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Development of an Adaptive Marketplace Management System for Real-Time Real Estate Business Models in Nigeria

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Abstract
The real estate sector in Nigeria is rapidly changing, and there is a growing demand for efficient marketplace management systems. These systems play a crucial role in connecting buyers and sellers, ensuring a smooth and positive user experience. However, traditional marketplace management systems often struggle to keep up with the dynamics of the real estate market, leading to inefficiencies and suboptimal outcomes for all stakeholders. Hence, this project introduces an adaptive model designed to manage the real estate market in Nigeria, employing real-time data analysis to dynamically respond to changing market conditions and user preferences. The adopted methodology involves a waterfall model for the development process of the adaptive model for managing the real estate marketplace in Nigeria. To facilitate the development of a user-friendly mobile application, a UI/UX was designed and implemented using a Figma framework plus data that was gathered from sources, such as real estate websites, user inputs and social media platforms. The mobile application and its backend were developed using Flutter and Firebase frameworks respectively. The implemented features include property listing, search properties, user registration, Google authentication, regular app updates, feedback and iteration unit, performance monitoring and optimization, payment processing, data security and privacy compliance. Analytic tools to track user behaviour, and app performance, and generate reports to acquire insights into user engagement and conversion rates were also implemented. A secure payment gateway, Paystack, was integrated to facilitate commission collection from real estate agents. The application was deployed to the Google Play Store and the Apple App Store for Android and iOS devices respectively. Three test models were adopted encompassing functionality, usability (register page, log in, main, edit profile, store registration, add product), and security testing. A pilot test of 10 users was also carried out and tested the app on a range of devices. Based on testing results, 70% of successful users were realized while the unsuccessful users were as a result of inappropriate inputs from users. Bugs or issues identified during testing were addressed and resolved. The application is working successfully.

Keywords: Marketplace Management Systems, Javascript UI/UX, Paystack, Google Play Store, Adaptive Real Estate Market.

Introduction
A marketplace is a platform that links different consumers and sellers to make the exchange of products or services easier. A marketplace management system is a software platform that automates the process of administering online markets by centralizing inventory, sales, and other components of the marketplace. This method aids in the effective administration of the marketplace, as well as the improvement of customer experience and profitability (Schmidt et al., 2020). The notion of a marketplace is not new, but the development of the internet and e-commerce has drastically altered it. E-commerce platforms like Amazon, eBay, and Alibaba have transformed the way individuals purchase and sell things online. These platforms have evolved into the go-to destination for online buyers, as well as the foundation of many e-commerce firms (Miljkovic et al., 2023) in their work titled "Real Estate App Development Based on AI/VR Technologies" stated. The real estate industry is embracing technology to make the buying and selling process more efficient, accurate, and effective for all parties involved (Miljkovic et al., 2023). The success of these platforms has sparked the development of new marketplace models for industries as diverse as transportation, food delivery, and

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real estate. In recent years, there has been a substantial increase in the use of marketplace management systems in the real estate business. It has evolved into an indispensable tool for real estate agents, brokers, and property developers. Developing countries have the potential to achieve rapid and sustainable economic and social development by building an economy based on an ICT-enabled and networked SME (Small and Medium-sized Enterprise) sector, capable of applying affordable yet effective ICT solutions. The technology gives these stakeholders a platform to exhibit their homes to potential purchasers while also managing the purchasing and selling process in a more streamlined and effective manner (Lau et al., 2008). With the rising demand for real estate assets in Nigeria, it is vital to establish an adaptable model for marketplace management for real-time real estate business models in Nigeria to assist bridge the gap between sellers and buyers. Despite the benefits of marketplace management systems, their implementation is fraught with difficulties. Security issues, technological difficulties, and the necessity for continual modifications to stay up with changing market trends are among them. However, with good planning, training, and the use of relevant tools and technology, these issues may be reduced (Lembcke et al., 2021). Finally, marketplace management systems have become an essential tool for firms in a variety of industries. The recent use in the real estate market demonstrates the potential benefits that may be achieved from its utilization. The creation of an adaptable model for marketplace management for real-time real estate business models in Nigeria has the potential to completely alter the Nigerian real estate sector. However, careful planning, execution, and ongoing improvement will be required for the successful adoption of this paradigm (Lembcke et al., 2021; Małkowska, 2020).

