To-Go: A Secure Ride-Hailing App with Advanced Route Optimization and VoIP for Enhanced User Experience for Nigeria Transport System

Stephen S. Oyewobi[a], Abdulkadir Olayinka Abdulbaki[b], Lawal O. Lawal[c] and Bala Abdulfattah Emi[d]
Department of Telecommunications Engineering, Federal University of Technology, Minna, Niger State, Nigeria

Keywords: Ride-Hailing, Route Optimization, VoIP, User Experience, Security, Mobile Application, Transportation.

Abstract: To-Go is an innovative ride-hailing platform that provides users with a secure, efficient, and seamless transportation experience. Leveraging advanced route optimization algorithms and integrated Voice over Internet Protocol (VoIP) technology, To-Go minimizes travel time and enhances user engagement. The app's robust security features ensure rider safety and driver accountability, utilizing real-time GPS tracking, in-app emergency response, and rigorous driver vetting processes. To-Go's intuitive interface and VoIP-enabled communication enable effortless ride scheduling, live support, and seamless driver-rider interactions. As an app intended to boost user satisfaction in Nigeria To-Go delivers precise routes and secure VoIP interactions. It resolves the safety and communication obstacles typical in this field. Through the application of sophisticated algorithms and VoIP tools. To-Go delivers a dependable platform for secure and efficient rides fostering smart transportation innovations in Nigeria.

1 INTRODUCTION

The entry of ride-hailing applications in Nigeria has resulted in major changes to transportation in notable cities. Lagos, Abuja, and Port Harcourt have specifically adopted these apps, expecting them to be more successful than conventional taxi services. Even though they are popular, limitations exist that constrain user experience (Chiatoh, 2020) (Olayode et al., 2023). The fundamental concerns currently include safety for drivers and passengers, the preservation of data privacy, and the larger question of fraud. Besides, route algorithm optimization in some apps might lead to suboptimal directions, which can cause lengthier travel durations and increased passenger costs (Adekoya et al., 2023). Specifically, difficulties that limit users' ability to interact on these platforms may arise, thereby leading to communication conflicts for both drivers and riders.

To mitigate these weaknesses, the idea of To-Go was formed. A creative ride-hailing service that primarily considers the user experience and strives to better its security framework.

2 LITERATURE REVIEW

2.1 Review of Related Works

The ride-hailing sector has seen fast expansion and change that greatly shifts urban transportation patterns. In this field's forefront are platforms such as Uber and inDrive that use technology to deliver smooth and accessible transport choices for users. (Li & Liu, 2021) conduct an important investigation into enhancing matching algorithms in ride-hailing systems. This research highlights the necessity of ongoing improvement in matching algorithms to

[a] https://orcid.org/0000-0002-1925-6490
[b] https://orcid.org/0000-0008-3747-0272
[c] https://orcid.org/0009-0005-4858-5890
[d] https://orcid.org/0009-0009-9227-321X

Oyewobi, S. S., Abdulbaki, A. O., Lawal, L. O. and Emi, B. A.
To-Go: A Secure Ride-Hailing App with Advanced Route Optimization and VoIP for Enhanced User Experience for Nigeria Transport System.
DOI: 10.5220/0013578900004639
In *Proceedings of the 2nd International Conference on Intelligent and Sustainable Power and Energy Systems (ISPES 2024)*, pages 114-118
ISBN: 978-989-758-756-6

satisfy changing user needs.

The adoption outcomes and effects of riding-hailing services are analyzed by (Ofori et al., 2021) in Nigeria. The research focuses on distinctive difficulties that users encounter in Nigeria including censorship and infrastructure issues. The examination of existing literature reveals that the industry offering ride-sharing services is diverse with several factors such as evaluation of user comfort, safety and technology progress. To keep pace with advancement, this sector's needs further research.

2.2 To-Go vs. Existing System

Uber and InDrive use Geo-location mapping that identifies a device's location by using network routing addresses to identify a device's location on a map. However, To-go uses route optimization algorithms and real-time data to plan the best route ensuring less time and money is spent on trips.

2.3 Gaps in Current Research

Some areas of ride-hailing still call for further investigation. There are still challenges of security and user data privacy violation as well as the availability of user-friendly App.

2.4 Major Contributions

The major contribution of this work is to build a secure ride-hailing mobile application with advanced route optimization and VoIP for enhanced user experience with the following benefits 1) enhanced security 2) advanced route optimization 3) improved user experience.

