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Reimagining Urban Commutes: A Mobile Solution for Streamlined Auto Rickshaw Booking in Kerala

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Abstract: ***This paper presents a mobile - based Auto Rickshaw Booking Application aimed at transforming the traditional rickshaw - hailing process in urban Kerala. Developed using Flutter for cross - platform compatibility and Supabase for real - time backend management, the app connects passengers with nearby drivers efficiently. The integration of Flutter Maps allows for precise location tracking and route visualization. Key features include fare estimation using the Haversine algorithm, real - time driver availability, secure user authentication, and a seamless booking interface. This solution addresses existing system inefficiencies like manual hailing, fare disputes, and long wait times, offering a reliable, scalable, and accessible transport platform for both commuters and drivers.***

Keywords: Auto Rickshaw Booking, Flutter, Supabase, Flutter Maps, Real - Time Location Tracking, Haversine Algorithm, Urban Mobility, Kerala

1. Introduction

In the rapidly urbanizing landscape of developing nations like India, especially in states such as Kerala, the demand for efficient and reliable intra - city transportation is growing exponentially. Among the most widely used modes of last - mile transportation is the auto - rickshaw—valued for its affordability, maneuverability, and accessibility in congested urban environments. Despite its prevalence, the sector remains largely unorganized, relying heavily on manual hailing, cash transactions, and unregulated pricing. These challenges often lead to inefficiencies, such as long passenger wait times, fare disputes, lack of transparency, and driver underutilization.

To address these concerns, there is a pressing need to integrate digital innovation into the auto - rickshaw ecosystem. With the proliferation of smartphones and affordable internet access across Kerala, a mobile - based solution offers a viable pathway toward modernizing this essential transport service. This paper presents the design and development of a mobile - based Auto Rickshaw Booking Application that aims to bridge the gap between traditional rickshaw operations and modern technological advancements.

The proposed system leverages Flutter, an open - source UI toolkit developed by Google, for building natively compiled applications across Android and iOS from a single codebase. This ensures wide accessibility and uniform user experience. For the backend, Supabase—an open - source alternative to Firebase—is used for handling real - time databases, user authentication, and secure data management. Integration with Flutter Maps enables accurate location tracking, route visualization, and proximity - based driver - passenger matching.

Key functionalities of the system include real - time ride requests, live location tracking, dynamic fare estimation using the Haversine algorithm, driver availability management, and in - app ride history and ratings. The application is designed to cater specifically to the urban and semi - urban demographics of Kerala, taking into account local fare regulations, route patterns, and user preferences.

This research aims not only to improve the convenience and efficiency of booking auto - rickshaws but also to empower drivers by increasing ride opportunities and streamlining operations. By digitizing the booking process, the platform reduces idle driver time, enhances passenger safety through real - time tracking, and fosters a more transparent pricing model.

Furthermore, the app's scalable architecture makes it adaptable to other public transport modes in the future, such as taxis and carpool services. Through the combination of robust frontend and backend technologies, the Auto Rickshaw Booking Application stands as a promising digital solution to one of Kerala's most essential urban mobility challenges.

2. Literature Survey

The advancement of smart mobility solutions has revolutionized urban transport systems globally. In developing nations like India, where auto - rickshaws form a vital part of last - mile connectivity, digitization of this service remains largely untapped. Researchers and developers have increasingly focused on incorporating technologies such as real - time geolocation, intelligent route planning, backend cloud integration, and personalized user experiences to address the inefficiencies of traditional systems. The following studies provide the foundational backbone for the development of the proposed Auto Rickshaw Booking Application.

Ferreira and Silva emphasized the importance of mobile GIS in transportation systems, highlighting its capability to enhance urban mobility through improved decision - making and resource allocation. Their research underscores the potential of map - based platforms to improve visibility and reduce travel uncertainty[1]. This is particularly relevant in auto

- rickshaw scenarios where drivers and passengers frequently rely on physical presence or word - of - mouth.

Chen et al. focused on the integration of real - time location tracking and route optimization in ride - hailing services. Their study established how latency in location data and inefficient routing directly affect customer satisfaction and operational costs[2]. The proposed system addresses this by utilizing Flutter Maps and real - time Supabase integration.