Aim and objectives of the study

This project aims to develop an adaptive marketplace management system for real-time real estate business models in Nigeria. The objectives are to:

1. Analyze user requirements.
2. Develop a user-friendly digital platform that enables convenient and secure connections between buyers and sellers.
3. Develop a platform that seamlessly integrates with third-party services.
4. Develop a platform for continuous data collection and analysis on user behaviour and market trends to implement market adaptability and inform business decisions.
5. Implement continuous integration and deployment (CI/CD) using Github actions.

Materials and Methods

This session presents the methods and the design of the real-estate application as shown in Figure 1. This project design puts into consideration the engineering design approach which covers simplicity of design, reliability and minimization of components. The software architecture as well as a prototype implementation of the real-estate application is also presented in this session.

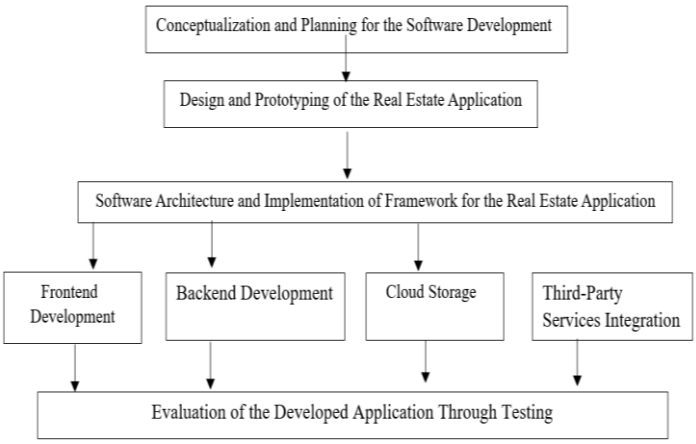

Figure1: The workflow processes

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Conceptualization and Planning
The app's purpose and objectives were defined and the target audience was identified along with their specific needs. Market research and competitor analysis were conducted, and then a comprehensive project plan that included timelines and budget considerations was created.

Design and Prototyping
Designing and prototyping the application was done using Figma, an industry-leading design and prototyping tool. Figma allows for collaborative design in real-time, enabling designers, developers, and stakeholders to work seamlessly on wireframes and high-fidelity prototypes. The platform facilitates the creation of interactive prototypes, allowing for the simulation of user experiences and the testing of functionalities before actual development. This made the design and prototyping of the application seamless.

Software Architecture
Frontend: User Interface (UI): Building the UI with Flutter entails using the Flutter framework to design an attractive and responsive user interface. This involved creating visually appealing components, implementing responsive layouts, and ensuring a seamless user experience across various screen sizes and orientations. The use of Flutter's widgets and features allows for efficient UI development.
State Management: The Flutter Provider package was used to manage the state of the application. It offers a straightforward mechanism for sharing and updating application states across different parts of the widget tree. The key components include the Provider widget, which exposes the state, and the Consumer widget for selectively rebuilding parts of the UI when the state changes. With its simplicity, scalability, and support for both local and global state management, Provider is a versatile choice for managing state in Flutter applications.
Backend (Firebase Cloud Functions): Firebase Cloud Functions enable server-side logic for tasks like property search and messaging in a real estate app. It handled advanced functions such as data processing and event-triggered operations. The Firebase project was set up using the Firebase console, the functions were defined and specified triggers, and finally deployed using the Firebase CLI. Integration with Firebase services like Firestore and Cloud Messaging enhances data handling and user notifications. Proper error handling and logging were crucial components of the implemented Firebase Cloud Functions setup.
Cloud Firestore: Firebase Cloud Firestore, a NoSQL database, served as a foundational backend component for the real estate application. Its schema-less structure accommodates diverse data types. Property details, user profiles, and app-specific data are organized into collections and documents, providing an organized and scalable architecture.
Queries in Cloud Firestore empower efficient data retrieval based on various criteria, fostering dynamic and personalized user experiences. Real-time synchronization ensures immediate updates across clients, enhancing the app's responsiveness in real time. Security rules were put in place, coupled with Firebase Authentication, to safeguard data access and protect user privacy. In essence, Firebase Cloud Firestore provides a versatile, real-time, and secure database solution, enabling the effective management of diverse data sets in a real estate application. Its features align with the evolving needs of a dynamic and scalable platform.

