

Neighborhood-Based Carpooling Pick-and-Drop System for Sustainable Urban Mobility

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Abstract— Rapid urban growth, increased reliance on private vehicles, and inefficient commuting habits have placed significant stress on urban transportation networks. The widespread use of single-occupancy vehicles continues to be a major cause of traffic congestion, excessive fuel consumption, and rising environmental pollution. Although ride-hailing platforms offer alternative transportation options, most operate on profit-oriented models and often overlook key aspects such as affordability, user trust, safety, and the specific commuting needs of local residential communities. To overcome these challenges, this paper proposes a Neighborhood-Based Carpooling Pick-and-Drop System that promotes shared travel among residents within nearby geographical areas. The system is designed with features such as verified user authentication, route-based ride matching, and community-level access control to ensure safety, transparency, and trust among users. Implemented using modern web technologies including React.js, Node.js, and MongoDB, the proposed platform enables efficient planning and coordination of routine short-distance trips while maintaining scalability and ease of use. The system supports common daily travel requirements such as commuting to workplaces, educational institutions, and nearby destinations, thereby reducing dependence on private vehicles. Experimental evaluation and usage analysis show that neighborhood-based carpooling can substantially lower the number of vehicles on the road, reduce individual travel expenses, enhance fuel efficiency, and decrease carbon emissions. The findings highlight that community-driven ride-sharing models can play an important role in achieving sustainable urban mobility by offering a secure, cost-effective, and environmentally responsible alternative to conventional ride-hailing services.

Keywords— Carpooling, Shared Mobility, Sustainable Transportation, Urban Traffic, Ride-Sharing System

Urban transportation has become one of the most critical challenges faced by modern cities. Rapid population growth, expanding urbanization, and increased dependence on private vehicles have significantly contributed to traffic congestion, environmental pollution, and rising transportation costs. Daily commuting, particularly for short distances such as travelling to workplaces, educational institutions, or nearby marketplaces, often results in excessive fuel consumption and inefficient vehicle utilization. Despite the availability of public

transportation and commercial ride-hailing services, many commuters continue to prefer private vehicles due to convenience, flexibility, and time efficiency. However, this growing reliance on individual transportation methods has intensified urban mobility problems and increased carbon emissions, thereby affecting both environmental sustainability and quality of life.

In recent years, shared mobility solutions such as ride-sharing and carpooling have gained attention as potential alternatives to reduce transportation challenges. These systems allow multiple passengers travelling in similar directions to share a single vehicle, leading to improved fuel efficiency, reduced traffic volume, and lower commuting expenses. Although several commercial ride-sharing platforms are available, most of them operate on profit-oriented business models that prioritize longer trips and high-demand urban routes. As a result, short-distance and neighbourhood-level commuting needs often remain unaddressed. Additionally, many users hesitate to share rides with unknown individuals due to safety concerns, lack of trust, and absence of community-based verification mechanisms.

The increasing demand for reliable and affordable short-distance transportation highlights the need for localized carpooling solutions that emphasize user trust and convenience. Community-based transportation models have the potential to strengthen social interaction, improve travel efficiency, and promote sustainable commuting habits. By encouraging residents within the same locality to share rides, transportation resources can be utilized more effectively while reducing the number of vehicles on the road.

This research focuses on the development of a neighbourhood-based carpooling pick-and-drop system designed to support daily short-distance travel. The proposed system integrates user identity verification, location-based ride matching, and route similarity detection to ensure secure and efficient ride sharing. By addressing the limitations of existing ride-sharing platforms, the study aims to provide a practical, cost-effective, and environmentally responsible transportation solution that supports sustainable urban mobility while maintaining user safety and convenience.

1.1 Problem Statement

Urban transportation systems are increasingly affected by traffic congestion, rising fuel consumption, and environmental

pollution due to the frequent use of private vehicles for daily commuting. Although public transportation and commercial ride-hailing services are available, they often do not effectively support short-distance and routine travel. Existing ride-sharing platforms primarily operate on profit-driven models and lack localized ride matching, affordability, and user trust. Consequently, carpooling remains underutilized, and urban mobility challenges continue to grow [1], [2].

