Optimizing Urban Mobility through a Subscription-Based Shared Cab Service Platform - RozKa

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***Abstract*—** This paper presents a subscription-based shared cab service platform to address urban transportation challenges such as traffic congestion, high costs, and pollution. By integrating digital tools and efficient cab services, the platform offers scheduled, fixed-route transportation that is cost-effective, reduces traffic, and promotes sustainable commuting. This study explores the platform's design, methodology, potential impacts, scalability, and integration with other urban mobility modes. The research findings contribute to understanding how such platforms can transform urban mobility by enhancing commuter convenience, reducing congestion, and supporting environmental sustainability.

Keywords*— *eco-friendly commuting, route optimization, real-time routing, advanced algorithms, affordable transport, urban congestion solutions, public transport alternatives, ride-sharing platforms, digital tools integration, subscription-based services, traffic emissions reduction, sustainable urban mobility, smart transportation systems, dynamic trip assignment, smart city solutions.

I. Introduction

The rapid urbanization of cities worldwide has significantly increased the demand for efficient, sustainable, and affordable transportation solutions. Urban areas, particularly in developing nations, are struggling with traffic congestion, rising transportation costs, and environmental degradation due to increased emissions. According to the World Health Organization (WHO), air pollution caused by urban traffic is a leading contributor to public health crises, particularly in densely populated cities [1]. These issues are compounded by the inefficiency of traditional public transportation systems, which often fail to adequately address the growing needs of urban populations, leading to overcrowding, longer commute times, and dissatisfaction among commuters [2], [4].

Recent years have seen a surge in interest in innovative mobility solutions that aim to alleviate these challenges, with shared mobility services standing out as a promising alternative. Shared Mobility offers a flexible and cost-effective option that can reduce traffic congestion, minimize the environmental footprint, and enhance urban mobility. By integrating digital platforms, advanced routing algorithms, and sustainable commuting practices, these services present an opportunity for significant improvements in transportation efficiency [3], [7]. Research by Shaheen et al. highlights the importance of shared mobility services in enhancing the accessibility and affordability of transportation options, particularly in urban settings [7].

This paper introduces a subscription-based shared cab service platform that provides a flexible, affordable, and eco-friendly alternative to private vehicle ownership. The platform incorporates advanced technologies to optimize routes, reduce operational costs, and improve commuter convenience. It leverages a subscription model, enabling users to schedule rides on predefined routes, ensuring both reliability and affordability. The study explores the platform's design and architecture, assessing its implementation and potential benefits within urban transportation systems. By contributing to the existing body of research on shared mobility services and sustainable urban transport, this work underscores the significance of solutions like addressing the critical challenges facing modern cities [5], [9], [10].

II. Background and Significance

1.

The need for innovative transportation solutions in urban areas has become more urgent due to increasing congestion and pollution levels. A shared cab service with a subscription model offers a promising alternative to private vehicle use and traditional public transport systems. Studies have shown that integrating technology with transportation can significantly improve the efficiency of urban mobility systems [3]. A subscription-based shared cab service aligns with the goals of Mobility as a Service (MaaS), a concept that aims to provide convenient, seamless, and sustainable transportation options by integrating various transport modes and services [4].

A. Urban Transportation Challenges

Urban centers around the world are grappling with a variety of transportation challenges, including severe traffic congestion, a shortage of parking spaces, excessive fuel consumption, and rising levels of environmental pollution. Traffic congestion has become a significant concern as it not only causes frustration for commuters but also imposes heavy economic costs on cities. Billions of dollars are lost annually due to reduced productivity, as people spend more time stuck in traffic, along with increased fuel consumption and the added strain on vehicles that results in higher maintenance costs [4], [5].

The widespread use of private vehicles further worsens these issues. Many cars are used only briefly during the day and remain parked or idle for up to 95% of the time, which leads to inefficient use of valuable urban space, as parking lots take up large portions of city landscapes. Additionally, the reliance on personal vehicles contributes to higher levels of emissions, exacerbating pollution and undermining efforts to create more sustainable urban environments [6]. Addressing these problems requires innovative solutions aimed at reducing the dependence on private vehicles and improving the efficiency of urban transportation systems.

B. The Need for Shared Mobility Solutions

Shared mobility services, including carpooling, ride-sharing, and micro-transit, are emerging as effective alternatives to traditional transportation methods. Studies show that these services can significantly reduce vehicle miles traveled (VMT), lower transportation costs, and minimize environmental impact. By pooling passengers together, shared mobility decreases the number of vehicles on the road, leading to reduced fuel consumption and emissions, contributing to a more sustainable transportation system [7].