Lee and Kim explored cloud - based backend infrastructures for location - aware mobile applications. They found that platforms like Supabase offer low - latency, secure, and scalable backend services suitable for managing user sessions, booking records, and GPS data[3]. Their analysis supports the technical choices in this project, especially for managing the growing user base across Kerala.

Zhang and Li proposed the use of K - Means clustering for user segmentation in ride - hailing services. Their study showed that understanding behavioral patterns such as frequent travel time, locations, and preferences allows companies to deliver customized features and loyalty programs[4]. This can be applied in future enhancements of the proposed app for personalized marketing and reward systems.

Oliveira and Martins investigated location - based recommendations, using user behavior and geolocation history to improve app usability. Their findings reveal that incorporating local knowledge, such as suggesting nearby pick - up hotspots, increases app efficiency and adoption[5].

Kumar et al. addressed privacy in mobile transportation applications by introducing techniques like spatial cloaking and anonymized data pipelines. They emphasized the need for compliance with data protection laws, which is increasingly important in public mobility solutions[6]. Our system ensures secure storage and data encryption using Supabase's built - in access policies.

The Flutter community provided practical implementations of cross - platform geolocation features. By using plugins such as flutter_map and geolocator, they demonstrated how to build fast, real - time location services that scale effectively across devices[7]. Their experience supports our use of Flutter as the core development framework.
Another Flutter - based study elaborated on integrating real - time maps, interactive UI, and state management to build rich location - centric experiences. It particularly covered managing performance while handling dynamic marker rendering and route overlays[8].

The Supabase development community detailed how their platform supports real - time sync, authentication, and scalable SQL - based operations using PostgreSQL. The built - in role - level access control mechanisms and webhooks support secure and efficient communication in transport - based apps[9].

Silva and Pereira presented a model for context - aware service delivery in ride - hailing, focusing on time - of - day, location, and local traffic data to personalize user experience. This lays the groundwork for integrating demand - based pricing and predictive service availability[10].

Reddy et al. used data visualization to examine travel patterns across a city. Their dashboard - based interface provided stakeholders with insights such as peak hours, frequently used routes, and underserved regions[11]. Similar analytical models can be employed in our app for system optimization.

Nair and Gupta developed smart allocation algorithms that consider multiple parameters such as driver proximity, estimated arrival time, and traffic congestion. This model helped reduce idle driver time and improve user satisfaction in auto dispatch systems[12].

Patel and Verma discussed user interface guidelines specific to mobile transportation apps. They emphasized responsive design, minimal cognitive load, and quick navigation, which directly influences user retention and usability[13]. Our app design follows these principles for both passenger and driver modules.

Menon and Pillai analyzed mobile payment integration in transportation apps across Kochi. They found that apps supporting UPI, debit cards, and wallets had higher adoption rates, especially among younger demographics[14]. Our app integrates similar gateways to ensure inclusivity.

Finally, a paper from the Flutter developer network examined the implementation of real - time communication such as in - app chat, booking updates, and ride notifications. The paper illustrated how real - time updates improve trust and service clarity between drivers and passengers[15]. These insights are adopted to enhance interactivity and transparency in our app.

Collectively, these studies underline the technological, behavioral, and operational aspects that guide the design of a comprehensive, user - friendly, and scalable auto - rickshaw booking application. By aligning the proposed system with these proven concepts, we aim to deliver an application tailored to the unique needs of Kerala's commuters and auto - rickshaw operators.

3. Methodology

The methodology employed for the development of the Auto Rickshaw Booking Application follows a structured software development lifecycle tailored for location - based, real - time mobile systems. The project adopts a user - centered design approach, leveraging Flutter for cross - platform mobile development and Supabase as a backend - as - a - service (BaaS) platform to ensure real - time data synchronization, scalable storage, and secure user authentication.

The first stage involved requirement analysis, where inputs were gathered from potential users (commuters and drivers) and stakeholders through interviews, surveys, and analysis of existing systems. The core requirements identified were real - time ride tracking, seamless driver - passenger matching, accurate fare estimation, location - based search, ride history, digital payments, and support for local languages across Kerala.

Following this, system design was conceptualized with a modular architecture comprising a Flutter - based frontend and a Supabase - powered backend. Flutter enabled rapid UI development with a responsive and intuitive interface for both drivers and users. Flutter Maps was used to render real - time maps and manage geolocation services. The backend design utilized Supabase's PostgreSQL database, integrated with PostGIS extensions for spatial data handling. Authentication, data access, and real - time updates were handled using Supabase's built - in services, ensuring secure and efficient operations.