Third-Party Services Integration
Payment Gateway (Paystack): Integrating the Paystack payment gateway into the application enhances its functionality by providing a secure and streamlined payment process. Paystack facilitates seamless transactions, allowing users to make payments for property transactions within the app. The integration involves utilizing the Paystack Flutter plugin, which offers a user-friendly payment interface for a smooth user experience. Secure communication with Paystack is ensured, and the integration includes features like payment confirmation and error handling. The integration of Paystack not only facilitates financial transactions but also contributes to a more comprehensive and user-centric real estate application.

Maps Integration
Google Maps API was integrated into the real estate app to provide an interactive map displaying property locations and nearby amenities. Google Maps API key was obtained and the Google Flutter package was added to enable it in the application. Google Maps enhances the app's functionality and aids users in making informed property decisions by creating dynamic property markers, fetching nearby amenities using the Places API, and ensuring user-friendly interactions.

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Cloud Storage

This involved using the Firebase-storage package in the application, configuring Firebase to enable storage operations for uploading and retrieving property images, establishing security rules and optimizing performance. This integration enhances the user experience by providing a reliable and scalable solution for managing property images and multimedia content.

Users and Components Interactions

The real estate app harmonizes various components to offer an all-encompassing user experience. The Flutter frontend intricately integrates with the Firebase backend, utilizing Firebase SDK for secure user authentication, real-time data synchronization, and streamlined storage operations through Firebase Cloud Storage. Leveraging Flutter's versatile widgets, the front end crafts an intuitive and visually appealing user interface, showcasing property listings, multimedia content, and interactive maps.

Firebase assumes the pivotal role of the backend, managing user authentication, and data storage in Firestore, and executing serverless operations through Cloud Functions. The external services, including the payment gateway and Google Maps API, further elevate the app's functionalities. The payment gateway ensures secure financial transactions, instilling user trust in property-related transactions. Simultaneously, the Google Maps API introduces a geospatial dimension, providing an interactive map interface that enhances user understanding of property locations and nearby amenities.

The use case diagram captures the dynamic behaviour of the system. The Admin and User's interaction with the system are presented in Figures 2 and 3.

