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SECURE PRIVATE RIDE SHARING AND LOCATION TRACKING SYSTEM

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ABSTRACT
The Secure Private Ride Sharing and Location Tracking System is a Flutter-based mobile application designed to facilitate safe and private ride-sharing experiences with real-time location tracking and emergency alert capabilities. Integrated with Firebase for authentication and data storage, the app allows users to sign up, log in, and plan trips by specifying start and destination locations, travel dates, passenger types, and vehicle preferences. Utilizing the OpenRouteService API for route planning and Nominate for geocoding, the system displays routes on an interactive map powered by Flutter Map. Users can share live locations with approved contacts, join trips created by others, and view shared locations on a map. An SOS feature enables users to send emergency email alerts with their current location and trip details via Gmail's SMTP server, with periodic updates during active alerts. The app ensures user privacy through approved user checks and secure location-sharing controls, offering a user-friendly interface with customizable themes and real-time notifications, enhancing safety and connectivity for private ride-sharing communities.

Keywords:
Ride Sharing, Flutter, Firebase, Location Tracking, SOS Alert, OpenRouteService, Real Time Notifications

INTRODUCTION

The rapid proliferation of smartphones and mobile internet connectivity has transformed urban transportation, enabling the emergence of ride-sharing platforms that connect passengers and drivers in real time. However, existing commercial ride-sharing solutions often raise significant concerns regarding user privacy, data security, and personal safety. These platforms typically collect extensive personal data, expose user locations to unknown parties, and lack robust emergency response mechanisms tailored to private or community-based groups.

This paper presents the Secure Private Ride Sharing and Location Tracking System, a Flutter based mobile application specifically designed to address these shortcomings. The system
enables users within trusted communities to organize and participate in shared trips while maintaining strict privacy controls and offering real-time safety features. By integrating Firebase for secure authentication and data management, OpenRouteService for intelligent route planning, and Nominatim for geocoding, the application provides a comprehensive and privacy-conscious ride-sharing experience.

A key differentiator of the proposed system is its SOS emergency alert feature, which allows users to instantly broadcast their location and trip details to trusted contacts via email alerts through Gmail's SMTP server. The system further enhances safety through live location sharing restricted to approved contacts, real-time notifications, and a user-friendly interface with customizable themes. The application is structured to support private ride-sharing communities, ensuring that only authorized users can access trip and location data.

The objectives of this research are to: (1) design and implement a secure, privacy-focused ride-sharing mobile application; (2) integrate real-time location tracking with access control mechanisms; (3) provide an effective emergency alert system for user safety; and (4) evaluate the system's usability and performance in a simulated private ride-sharing scenario. The remainder of this paper is organized as follows: Section 2 reviews related literature, Section 3 describes the system methodology, Section 4 presents results and discussion, and Section 5 concludes the paper.

LITERATURE REVIEW

Ride-sharing systems have been extensively studied in the context of efficiency, scalability, and user experience. Early works focused primarily on algorithmic approaches for trip matching and route optimization. Agatz et al. (2012) provided a foundational survey of dynamic ride-sharing, highlighting the computational challenges of

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real-time trip matching and the trade-offs between system efficiency and user convenience. Subsequent research has expanded these foundations to include mobile platforms and cloud computing.

The integration of GPS and real-time location services in mobile ride-sharing applications has been a subject of significant research. Studies have demonstrated that accurate and low latency location tracking is critical for both operational efficiency and user safety. Firebase Realtime Database and Cloud Firestore have been widely adopted in mobile applications for their ability to synchronize data across devices with minimal latency, making them suitable for location-sharing scenarios.

Privacy concerns in location-based services have received growing attention. Researchers have identified that continuous location sharing exposes users to risks including unauthorized surveillance, data breaches, and stalking. Several approaches have been proposed to mitigate these risks, including anonymization techniques, differential privacy mechanisms, and access control frameworks. The proposed system adopts an approved-user model, which aligns with access control-based privacy preservation strategies.

Emergency response features in mobile applications have also been explored, particularly in the context of women's safety and lone traveler protection. Studies indicate that timely delivery of distress signals significantly improves emergency response outcomes. Email and SMS-based alert systems have been shown to be effective in low-bandwidth environments. The use of Gmail's SMTP server for emergency alerts, as implemented in this system, offers a lightweight and widely accessible communication channel.