1.2 Significance

The absence of efficient and trusted shared mobility solutions contributes directly to increased traffic density, higher transportation costs, and environmental degradation. Research highlights that encouraging shared travel practices is essential for reducing vehicle dependency, lowering fuel consumption, and promoting sustainable urban mobility [3].

1.3 Proposed Solution

This study proposes a neighbourhood-based carpooling pick-and-drop system that allows users to share rides with nearby residents traveling along similar routes. By combining verified user identities with route-based ride matching, the system aims to promote safe, affordable, and sustainable shared transportation. The proposed solution focuses on short-distance daily commuting and serves as a practical alternative to conventional ride-hailing services.

2. LITERATURE REVIEW

Ride-sharing systems have been widely explored as a solution to reduce traffic congestion and improve vehicle utilization in urban areas. Dimitrijevic et al. proposed a real-time, cloud-based ride-sharing architecture using WebSockets and NoSQL databases, demonstrating the scalability and technical feasibility of large-scale ride-sharing platforms [1]. However, the study primarily focused on system performance and did not adequately address user trust, safety, or community-level adoption.

Recent research published in the International Research Journal of Engineering and Technology discussed the development of ride-sharing applications using modern web technologies such as React.js and Node.js, emphasizing system responsiveness and real-time interaction [2]. While technically effective, the approach relied on centralized control mechanisms and lacked support for localized or neighbourhood-based ride matching.

Other studies have focused on algorithmic optimization of ride-sharing systems. Research presented at ICCIDT examined stable matching algorithms and fair cost-sharing models to improve ride-sharing efficiency and user satisfaction [3]. Although these models showed promising results in simulations, they did not consider real-world deployment challenges, safety concerns, or usability in community-oriented environments.

Research Gap

The existing literature largely emphasizes scalability, centralized architectures, and algorithmic efficiency, with limited focus on trust-oriented, neighborhood-based carpooling systems. There is a lack of practical

implementations that address social familiarity, safety, and routine short-distance commuting. This research addresses this gap by proposing a localized, community-driven carpooling system designed for sustainable and trusted urban mobility.

3. METHODOLOGY (DEVELOPMENT PROCESS)

3.1. Methodology

The methodology of the Neighborhood Carpooling Pick-and-Drop Service is implemented using a simple Frontend–Backend–Database architecture, as reflected in the project source code. The system workflow focuses on user interaction, secure data processing, and efficient ride management within a neighborhood environment.

3.2 Frontend Methodology

The frontend of the system is developed using HTML5, CSS3, JavaScript, and React.js, providing a responsive and user-friendly interface for both drivers and riders (IRJET, 2023). The frontend includes pages for user registration, login, ride request, ride acceptance, and reviews, as implemented in the project. React.js is used to manage components such as forms, dashboards, and ride listings, enabling dynamic data updates without reloading pages. User inputs such as pickup location, destination, and travel time are collected from the frontend and sent to the backend through REST APIs. This approach follows common frontend design practices adopted in modern ride-sharing applications (IRJET, 2023).

3.3 Backend Methodology

The backend is implemented using Node.js and Express.js, which handle the core application logic and API processing (Dimitrijevic et al., 2013). The backend manages user authentication, ride creation, ride requests, and ride acceptance functionality exactly as defined in the project. Authentication is handled using Firebase Authentication / JWT, ensuring that only registered users can access the system. The backend processes requests received from the frontend, applies validation logic, and updates ride status such as requested, accepted, and completed. This server-side processing ensures secure and controlled system operation.

3.4 Database Methodology

The system uses MongoDB Atlas as the database for storing user details, ride information, and feedback records. Data is stored in document format, allowing flexible handling of ride and user information (IRJET, 2023). The backend interacts with the database to fetch available rides, store new ride requests, and update ride records.