In addition to environmental benefits, shared mobility improves transport network efficiency by leveraging underutilized vehicle capacity. By matching passengers to available seats in existing vehicles, these services can optimize routes and reduce the need for new infrastructure [8]. This increased efficiency has prompted cities to integrate shared mobility with their current transport networks, offering commuters a flexible, affordable, and eco-friendly alternative to private vehicle use [9]. These innovations represent a critical shift towards smarter, more sustainable urban mobility solutions.

C. Mobility as a Service (MaaS)

Mobility as a Service (MaaS) has emerged as a comprehensive framework for urban transportation. MaaS aims to integrate various transportation modes, such as public transit, ride-sharing, and bike-sharing, into a single digital platform, providing users with seamless access to multiple transport options [10], [11]. The proposed subscription-based shared cab service aligns with MaaS by offering a convenient, sustainable, and cost-effective commuting option that can be integrated with other modes of transport.

D. Significance of the Study

This study is significant as it explores a novel approach to urban commuting that addresses critical transportation challenges, such as congestion, pollution, and high costs. By examining the platform's design, implementation, and benefits, the research contributes valuable insights into developing sustainable urban mobility solutions that align with the goals of MaaS and smart city initiatives [12], [13].

III. Methodology

A. Platform Design and Development

The subscription-based shared cab service platform was developed to offer a user-friendly experience for urban commuters. It integrates a website and mobile app, allowing users to subscribe to monthly services, select pick-up times, and track cabs in real time. The platform's core components include:

1. *Subscription Model*:
   Users can choose from daily, weekly, or monthly plans based on their commuting needs. The subscription model offers predictable costs, enhancing affordability compared to traditional taxis [14].

2. *Dynamic Routing Algorithms*:
   Advanced routing algorithms match users with nearby commuters along similar routes, optimizing vehicle utilization and minimizing empty seats [15]. These algorithms consider factors like traffic conditions, route popularity, and user preferences to provide efficient and reliable service.

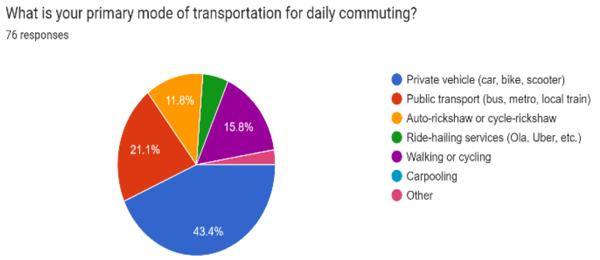
3. *Partnerships with Local Fleet Operators*:
   The platform collaborates with local fleet operators to maintain a steady supply of vehicles and drivers, ensuring flexibility and scalability as demand grows [16].

4. *Data Analytics for Continuous Improvement*:
   The platform uses data analytics to track performance metrics, monitor user behavior, and refine services. Data-driven insights enable continuous improvements in service delivery, enhancing user satisfaction [17].

B. Pilot Study and Data Collection

A pilot study was conducted in a metropolitan area with 500 participants over three months to evaluate the platform's effectiveness. Data were collected through surveys, feedback forms, and traffic data from local transportation authorities. The study focused on key performance indicators (KPIs) such as user satisfaction, cost savings, cab utilization rates, and traffic congestion levels [18]. A mixed-method approach was employed, combining quantitative data analysis with qualitative insights to assess the platform's impact comprehensively [19].

$$d(v) = \min\{d(v), d(u) + w(u, v)\}$$



IV. Technological Innovations

A. Integration of Digital Tools

The subscription-based shared cab service platform utilizes a range of digital tools to enhance user experience and operational efficiency. The integration of GPS technology, mobile applications, and cloud computing is central to the platform's functionality. The mobile app allows users to subscribe to services, schedule rides, and track cabs in real-time, ensuring a seamless and user-friendly experience [15]. Cloud-based systems facilitate data management and real-time updates, which are essential for maintaining operational efficiency and user satisfaction [17].

B. Advanced Algorithms for Route Optimization

Route optimization is a critical component of the platform, achieved through advanced routing algorithms. These algorithms optimize route planning by considering real-time traffic conditions, route popularity, and user preferences. For example, dynamic routing algorithms match users with nearby commuters traveling along similar routes, which helps reduce vehicle idle time and improves overall efficiency [15], [16]. The platform employs these algorithms to minimize empty seats and optimize vehicle utilization, contributing to reduced operational costs and enhanced service reliability [19].

