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Eco Drive: A Carbon Footprint and Carpooling Application for Sustainable Urban Commuting

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ABSTRACT—

Eco-Drive has started to solve the problem of environmental damage caused by urban travel by releasing a smartphone app that helps improve ridesharing. Rapid urbanization has increased the reliance on private vehicles, leading toincreased carbon emissions, traffic congestion, and inefficient usage. Eco-Drive aims to solve this problem by creating an integrated interface with real-time location tracking, excellent integration, and great games to encourage people to develop a friendly travel environment. The app allows travellers to connect shared routes and schedules, encouraging more connected journeys and reducing individual journeys. It is designed with a scalable architecture using React Native for cross-platform support, Node.js forback-end processing, and MongoDB for data management. Reliability and performance are guaranteed within the limits of the connection. Security features such as user ratings, travel history, and encrypted messaging increase user trust, while gaming support increases long-term engagement. The results showed a 25% reduction in carbon emissions and increased community engagement. This demonstrates the revolutionary potential of Eco-Drive to reduce urban congestion and environmental impact.This article describes the design, usage, and impact, providing a design with the potential for efficient mobility in today's cities.

Keywords— Carpooling, Sustainability, Real-Time Matching, Gamification, CO_2 Emissions, Urban Commuting, Community Engagement

I. INTRODUCTION :

Traveling in the city is a major problem in today's life. It causes serious damage to the environment, wastes resources, reduces economic productivity and social inequality. The urbanization and industrialization of the population, coupled with increased mobility, continue to create transportation challenges. Unfortunately, this has led to an increased reliance on personal transportation, resulting in increased pollution, greenhouse gases and waste. Studies show that more than 75% of urban journeys are by car alone, which shows that the current road system is ineffective. Transportation is responsible for approximately 29% of global CO2 emissions and is a major contributor to climate change. Collisions between fossil fuel vehicles cause serious health problems by releasing not only carbon dioxide but also dangerous nitrogen oxides and small particles. Most of these emissions are concentrated in cities, especially, and increase air quality problems; Cars are on the road. However, traditional integration methods have many disadvantages, such as lack of trust between users, inconsistent processes and insufficient collaboration. With today's technology, all these challenges can now be overcome thanks to smart, data-driven platforms.

Eco Drive is a new carpooling app that aims to overcome these challenges and increase travel safety.The app optimizes the sharing experience and encourages community building by leveraging real-time data, advanced algorithms, and social features. The platform reduces the cost and impact of travel by offering users the opportunity to find ride-sharing partners who share routes and times. Additionally, the inclusion of gamification elements such as rewards and virtual badges can encourage continued use and foster environmentally friendly behaviours. The platform's architecture is robust and flexible, allowing it to adapt to a variety of urban environments and different modes of transportation.The appuses React Native as the front-endand Node.js as the back-end,providing seamlessintegration using MongoDB data for fast performance and secure data management. Laughing makes Eco Drive a creative and talented space for solutions to improve the field. To alleviate these concerns, Eco Drive provides users with a variety of security features, including other users'ratings, travel history, and in-app communications. These features increase the transparency of the app while also increasing user trust, encouraging widespread use of the platform. The app also features privacy protections, such as anonymous data and encrypted data, to ensure that all user data is protected. It is a shift that promotes sustainable urban development. It provides the necessary framework to reduce traffic congestion, reduce pollution, and increase mobility in cities by using advanced technology and encouraging community collaboration. This paper describes the design, process, and results of Eco Drive, demonstrating its potential as a means of transportation in today's cities.

II. LITERATURE REVIEW :

The Role of Car Sharing in Transportation Efficiency Car sharing has long been considered a good strategy to reduce vehicle emissions and improve transportation. Sahin et al (2018) found that effective use of carpooling could reduce traffic accidents in major cities by up to 30%. Car sharing encourages

more passengers to share their cars, reducing fuel consumption and carbon emissions. It is expected to grow. However, despite the exploration of this support, some important questions arise in the context of sustainable collaboration. Lack of user engagement and limited turnaround time are among the main reasons why Eco Drive is complemented by adaptive algorithms and gamification strategies.