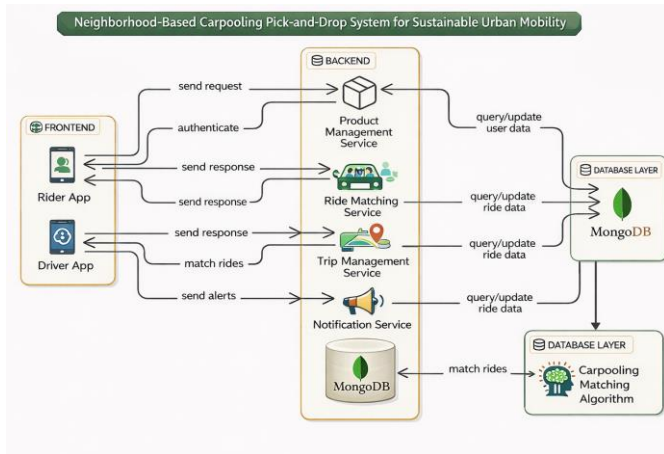


Figure 1 System Architecture

4.1 Technologies Used

The proposed neighbourhood-based carpooling pick-and-drop system is developed using a modern web technology stack to ensure scalability, reliability, and efficient system performance. The selected technologies support real-time ride management, secure user authentication, and seamless communication between system components. Table 1 presents the major technologies used at different levels of the system.

Table 1: Technology Stack for Neighbourhood-Based Carpooling System

Component	Technology Used
Frontend	React.js, HTML, CSS, JavaScript
Backend	Node.js, Express.js
Database	MongoDB
Authentication	JSON Web Token (JWT) / Firebase Authentication
API Communication	REST API
Mapping & Routing Services	Geolocation and Route-Matching APIs

4.2 User Interface (UI) & Screenshots

The neighbourhood-based carpooling pick-and-drop system is developed with a simple and interactive user interface to support smooth coordination between riders and drivers within a local community. The interface is designed to work efficiently on both desktop and mobile devices, allowing users to access the platform anytime for their daily commuting needs. The design focuses on clarity and ease of navigation so that users can perform actions quickly without technical difficulty.

Special attention is given to presenting ride information in a clear and organized manner, including pickup and drop locations, ride status, and route details. The overall interface

design aims to improve usability, reduce complexity, and encourage users to adopt shared travel practices by providing a convenient and reliable carpooling experience within neighbourhood environments.

4.2.1 User Interface Overview

The neighbourhood-based carpooling pick-and-drop system provides multiple role-based and functional interfaces to support smooth interaction between riders and drivers. The interfaces are designed according to the implemented system and corresponding screenshots included in this research paper.

- **Homepage:**

The homepage presents an overview of the carpooling platform, its purpose, and core features, along with navigation options for user login and registration, as shown in Figure 2.

- **User Registration Interface:**

The system provides separate registration interfaces for riders and drivers, allowing users to create accounts based on their selected role. The rider and driver registration pages are illustrated in Figures 3(a) and 3(b).

- **Login Interface:**

A common and secure login interface is provided for both riders and drivers to access the system using authenticated credentials, as depicted in Figures 4(a) and 4(b).

- **Ride Request Interface (Rider):**

This interface enables riders to request a ride by entering pickup and drop-off locations and viewing route details. The rider ride request process is shown in Figure 5.

- **Ride Acceptance Interface (Driver):**

Drivers can view incoming ride requests and accept rides based on route suitability and availability. This functionality is illustrated in Figure 6.

- **Review Interface:**

After ride completion, riders can submit ratings and feedback through the review interface, helping to improve service quality and trust among users, as shown in Figure 7.

- **About Interface:**

The about page provides information regarding the system objectives, features, and benefits for both riders and drivers, as illustrated in Figure 8.

- **Payment Interface:**

The payment interface allows riders to complete ride payments securely after ride confirmation. This interface is shown in Figure 9.

• Database Management Interface:

The system stores and manages rider and driver data using MongoDB and MongoDB Atlas cloud services. Database storage and management are illustrated in Figures 10 and 11.

4.2.2 UI Screenshots

The following figures illustrate the key user interface screens of the Neighborhood-Based Carpooling Pick-and-Drop System for Sustainable Urban Mobility, highlighting the main functional components of the application.

