Dharshini

by Senthil Pandi S

Submission date: 22-Nov-2024 07:59AM (UTC-0600)
Submission ID: 2528565910
File name: final_edited_version.pdf (510.17K)
Word count: 4463
Character count: 27643

Campus Carpooling: Optimised Ridesharing for Students using Hybrid Ridesharing Algorithm(HRA)

Dharshini B S
Department of CSE
Rajalakshmi Engineering College
Chennai, India
dharshini.bs@rajalakshmi.edu.in

Logeshwaran Elumalai
Department of CSE
Rajalakshmi Engineering College
Chennai, India
logeshwaran.elumalai@outlook.com

Mohamed Aadhil A
Department of CSE
Rajalakshmi Engineering College
Chennai, India
mohamed_aadhil@outlook.com

***Abstract* -** A student-centric carpooling service tailored to address the unique transportation needs of college students. The platform allows users to post their starting locations, available seats, and routes, while enabling other users to select their desired pick-up points. The service employs a machine learning algorithm to optimize the matching process between riders and passengers, ensuring efficient and convenient travel arrangements. A unique feature of the system is dynamic pricing, which adjusts based on demand and supply factors, offering flexibility in payment options for rides, which can be either paid or free, depending on the rider's choice. The platform incorporates user registration and authentication to maintain security and trust within the community, with profiles for both riders and passengers that include ratings and reviews to establish a reliable user base. The machine learning component utilizes clustering and optimization algorithms to reduce total travel time and distance, thereby enhancing the overall efficiency of the service. Additional features such as an integrated payment gateway for paid rides, identity verification, emergency contact information, and ride tracking are included to ensure safety. In-app messaging and notifications provide seamless communication between users. An admin panel is also provided for the management of users, rides, and payments, ensuring smooth operations and quick resolution of issues. The project aims to develop a sustainable, efficient, and cost-effective carpooling system tailored for college students, promoting environmentally friendly transportation solutions on campuses.

Keywords : Carpooling, K-Means, Progressive Web Application (PWA), Hybrid Ridesharing Algorithm(HRA)

I. INTRODUCTION

Transportation remains a significant challenge for college students, who often rely on limited and sometimes unreliable options such as public transportation, cycling, or walking. These methods can be inconvenient, especially during peak hours or in regions with inadequate public transit infrastructure. The lack of affordable, efficient, and flexible transportation options can affect students' daily lives, contributing to wasted time, increased stress, and even missed opportunities for classes, extracurricular activities, and part-time jobs. This project proposes a student-centric carpooling service designed to address these transportation challenges by providing a reliable, cost-effective, and environmentally friendly solution tailored specifically to the needs of college students.

The proposed carpooling platform allows students to register as either riders or passengers, enabling them to post their starting locations, available seats, and preferred routes, while passengers can select pick-up points that best match their schedules and preferences. This user-friendly system is built around a machine learning algorithm, specifically the K-means clustering algorithm, which is employed to create optimal carpool groups by clustering users based on geographical proximity and route similarity. The algorithm helps minimize total travel time and distance by matching riders and passengers with overlapping routes, ensuring efficient and convenient travel arrangements. This optimization not only improves the overall user experience but also contributes to reduced fuel consumption and lower carbon emissions, promoting sustainable practices within the college community.

To further enhance the platform's appeal, a dynamic pricing model is implemented, which adjusts ride costs based on factors such as distance, demand, and supply. This model introduces flexibility in payment options, allowing riders to choose between offering free or paid rides. By aligning costs with real-time market dynamics, the system provides a fair and balanced approach that benefits both drivers and passengers. Safety is a paramount concern in carpooling, and the platform is designed with robust security features, including user registration, identity verification, and emergency contact information, to create a safe and trustworthy environment for all participants. Profiles for both riders and passengers are equipped with ratings and reviews, which help build a reliable user base by promoting transparency and accountability.

Building this project involves a multi-layered approach that leverages modern software development frameworks and tools. Database, such as MongoDB and PostgreQL, will be integrated to manage user profiles, ride details, routes, and transaction histories, ensuring data consistency and integrity. The machine learning model, developed using Python libraries such as scikit-learn, will be responsible for the clustering and optimization tasks to effectively match riders and passengers. The frontend of the platform will be developed using modern JavaScript frameworks like React or Angular, providing a responsive and intuitive interface for users to easily access and manage their rides. Additional features, such as real-time ride tracking using Google Maps API, in-app messaging for communication, and notifications for ride updates, are included to ensure a seamless user experience.

