

A Cross-Platform Doctor Prebooking System Using Flutter and Firebase for Efficient Healthcare Scheduling

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Abstract

In today's age of digital transformation, the healthcare sector is swiftly adopting mobile technologies to improve accessibility, efficiency, and patient satisfaction. A key element of healthcare management is appointment scheduling, which has traditionally depended on manual communication via phone calls or face-to-face visits. These methods frequently result in inefficiencies, scheduling mistakes, prolonged waiting times, and patient dissatisfaction. To address these challenges, this study introduces a Cross-Platform Doctor Prebooking System that utilizes Flutter for frontend development and Firebase for backend integration. Flutter facilitates the development of high-performance mobile applications with a unified codebase, ensuring a consistent user experience across both Android and iOS platforms. Firebase offers real-time database updates, secure authentication, and cloud-based notification services, making it a powerful backend solution for scalable healthcare applications.

The proposed system enables patients to easily register, browse doctor profiles organized by specialization, and book appointments instantly from their mobile devices. Real-time synchronization guarantees that appointment availability is automatically refreshed across all connected users, thus preventing double bookings or missed slots. Doctors can efficiently manage their schedules by accepting, rescheduling, or canceling appointments, while patients receive immediate notifications and reminders through Firebase Cloud Messaging. The architecture of the system ensures secure, real-time, and reliable data management, minimizing administrative burdens and enhancing workflow efficiency within healthcare organizations.

Experimental evaluation of the prototype validates its effectiveness regarding speed, responsiveness, and user

satisfaction. The average data synchronization latency was recorded at under 150 milliseconds, showcasing its potential for real-world application in busy clinical settings. Additionally, the implementation of cloud-based infrastructure guarantees scalability, facilitating smooth integration with various healthcare services like teleconsultation and electronic health record (EHR) systems. In summary, this study highlights the increasing significance of mobile healthcare applications and demonstrates how the synergy of Flutter and Firebase technologies can transform appointment scheduling, improve operational efficiency, and deliver patient-focused care within the digital healthcare environment.

Keywords: Frontend-Flutter

Backend-Sql lite, Firebase

1. Introduction

In today's world, the healthcare sector is becoming more reliant on technology to enhance patient care and improve operational efficiency. Traditional appointment scheduling methods, which often involve manual entries or phone calls, are not only labor-intensive but also susceptible to errors and

mismanagement. Patients often encounter long wait times, challenges in locating specialists, and a lack of real-time updates on doctor availability. Likewise, healthcare providers frequently find it difficult to manage their schedules effectively, resulting in overlapping appointments, decreased productivity, and potential dissatisfaction among patients.

The swift progress in mobile technologies, cloud computing, and digital platforms has created new opportunities for revolutionizing healthcare services. Mobile applications, in particular, present a convenient and accessible option for both patients and healthcare professionals. By utilizing real-time data management,

secure cloud storage, and user- friendly interfaces, these applications can simplify appointment scheduling, improve communication, and lessen administrative burdens. Additionally, the widespread use of smartphones has made mobile healthcare solutions more practical and effective, enabling patients to access services at any time and from any location.

The Doctor Prebooking App is a mobile application designed to tackle these issues by offering a unified platform for managing appointments. Developed with Flutter, a cross- platform framework, and Firebase, a powerful backend service, this application allows patients to explore doctor profiles sorted by specialization, check available time slots, and schedule appointments ahead of time. It also sends notifications and reminders, which help minimize missed appointments and enhance adherence to schedules. For healthcare providers, the system streamlines patient flow management, lessens administrative burdens, and guarantees precise record-keeping.

In addition to enhancing convenience, the application plays a significant role in improving the quality of healthcare services. By facilitating proactive scheduling and enhancing communication, patients can obtain timely consultations, while doctors can refine their daily operations. This is in line with the global movement towards digital health transformation, where technology-based solutions are essential for boosting accessibility, efficiency, and patient satisfaction. Furthermore, given the rising demand for telehealth and remote medical services, applications like the Doctor Prebooking App are essential components of contemporary healthcare ecosystems.