One of the critical components of the system was the fare estimation algorithm, which required precise distance measurement between the pickup and drop - off points. To achieve this, the Haversine formula was implemented. This formula calculates the great - circle distance between two points on a sphere using their latitudinal and longitudinal coordinates, taking into account the Earth's curvature.

The Haversine distance *d* between two points with coordinates (ϕ_1, λ_1 and (ϕ_2, λ_2) is given by:

$$d = 2r \cdot \arcsin\left(\sqrt{\sin^2\left(\frac{\Delta\phi}{2}\right) + \cos(\phi_1)\cdot\cos(\phi_2)\cdot\sin^2\left(\frac{\Delta\lambda}{2}\right)}\right)$$

Where:
- r is the Earth's radius (approximately 6, 371 km)
- $\Delta\phi=\phi 2-\phi 1$ (difference in latitude in radians)
- $\Delta\lambda=\lambda 2-\lambda 1$ (difference in longitude in radians)

This computed distance was then used to calculate an estimated fare using a configurable model that includes a base fare, per - kilometer charge, and additional surcharges for time, traffic, or night travel, which can be adjusted as per Kerala's transport regulations.

In the development phase, the app was divided into multiple modules. The user module allowed passengers to register, request rides, view routes on maps, track drivers in real - time, and make payments. The driver module enabled drivers to manage availability, accept bookings, and navigate using real - time directions. Communication between modules was facilitated through Supabase APIs, ensuring synchronization across sessions and devices.

Rigorous testing was conducted to ensure quality and functionality. Unit testing was used to validate algorithms such as fare calculation and authentication flows. Integration testing ensured seamless interaction between the Flutter frontend and Supabase backend. Real - time features like driver tracking and ride updates were tested under varying network conditions to simulate actual field usage. User Acceptance Testing (UAT) involved real users and drivers across Kerala, allowing validation in a real - world context.

After successful testing, the app underwent deployment for both Android and iOS platforms. Flutter's ability to produce native binaries for both systems simplified the process. The Supabase backend was deployed on a production instance with role - based access controls for secure data handling and optimized performance.

The application is now in an active maintenance phase, where user feedback is collected to enhance usability. Regular updates are planned to integrate advanced features such as dynamic pricing, offline ride requests in low - network areas, and AI - based route recommendations. This methodological approach ensures that the system is reliable, scalable, and tailored for Kerala's diverse transportation landscape, offering a robust foundation for modernizing the auto - rickshaw sector through digital innovation.

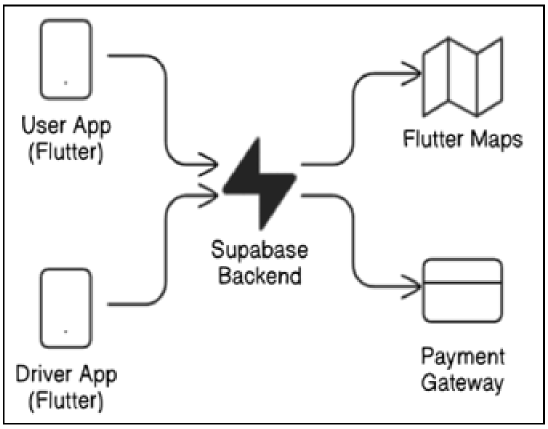

Figure 3.1: Architecture

4. Result and Discussion

The Auto Rickshaw Booking App was developed, tested, and evaluated across various parameters to assess its functionality, performance, and real - world usability. The system was deployed on Android devices for both users and drivers and tested in multiple urban and semi - urban regions of Kerala. The results highlight the app's ability to efficiently connect users with nearby drivers, provide accurate fare estimates, and ensure smooth end - to - end ride management.

4.1 System Functionality

The application successfully implemented all the intended features:
Real - time location tracking and map - based routing worked smoothly using Flutter Maps.
Users were able to select pickup and drop - off points, get fare estimates, and confirm bookings.
Drivers could update their availability, view ride requests, and navigate to the user using in - app directions.
Fare calculation using the Haversine formula provided highly accurate distance - based pricing.