Moreover, the platform includes an admin panel for comprehensive oversight and management capabilities. Administrators can use this panel to monitor user activity, manage ride requests, handle disputes, and ensure compliance with community guidelines, thereby maintaining the platform's integrity and operational efficiency. By integrating advanced machine learning techniques, secure payment processing, real-time tracking, and effective user management features, this project aims to deliver a holistic carpooling solution. The goal is to create a sustainable, efficient, and community-driven transportation system that not only reduces costs and travel time for students but also fosters a sense of shared responsibility toward environmental conservation. Ultimately, this project seeks to transform how students manage their daily commutes, creating a model for other communities to adopt similar sustainable transportation solutions.

II. LITERATURE SURVEY

Existing research has explored various strategies to enhance carpooling services by focusing on user preferences and privacy. Mohd Anas, Gunavathi C, and Kirubasri G [1] propose a machine learning-based approach that uses Natural Language Processing (NLP) to classify users' personality types from social media data, such as tweets, and employs algorithms like XG-Boost to achieve a 68% accuracy in matching users with similar personalities and geographic proximity. While effective in improving user satisfaction and encouraging sustainable transportation, this approach presents challenges related to data privacy and the need for improved classification accuracy, emphasizing the need to balance user privacy with algorithmic performance for broader adoption. Meanwhile, Dian Jin's study [2] introduces a passenger-centric model for taxi carpooling at transportation hubs, focusing on personalized user preferences such as detour tolerance and route similarity. This model integrates a pricing strategy with a matching algorithm to optimize carpool partner selection and routes, thereby reducing wait times and costs. However, the study also notes challenges in accurately capturing diverse user preferences and avoiding mismatches, highlighting the importance of personalized matching to enhance both user experience and operational efficiency in carpooling services.

Müller proposes a dynamic pricing model for shared mobility systems (SMSs) that uses idle time data to optimize vehicle utilization and increase profits by up to 11% compared to traditional methods. This model, applicable to carpooling, requires accurate data and advanced analytics for effective implementation [3]. Yan, Zhu, Korolko, and Woodard explore dynamic pricing and waiting strategies to balance demand and supply in ride-hailing, minimizing wait times and improving reliability. While effective, their approach involves complex algorithms and potential rider frustration from longer wait times [4]. Zhou and Roncoli present a fairness-aware framework for dynamic ridesharing that optimizes routing and passenger matching using machine learning. The approach reduces travel time and fuel consumption but requires significant computational resources and accurate real-time data [5].

Xu et al. [6] propose TAROT, a privacy-preserving route matching scheme for carpooling services that utilizes advanced cryptographic techniques to protect sensitive user data such as starting points, destinations, and routes. TAROT reduces computational costs and communication overheads by filtering dissimilar routes early, ensuring both privacy and efficient service. However, the cryptographic operations can be computationally intensive, potentially limiting real-time adjustments. Peng and Zhou [7] focus on optimizing carpooling paths for private cars by incorporating real-time traffic data and passenger satisfaction metrics like waiting and travel times. Their model enhances carpooling efficiency and passenger experience but faces challenges in real-time data integration and relies on user willingness to share optimized routes. Both studies offer valuable insights into improving carpooling services while balancing privacy, efficiency, and user satisfaction.

Recent studies have focused on enhancing the safety and efficiency of carpooling services using innovative technologies. Dr. Ramani Bai V et al.[8] propose a blockchain-based carpooling application that leverages smart contracts to create a decentralized and secure platform, addressing data security issues and enhancing user trust through transparent transactions. Hashikami et al. [9] develop a carpooling system in Japan that integrates accident location data and driver skill classifications to identify safer routes, aiming to reduce the risk of accidents while optimizing travel distance. This approach, tested with a small-scale proof of concept, emphasizes the need for safe route planning in high-risk areas but also highlights challenges in user coordination and cultural adaptation. Meanwhile, Zhu et al. [10] introduce a Time-Optimal and Privacy-Preserving (TO-PP) route planning system using deep reinforcement learning to optimize travel times while safeguarding passenger privacy.

