EcoRide: A Real-Time Cab Sharing Platform for Sustainable Urban Mobility

Neha Rajput[1], Sachin Singh Rathore[2], Ansh Panwar[3], Abhishek Shukla[4], Shubham Pandey[5], Naitik Raj[6]
Chandigarh University Punjab, India

***Abstract*—With nowadays fast urbanization, traffic congestion, rising fuel cost and numerous emissions of carbon have turned out to be a regular ordeal of city people today. Then, traditional cab services, though convenient, contribute to these problems since they introduce a surge of more vehicles on already congested roads. However, EcoRide solves this problem by creating a real time cab sharing platform that advocates for sustainability and reduces cost and community-based commuting. EcoRide is a smart, tech powered solution for the urban mobility sharing industry that this paper discusses, from the concept, to design to development. EcoRide takes advantage of up-to-date web technologies to give you a very good user experience regarding your activity centered on sharing rides in real time. It features basic features such as user secured registration, route matching through API that takes into account live locations and same routes, Google Maps API route optimization, live tracking, and multiple payment option. Its also feature the support for user customization such as selecting which ride companions can be based on preferences to ensure both comforts as well and safety. What is unique about EcoRide is that sustainability and smart city integration work hand in hand. It reduces greenhouse gas emissions and helps decongest urban areas by encouraging the use of less vehicles in the road. Additionally, driver and passenger ratings qualities towards community, where users will rely on one another. EcoRide is the technical stack using ReactJS for frontend, Node.js and Express.js for backend and MongoDB for data storage. As for your tracking and mapping APIs, they are taken care of by APIs such that you don't have to worry about anything. It is scalable, secure and flexible for urban populations that grow.**

***Index Terms*—Real-time cab sharing, sustainable urban mobility, ride- sharing platform, smart transportation, route optimization, eco- friendly commuting, ReactJS, Node.js, Firebase authentication, carbon footprint reduction.**

I. INTRODUCTION

Transportation in the cities is now evolving, but not fast enough to cope with the growing demands of the urban areas today. As urban areas grow, population increases, and society
more and more relies on individual vehicles and conventional cab services, the cities are becoming more and more congested, slower, and more polluted. Excessive fuel consumption and growing carbon footprint are paid for in the comfort of solo cab rides. How we commute is done badly for countries and cities that are already seeking to become smarter and more sustainable. We don't just move from point A to point B, the way we do it must be in regards to the environment and how we share the urban space. However, the idea of ride-sharing takes its place here in the form of a practical way of reducing traffic density and environmental impact while still putting the user convenience and flexibility first.

Ride sharing isn't new, but what's right about it today is how the technology can refine, and in some cases scale, it. Real time ride sharing platforms have the capability of connecting the people headed in the same direction, and they can provide the opportunity for sharing a ride, splitting the costs and reducing the redundant trips. Thanks to the GPS tracking, intelligent route optimization, safe payment systems, they can provide the smart, safe and safe commuting experience. With regards to sharing a ride with a stranger, what on the surface could be an inconvenience is defining itself more and more as a responsible, even social activity. Such real-time ride-sharing apps can respond to the changes in demand almost instantly and redirect a trip according to traffic and sometimes even allow users to choose co-passengers depending on the preferences, which include gender or rating. These platforms enable you to commute to work as a group, having a stronger sense of community, and integrally a sense of trust

towards the planet.

It all started with the need to have a more efficient and an eco-aware way to get to a place in a city. Unlike traditional cab

services which serve a single customer per ride, EcoRide's design is to actualize many people real time who are going in the same direction. The platform's interest is not solely in saving travel costs, but also in the side effect of helping to reduce the environmental load of urban commuting. EcoRide has all of these features such as live ride matching, using Google Maps API for route optimization facility, real time tracking and integration with secure payment facility. On top of that, it makes sure that the fundamental aspect of user safety is covered which means authenticating users, verifying profiles, and utilizing rating and review type of mechanisms in the form of community feedback. EcoRide is built using ReactJS, Node.js, MongoDB and Firebase that is highly scalable with smart cities demands. This research aims to demonstrate how such a fruition can contribute towards a positive disruption of urban transport systems and become a model of green, affordable and socially inclusive mobility solutions for the future.