Table 2: Description of System Interface Screens and Database Components

Figure No.	Description
Figure 2	Homepage displaying an overview of the platform, key features, and login/register options.
Figure 3 a	User registration page for creating a new account on the platform for Rider.
Figure 3 b	User registration page for creating a new account on the platform for Driver.
Figure 4 a	Common login page allowing registered users to securely access the system for Rider.
Figure 4 b	Common login page allowing registered users to securely access the system for Driver.
Figure 5	Interactive map interface displaying accessibility information for locations and routes. For book the ride from rider.
Figure 6	Interactive map interface displaying accessibility information for locations and routes. For accept the ride form Driver.
Figure 7	Rider review page displaying rating and feedback options for passengers after ride completion.
Figure 8	About page describing the objectives, functionality, and benefits of the ride-sharing system for passengers and drivers.
Figure 9	Payment page enabling riders to securely complete ride payments using multiple payment methods.
Figure 10	MongoDB database used to store and manage rider and driver information securely.
Figure 11	MongoDB Atlas cloud database used to securely store rider and driver data online.

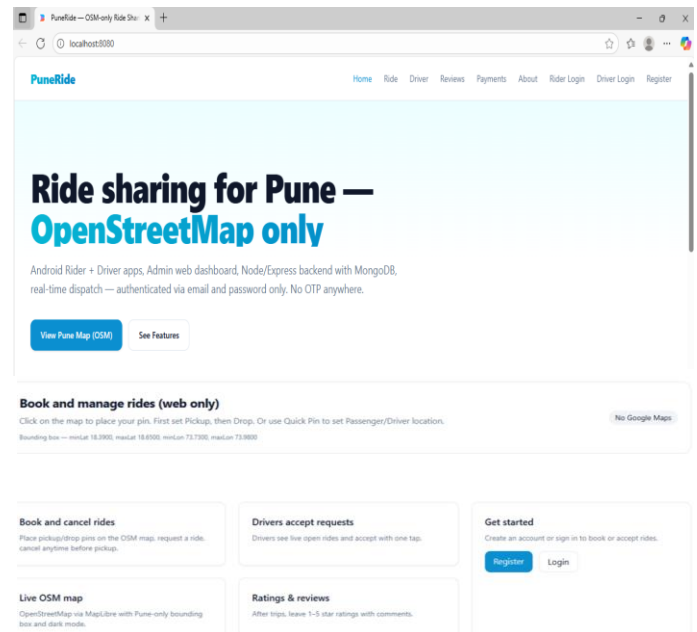


Figure 2

Create your account

Choose your role and start using PuneRide.

Rider
 Driver

tanjila tamboli

tanjilatamboli@gmail.com

.....

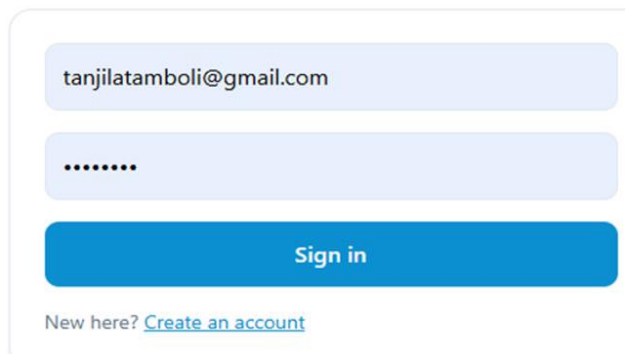
Create account

Already have an account? [Sign in](#)

Figure 3 a

Welcome back

Sign in to book rides or go online as a driver.

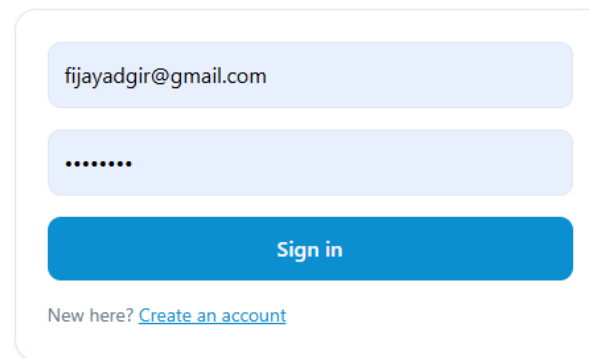


A sign-in form with a light blue background. It features a text input field containing the email address 'tanjilatamboli@gmail.com', a password input field with seven dots, and a blue 'Sign in' button. Below the button is a link that says 'New here? [Create an account](#)'.