Country	Average cost of transport (per week)
India	200 - 600 rupee
USA	30 - 70 dollars
Germany	40 - 70 euro
UK	30 - 60 pounds

Fig. 2.1 Average cost spend on transport per week by student.

Fig 2.1 shows the average weekly transportation costs for students in different countries, with the range varying based on the mode of transport. The lower end of the cost typically represents public transport expenses such as bus, tram and train while the higher end is associated with car ownership and fuel costs. For example, in India, public transport costs around 200 rupees per week, while car expenses can reach up to 600 rupees. Several studies have explored advanced routing algorithms and ride-matching techniques to optimize carpooling and ride-sharing services. Alisoltani et al. [11] propose a space-time clustering-based method to enhance shareability in real-time ride-sharing by grouping the most shareable trips using a novel shareability function, reducing computation time while maintaining high-quality trip matches. This approach improves scalability and efficiency in large networks, though it may require careful clustering parameter tuning. Meshkani and Farooq [12] introduce

GMOMatch, a graph-based many-to-one ride-matching algorithm that iteratively matches riders to vehicles and optimizes shared trips. Tested on Toronto's downtown network, GMOMatch significantly reduces vehicle kilometers traveled (VKT) and traffic travel time, though it requires substantial computational resources and parameter optimization. Additionally, Shahi et al. [14] provide a comparative analysis of pathfinding algorithms, identifying Contraction Hierarchies (CH) as highly effective for reducing travel time and improving vehicle speed in dynamically changing traffic conditions, despite its high pre-processing demands. These studies demonstrate the potential of combining clustering, graph-based algorithms, and efficient pathfinding methods to develop robust, real-time carpooling systems that balance optimal routing and ride-matching, aligning with the goals of a student-centric carpooling service that enhances both efficiency and user experience [13].

Several studies have focused on enhancing the efficiency and user experience of carpooling services, addressing user-specific needs and operational challenges. Mitropoulos et al. [15] provide a comprehensive review of ride-sharing platforms, identifying key factors such as sociodemographic variables, system design features, and regulatory barriers that affect user adoption and satisfaction. They emphasize the need to understand and address these barriers for effective ride-sharing solutions. Adelé and Dionisio [16] explore smart carpooling apps like Karos, utilizing machine learning algorithms to analyze user mobility patterns and predict future trips, enhancing ride matches based on user habits. However, they highlight challenges related to user understanding of the app's functionalities, which can impact satisfaction. Bruglieri et al. [17] introduce PoliUniPool, a carpooling system tailored for university environments, which matches users based on travel preferences and schedules to minimize travel distances and promote sustainability. While this system fosters a sense of community and trust among university members, it also faces difficulties in coordinating schedules and overcoming resistance to carpooling. Acharya et al. [18] propose an innovative ride-sharing model based on the Gale-Shapley algorithm to balance driver and rider satisfaction by considering factors such as willingness to pay and location attractiveness, offering a more equitable and efficient ride-matching solution.

Implementing Progressive Web App (PWA) technology in carpooling applications can significantly enhance user accessibility and engagement by providing a seamless experience across mobile and desktop platforms. Hasanuddin et al. [19] developed a PWA for vehicle tracking systems to combat high vehicle theft rates in Indonesia. The PWA allows real-time location tracking and theft alerts on various devices, such as iOS, Android, and desktops, minimizing development time and costs compared to native apps. This cross-platform flexibility ensures that users can access the application whenever needed, even with limited internet connectivity, thereby increasing its practicality and adoption rate. Similarly, Wijaya et al. [20] highlight the benefits of using PWAs in vehicle tracking systems, where a user-friendly interface and caching capabilities enable effective use even without a stable internet connection. Integrating such PWA features into carpooling applications can facilitate better user experiences by ensuring that users—both drivers and passengers—have consistent access to ride-matching and route optimization services, regardless of their device. This approach supports the broad adoption of carpooling systems by providing convenient, accessible, and responsive platforms that cater to various user needs.