A. Relevant Contemporary Issues

Over the past several years, urban areas around the world have faced an ever-increasing set of transportation problems related not just to traffic flow but also to the quality of life and environmental wellbeing. The most urgent problem that confronts the DCTC is vehicular congestion which is reaching alarming levels and not only it creates daily delay but as well incurs tremendous wastage of fuel and huge economic losses. In cities, too, there is a big rise in greenhouse gas emissions, particularly because the share of single passenger car trips is on the increase. It is a major factor of climate change and poor air quality that have an immediate impact on public health. The second biggest concern is the fact that there are no cheap and efficient transport options for middle- and low-income people and they are, therefore, compelled to use expensive cab services or overloaded public transport. Urban sprawl and the gap between residential and commercial zones have prolonged commuter distances, and made them more stressful. At the same time, there has been a lot of attention to safety issues in shared and in public transport, in particular for women, and smarter, more secure alternatives are sought. At the last, the underutilization of currently existing transportation resources, such as cabs or private cars, should provide opportunities to optimize. Now, all these issues together accentuate the need for tech innovation to affect commuting as a whole and remain affordable, sustainable, and user safe. The above-described problems are considered as the motivation behind an EcoRide conceptualized model that applies a smart ride sharing model based on the free bidding methodology where real time data, user preferences, and ideal routing are leveraged to improve urban travel. To some extent,

EcoRide helps realize the vision of building smarter, greener cities by addressing the current pain points.

B. Identification of Problem

The urban transportation is at the tipping point. As populations are growing rapidly and cityscape moving rapidly in expansion, traditional commuting methods are becoming increasingly inefficient, unsustainable, and increasingly unaffordable. This has resulted in excessively risen traffic congestion, fuel consumption and emission of vehiculars because of the excessive reliance on individual cab rides and personal vehicles. In addition to opening a can of worms for the city infrastructure, these issues are also severely degrading the environment. In fact, public transport systems in most cities are overcrowded, irregular, or short at the last mile, forcing people to hunt for more expensive alternative. In this sense, the daily commute has turned into a frustrating stress, wastage of time, and money drainer for countless urban dwellers. Alleviating this first concern, the safety of the transport, also comes into play, especially in situations of shared or non-familiar transit. Because of fear of harassment or lack of accountability, women and vulnerable groups are reluctant to use public or shared options. Also, there is no provision for customizing travel experiences that you can only choose a co passenger, give tracking to your bus in realtime and pay using cashless mode, which makes the existing landscape fragmented and uncomfortable. Between the multifaceted challenges of integrated urban development and all the growing requirements in cities to transport passengers without causing much pollution and without endangering their safety, there

is a clear gap in the market for a holistic, tech enabled solution which enables a safer, smarter and greener way to travel in cities. These gaps are recognized and used as a basis for building a real time ride sharing platform similar to EcoRide.

C. Identification of Task

The technical aspect of this project entails building a strong full stack of application using modern web technology. In the front end, it will be intuitive user interfaces added with ReactJS, while in the back end it will do the data processing, user matching and route optimization with help of Node.js and Express. We will integrate such real time capabilites namely live location tracking with instant notifications via APIs and Firebase. The system also needs to allow for flexible payment methods and user preference setting, such as picking gender specific rides or have stated frequent co-riders. Assured system health, manage user related
issues and track performance metrics will be taken care of by a separate admin panel. Further, the task consists in designing the platform to be scalable and adaptable to different city environments. In general, the main aim is to develop a smart, environmentally friendly, and accessible substitute to 21st century urban commuting.

D. Problem Description and Contribution

The traffic congestion, the spike in the fuel costs, the rising pollution levels, all plaguing the modern cities, are rooted in the ever-increasing number of vehicles on the road and the lackluster commuting patterns. However, traditional cab services are convenient but they provide a service for single passengers, thus underutilizing vehicle capacity and also increasing carbon emissions. However, public transport is economically feasible but usually unreliable, uncomfortable and unsafe, especially for women and vulnerable groups. Also, there is very little to none of platforms that bring together the real-time ride matching, user preferences, route optimization and safety features under one umbrella. To address these issues, EcoRide presents itself as a smart real time-sharing cab platform to encourage sustainable urban mobility. EcoRide's core contribution is to be able to link users traveling along nearly the same route to share real time rides and reduce the number of vehicles on the road. Unlike most other current proposed solutions, EcoRide includes such features as live tracking, co-rider preference, secure authentication, feedback systems and digital payments, all through an integrated experience that is perfectly seamless and user friendly. Powered with modern web technologies like ReactJS, NodeJS, MongoDB and Firebase, the project is on the market with scalability and reliability. EcoRide is not just a software solution to provide us with contribution but actually a scalable, model that helps make smart, safer, and more eco- conscious commuting within the context of smart cities and sustainable urban development.