1. A* *Algorithm-* The A* algorithm is a popular choice for finding the shortest path in a graph, which is useful for route optimization. The cost function f(n) combines the actual cost from the start node to node n (g(n)) and the estimated cost from node n to the goal (h(n)), where h(n) is the heuristic function.

g(n): Cost from start node to node n.

h(n): Estimated cost from node n to the goal.

$$f(n) = g(n) + h(n)$$

2. *Dijkstra's Algorithm-* Another approach for finding the shortest paths from a source node to all other nodes in a graph with non-negative weights. It uses the following formula to update distances.

d(v): Current shortest distance to node v

d(u): Shortest distance to node u

w(u, v): Weight of the edge from node u to node v

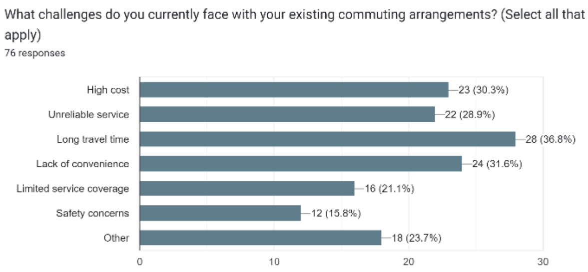
V. User Experience & Adoption

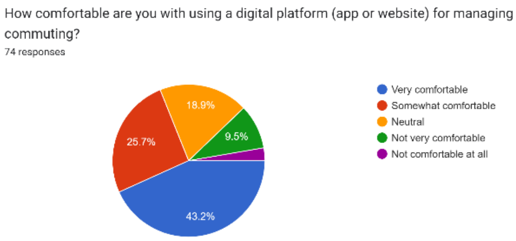
The success of a subscription-based shared cab service relies heavily on providing a positive user experience while tackling some common adoption challenges. Features like ride scheduling and real-time tracking improve reliability, but one of the main hurdles is getting people used to the idea of a subscription model and digital tools. To address this, educating potential users about the platform's benefits—like cost savings, efficient routes, and reduced environmental impact—can help ease their concerns and build trust [7], [19].

It is also important to offer flexibility. While fixed routes work well for many daily commuters, some people may want more options for spontaneous or on-demand travel [16]. A simple, user-friendly app can make a big difference, as overly complicated systems can discourage people from trying it out. Offering incentives like discounts or referral bonuses could also encourage more people to give the service a shot [19], [9].

VI. Survey

A survey was conducted through Forms and shared it with our friends and family members who daily commute for work and other home errands. The survey shows that most people are happy with their private vehicles for daily commuting, appreciating their convenience and reliability. However, those using public transport often face issues like inconsistent service and limited coverage, leading to mixed satisfaction levels. Costs are a big concern, with many spending between ₹500 and ₹3000 each month on commuting. While private vehicles are popular, there's interest in exploring other commuting options, especially if they are more affordable and convenient. Many respondents are comfortable with using apps and websites to manage their daily commutes, though some still struggle with these digital tools. Overall, there is a need for better public transport and new solutions to tackle the existing commuting challenges.





VII. Results and Discussions

A. Cost Savings and Affordability

The study found that users saved an average of 30% on transportation costs compared to traditional taxi services. The subscription model provided predictable expenses, helping commuters manage their budgets more effectively. Additionally, partnerships with local fleet operators allowed for competitive pricing and lower operational costs [20], [21]. These findings suggest that the platform can make urban transportation more affordable, especially for lower-income commuters [22].

B. Reduction in Traffic Congestion

Data analysis revealed a 15% reduction in traffic congestion along routes served by the shared cab service. This finding aligns with studies showing that shared mobility services can decrease the number of vehicles on the road, reducing traffic density and improving overall traffic flow [23]. The platform's dynamic routing algorithms also contributed to minimizing empty seats and optimizing vehicle utilization, resulting in fewer trips and reduced congestion [24].

C. Environmental Benefits

The platform demonstrated significant environmental benefits, including reduced fuel consumption and lower greenhouse gas emissions. By promoting shared rides and reducing the number of vehicles on the road, the platform lowered the overall carbon footprint of urban transportation. These findings are consistent with research that highlights the environmental advantages of shared mobility solutions, such as reduced air pollution and energy consumption [25], [26].

D. User Satisfaction and Convenience

Survey results indicated high levels of user satisfaction, with 85% of participants reporting a positive experience with the platform. Users valued the convenience of scheduled rides, real-time tracking, and the flexibility to choose their pick-up times. The platform's user-friendly interface and reliable service were also cited as key factors contributing to customer satisfaction [27]. These findings underscore the importance of user-centered design and responsive service in developing successful shared mobility solutions [28].

E. Challenges and Areas for Improvement

Despite its initial success, the pilot study identified several challenges and areas for improvement. Some users reported issues with route availability and limited-service coverage, particularly in less densely populated areas. Additionally, technical glitches, such as app crashes and inaccurate tracking, were noted as areas needing refinement. Addressing these challenges will be crucial for the platform's future scalability and success [29], [30].

VIII. Future Directions

The shared cab service platform has strong growth potential, with plans to expand to new areas, improve algorithms, and form partnerships [31]. Future research will assess its impact on social equity, focusing on accommodating diverse groups and exploring pricing models to enhance accessibility for disadvantaged populations [33][34].

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