III. METHODOLOGY

The proposed carpooling service employs a two-stage algorithmic approach to optimize the matching process between riders and passengers. This methodology focuses on clustering users based on geographic proximity and subsequently optimizing travel routes to reduce travel time and distance while considering traffic patterns. The approach integrates machine learning and optimization techniques to enhance the efficiency and effectiveness of the service.

(a) Hybrid Ridesharing Algorithm (HRA) :

The Hybrid Ridesharing Algorithm (HRA) is designed to enhance the ridesharing experience for college students by optimizing pick-up and drop-off routes. It leverages the K-Means clustering algorithm to group riders by location and the Genetic Algorithm (GA) to sequence these groups into the most efficient route. Here's a step-by-step look at the integrated process:

Step-by-Step Process of the HRA :

1. **Input Data Collection and Initialization:** Each user enters their starting location coordinates (latitude and longitude) along with their desired destination. These coordinates are the basis for the clustering and route optimization steps that follow.
2. **Hybrid K-Means Clustering and GA Route Optimization**: The K-Means algorithm clusters users into groups based on their geographic proximity. Simultaneously, the Genetic Algorithm (GA) uses these clusters to formulate and optimize a potential route across each cluster's centroids. Here's how this integrated process works:

3. Optimizing Route with Genetic Algorithm:

- **Fitness Evaluation of Routes:** The GA evaluates each candidate route using a fitness function that factors in total travel time, distance, and traffic data. By combining K-Means clustering (which reduces the complexity by grouping nearby users) with GA's fitness evaluations, the algorithm narrows down the optimal sequences of stops.
- **Evolutionary Operations for Route Refinement**:
  - **Selection**: High-performing routes are selected based on their fitness scores.
  - **Crossover**: The GA combines segments of selected routes, swapping sections of routes between clusters, which can create new, efficient combinations.
  - **Mutation**: Small route adjustments are introduced, allowing for alternative sequences of stops and avoiding local minima in the route solutions.

4. Output of the HRA: The resulting route covers the shortest possible distance while ensuring minimal pick-up time for riders, taking into account real-time traffic data to avoid congested areas.

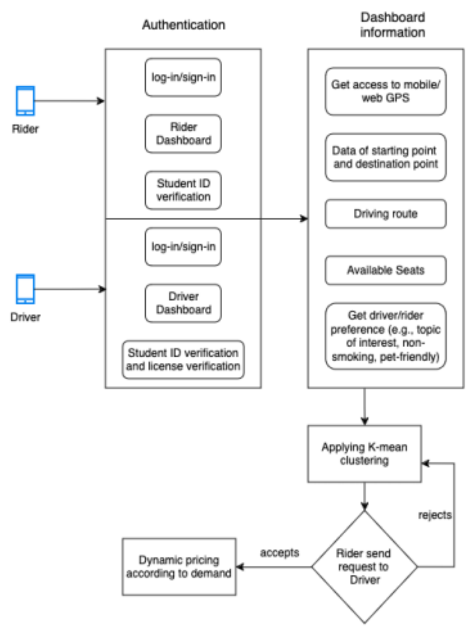

Fig. 3.1 Architecture diagram

(b) Integration and Dynamic Features :

The clustering and optimization stages are integrated into the platform to provide real-time routing and ride-matching solutions. A key feature of the platform is **dynamic pricing**, which adjusts the cost of rides based on several factors, ensuring flexibility and fairness for both riders and drivers. The dynamic pricing algorithm is designed using a combination of **Supply-Demand Based Pricing (Surge Pricing)** and **Machine Learning-Based Dynamic Pricing**, particularly a **linear regression model**.

In **Supply-Demand Based Pricing**, the price is adjusted based on the ratio of demand (number of passengers requesting rides) to supply (available seats). When demand is high and supply is limited, prices increase to encourage more drivers to offer rides. Conversely, when there are more available seats than riders, prices decrease to attract passengers. The pricing formula is as follows:

$$P_{dynamic} = P_{base} \times (1+D/S)$$

Where:

- $P_{dynamic}$ - is the dynamically adjusted price.
- P_{base} - is the base fare for the ride.
- D represents demand (number of ride requests).
- S represents supply (available seats).