Figure 3 b

Welcome back

Sign in to book rides or go online as a driver.

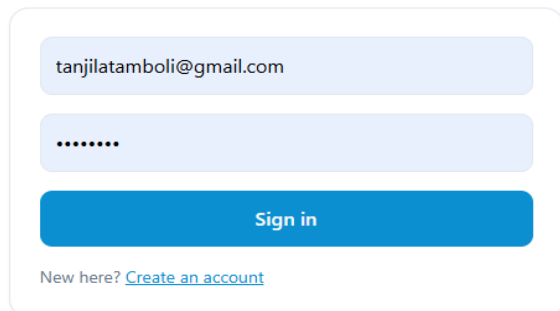


A sign-in form with a light blue background. It features a text input field containing the email address 'fijayadgir@gmail.com', a password input field with seven dots, and a blue 'Sign in' button. Below the button is a link that says 'New here? [Create an account](#)'.

Figure 4 b

Welcome back

Sign in to book rides or go online as a driver.



A sign-in form with a light blue background. It features a text input field containing the email address 'tanjilatamboli@gmail.com', a password input field with seven dots, and a blue 'Sign in' button. Below the button is a link that says 'New here? [Create an account](#)'.

Figure 4 a

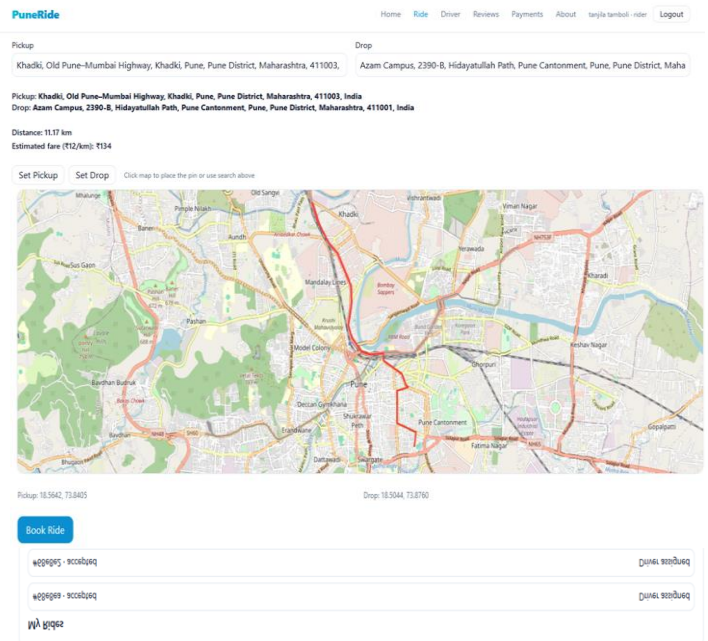


Figure 5

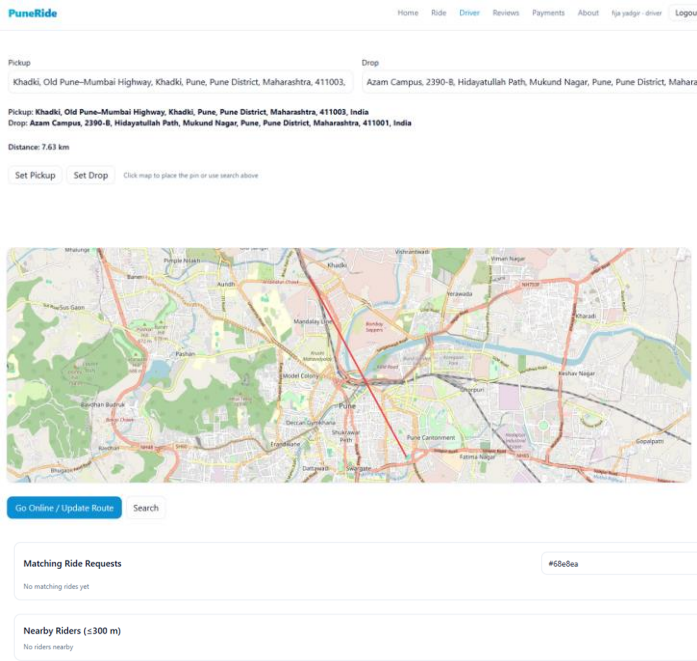


Figure 6

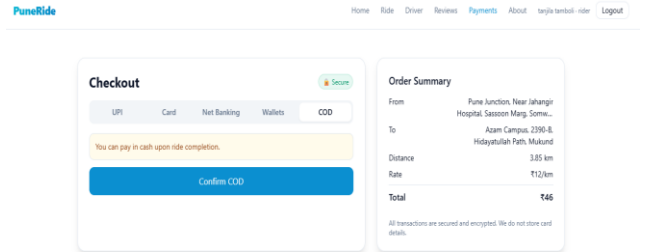


Figure 9

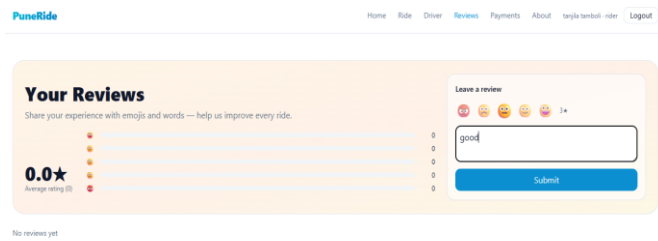


Figure 7

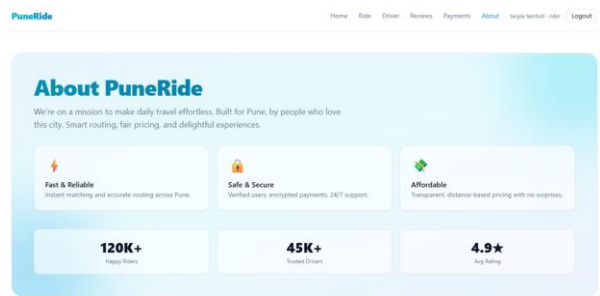


Figure 8

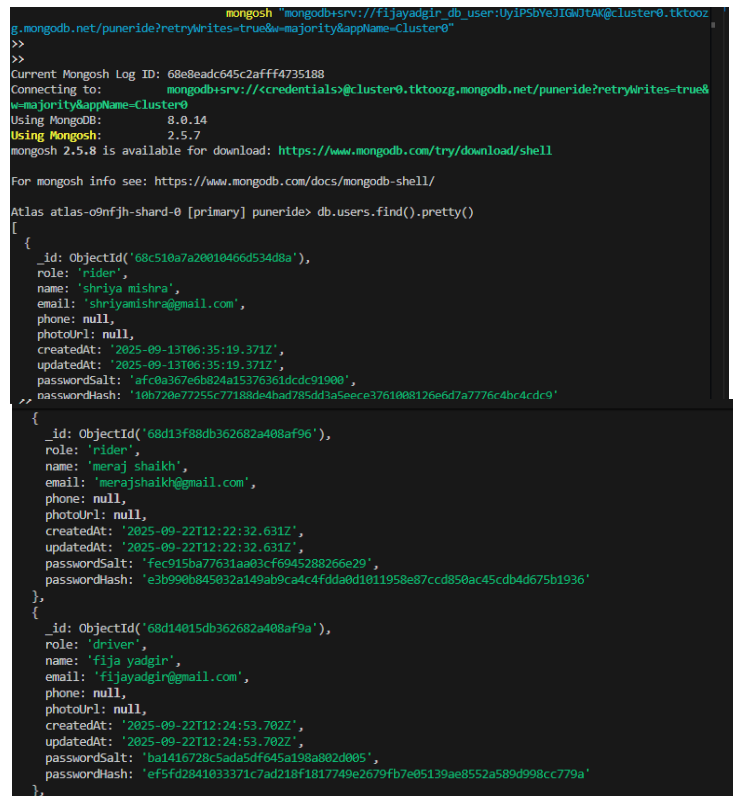


Figure 10

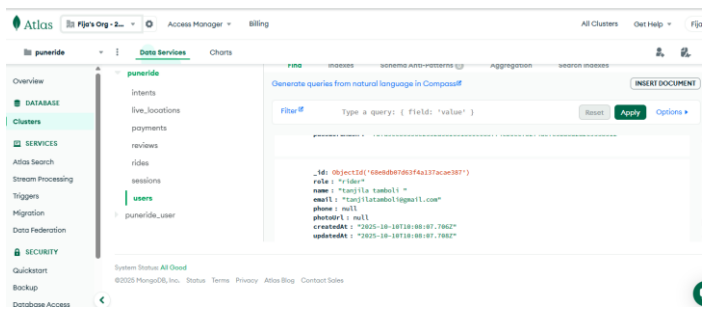


Figure 11

5. DISCUSSION

5.1 Strengths of the System

- **Reduction in Traffic Congestion:** The neighbourhood-based carpooling system reduces the number of single-occupancy vehicles on the road by encouraging shared travel among nearby residents, thereby helping to ease traffic congestion in urban areas.
- **Cost-Effective Commuting:** By enabling users to share rides and travel expenses, the system lowers individual commuting costs compared to private vehicle usage or commercial ride-hailing services.
- **Enhanced Trust and Safety:** The use of verified user identities and neighbourhood-level access control increases user trust and safety, making participants more comfortable with sharing rides within their local community.