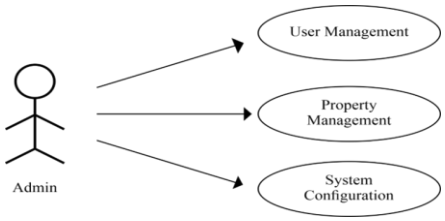

Figure 2: Use case diagram for App Admin

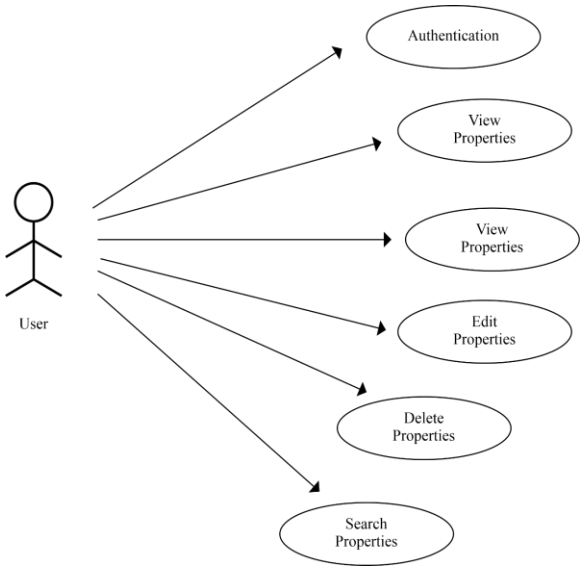

Figure 3: Use case diagram for App User

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The real estate app's architecture synergizes Flutter's front-end, Firebase's backend capabilities, and external services to provide a feature-rich and seamless user experience, meeting and exceeding user expectations in property exploration and transactions.

Results

This session unveils the outcomes of the methods elucidated in session 2. Section 3.1 presents the results from the development of the authentication process. Section 3.3 presents the results from the Search property feature under the user interface. Section 3.4 presents the user interface for the real estate application. Section 3.5 presents the results from the Add property under the user interface. Section 3.6 presents the results from the development of the My Properties page under the user interface. Section 3.7 presents the results from the Saved Properties page. Section 3.8 presents the results from the development of the Profile page under the user interface.

Authentication

The Application places a strong emphasis on the security and seamlessness of its authentication process. The user-friendly design enables swift access to the app using Google credentials, eliminating the need for cumbersome registration forms or password management. This approach streamlines onboarding and significantly enhances the overall user experience. In the realm of secure connections, thorough testing has been conducted to ensure the robustness of the authentication process. Specifically, testing has focused on validating the secure transmission of user credentials and data during the authentication phase. The goal is to guarantee that industry-standard security protocols, integral to Firebase Authentication, effectively safeguard user data from potential threats and unauthorized access. The implementation of Google Sign-In further reinforces user trust by assuring them that their information is handled with utmost security. The testing procedures under the secure connection category have systematically validated these authentication measures, ensuring the seamless and protected interaction of users with the Real Estate Application. These efforts not only contribute to the app's overall security posture but also cultivate a trustworthy environment for users to engage with confidence.

Authentication Type

The primary authentication method employed is based on single-factor authentication as shown in Figure 4, where users securely log in using their Google credentials. While the application ensures a robust and secure authentication process, two-factor authentication (2FA) is not currently implemented.

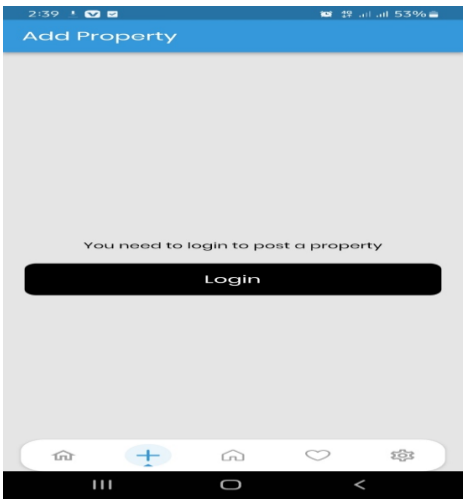

Figure 4: Single-Factor Login Authentication

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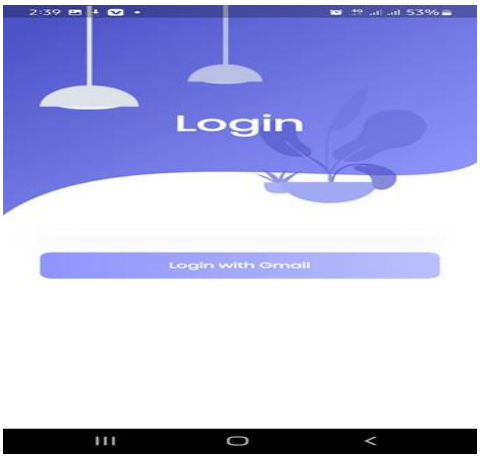

Figure 5: Two-Factor Login Authentication

3.4 The Home Page

The Home Page serves as the primary gateway for users, offering an intuitive and informative interface. The Home Page is thoughtfully designed to provide users with immediate access to key features and property listings, enhancing their overall experience.