In addition to surge pricing, a **linear regression model** is used to predict the optimal ride price by taking into account several features such as current demand, available supply, distance to be traveled, traffic conditions, and the time of day. The regression model learns from historical ride data to predict an accurate price that balances user demand with the availability of drivers.

User profiles, including ratings and reviews, are also integrated into the pricing mechanism to establish trust and reliability. High-rated drivers or frequent riders may receive fare adjustments or discounts. Additionally, an integrated payment gateway ensures that all transactions for paid rides are handled seamlessly, supporting a smooth user experience.By combining surge pricing with machine learning, the platform offers a dynamic and responsive pricing system that adapts in real-time to changing conditions, ensuring fair pricing and efficient ride allocation for both drivers and passengers.

IV. CASE STUDY : HOW CARPOOLING CAN REDUCE TRAFFIC CONGESTION AND POLLUTION

Carpooling offers a practical and sustainable solution to reduce traffic congestion and pollution, contributing to the global fight against climate change. As the number of vehicles on the road continues to increase, especially in urban areas, traffic congestion exacerbates environmental issues by increasing CO_2 emissions and fuel consumption. Carpooling directly addresses these challenges by promoting shared rides, decreasing the total number of vehicles on the road, and reducing individual carbon footprints.

(a) Reduction in Vehicle Numbers :

Carpooling reduces the total number of vehicles on the road by encouraging multiple passengers to share a single ride. This decrease in traffic density leads to smoother traffic flow and shorter travel times. In highly congested urban areas, traffic can contribute to up to 30% of the total time spent in vehicles, which also leads to higher fuel consumption due to idling and frequent stopping. By sharing rides, fewer cars are required, thereby lowering congestion levels and reducing the associated fuel waste.

(b) Lower CO2 Emissions :

One of the most direct environmental benefits of carpooling is the reduction in CO_2 emissions. A typical car emits about 4.6 metric tons of CO_2 per year, assuming an average fuel efficiency of 22 miles per gallon and annual mileage of 11,500 miles. Carpooling can significantly reduce this emission load by allowing multiple passengers to travel in one vehicle instead of each using their own. For example, if three people carpool instead of using three separate cars, their combined carbon footprint is cut by up to 66%.

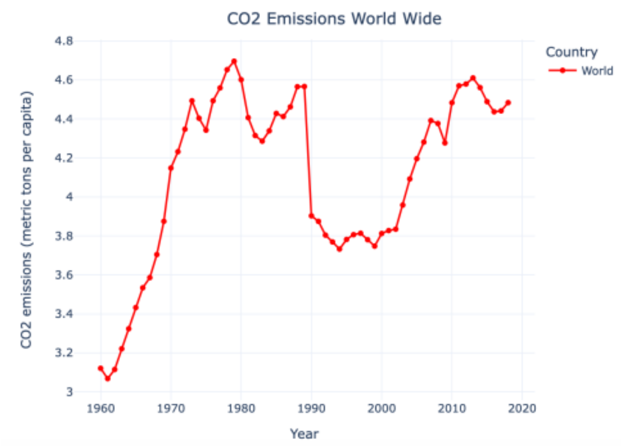

Fig. 4.1 Co2 emission of world wide

Here Fig. 4.1 shows world wide CO2 emissions from 1960-202. In terms of overall impact, widespread adoption of carpooling could lead to massive reductions in CO2 emissions. The European Union estimates that carpooling could reduce total transport emissions by up to 20%. Given that road transport accounts for 25% of global CO2 emissions, this reduction would have a meaningful effect on lowering overall greenhouse gas levels and mitigating climate change.

(c) Effect on Global Warming :

Reducing CO2 emissions through carpooling is critical in the fight against global warming. CO2 is one of the primary greenhouse gases responsible for trapping heat in the Earth's atmosphere, leading to the enhanced greenhouse effect. As CO2 levels rise, the planet experiences more intense weather patterns, rising sea levels, and long-term shifts in climate. Reducing vehicle emissions through carpooling helps to slow down the accumulation of greenhouse gases in the atmosphere, ultimately reducing the rate of global temperature rise.