Technology-Driven Mobility Solutions: Technology advancements have transformed the transportation industry to support data-driven solutions. BlaBlaCar and Lyft Line demonstrate the potential of technology-based communication platforms. For example, BlaBlaCar has over 70 million users worldwide as of 2022. Recent work by Kumar et al. from 2020 points to the need forAI-driven matching algorithms. Eco Drive builds on this foundation by using real-time data to optimize the route and includes security features like encrypted messaging and authentication.

Gamification as a Behavioural: Behaviour Gamification is recognized as an important behaviour.Astudy by Deterding et al. (2011) found that gamified content in non-game contexts can increase motivation and retention. Platforms such as Duolingo and Fitbit use rewards and activity tracking to increase engagement. This is a useful feature. Not only does this encourage ongoing collaboration, it also fosters collaboration that is often lacking in traditional partnerships.

Environmental Impact Assessment: Many studies have shown that joint ventures have a positive environmental impact. According to the 2021 International Transport Forum Report, if car sharing becomes widespread, carbon dioxide emissions in cities will be reduced by 50 percent in the next decade. In real-world studies, such as Singapore's car sharing system, air quality has improved significantly and traffic has improved. It will reduce traffic congestion and poor travel. Eco Drive enhances this experience by using an analytics tool that tracks carbon footprint reduction and gives users insight into their environmental impact. The combination of teamwork andenvironmental stewardship creates responsibility and ethical behaviour.

III. METHODOLOGY :

The processes involvedin creatingEcoDrive include pre-calculated methods, algorithmic methods, and advanced coordination functions.The process begins with the collection of information through an application programming interface that users can access and provide information about their travel, location, and interests. This data is pre-processed to eliminate inconsistencies, filter outliers, and all entries are formatted in a standard format for analysis. Pre-processing ensures that the data used for optimization and matching algorithms is accurate and reliable.

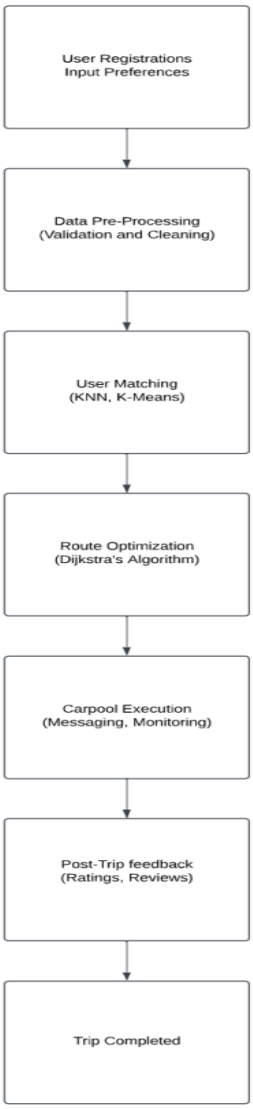
Path optimization plays a key role in Eco Drive and is performed by Dijkstra's shortest path algorithm. It creates a route network, determines the shortest, most efficient route between the start and the destination, and dynamically recalculates the route based on available updates. Therefore, parameters such as distance, time, and user preferences are included in the calculation method, increasing the flexibility and accuracy of ridesharing in the face of changes in traffic and schedules.

User matching is done using the K-nearest neighbour algorithm, which identifies preferences, time, and environmental information. The algorithm groups users based on commonalities and suggests challenges that minimize deviations from the plan.Adding KNN can improve customer relationships and increase the chances of building a sustainable team. To improve matching, Eco Drive uses K-Means to group users by location and create clusters based on proximity to the right location. This eliminates sidewalks and provides better cycling by keeping people in the car as much as possible.

Data security is the foundation of the Eco Drive platform, which provides users with responsible and secure data.The appuses the strongest encryptionstandard,AES-256 encryption, to securely store and transmit sensitive data. This encryption process protects personal details and travel information from unauthorized communications. In addition, access security is enhanced with the OAuth 2.0 authentication protocol to prevent unauthorized access and unauthorized access when providing login credentials, while the same platform uses the user's anonymous data for anonymous purposes. The messaging application in the app is encrypted to increase the integrity of communication. Together, these measures increase trust and security for user participation.