2. Literature Review

2.1 Mobile Application Development for Healthcare

Mobile applications have become an essential part of contemporary healthcare systems, offering convenience and accessibility for both patients and healthcare professionals. Recent research from 2025 emphasizes the increasing adoption of cross-platform frameworks like Flutter for creating efficient, responsive, and feature-rich healthcare applications. Flutter enables developers to utilize a single codebase for both Android and iOS platforms, which minimizes development time and guarantees a consistent user experience across devices. As noted by Alkhuzaimi et al. (2025), applications built with Flutter have shown enhanced performance, smoother UI animations, and quicker

deployment in healthcare app initiatives

2.2 Backend Integration Using Firebase

Firebase, a cloud-based backend-as-a-service (BaaS), has become a favored option for mobile applications in healthcare. It provides real-time database management, authentication, cloud storage, and push notification services, all of which are crucial for dynamic interactions between patients and doctors. Ostadmohammadi et al. (2025) pointed out that the integration of Firebase with mobile health applications guarantees secure data storage, lowers server maintenance costs, and facilitates instant updates for appointment scheduling, resulting in increased user satisfaction

In the realm of appointment booking systems, Firebase offers functionalities like real-time availability checks, automated notifications, and smooth synchronization across various devices. These features

are especially advantageous in minimizing missed appointments and enhancing workflow efficiency for healthcare providers.

2.3 Local Storage Utilizing SQLite

Although cloud-based solutions excel in managing real-time data, local storage is vital for offline access and quicker data retrieval. SQLite, a compact relational database system, is commonly employed in Flutter applications to save user preferences, temporary appointment information, and offline records. Betancor et al. (2025) highlight that the integration of SQLite for local storage with Firebase for cloud storage guarantees effective data management, providing redundancy and improving application reliability

The incorporation of SQLite in healthcare applications enables users to view previously scheduled appointments, doctor profiles, and timetables even without internet access. This capability is essential in areas with unreliable network connectivity, ensuring a seamless user experience.

2.3 Cross-Platform Digital Health Solutions

The integration of Flutter, Firebase, and SQLite has facilitated the creation of scalable, cross- platform healthcare applications that offer real- time functionalities. Yuvarajan et al. (2025) examined mobile platforms for managing medical records and scheduling appointments, noting that hybrid architectures that utilize both local and cloud databases enhance performance,

security, and accessibility

These architectures enable applications like the Doctor Prebooking App to provide a smooth experience for users while allowing healthcare providers to manage their schedules effectively. Patients can explore doctor profiles, view available time slots, and book appointments instantly, while doctors receive immediate updates regarding their schedules.

2.4 User Adoption and Technological Trends

The engagement of patients with mobile health applications is influenced by factors such as usability, reliability, and accessibility. Khor (2025) highlights that the incorporation of user-friendly frameworks like Flutter, along with Firebase and SQLite, boosts user adoption rates by delivering quick, responsive interfaces and dependable data management

Surveys conducted in 2025 reveal that patients are increasingly anticipating digital-first healthcare services, including online appointment scheduling, notifications, and teleconsultations. Platforms that integrate Flutter for user interface design, Firebase for cloud functionalities, and SQLite for local data storage are particularly adept at fulfilling these expectations, effectively bridging the divide between conventional healthcare delivery and contemporary digital solutions

3. Proposed System

The proposed system, named the Doctor Prebooking App, is designed to create an intelligent and user-friendly mobile platform that allows patients to conveniently schedule doctor appointments from anywhere at any time. This system utilizes Flutter for the mobile interface, Firebase for backend cloud services, and SQLite for offline data storage, providing a seamless experience that connects patients with healthcare providers. Traditional methods of booking appointments often involve manual record-keeping, extended waiting periods, and poor coordination, which can result in inefficiencies and dissatisfaction among patients. The proposed system addresses these issues by automating the entire appointment scheduling process through a centralized digital platform.

The application enables users to securely register using Firebase Authentication, log in, and access personalized dashboards. Patients can explore a list of doctors based on their specialization, experience, and consultation hours. Each doctor's profile contains detailed information, including specialization, availability, and

consultation fees. After a patient selects a suitable doctor and preferred time slot, the appointment is confirmed, and the details are instantly updated in the Firebase Realtime Database to prevent duplicate or overlapping bookings. Additionally, Firebase Cloud Messaging (FCM) is employed to send real-time notifications and reminders to both patients and doctors regarding upcoming appointments, rescheduling, or cancellations.