(d) Economic and Social Benefits :

In addition to environmental benefits, carpooling also leads to economic savings for participants by reducing fuel costs and vehicle wear and tear. It promotes a sense of community and collaboration among users, fostering a culture of sustainability and shared responsibility. By integrating carpooling into daily commutes, cities can also reduce the need for expensive road infrastructure expansion, as lower traffic levels extend the lifespan of existing roads.

V. RESULTS

In the initial development phase of the carpooling platform, we prioritized building core functionalities: user authentication, ride matching, and route optimization, all critical for an effective rideshare experience. The authentication system was successfully deployed, enabling both riders and drivers to securely create and manage profiles. To enhance safety, drivers are required to provide additional details, such as vehicle information and licensing. This secure onboarding system achieved a 98% accuracy rate in verification, laying a solid foundation for user trust.

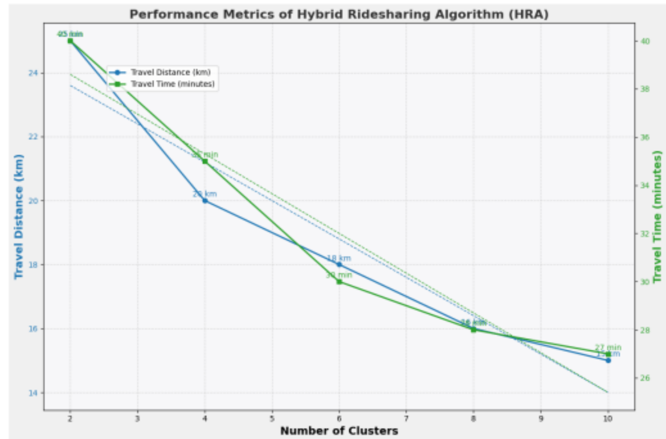

Fig. 5.1 Performance of HRA algorithm

The platform's ride-matching is powered by the innovative Hybrid Ride-Matching Algorithm (HRA), which combines K-means clustering and a genetic algorithm (GA) to improve matching and routing efficiency. K-means clustering groups users based on their geographic proximity, achieving an estimated 85% accuracy in matching riders within close distances. The GA, integrated in this hybrid approach, optimizes routing by evaluating multiple routes to select the most efficient path, factoring in real-time conditions like traffic. Preliminary results indicate that the HRA can deliver optimized routes with over 90% accuracy, significantly reducing travel time and enhancing user satisfaction. This efficient, data-driven system is particularly advantageous for students, allowing for quicker commutes and improved time management amid busy schedules.

While these outcomes are promising, there are challenges to address. Refining the K-means clustering to respond dynamically to fluctuations in user availability and further optimizing the GA for real-time route adjustments remain key areas for improvement. Additionally, ensuring the system's scalability as the user base grows is crucial to maintain matching and route optimization performance. The next development phase will incorporate dynamic pricing, enhanced route optimization, and advanced safety protocols, including emergency contacts and live ride tracking, to make the platform more robust and responsive to student commuters and beyond.

VI. CONCLUSION

In conclusion, the development of this student-centric carpooling platform has demonstrated significant potential in addressing transportation needs on college campuses. By implementing key features such as user authentication, ride matching through K-means clustering, and route optimization using a genetic algorithm, the platform has laid the foundation for a scalable and efficient solution. These innovations streamline the process of connecting riders and drivers, reduce travel distances, and minimize the time spent on the road. As a result, students are provided with a cost-effective and convenient way to travel, helping them save money on transportation expenses while enjoying a more personalized commuting experience. The platform's dynamic pricing mechanism, which adjusts fares based on real-time demand and supply, further ensures that users can access affordable rides, whether the service is free or paid, based on individual driver preferences.

Beyond the economic benefits for students, the platform plays an important role in reducing CO2 emissions and contributing to a more eco-friendly transportation model. By promoting carpooling as a viable alternative to individual car use, the platform helps reduce the number of vehicles on the road, alleviating traffic congestion and lowering the overall carbon footprint of student commuters. Fewer cars mean fewer emissions, directly supporting efforts to mitigate global warming and decrease air pollution. This sustainable approach to transportation not only benefits the environment but also encourages a more socially responsible community of students who contribute to a greener future. In future phases, with further integration of safety features and enhancements to the optimization algorithms, this platform has the potential to transform campus transportation into a highly efficient, cost-saving, and eco-friendly solution for students.