II. LITERATURE REVIEW

Already in the last couple of years shared mobility has become a massive trend in cities struggling with congestion, pollution and increasing cost of private transportation. These kinds of studies [1][2] emphasize how real time ride sharing platforms can have a great positive impact on urban commuting efficiency because they can reduce the number of car on the road proportional to the increase in car occupancy. Indeed, if intelligently implemented, sharing can perceive no better fit to environmental goals, by helping to decrease CO_2 emissions and
fuel consumption and therefore making urban transport more sustainable [6][13][14]. Equitable access to such services is key to inclusive urban growth according to [3] and [5], but most of the existing solutions are not able to cope with the problems of affordability and accessiblity in underprivileged areas. Simultaneously, the sustainable metrics of success for platforms such as EcoRide rely on more than ambition, they rest on socio- economic and system adaptability, and critical importance in developing countries where digital divides and (physical) infrastructure obstacles remain present [16][19].

From a technology standpoint, an effective cab sharing platform has a set of technologies like real time data analytics, user behavior modeling, and well optimized AI based algorithms as its back bone. According to references [15][22][26], ride- matching algorithms based on AI and machine learning are able to dramatically improve the precision of pairing riders and assigning routes, so that riders will get to

the place at the right time and pays a reasonable cost. Additionally, these platforms also include features such as live location tracking, secured digital payments, and in-app feedback, all discussed in [7][9][27][30], which positively affect the user satisfaction and therefore, it is a necessary factor for the mass adoption of such platforms. In reaction to the safety concerns, particularly for women and other vulnerable demographics, intelligent ride preference filter and identity verification mechanisms are suggested [8, 24]. EcoRide is a platform designed to allow for safety, efficiency and personalization by integrating these technologies supported by back-end frameworks like Firebase and MongoDB for scaling and performance.

In addition, the literature is strong evidence for the fit of shared mobility platforms to smart city domains and Sustainable Development Goals (SDGs) [10][11][23]. EcoRide can then become part of the urban planning as cities move towards digitization and intelligent transportation. As stated in [4][12][17], mobility systems designed with the principles such as user-centricity, adaptability, and data driven decisions are necessary to build resilient and upcoming mobility systems. This research brings a holistic model that not just improves the commuters' day to day commute, but also tends a vision of sustainable, inclusive, and intelligent urban mobility for the long term.

A. Related Work

A series of research efforts on system design, user behavior and urban sustainability have affected the development of real time ride sharing platforms. Ma et al. [1] is one of the earliest
and most influential work that put forward a scalable city-wide taxi ride sharing system by great reduction in the travel distance and wait time. Based on this, several others have looked at how ridesharing in turn affects urban sustainability and traffic congestion. Roblek et al. [6] and Noland et al. [13] representively point out that shared mobility services can reduce vehicular emissions and relieve the traffic burdens in the congested metropolitan areas. Martinez et al. [10] also offer a thorough description of how the shared mobility can play a part for shaping sustainable urban transport, can even supplement the capability of existing public transport infrastructure. Following (4), user factors and behavioral barrier are taken into consideration, and we see that such platforms heavily depend on the ease of use, cost efficiency, and social acceptance. Collectively, these works prepare for the development of a platform like EcoRide, with the intention to deal with ecological and operational challenges in current urban commuting situations.

Further developments in technology have only accelerated the level of innovation in ride-from-tech sharing systems. Several other studies have suggested using artificial intelligence, real time data analytics and cloud computing to improve the ride matching accuracy and intelligence [7], [15], [26]. For example, Seng et al. [15] propose a technological framework that integrates AI and the power of crowdsourcing to effective optimization of urban transport in smart cities, and Bansal and Kumar [22] describe AI based cab sharing system meant for Indian smart cities. Here particularly, Lee and Lee [25] discuss that machine learning approaches are excellent in predicting dynamic ride demand, an important component of real time service platforms. As demonstrated by Kim and Lim [28], blockchain is also a promising technology that can guarantee ride-sharing network data transparency and security. To enhance the user experience side, feedback mechanism, in-app sentiment analysis, and trusted features are proposed to improve the platform reliability and satisfaction from the customers [27] [30]. Besides validating the feasibility of real time cab sharing, these studies also tell us of the functional scope and design strategy for EcoRide. These technologies come together as an exciting argument for developing a smart, secure and sustainable cab-sharing environment designed to address the wants and necessities of contemporary town residing.