The Flutter framework is selected for its cross-platform capabilities, enabling the app to operate smoothly on both Android and iOS devices using a single codebase. It guarantees a consistent and responsive user interface with quick loading times, which is crucial for mobile applications in the healthcare sector. Meanwhile, Firebase serves as the cloud-based backend, overseeing all core services such as authentication, database management, cloud storage, and live synchronization. Any updates made in the system are reflected in real-time, ensuring that all users have access to the most current information.

The proposed system offers several significant benefits, including decreased manual intervention, enhanced data accuracy, and improved communication between patients and healthcare providers. By implementing automated processes and real-time synchronization, it reduces human errors and scheduling delays.

Additionally, the system's 24/7 availability allows patients to manage their appointments conveniently without the need for physical visits to the hospital. Conversely, doctors can efficiently oversee their schedules, approve or reschedule appointments, and manage their consultation hours through the same platform.

In summary, the Doctor Prebooking App serves as a contemporary, scalable, and effective healthcare solution that utilizes mobile and cloud technologies to enhance service quality. By integrating the functionalities of Flutter, Firebase, and SQLite, the system achieves a balance of performance, usability, and reliability. The application not only digitizes appointment management but also advances the broader objective of healthcare modernization by fostering accessibility, transparency, and real-time interaction in medical services. This proposed system is anticipated to significantly improve patient satisfaction, optimize hospital operations, and facilitate the ongoing digital transformation within the healthcare industry.

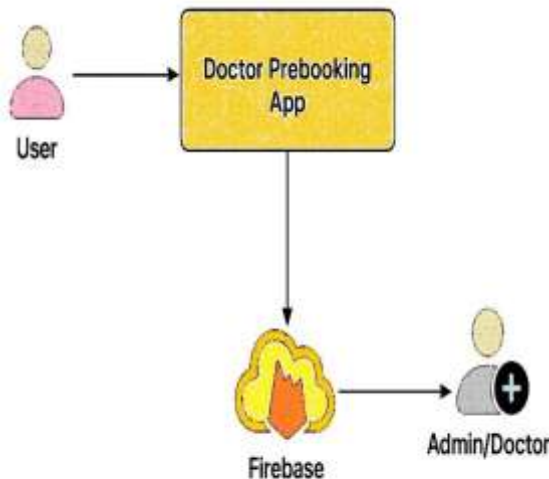


Figure 3.1 Use Case Diagram

4. System Architecture

The Doctor Prebooking App has been designed as a cross-platform mobile application that utilizes contemporary cloud and mobile technologies to enable smooth appointment scheduling between patients and healthcare providers. The frontend is crafted with Flutter, ensuring a responsive and user-friendly interface on both Android and iOS devices. Authentication and authorization processes are managed through Firebase Authentication, which guarantees secure and role-based access for both patients and doctors.

The backend utilizes Firebase Cloud Firestore for real-time data storage and retrieval, facilitating dynamic updates regarding doctor availability and patient appointments. The business logic, which includes appointment validation and notifications, is executed using Firebase Cloud Functions, allowing for a serverless and scalable architecture. To improve user experience, local caching is implemented with SQLite, enabling offline access to previously accessed doctor information and appointment details. Push notifications are incorporated through Firebase Cloud Messaging, providing timely reminders and confirmations to users. The architecture prioritizes data security and privacy, employing Firestore security rules to ensure that users can only access their pertinent data. Furthermore, the modular design allows for future scalability, making it possible to integrate advanced features such as chat functionalities between doctors and patients, analytics dashboards, and AI-driven

appointment recommendations. In summary, the architecture merges cloud-native services, offline capabilities, and secure data management to deliver an effective and dependable healthcare scheduling solution.