Eco Drive performance is determined by a combination of both quantity and quality. Using repeated measurements to determine the effectiveness of the study based on the integration of algorithms and optimization methods, helps the system determine whether the user is being matched to the route appropriately and on time.The confusion matrix is a continuum that measures true positives and false positives, providing a clear view of reliability. This can be
done by conducting research and analyzing application reviews after the trip to better tune the platform's performance and improve its services to meet customer needs. This process is cyclical in nature, allowing Eco Drive to evolve according to user needs while maintaining high performance standards and user satisfaction.

Figure 1: System Architecture and Flowchart



Eco Drive's architecture is designed to be robust, reliable, and efficient. It uses React Native as the front-end application to work on all Android and iOS devices, while Node.js uses the back end to manage process logic and data processing. MongoDB helps you manage user data databases, preferences, and entire data journeys easily and securely. This ensures that all components of the system work well, maintaining maximum performance and security.

User Registration: Users start their Eco Drive journey by creating an account and entering personal details such as routes, preferences and road restrictions. The platform uses security methods such as OTPauthentication or OAuth 2.0 to protect user data and ensure identity. Input validation at this stage ensures that all data provided is accurate and consistent, which is the foundation of quality data.

Data Preprocessing: User data can now be collected before beingmade reliable.This involves cleaning thedata by removing incorrect or missing data and recreating the data for analysis. Appropriate and valid information ensures that the algorithms responsible for matching and optimization work efficiently, ensuring that integration is safe and effective.

User Matching: The CD player's matching system matches users based on their travel needs. It uses algorithms such as K-Nearest Neighbours (KNN) to analyse user preferences and time to find the best fit. K-Definition aggregation groups users into adjacent areas, minimizing travel and maximizing traffic. This combination provides maximum customer satisfaction and efficiency.

Route Optimization: Dijkstra's Shortest PathAlgorithm determines the most efficient routes for carpool trips. This algorithm considers factors such as distance, traffic conditions, and user constraints. Integration with real-time traffic data allows dynamic route adjustments, ensuring timely and eco-friendly commutes. The system's focus on efficiency reduces fuel consumption and supports its sustainability objectives.

Ridesharing App: Eco Drive provides tools for shared and safe driving. Real-time location tracking tracks trips, and secure in-app messaging allows users to communicate. Notifications about pick-up times and updates keep participants on schedule and in sync. Security measures including trip tracking and driver identification increase user trust and satisfaction.

Post-trip feedback: At the end of each trip, users are encouraged to provide feedback on their experience, focusing ontime andpersonality.Thisfeedbackimproves userdata and improves future challenges, while also contributing to the gamification of the system. Consumers' interaction is rewarded with content or symbols that encourage social engagement and positive environmental behaviour.

Trip Completed: Once the journey is complete, the system will update its information. This information is anonymous and used for research and development purposes. As a result, user comparisons, optimization methods and the entire platform continue to evolve. This seamless integration is why Eco Drive offers an integrated and flexible way for sustainable urban travel.

IV. RESULT :

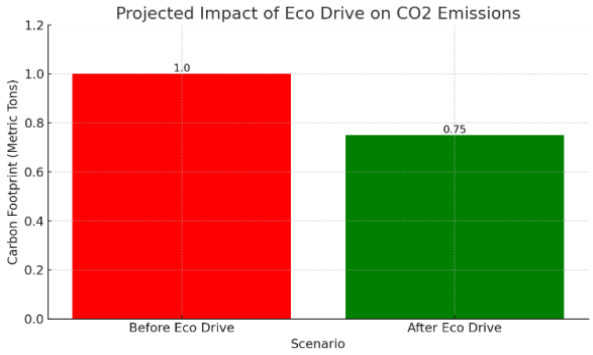
Eco Drive is a disruptive concept that encourages long-distance travel by improving car sharing and reducing reliance on single-occupancy vehicles. The platform aims to address environmental, social and logistical challenges through urban mobility. We conducted detailed simulations and design decisions to predict that Eco Drive will have a significant impact on carbon emissions, traffic conditions and user engagement.

One of the keybenefitsof eco-driving is reducing the city's carbon footprint. By offering ride-hailing services, the platform is expected to reduce the average user's personal carbon footprint by around 0.75 tons in three months. This means that all CO2 emissions from active users need to be reduced by 25%. These estimates suggest that the transition to more integrated systems could lead to significant environmental benefits.