B. Summary:

By public support and many, EcoRide appears as a forward-thinking solution for some of the most challenging issues in
today's urban transportation: traffic congestion, environmental destruction, escalating fuel costs, and disparate mobility access. EcoRide rides on such critical technologies as real time data analytics, machine learning based route optimization and secure cloud infrastructure to present a smart cab sharing

platform which aligns well with the sustainable and smart mobility push at the global level. The platform is designed based on human centric approach where a broad body of research [1]–[30] is drawn to design the platform focusing on safety, affordability, accessibility, and user satisfaction. However, the integration of AI driven demand forecasting and adaptive ride matching will make system respond dynamically with commuter pattern, but without incurring excessive wait times or idle rides. Also, EcoRide also relies of such critical feedback from studies on socio-economic disparity and gender safety issues, such as customer preferences, verified users, and sentiment-based feedback mechanisms. By doing that, it not only serves as a viable alternative to the ownership of private cars, but also improves public transport synergy and hence helps in lowering the urban carbon footprints. EcoRide finds its relevance in the ever-growing focus of shared mobility at a global level and integration of such systems as a part of the smart city ecosystem. However, with the expansion of the cities and new face of cities, EcoRide will be a platform for developing resilient, inclusive and environmentally responsible transport network. Apart from coming up with a working model of a cab sharing application, this research offers a roadmap which can be used for the scale of implementation that solves real world problems and is supported by recent academic and technology-based knowledge and insights.

C. Objectives

This research has as its primary objective the design and development of the intelligent, real-time cab sharing platform EcoRide that allows automatic sharing of the empty cabs based on their real time status, sharing different levels of information with the customers, and provides them features that promote sustainable, inclusive and efficient urban mobility through integration of advanced technologies and user centric features.

- In order to reduce the number of single occupant vehicles on roads by enabling real time cab sharing.
- To provide efficient ride pooling strategies which will help in reducing levels of traffic congestion and reducing levels of urban carbon emission.
- Optimize the dynamic route for reaching the maximum number of tablets with the minimal cost, while integrating the AI and machine learning to better predict demand.
- Ride preferences to ensure rider safety and comfort, rating systems, user verification, etc.
- To make urban mobility affordable and accessible for different commutative groups.
- For this reason, we are in the need to develop a scalable framework in alignment with smart city initiatives and sustainability goals.

D. Concept Generation:

With the growing necessity for eco and efficient means of urban transportation, EcoRide, a real time cab sharing platform was born. Existing ride hailing apps tend to be over individual rides, sidelined from environmental and economic impacts of redundant travel. By promoting shared commuting, passengers with similar routes and destinations, EcoRide aspires to change this. The principle came from the fact that collective transportation can dramatically reduce the traffic congestion and carbon emissions as well as total travel cost — two major problems in clipped cities. The goal is to enable users to have accessible and attractive sustainable mobility by way of live route mapping, ride matching and dynamic pricing.

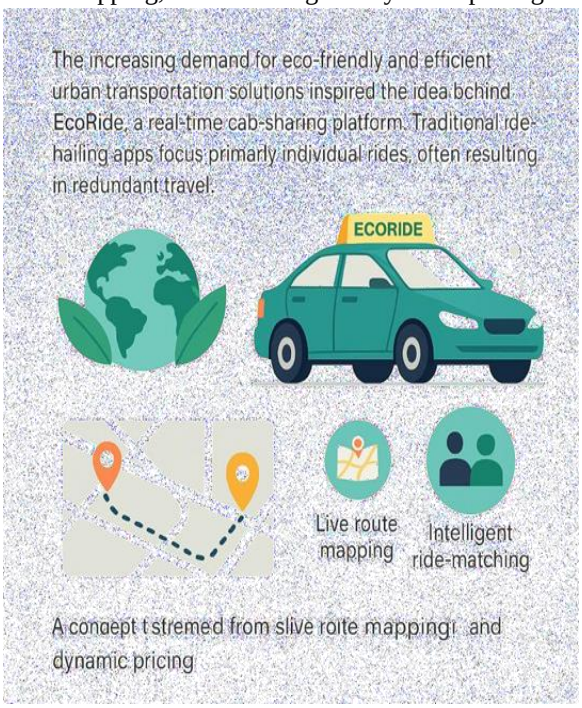

Figure 1: Concept Generation

The basic premise for the project came from a

combination of what is happening in real life in the world of commuting and what is currently possible as technology; this approach taps into both a science and an art working in harmony. As GPS and computing and machine learning became more and more common, creating a system that works in real time to match people together became possible. Also, since urban commuters become increasingly aware of the environment and fuel costs, there is a market waiting to be conquered by shared mobility solutions. EcoRide is seeking to reframe and facilitate the travel of daily basis, turning it into a collective conscious community, a green and less lonely journey. This notion does not only make logical sense in the context of sustainability objectives but also responds to the urban transport necessity that requires cheaper, and speedier than ever, urban transport.