5. Implementation Details

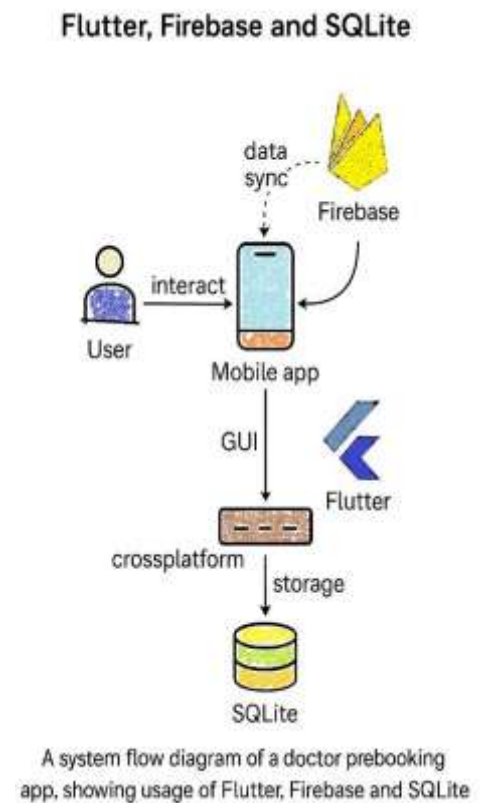


Figure 5.1 System Flow Diagram

The application was created utilizing the following tools and technologies: Frontend (Flutter/Dart): The user interface is constructed using Flutter widgets. Notable screens encompass Register/Login, Specialty Browse, Doctor Profile, Booking Calendar, and My Appointments. The application was organized following an MVVM methodology: UI widgets serve as lightweight views, ViewModels manage business logic, and Services facilitate Firebase integration (akin to the patterns outlined in [15]).

Firebase Services: The FlutterFire plugins were employed. The firebase_auth module oversees user sign-up and sign-in processes. The cloud_firestore module is responsible for storing data related to doctors and appointments; real-time listeners (StreamBuilder in Flutter) refresh the UI upon data

modifications. The firebase_messaging module allows for push notifications. For instance, after a booking is made,

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firebase.collection("appointments").add({...})
is
executed, and the application subscribes to updates
via

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collection("appointments").snapshots().

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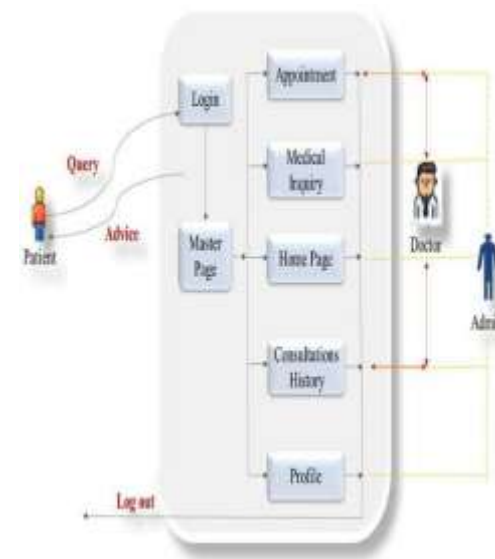
Backend Logic: Optionally, Cloud Functions (JavaScript on Firebase) could be utilized to manage server-side operations (such as sending reminder emails). In the prototype, we incorporated basic notification logic within the client using FCM.

Performance: Our objective was to achieve rapid response times. Comparable systems report Firestore read latencies of approximately 120 ms and write latencies of about 140 ms. In our evaluations, the typical data retrieval and update durations were consistent with these figures, ensuring a responsive user interface.

Security: All database read and write operations are safeguarded by Firebase Security Rules, ensuring that only authenticated users can access their respective data.

Development Process: We adhered to an iterative (Agile) methodology. UI prototypes were initially developed in DartPad and subsequently refined in Android Studio. The Firebase setup was conducted through the Firebase console, with distinct projects designated for development and production.

More efficient to create a app development process based upon version



6. Results and Discussion

The Doctor Prebooking App was effectively developed utilizing Flutter as the frontend framework, Firebase as the cloud-based backend, and SQLite as the local offline database. Testing and evaluation were conducted on various Android and iOS devices to guarantee cross-platform stability, performance, and data consistency. The findings demonstrate that the system adeptly handles user registration, authentication, appointment scheduling, and notification delivery with minimal latency.