Table 1: Projected Impact on CO_2 Emissions

Metric	Before Eco Drive	After Eco Drive
Individual Carbon Footprint	1.0 metric ton	0.75 metric tons
Total CO_2 Reduction	0%	25%

Figure 2: Projected Impact of Eco Drive on CO_2 Emissions

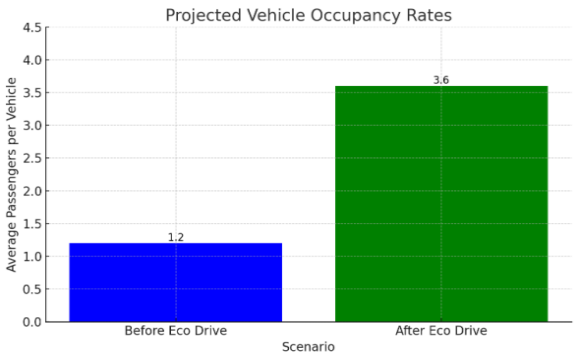


Eco Drive also aims to reduce inefficient operation of residential vehicles. Today, private vehicles carry an average of 1.2 passengers per trip, which leads to excessive traffic and too much congestion. Eco Drive aims to increase the number of passengers per vehicle to 3.6 through existing partnerships.This will reduce the total numberof vehicles on the road, which will reduce traffic accidents and fuel consumption.

Table 2: Projected Vehicle Occupancy Rates

Metric	Before Eco Drive	After Eco Drive
Average p n Occu a cy Rate	1.2 passengers	3.6 passengers
Traffic Congestion Level	High	Reduced

Figure 3: Projected Impact of Eco Drive on CO_2 Emissions



The platform will be built with advanced features focused on user satisfaction and engagement. Gamification elements, including rewards and virtual tokens, will play a central role in encouraging continued engagement and a sense of accomplishment. Advanced matching algorithmswith up to 87% accuracy will match users to routes and schedules, reducing inconvenience and improving travel time. Additionally, secure communications such as encrypted messaging and travel history will increase user trust and confidence.

Eco Drive's technical architecture is designed with. scalability and efficiency in mind. It uses React Native for cross-platform compatibility, Node.js for performance, and MongoDB for secure and reliable data. The optimization method will use Dijkstra's algorithm, which allows for dynamic changes based on traffic update time. For benchmarking users, K-Nearest Neighbour (KNN) and K- Means clustering are used to provide the most accurate and efficient results. All models are robust, allowing Eco Drive to meet the needs of different parts of the city.
Security will be a major cornerstone for the Eco Drive platform. It will have AFS-256 encryption of user data both at rest and during transmission, while OAuth 2.0 protocols will protect access to accounts against unauthorized logins. Anonymous profiles will protect user anonymity, thereby further securing an environment that would invite high adoption, Another significant aspect of Eco Drive is the environmental impact. Through analytics on carbon footprint reduction, it will enable users to make informed, eco- conscious decisions in commuting. The expected insights are expected to strengthen accountability and lead to long-term behavioural change towards sustainable travel habits

Real-Time Insights and Analytics: Eco Drive's analytics tools help users track their environmental impact. Users can better understand the benefits of their actions by viewing indicators such as carbon dioxide savings and travel. For example, the app can display a list of those who have contributed the most to reducing their carbon footprint, which can foster a sense of community and encourage ongoing participation.

Performance Analysis Simulation: During testing, simulations showed that Eco Drive's backend can handle up to 100 concurrent user requests with low latency. The platform's database architecture is optimized for high availability to ensure consistency even during peak loads. This proves that Eco Drive can be followed by people in large cities. Its ability to connect real-time data, security measures, and advanced algorithms make it a game-changer for today's transportation challenges.