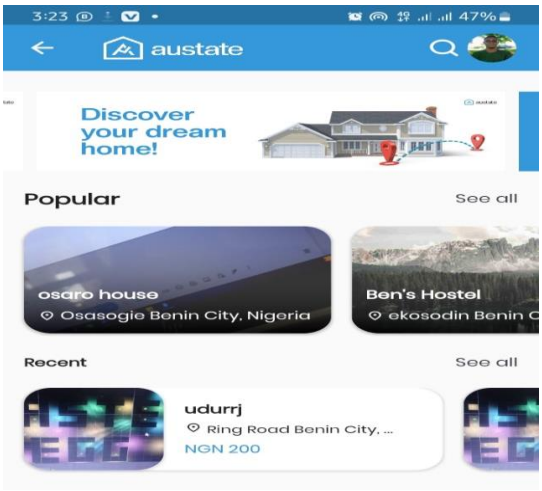

Figure 5: Home Page

Key Elements of the Home Page:

1. **Carousel:** The Home Page features an engaging motion carousel that effectively showcases the app's key features. This visual presentation not only introduces users to the app's functionalities but also highlights its user-friendly and feature-rich nature.

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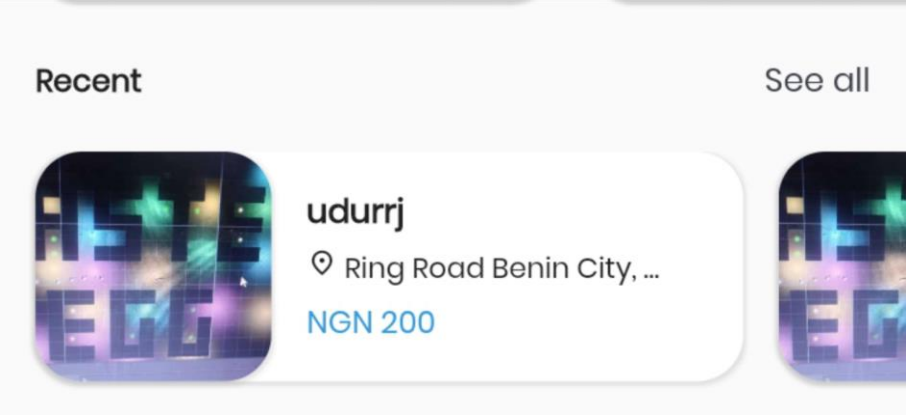

Figure 6: Overview of Carousel

1. **Popular Properties:** Leveraging the Featured Ads listing, real estate agents can gain prominence on the platform by listing their properties. These featured listings occupy top positions on the Home Page for a limited duration. This strategic placement ensures that these properties enjoy enhanced visibility, contributing to an improved search experience for users.
2. **Recently Added Properties:** Users can readily explore recent properties available on the platform. This section offers a curated selection of properties that have garnered significant interest from users, helping prospective buyers and renters discover attractive options quickly.
3. **Properties close by:** The Home Page dynamically displays properties located in close proximity to the user's current location. This geolocation-based feature not only assists users in discovering nearby properties but also provides essential information, including property location, pricing details, and brief descriptions. Users can access more details by clicking on these listings.
4. **Add Property:** The "Add Property" page is a fundamental feature designed to empower authenticated users to efficiently and comprehensively list their properties within the platform. This critical page comprises a meticulously crafted set of input fields, each serving a unique purpose in facilitating the property listing process. Below is an exhaustive description of these essential input fields:
5. **Select Category:** The 'Select Category' input field serves as the initial step for real estate agents when listing their properties. Within this field, users are presented with a dropdown or selection menu that allows them to specify the precise category or type of property they intend to upload. These categories encompass a diverse range, including villas, shops, buildings, houses, and more. The categorization system ensures that each property is appropriately classified, simplifying the process for potential buyers and renters to identify listings that align with their preferences and requirements.