3 SYSTEM DESIGN AND IMPLEMENTATION

The micro services-based design in the work makes it both agile and capable of adapting to the ongoing changes in both rider and driver needs in Nigeria (Dissanayake, 2020).

3.1 Routing

The route algorithm for route optimization used in this work is a heuristic AI model that analyses historic data, such as distance covered, weather information, estimated delivery time, and real-time traffic information. Then it suggests a route based on this data.

The model also tracks the vehicle's movement and determines if the route is optimal in real time.

At the beginning of a ride, the AI model conducts a search from the arrival point to the destination to determine all possible routes. Based on the factors and the criteria mentioned above, the model selects the optimal route.

The AI model was trained based on historical data and real-time data such as current traffic and GPS information. Therefore, the system was integrated with Google API and was able to find and predict the optimal route based on this given information.

3.2 Block Diagram

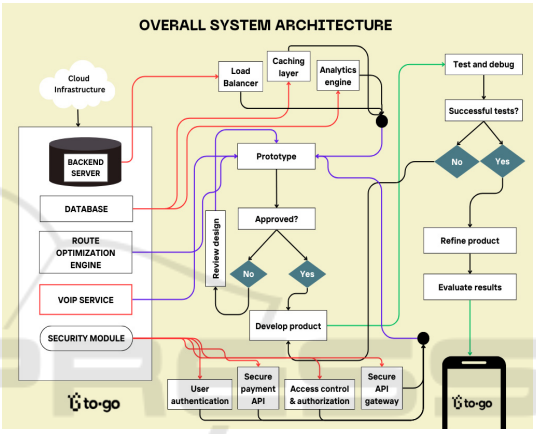

Figure 1: Overall system architecture for To-Go.

The block diagram in Figure 1 shows an outline of the design of the To-Go system including components such as the backend server deployment and database setup along with features like route Optimization, voice communication functionality, security, payments and map services (Dissanayake, 2020) (Hasan & Abul, 2018). The entire setup relies on cloud infrastructure that allows for scalability and can handle demand during peak hours. This is particularly crucial, in populated regions of Nigeria (Ajiga et al., 2024).

3.3 Rider and Driver App Interconnection

3.3.1 User Registration and Authentication

The process begins by registering individuals who wish to join the platform as either drivers or riders by providing details during the account creation process. A factor authentication system that merges regular passwords with a one-time password (OTP) sent through SMS—a method widely embraced in Nigeria

for its ease of use and proven reliability is implemented.

3.3.2 Ride Request Flow

When a user wants to use transportation, they open the To-Go app and request a ride. After selecting a pickup point, users can choose their preferred ride type, such as a car, tricycle, bus, or bike, based on their needs. Additionally, users can easily set a budget.

3.3.3 Driver Matching Algorithm

Once a ride is requested, the advanced algorithm evaluates several factors to identify the best driver: 1) The rider's location, 2) The driver's current rating, 3) The type of vehicle, 4) The driver's acceptance rate. A notification is then sent to the selected drivers, giving them the option to accept the ride. If a driver declines, the system quickly moves on to the next best option, ensuring minimal wait time for the rider.

Figure 2 presents visual illustration of the complex interaction of data and the decisions made at each stage—from the initial ride request to its final conclusion.

3.3.4 Emergency Features

Safety is top priority in this work. Both the rider and driver applications have a clearly visible SOS button. When activated, it immediately connects users with a support team and shares their real-time location.

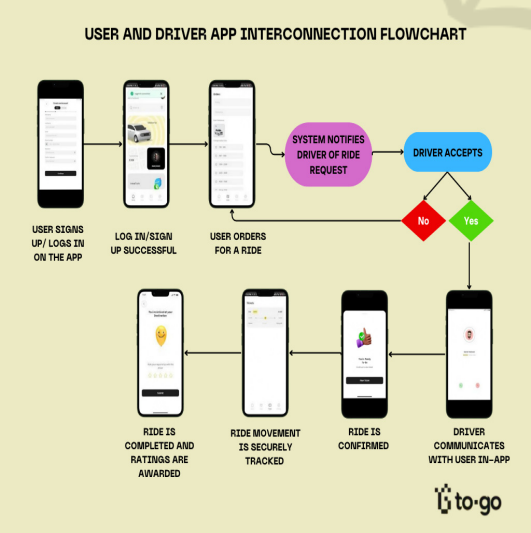

Figure 2: User and driver App interconnection flowchart.