- **Efficient Ride Matching:** Route-based matching ensures that drivers and passengers traveling along similar paths are efficiently paired, minimizing detours and travel time.
- **Support for Sustainable Urban Mobility:** By reducing fuel consumption and vehicular emissions, the system promotes environmentally responsible commuting and contributes to sustainable urban transportation goals.

5.2 Challenges and Limitations

- **User Awareness and Adoption:** The effectiveness of the neighbourhood-based carpooling system depends on user participation and willingness to share rides. Users may require awareness programs and motivation to adopt shared mobility practices, especially in areas where private vehicle usage is preferred.
- **Dependence on User Participation:** Ride availability and system effectiveness rely on active participation from both drivers and passengers. Limited user engagement within a neighbourhood may reduce ride-matching opportunities and system usage.
- **Limited System Scalability:** The current system is designed primarily for neighbourhood-level

deployment and may have limited scalability across larger geographic regions without additional coordination and system enhancements.

5.3 Future Scope

- **Mobile Application Development:** Developing a dedicated Android-based mobile application can significantly improve accessibility and convenience by enabling users to create, request, and manage carpool rides directly from their smartphones. The mobile application will be fully integrated with the existing web-based system, allowing real-time ride updates, seamless synchronization of user data, and on-the-go access to carpooling services.
- **Integration with Smart City Infrastructure:** Future versions of the system can integrate with smart city platforms, traffic management systems, and navigation APIs to enhance route optimization and real-time ride coordination.