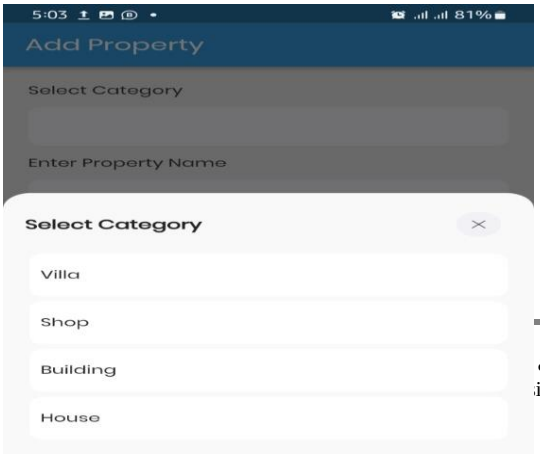

Figure 7: Overview of Select Category

Search Property

The real estate application implemented a robust and intuitive search feature that empowers users to efficiently explore a vast database of available properties. This essential functionality is designed to provide users with a seamless and highly responsive search experience, ultimately facilitating the discovery of properties that align with their preferences and requirements.

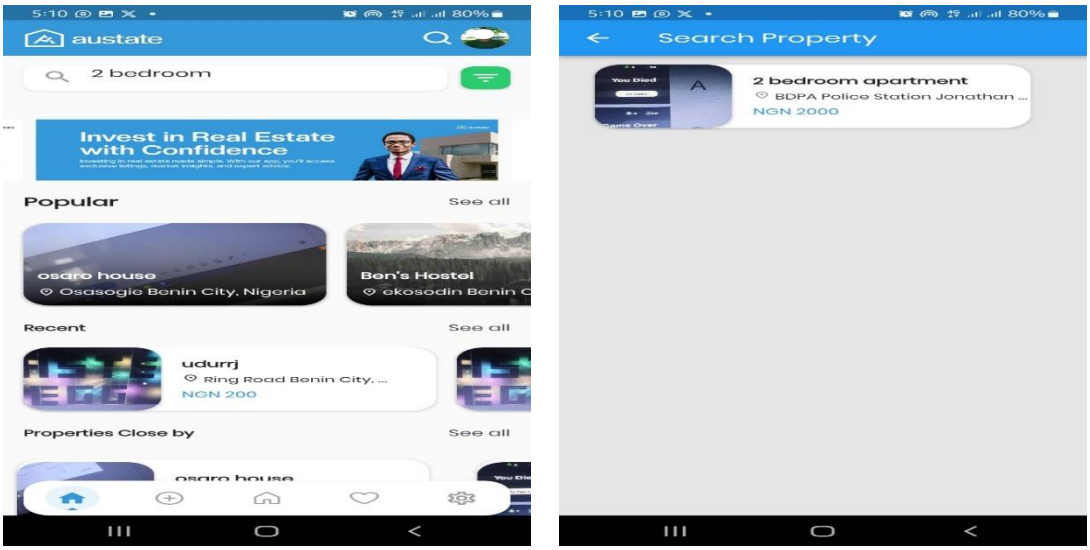

Figure 8: Property Search Results

Property Listing and Payment Gateway Service

This is a pivotal component of the real estate marketplace application, offering users the opportunity to enhance the visibility of their listed properties and streamline the payment process. Authenticated users, primarily real estate agents, have the option to promote their properties by featuring them at the top of the platform for a specified duration. This strategic placement significantly increases the visibility of their listings, improving the chances of attracting potential buyers. To access this premium service, users are required to pay a fee, which is seamlessly facilitated through the integration of the Paystack payment gateway.