3.4 Security Features and Their Implementation

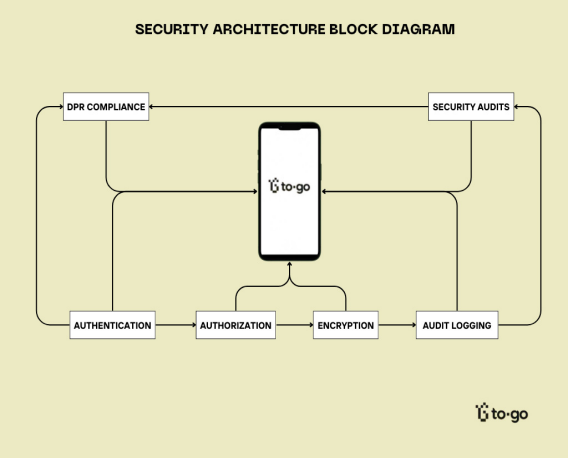

Figure 3: Security architecture.

This section outlines the security architecture and components of the To-Go app, Figure 3 illustrates these features. As can be seen the security architecture encompass the following features: 1) authentication, 2) authorization, 3) encryption, 4) audit logging, 5) regular security audits and 5) compliance with data protection regulations.

3.5 Route Optimization Algorithm

The To-Go app requires a crucial route optimization algorithm that aims to enhance both user satisfaction and productivity by supplying the most efficient routes for trips. Figure 4 presents the route optimization algorithm flowchart.

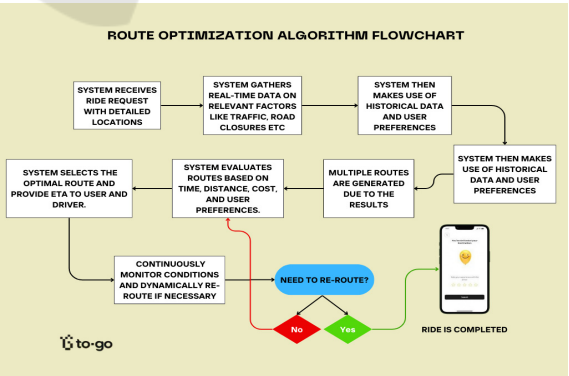

Figure 4: Security architecture.

As can be seen the security architecture encompass the following features: 1) authentication, 2) authorization, 3) encryption, 4) audit logging, 5) regular security

audits and 5) compliance with data protection regulations.

3.6 Route Optimization Algorithm

The To-Go app requires a crucial route optimization algorithm that aims to enhance both user satisfaction and productivity by supplying the most efficient routes for trips. Figure 4 presents the route optimization algorithm flowchart.

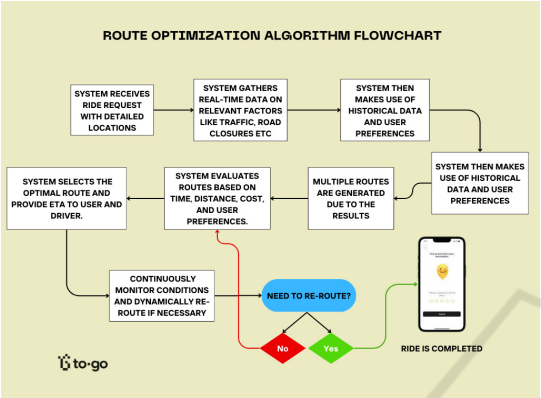

Figure 5: Route optimization flowchart.

3.7 VoIP Integration

With the aid of Voice over Internet Protocol (VoIP) technology, the To-Go application assists in coordinating conversation among drivers and riders while upholding their private data protection. The VoIP integration, as shown in Figure 5, operates as follows: 1) initiate a call, 2) establish secure connection 3) encrypt voice data 4) decrypt and play.

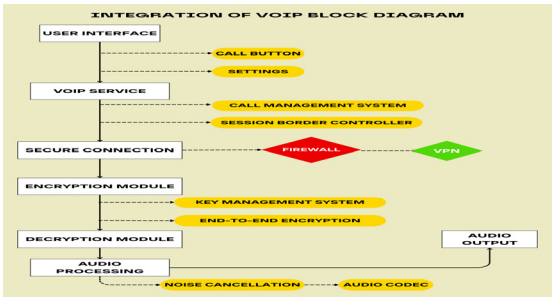

Figure 7: Integration of VoIP flowchart.