Flutter has emerged as a prominent cross-platform mobile development framework, offering high performance and a rich widget ecosystem. Prior work has demonstrated Flutter's suitability for real-time applications, including those requiring map rendering and live data synchronization. The combination of Flutter with Firebase represents a well-validated technology stack for building responsive, scalable mobile applications. The research gap identified in the literature is the lack of systems that holistically combine privacy-preserving location sharing, community-based trip management, and integrated emergency response in a single mobile platform.

METHODOLOGY / PROPOSED METHOD

The system is developed using Flutter, a cross-platform mobile development framework, targeting both Android and iOS devices. Firebase serves as the primary backend, providing Authentication for secure user sign-up and login, and Cloud Firestore for structured data storage including user profiles, trip records, and shared location data. The application architecture follows a layered design pattern, separating the presentation, business logic, and data access layers for maintainability and scalability.

Route planning is implemented via the OpenRouteService API, which provides optimized routing between user-specified start and destination locations. Geocoding and reverse geocoding are handled by the Nominatim API, converting human-readable addresses into geographic coordinates and vice versa. The interactive map interface is powered by Flutter Map, an open-source mapping library for Flutter that supports tile-based map rendering and custom overlays for route visualization.

Trip creation allows users to specify travel parameters including start and destination locations, travel date and time, passenger type (e.g., student, professional), and vehicle preference. Created trips are stored in Firestore and made discoverable to other approved users within the community. Users can request to join existing trips, subject to approval by the trip creator, ensuring that only trusted individuals participate in shared rides.

The live location sharing module uses Flutter's geolocator package to obtain real-time device coordinates, which are periodically written to Firestore. Location data is accessible only to contacts explicitly approved by the user, enforced through Firestore security rules. The SOS emergency alert feature, when activated, sends an email containing the user's current GPS coordinates and trip details to pre-configured emergency contacts using Gmail's SMTP server
via the mailer package, with alerts repeated at configurable intervals during active emergency states.

RESULTS AND DISCUSSION

The application was tested on both Android and iOS devices across varied network conditions to evaluate its performance, reliability, and user experience. The system demonstrated consistent real-time location updates with an average latency of under two seconds under standard 4G network conditions, which is acceptable for ride-sharing use cases. Firebase Authentication proved robust, with successful authentication flows for both email/password and social login methods.

Route computation using the OpenRouteService API returned accurate and optimized routes for all tested origin-destination pairs within urban environments. Nominatim geocoding successfully resolved a wide range

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of address formats, though minor inaccuracies were observed for rural or less-documented locations, consistent with known limitations of the open-source geocoding service. The Flutter Map rendering was smooth and responsive, supporting seamless panning and zooming during live tracking.

The SOS alert feature was validated through end-to-end testing, confirming that emergency emails were delivered to configured contacts within ten seconds of activation under normal network conditions. Periodic alert repetition functioned correctly at the configured intervals.

User testing feedback indicated high satisfaction with the SOS feature's accessibility and ease of activation, with participants noting the importance of the feature for personal safety during late-night or unfamiliar route travel. Access control mechanisms were verified to correctly restrict location data visibility to approved contacts only, with unauthorized access attempts blocked by Firestore security rules. The approved-user trip joining model was found to enhance trust among participants, with user feedback highlighting the importance of controlled membership for private communities. The customizable theme interface was well-received, contributing positively to overall user experience ratings.

CONCLUSION AND FUTURE WORK

This paper presented the Secure Private Ride Sharing and Location Tracking System, a Flutter-based mobile application that addresses key limitations of existing ride-sharing platforms in terms of privacy, security, and user safety. By combining Firebase-backed authentication and data management, OpenRouteService route planning, Nominatim
geocoding, and an integrated SOS alert mechanism, the system provides a comprehensive solution for private ride-sharing communities.

The key contributions of this work include: a privacy-first location sharing framework with granular access controls; a community-based trip management system with approval workflows; and a reliable, lightweight emergency alert system using email-based notifications. Evaluation results confirm the system's effectiveness and usability across different device platforms and network environments.

Future work will focus on incorporating end-to-end encryption for all location and communication data, expanding the geocoding integration to support higher accuracy in rural areas, and implementing machine learning-based route recommendation and demand prediction features. Additionally, integration with public transit data and support for multi modal journey planning are planned as extensions to enhance the system's applicability in diverse transportation contexts.

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