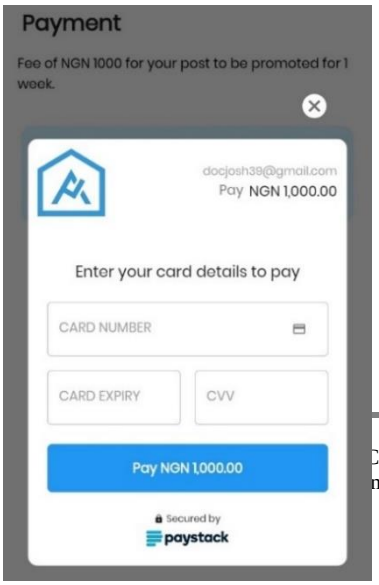

Figure 10: Payment Gateway Service

The process begins with an authenticated user navigating to the property listing page, where they can select the option to feature their property. Upon selection, the system prompts them to choose the desired duration for the featured listing, with various packages available to suit different promotional needs. Once the user has made their selection, they are directed to the payment gateway, where they can securely complete the transaction.

Paystack, a trusted and widely used payment gateway, ensures the security and efficiency of the payment process. Users can make payments using various methods, including debit/credit cards and bank transfers. The integration with Paystack not only enhances the user experience by providing a seamless payment process but also assures users of the security of their financial transactions.

Upon successful payment, the user's property is instantly featured at the top of the platform, gaining maximum visibility to potential buyers. This feature provides a valuable tool for real estate agents to effectively market their properties and expedite sales.

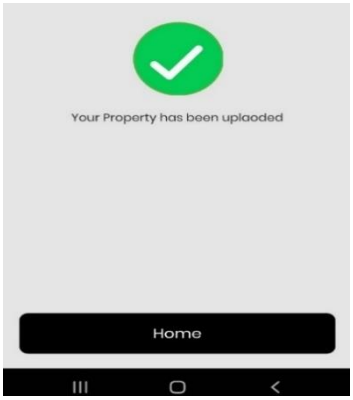

Figure 9: Overview of a pre-promoted property upload

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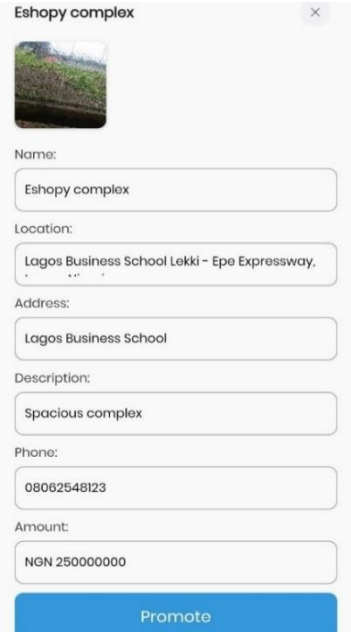

Figure 9: Overview of a pre-promoted property

Discussion

The development of the real estate marketplace application represents a significant advancement in the Nigerian real estate sector, addressing the evolving needs of property seekers and real estate agents. The user-friendly onboarding process via Google Authentication streamlines access, promoting convenience and engagement. The homepage's dynamic features, including location-based property displays and featured ads, enhance the property search experience. Real estate agents benefit from an efficient "Add Property" page for listing properties, and the "My Properties" section facilitates comprehensive portfolio management. Transparent property insights and direct communication channels promote trust and effective negotiation. Performance analytics empower agents, while secure payment gateways ensure transparent transactions. Overall, this app offers a holistic solution to bridge the gap between property buyers and sellers in Nigeria, fostering transparency, convenience, and efficiency in the real estate market.

Conclusion

This project has achieved the development of a dynamic and user-centric real estate marketplace application tailored specifically for the Nigerian market. The Nigerian real estate landscape, characterized by its rapid evolution, presented both opportunities and challenges, all of which the platform has been carefully designed to address. Extensive research and innovative technological integration have resulted in a solution that not only streamlines property transactions but also elevates the overall real estate experience for all participants.

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