3.8 Database Design

The Entity relationship diagram in Figure 6 illustrates the main entities and their relationships in the To-Go database.

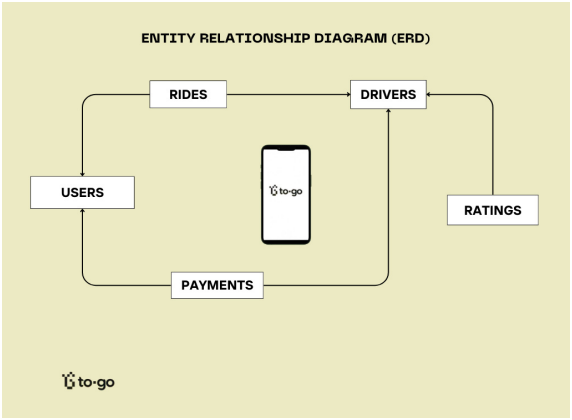

Figure 8: Entity relationship diagram.

4 EMPIRICAL RESULTS AND DISCUSSION

4.1 Testing Methodologies

To ensure the reliability and performance of the To-Go app, several testing methodologies were employed:

4.1.1 Unit Testing

To verify that they performed correctly without relying on interconnections, individual parts of the application were unit tested.

4.1.2 Integration Testing

Integration testing serves the central purpose of verifying the proper cooperation of all modules. The focus was on understanding how the interaction of user interface, backend services, and database played out.

4.1.3 Security Testing

Security testing was performed to identify vulnerabilities within the application

4.1.4 Penetration Test

A penetration test was conducted to mimic assaults on the system.

4.1.5 Stress Test

Stress testing has been discovered to determine the limit of the application by making it vulnerable to

extreme circumstances.

4.1.6 User Acceptance Testing

User acceptance testing requires actual users to test the app in a controlled environment to gather feedback on its usability and functionality.

4.1.7 User Feedback

Preliminary user feedback suggests that a big portion of users are content with the quick ride booking and communication options they get.

5 CONCLUSION

Ultimately, the To-Go app showcases a significant improvement in Nigeria's ride-hailing scene, presenting users with more efficient and reliable solutions that facilitate their trip planning. To-Go integrates route optimization and VoIP communication to resolve major user challenges and enhance safety and convenience.

This project shows its capacity to deliver benefits for urban mobility improvement in Nigeria. However, sustained efforts are needed to correct existing limitations and respond to developing market scenarios. To-Go intends to keep improving and developing, targeting to be at the leading edge of the ride-hailing market and pushing transportation advances for its Nigerian customers.

REFERENCES

Adekoya, O. D., Mordi, C., Ajonbadi, H. A., & Chen, W. (2023). Implications of algorithmic management on careers and employment relationships in the gig economy – a developing country perspective. Information Technology & People, https://doi.org/10.1108/ITP-01-2023-0064

Ajiga, D., Okeleke, P. A., & Folorunsho, S. O. (2024). Methodologies for developing scalable software frameworks that support growing business needs. August. https://doi.org/10.51594/ijmer.v6i8.1413.

Chiatoh, C. C. (2020). Factors Motivating and Hindering the Use of the Ride-Sharing Economy Platform By Clients-Residents Within the City of Douala and Yaoundé. Digikogu.Taltech.Ee. https://digikogu.taltech.ee/en/Download/9ebd8dd0-7904-4eb1-a627-de7925f3c359/

Dissanayake, G. N. (2020). A Study on Real-Time Database Technology and Its Applications. Hasan, M., & Abul, R. (2018). Developing a Mobile Application for Ride Sharing Service. May.

Li, Y., & Liu, Y. (2021). Optimizing flexible one-to-two matching in ride-hailing systems with boundedly rational users. Transportation Research Part E: Logistics and Transportation Review, 150, 102329. https://doi.org/https://doi.org/10.1016/j.tre.2021.102329

Ofori, K., Simpe, A., & Adeola, O. (2021). Understanding ost-adoption behaviour in the context of ride-hailing apps : the role of customer perceived value. August. https://doi.org/10.1108/ITP-06-2019-0285

Olayode, I. O., Severino, A., Justice Alex, F., Macioszek, E., & Tartibu, L. K. (2023). Systematic review on the evaluation of the effects of ride-hailing services on public road transportation. Transportation Research Interdisciplinary Perspectives, 22, 100943. https://doi.org/https://doi.org/10.