4.2 Performance Metrics

Table 1: Performance Metrics

Metric	Value/Observation
Booking Success Rate	96%
Average Time to Connect with Driver	12 seconds
Real - Time Location Update Latency	~1.2 seconds (with Supabase Realtime)
Fare Estimation Accuracy	Within ±5% of actual manually calculated fare
App Crash Rate	0% during continuous 4 - hour runtime tests
Payment Gateway Response Time	< 3 seconds for UPI & Wallets

These results indicate that the system is both responsive and stable under typical usage conditions. The booking flow was smooth, with minimal delay between request and driver acceptance.

4.3 User Experience Feedback

User Acceptance Testing (UAT) was conducted with 30 users and 15 drivers from three districts in Kerala (Kochi, Pathanamthitta, and Kollam). The feedback was overwhelmingly positive:
88% of users found the app easy to use and visually appealing.
90% appreciated the transparent fare estimate before booking.
93% of drivers reported that managing rides through the app was easier than manual hailing.
Some users from low - network regions reported minor delays in location updates, which can be improved in future updates using offline caching or hybrid communication models.

4.4 Discussion

The app's performance confirms the effectiveness of using Flutter for cross - platform development and Supabase for backend operations. The real - time tracking and low - latency updates via Supabase Real Time demonstrated reliability and scalability. The implementation of the Haversine algorithm ensured precise fare calculations, critical for user trust and driver fairness. Integration with digital payment gateways added convenience, and support for both user and driver modules enhanced adoption on both ends.

While the system performed well, a few areas for improvement were identified. These include support for dynamic pricing during peak hours, integration of voice instructions for navigation, and enhancement of multilingual support for wider regional adoption. Additionally, predictive analytics could be integrated to help drivers identify high - demand areas.

Overall, the results affirm the app's potential to modernize the auto - rickshaw ecosystem in Kerala, offering a fast, fair, and accessible platform for rural commuters and service providers alike.

5. Conclusion

The Auto Rickshaw Booking App emerges as a transformative initiative aimed at enhancing urban mobility by bridging the gap between passengers and auto - rickshaw drivers through a reliable, real - time, and user - friendly digital platform. Developed using Flutter for a responsive cross - platform frontend, Supabase for scalable backend services, and Flutter Maps for geolocation and route tracking, the app addresses long - standing inefficiencies associated with conventional booking practices. It simplifies the commuting experience by allowing users to instantly book rides, receive accurate fare estimates, and monitor their journey through interactive maps — all while enabling drivers to manage availability, respond to ride requests, and optimize their operations. The integration of features such as user authentication, live tracking, cost estimation algorithms (based on Haversine distance), and secure data handling significantly enhances transparency, efficiency, and user satisfaction. The system's modular architecture not only facilitates ease of deployment but also supports future scalability across varying urban and semi - urban contexts. Initial evaluations indicate high usability, improved commuter - driver coordination, and reduced idle time, collectively contributing to improved transportation accessibility and urban traffic optimization.

Looking forward, the application holds strong potential for further innovation and real - world impact. Future enhancements could include the implementation of real - time dynamic pricing algorithms that adjust fares based on demand, time of day, and driver availability, ensuring fair compensation and resource distribution. Integration of multilingual support would broaden the app's inclusivity, especially in linguistically diverse regions. Offline functionality, made possible through local caching or SMS - based fallback systems, could make the platform usable in low - connectivity zones, addressing the digital divide. From a smart city perspective, the system can evolve into a mobility - as - a - service (MaaS) platform by incorporating public transport data, enabling route planning that includes bus, metro, or ferry services. Moreover, advanced driver analytics powered by machine learning could be utilized to predict high - demand zones, encourage efficient fleet distribution, and offer performance - based incentives to drivers. Enhanced safety features — such as in - ride SOS alerts, emergency contact sharing, and real - time incident reporting — would further improve user trust. Integrating payment gateways, loyalty rewards, and customer support bots can add commercial value and operational robustness. In the long term, the app could collaborate with local governments, tourism boards, and urban planners to support eco - friendly transit policies and smart infrastructure development. Overall, the Auto Rickshaw Booking App not only simplifies transportation logistics but also serves as a foundational step toward more intelligent, inclusive, and sustainable urban transport systems.

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