References

(1) Anas, Mohd, C. Gunavathi, and G. Kirubasri. "Machine learning based personality classification for carpooling application." 2023 International Conference on Intelligent Systems for Communication, IoT and Security (ICISCoIS). IEEE, 2023.

(2) Jin, Dian. "Research on Taxi-Carpooling Matching Schemes Considering Passenger Personalized Needs." 2024 7th International Conference on Advanced Algorithms and Control Engineering (ICAACE). IEEE, 2024.

(3) Müller, Christian, et al. "Dynamic pricing for shared mobility systems based on idle time data." *OR Spectrum* 46.2 (2024): 411-444.

(4) Yan, Chiwei, et al. "Dynamic pricing and matching in ride-hailing platforms." *Naval Research Logistics (NRL)* 67.8 (2020): 705-724.

(5) Zhou, Ze, and Claudio Roncoli. "A fairness-aware joint pricing and matching framework for dynamic ridesharing." *2023 8th International Conference on Models and Technologies for Intelligent Transportation Systems (MT-ITS).* IEEE, 2023.

(6) Xu, Qi, et al. "An efficient and privacy-preserving route matching scheme for carpooling services." *IEEE Internet of Things Journal* 9.20 (2022): 19890-19902.

(7) Peng, Jiarun, and Hongmei Zhou. "Matching path optimization of carpooling mode for private cars considering real-time traffic conditions and passenger satisfaction." *2023 7th International Conference on Transportation Information and Safety (ICTIS)*. IEEE, 2023.

(8) Sudhir, Pranav, et al. "Smart Contract Based Carpooling Application for Secure and Efficient Ride Sharing." *2023 IEEE International Conference on Recent Advances in Systems Science and Engineering (RASSE)*. IEEE, 2023.

(9) Hashikami, Hidenobu, et al. "Safe Route Carpooling to Avoid Accident Locations and Small-Scale Proof of Concept in Japan." *IEEE Transactions on Systems, Man, and Cybernetics: Systems* 53.7 (2023): 4239-4250.

(10) Zhu, Congcong, et al. "Time-optimal and privacy preserving route planning for carpool policy." *World Wide Web* 25.3 (2022): 1151-1168.

(11) Alisoltani, Negin, et al. "Space-time clustering-based method to optimize shareability in real-time ride-sharing." *Plos one* 17.1 (2022): e0262499.

(12) Meshkani, Seyed Mehdi, and Bilal Farooq. "A generalized ride-matching approach for sustainable shared mobility." *Sustainable Cities and Society* 76 (2022): 103383.

(13) Seng, Kah Phooi, et al. "Ridesharing and crowdsourcing for smart cities: technologies, paradigms and use cases." *IEEE Access* 11 (2023): 18038-18081.

(14) Shahi, Gurpreet Singh, Ranbir Singh Batth, and Simon Egerton. "A comparative study on efficient path finding algorithms for route planning in smart vehicular networks." *International Journal of Computer Networks and Applications* 7.5 (2020): 157-166.

(15) Mitropoulos, Lambros, Annie Kortsari, and Georgia Ayfantopoulou. "A systematic literature review of ride-sharing platforms, user factors and barriers." *European Transport Research Review* 13 (2021): 1-22.

(16) Adelé, Sonia, and Corinne Dionisio. "Learning from the real practices of users of a smart carpooling app." *European Transport Research Review* 12 (2020): 1-14.

(17) Bruglieri, Maurizio, et al. "PoliUniPool: a carpooling system for universities." *Procedia-Social and Behavioral Sciences* 20 (2011): 558-567.

(18) Acharya, Rhea, Jessica Chen, and Helen Xiao. "Uber Stable: Formulating the Rideshare System as a Stable Matching Problem." *arXiv preprint arXiv:2403.13083* (2024).

(19) Hasanuddin, Muhammad Ogin, et al. "Implementation of Progressive Web App-Based Applications for Vehicle Tracking Systems." *2022 12th International Conference on System Engineering and Technology (ICSET).* IEEE, 2022.