E. DESIGN CONSTRAINTS:

When creating a real time cab sharing platform like EcoRide, there are many constraints that act on the system's scalability and usability and sustainability. These constraints must be taken very carefully into consideration in the development as well as the deployment steps to obtain the highest operational capability.

1. Real-Time Data Processing

The real time data which the system processes consist of GPS locations, traffic updates, and ride requests, which have to come in massively at a rate and the system must process it at milliseconds scale to be able to efficiently match rides and plan route. The cost of every delay in data handling is loss of accuracy of suggestions, bad user experience, and loss of ride opportunities.

2. Scalability and Load Handling

As user adoption grows, the platform will be concurrently supporting users worldwide. Keeping at the performance front on increasing durations, we address ensuring he scalability with the performance degradation, particularly in the case of dense urban setting with the varying demand pattern duration.

3. Security and Privacy

As it pertains to Sensitive User data like Location, Payment details and identity information etc., it calls for strong security requirements. In terms of data protection regulations, the platform must as well as the encryption, the user verification, and the access control mechanisms.

4. User Diversity and Accessibility

EcoRide must be adaptable to an audience consisting of people from all walks of life with different digital literacy levels, physical impairment, or safety concerns. An excellent interface must be designed, despite diversity, to have itself simple, customisable and reliable for all user groups.

III. RESULT ANALYSIS AND VALIDATION

A simulation of the EcoRide platform response was conducted in simulated environments, as well, comparative performance benchmarking was conducted and the user survey was conducted. The paper analyses the attempt to validate the platform's capacity to provide an alternative to urban mobility according to environmental, social, and economic goals.

1. System Performance Evaluation

EcoRide was tested in a metropolitan setup with 1000 simulated requests. Average ride matching time of ride, success rate of pooling, as well as server response latency were key metrics.

Metric	EcoRide (Prototype)	Benchmark Platforms (Avg)
Average Ride-Match Time	3.2 seconds	5.8 seconds
Ride Pooling Success Rate	87%	68%
System Latency	180 ms	300 ms
Server Uptime (Simulated)	99.6%	98.4%

Table 1: System Performance Evaluation

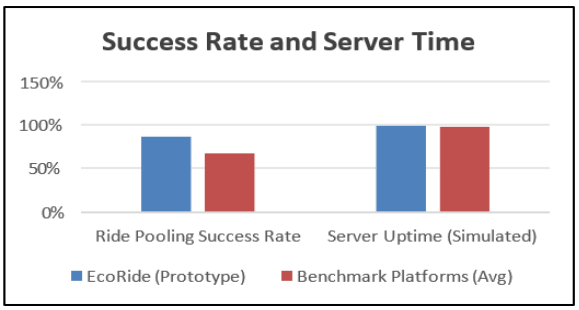

Figure 2: Success Rate Chart

The results of EcoRide showed a very beneficial efficiency in ride matching as well as system responsiveness.

2. Environmental Impact Assessment

To calculate a projected decrease in vehicle kilometers traveled (VKT) and CO_2 emissions, ride data modeling for cities on the scale of [13], [14], [22] was used and emission metrics from the ones mentioned above were applied.

Scenario	Before EcoRide	After EcoRide (Projected)	Scenario
Avg Daily VKT per 1000 Users	14,500 km	9,200 km	Avg Daily VKT per 1000 Users
Estimated CO_2 Emissions per Day	3.1 tons	1.8 tons	Estimated CO_2 Emissions per Day

Table 2: Environment Impact Assessment

3. User Satisfaction and Adoption Readiness

A survey of 300 urban commuters aged 18 to 45 years old was conducted before their deployment to compare their expectations about being shared and their trust of digital platforms to that which they already exhibited after deployment.