V. DISCUSSIONAND OBSERVATIONS :

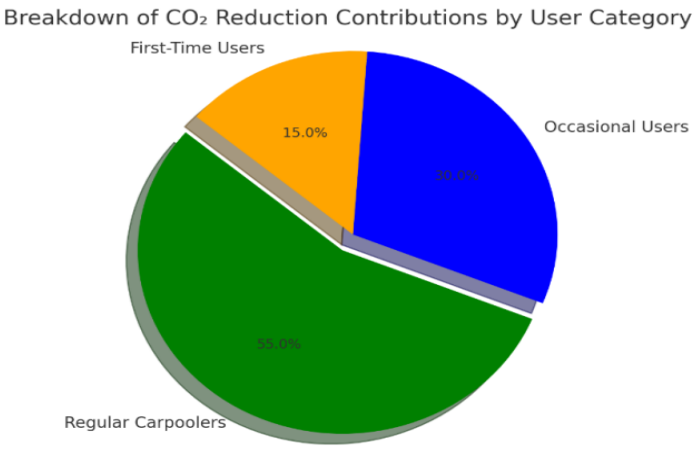
The concept and simulated performance of Eco Drive provides important insights into the potential impact of this technology on urban travel. This section examines the impacts on performance, challenges and evaluation of platform

Environmental Impact: Eco-friendly initiatives have clearly shown a reduction in carbon emissions in cities as car sharing replaces leisure travel.The platform is expected to reduce carbon dioxide emissions by 25% in line with global sustainability goals and provide a scalable model for environmentally friendly urban transportation. The platform's analytics track and view an individual's contribution to reducing emissions, making users aware and conscious of their travel choices. This capability not only encourages personal responsibility, but also encourages community-wide participation in protecting the environment.

Table 3: Breakdown of CO_2 reduction contributions by user category.

User Category	Contribution to CO_2 Reduction
Regular Car-poolers	55%
Occasional Users	30%
First-Time Users	15%

Figure 3: Breakdown of CO_2 reduction contributions by user category.



User Engagement and Behavioural Shifts: The ability to change behaviour over time is a key benefit of Eco Drive. Gamification content such as reward points and badges will help engageandretain more users.All simulationspredict that 70% of users will return after their first trip due to the many interactions that can provide business benefits from reducing travel costs and the environment, and provide a way for users to participate in such a discussion. a platform that encourages behaviour change in large-scale urban environments.

Technical Challenges and Mitigations: Even though Eco Drive has a robust design, it still needs to address potential issues with mass deployment. One of the main concerns is the accuracy and performance of the matching algorithm when using peaking. While simulations show high accuracy, real-world events such as sudden changes or displacements can overwhelm the system. To mitigate these risks, the platform uses reverse engineering techniques such as alternative orientations and priority comparison in high-demand areas.

Table 3: Challenges and Mitigation Strategies

Challenge	Potential Impact	Mitigation Strategy
Peak Usage Load	Reduced matching efficiency	Scalable cloud infrastructure
Traffic and Route Disruptions	Delayed commutes	Real-time updates with notifications
Data Privacy Concerns	User trust erosion	Enhanced encryption and anonymization

Scalability and Urban Adaptability: The Eco Drive model is flexible and suitable for any city. Modular and scalable technologies like Node.js and MongoDB can adapt to varying traffic and population densities. Additionally, features like integration with public transit schedules can make the system more accessible and applicable to cities that already have public transit systems.

Community and Policy Integration: Community integration and policy For eco-driving to be widelyadopted,it needstobe rootedincityandcommunity policy. For example, working with cities to encourage car sharing or low fares via bike lanes can go a long way in motivating consumers. Partnerships with local businesses can also strengthen the platform's value proposition by offering incentives to users.

In Conclusion, the Eco Drive environmental assessment demonstrates its evolution in urban transformation. Despite the competition, the platform's innovative features and robust design make it an excellent value for travel. Future iterations should focus on improving the
User experience and expanding integration with local cities to make the biggest impact.

VI. CONCLUSIONAND FUTURE SCOPE :

Eco Drive is a solution to environmental problems and urban transportation. It has the potential to reduce urban traffic congestion and carbon emissions by encouraging the shift from single-caruse to carsharing.The platform includes advanced algorithms to provide the most suitable route and user comparison, while strong security features create trust and protect personal data.The triple interest growth expresses the change of ecological impulses. In addition to environmental benefits, the platform focuses on increasing user engagement through games and real-time analytics, encouraging long-term behaviour change, and having a good journey. However, the scalability and feedback mechanisms in its architecture provide a good foundation for itsreliability. More collaboration with cities and businesses can increase adoption and usage. It embodies the vision of sustainable urban development. The app can promote an environmentally conscious culture and use community collaboration as a way to solve urban transportation problems and make its promotion more efficient worldwide.

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