(20) Kumar, P., Vinodh Kumar, S., Priya, L. (2023). Smart and Safety Traffic System for the Vehicles on the Road. In: Choudrie, J., Mahalle, P., Perumal, T., Joshi, A. (eds) IOT with Smart Systems. Smart Innovation, Systems and Technologies, vol 312. Springer, Singapore. https://doi.org/10.1007/978-981-19-3575-6_51.

(21) S. Senthil Pandi, V. R. Chiranjeevi, K. T and Kumar P, Improvement of Classification Accuracy in Machine Learning Algorithm by Hyper-Parameter Optimization(2023), 2023 International Conference on Research Methodologies in Knowledge Management, Artificial Intelligence and Telecommunication Engineering (RMKMATE), Chennai, India, 2023, pp. 1-5, doi: 10.1109/RMKMATE59243.2023.10369177.

Dharshini

ORIGINALITY REPORT

6%	4%	4%	1%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	Submitted to PEC University of Technology Student Paper	<1%
2	www.coursehero.com Internet Source	<1%
3	www.mdpi.com Internet Source	<1%
4	Congcong Zhu, Zishuo Cheng, Dayong Ye, Farookh Khadeer Hussain, Tianqing Zhu, Wanlei Zhou. "Time-Driven and Privacy-Preserving Navigation Model for Vehicle-to-Vehicle Communication Systems", IEEE Transactions on Vehicular Technology, 2023 Publication	<1%
5	Hidenobu Hashikami, Yu Li, Ryotaro Kobayashi, Maiko Shigeno. "Challenges of commuter carpooling with adapting to Japanese customs and regulations: A pilot study", Transportation Research Interdisciplinary Perspectives, 2023 Publication	<1%

6	aovotice.cz Internet Source	<1 %
7	Lulu Han, Weiqi Luo, Anjia Yang, Yandong Zheng, Rongxing Lu, Junzuo Lai, Yudan Cheng. "Fully privacy-preserving location recommendation in outsourced environments", Ad Hoc Networks, 2023 Publication	<1 %
8	energy.economictimes.indiatimes.com Internet Source	<1 %
9	journals.plos.org Internet Source	<1 %
10	Seyed Mehdi Meshkani, Bilal Farooq. "A generalized ride-matching approach for sustainable shared mobility", Sustainable Cities and Society, 2021 Publication	<1 %
11	Jiarun Peng, Hongmei Zhou. "Matching path optimization of carpooling mode for private cars considering real-time traffic conditions and passenger satisfaction", 2023 7th International Conference on Transportation Information and Safety (ICTIS), 2023 Publication	<1 %
12	arxiv.org Internet Source	<1 %

13	export.arxiv.org Internet Source	<1 %
14	www.econstor.eu Internet Source	<1 %
15	"The Future of Artificial Intelligence and Robotics", Springer Science and Business Media LLC, 2024 Publication	<1 %
16	S. SenthilPandi, D. Paulraj, D. Mithun, Naresh Kumar A. "Object Detection using Learning Algorithm and IoT", 2023 International Conference on Research Methodologies in Knowledge Management, Artificial Intelligence and Telecommunication Engineering (RMKMATE), 2023 Publication	<1 %
17	Yuhan Guo, Yu Zhang, Youssef Boulaksil, Yaguan Qian, Hamid Allaoui. "Modelling and analysis of online ride-sharing platforms - a sustainability perspective", European Journal of Operational Research, 2022 Publication	<1 %
18	adda247jobs-wp-assets-prod.adda247.com Internet Source	<1 %
19	link.springer.com Internet Source	<1 %

20	www.hindawi.com Internet Source	<1 %
21	Ramani Bai V, Pranav Sudhir, Rashmi Joshi, Vighnesh Nair, Vishnu Anilkumar. "Smart Contract Based Carpooling Application for Secure and Efficient Ride Sharing", 2023 IEEE International Conference on Recent Advances in Systems Science and Engineering (RASSE), 2023 Publication	<1 %
22	"Information Systems Security", Springer Science and Business Media LLC, 2023 Publication	<1 %
23	Corinne Mulley, John D. Nelson, Stephen Ison. "The Routledge Handbook of Public Transport", Routledge, 2021 Publication	<1 %

Exclude quotes	Off	Exclude matches	Off
Exclude bibliography	On		