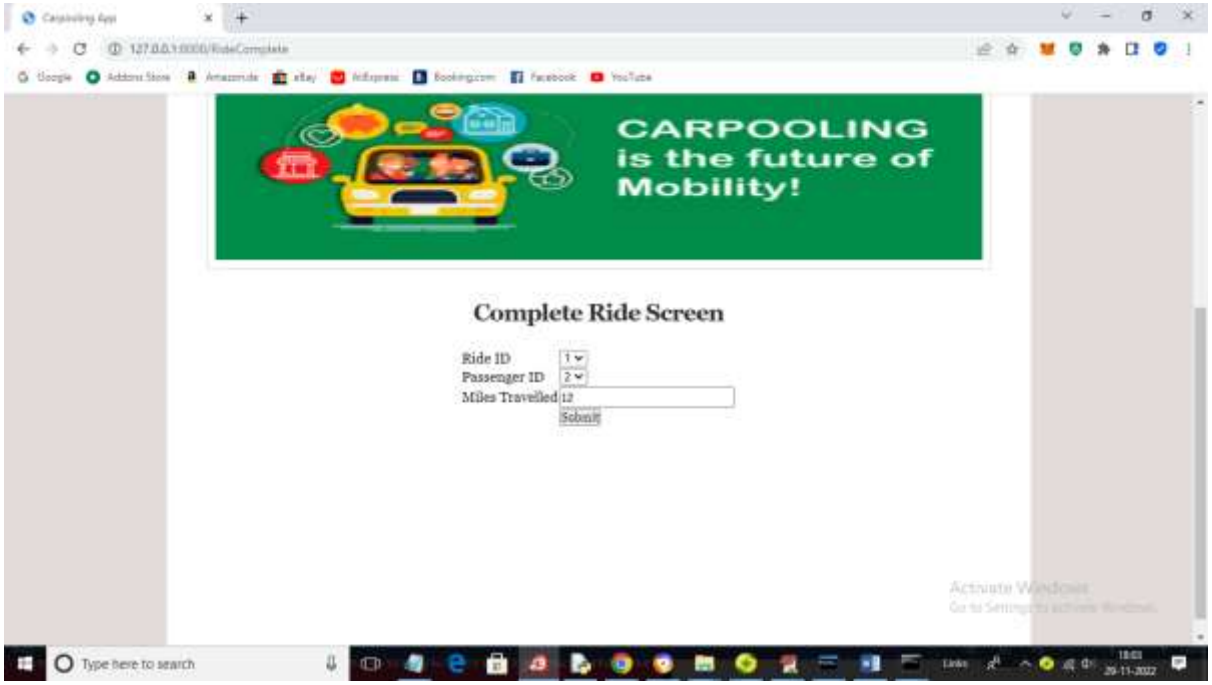

In above screen I selected Ride ID as 1 and passenger ID as 2 and then miles travelled as 12 and then press button to get below Fare amount

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in above screen in blue colour text we can see fare amount is 12 and now in user page click on 'Giving Rating' link to get below page

VIII. CONCLUSION

This research presents a web-based carpooling application designed to improve transportation efficiency and promote sustainable mobility. The proposed system addresses key challenges in urban transportation, including traffic congestion, fuel consumption, and underutilization of vehicle capacity.The system leverages modern web technologies and a robust backend framework to provide efficient ride-sharing services. By enabling drivers to offer rides and passengers to book them conveniently, the platform ensures optimal utilization of resources. The dynamic seat management feature prevents overbooking and enhances system reliability.The integration of role-based access control ensures secure and organized system operation. The reporting mechanism improves accountability and user trust, while the administrative dashboard provides valuable insights for system management.

The implementation demonstrates that the proposed system is scalable, efficient, and user-friendly. It can handle real-time operations and large datasets, making it suitable for real-world deployment. The modular architecture allows for easy integration of advanced

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features such as GPS-based tracking, route optimization, and mobile application support.Future enhancements may include the use of machine learning algorithms for ride matching, dynamic pricing models, and integration with external APIs for navigation and traffic data. Additionally, incorporating mobile platforms can further improve accessibility and user engagement.In conclusion, the proposed carpooling application provides an effective solution for modern transportation challenges. It promotes shared mobility, reduces environmental impact, and enhances user convenience, contributing to the development of smarter and more sustainable cities.

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