- **Advanced Analytics and AI Support:** Machine learning techniques can be applied to analyze travel patterns, predict ride demand, and suggest optimal ride matches based on user behavior and historical data.
- **Multilingual and User-Friendly Support:** Incorporating regional language options and simplified user interfaces can improve usability and encourage wider adoption of the carpooling system across diverse user groups.

6. CONCLUSION

This research demonstrates that a Neighbourhood-Based Carpooling Pick-and-Drop System can effectively address key urban transportation challenges by integrating modern web technologies with community-driven design principles. The proposed system focuses on short-distance and routine commuting needs, offering a practical solution to traffic congestion, fuel inefficiency, and environmental pollution.

By prioritizing trust, affordability, and safety through verified user identities and localized ride matching, the system provides a viable alternative to conventional commercial ride-hailing platforms. The findings suggest that neighbourhood-based carpooling not only reduces travel costs and vehicle dependency but also promotes cooperative and sustainable urban mobility practices (Dimitrijevic et al., 2013; Santi et al., 2014).

Although the current implementation has certain limitations, such as dependence on user participation and limited scalability beyond neighborhood boundaries, the system establishes a strong foundation for future enhancements. Potential improvements include mobile application development, intelligent ride recommendation mechanisms, and integration with navigation and traffic

services. Overall, the proposed approach highlights the potential of community-focused ride-sharing systems in contributing to environmentally responsible and sustainable urban transportation.

7. REFERENCES

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