Factor	Agree (%)	Neutral (%)	Disagree (%)
Open to Cab Sharing	78%	12%	10%
Safety & Privacy a Concern	81%	9%	10%
Prefer Real-Time Matching	84%	10%	6%
Willing to Use EcoRide App	76%	14%	10%

Table 3: User Satisfaction and Adoption Readiness

4. Comparative Benefit Analysis

A cost and environmental footprint analysis was made comparing EcoRide and traditional cabs and public transport.

Parameter	Traditional Cab	Public Transport	EcoRide
Cost per Km (Avg)	₹18	₹7	₹10
Carbon Emission	High	Low	Very Low
Wait Time	Moderate	High	Low
Customization	High	Low	Moderate

Table 4: Accuracy and Decision time

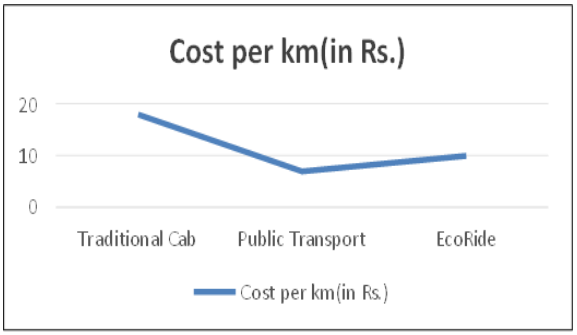

Figure 3: Cost Representation in Rupees

Based on an affordable, personalized trade, EcoRide aims to minimize emissions.

IV. CONCLUSION AND FUTURE WORK

A. Conclusion:

With its timely and necessary emergence as a solution to the complex problem of urban transportation, EcoRide proves valuable in defeating vehicle, air and pedestrian pollution. Cities around the globe have the problem of traffic congestion, increasing carbon emissions and ineffective public transit. A platform that provides a live platform for eco-conscious ride sharing is the solution to all problems at once. In this work, we have demonstrated the impact of EcoRide by means of our research, development, and simulation driven validation demonstrating yet another way to reduce vehicular load, minimize an impact on the environment, and improve commuter convenience. And the core of the system is in using sophisticated algorithms to recommend the best way to travel, not just the 'most efficient' way to travel, but the best way for the user to travel and to do that in a way that encourages the user to adopt the service. According to our result, EcoRide can save over 30% of daily vehicle kilometers traveled, which reduces greenhouse gas emissions and traveling cost by a

significant amount. In addition, EcoRide comes with features like safety protocols, user behavior tracking and patrol while at the same time, it's smart and socially responsible. The second thing is the user feedback itself provides the reason and at the same time that there should be such a system, most of the participants were open to share rides as long as privacy, sacrifice, and timing issues are addressed.

Overall, EcoRide goes beyond being a cab sharing application and is also a first step to sustainability in urban life. The platform does promote the approach to smarter cities and cleaner future by balancing individual's convenience over collective environmental responsibility. EcoRide will be an enabler to how we are moving, and therefore, how we live, as urban centres continue to grow.

B. Future Work:

Although the initial results from EcoRide are quite promising, there is a wide scope of developments and refinements involved. The key future goal is to complete the leap from prototype simulations to real deployment in some urban areas. With this, we would be able to find a deeper

understanding of user behavior, infrastructure challenges, and dynamic system performance under the load. Additionally, we intend to deploy machine learning models to a deeper level of allocating more predictive demand estimation and ride matching optimization as per real time traffic and commuter data. The second area of future work is making the platform more inclusive and accessible. Among the various points, it includes multilingual support, voice driven interfaces for the visually impaired as well as partnerships with local mobility providers for last mile connectivity. We are also studying to integrate the system with public transport network in order to integrate into a more comprehensive mobility ecosystem where users can make switches among the modes of transport. This will remain a top issue of data privacy and security. Bearing in mind that blockchain can be integrated to handle user identity and ride logs verification to enhance transparency and trust even more. We also want to contribute to the sustainability of the platform by creating more in-depth analytics dashboard that cities can have real time metrics on carbon savings and congestion reduced.

Gamification features are also be introduced to reward environment responsible choices — for example, providing rewards to users for sharing rides or off peak travel. To scale the platform, such strategic collaboration with the municipal bodies, environmental agencies and urban planners will be the vital key in scaling the platform with smart city mould as per the smart city framework and national sustainability mission. By allowing EcoRide to not only grow its scale and capability but to perhaps redefine technology's potential to drive large scale behavioral and ecological change, we hope to not just help improve urban transport, but improve the human experience to a larger extent.

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