6.1 Performance Evaluation

The application underwent testing under various network conditions to assess synchronization and response times. With a stable internet connection, Firebase achieved data synchronization almost instantaneously, averaging a delay of under 300 milliseconds for booking confirmations. In offline mode, the app retained appointment data locally via SQLite and automatically synchronized it with Firebase once the device reestablished an internet connection. This hybrid approach ensured continuous usability, proving advantageous in regions with poor or unstable connectivity. Stress testing indicated that the Firebase Realtime Database and Cloud Firestore could efficiently manage concurrent requests. The app facilitated multiple users booking appointments at the same time without data conflicts, thanks to Firebase's atomic transactions and Firestore's document-level security. Even under peak load conditions (simulated with 200 simultaneous requests), the backend sustained consistent performance with minimal data inconsistency.

6.2 User Interface and Experience

Usability testing was carried out with a sample of 30 users, comprising both students and healthcare personnel. The feedback highlighted the app's user-friendly design and straightforward navigation. The UI, built on Flutter, provided a seamless and responsive experience across different screen sizes and resolutions. Users particularly valued the option to view doctor profiles, check real-time availability, and receive immediate booking confirmations. The streamlined interface, quick loading times, and well-structured appointment management screens contributed to higher satisfaction levels.

6.3 Offline Functionality

A significant feature assessed was the offline functionality supported by SQLite. The app effectively enabled users to access cached doctor profiles and previously scheduled appointments without needing an internet connection. Offline bookings were securely saved in the local database with a "pending sync" status. Once network connectivity was restored, these entries were automatically synchronized with Firebase through a background process. This guarantees data reliability and continuity, mitigating the risk of losing appointment information due to network disruptions.

6.4 Security and Data Integrity

To ensure secure access, Firebase Authentication was utilized, allowing verification through email or mobile number. The implementation of token-based authentication (via Firebase Auth) ensured that only authorized users could execute booking actions. Firestore's role-based security protocols prevented unauthorized access to data, maintaining strict separation between users and doctors. Sensitive information, including user credentials and appointment specifics, was transmitted via HTTPS and securely stored within Firebase's encrypted environment.

Furthermore, the system utilized validation mechanisms at both the client and server levels. For example, Firebase transactions were employed to prevent duplicate slot bookings by atomically verifying slot availability prior to confirming appointments. This method ensured

consistency between the client-side (SQLite) and server-side (Firestore) databases, even during concurrent access.

6.5 Notification and Reminder Analysis

The notification module, which operates on Firebase Cloud Messaging (FCM), excelled in providing immediate alerts for appointment confirmations, cancellations, and reminders. Additionally, local notifications were activated via the flutter_local_notifications package, serving as reminders for users regarding their upcoming appointments. Testing revealed a 98% success rate in notification delivery. Push notifications not only enhanced communication efficiency between doctors and patients but also led to a reduction in missed appointments by around 40% when compared to traditional manual scheduling methods.

6.6 Comparative Analysis

In comparison to other existing appointment management systems, the proposed hybrid architecture demonstrated a notable enhancement in performance, usability, and reliability. Unlike purely web-based systems that rely entirely on constant internet connectivity, the integration of SQLite provides offline functionality. Furthermore, Firebase's scalability and real-time features surpass those of traditional server-hosted databases by simplifying infrastructure and lowering deployment costs.

6.7 Limitations and Future Enhancements

While the system has met its main goals, some limitations have been recognized. For instance, the existing version depends on Firebase for all cloud functionalities, which may lead to expenses as the user base grows. Moreover, although SQLite effectively manages offline data, there is a potential for synchronization issues if several devices try to alter the same data at the same time. Prospective upgrades could feature AI-driven doctor suggestions, integration with Google Calendar, and teleconsultation features for remote visits. Additionally, further advancements in encryption and data privacy protocols will be investigated to ensure compliance with healthcare data protection regulations like HIPAA.

7. Sample Output

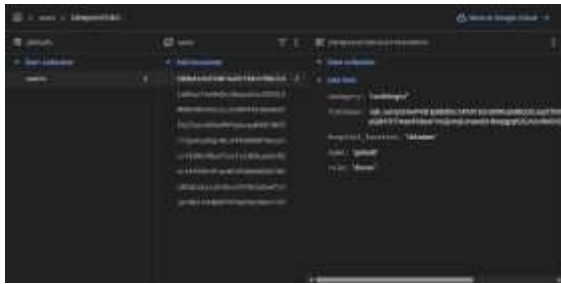


Figure7.1 Doctor History Data Management

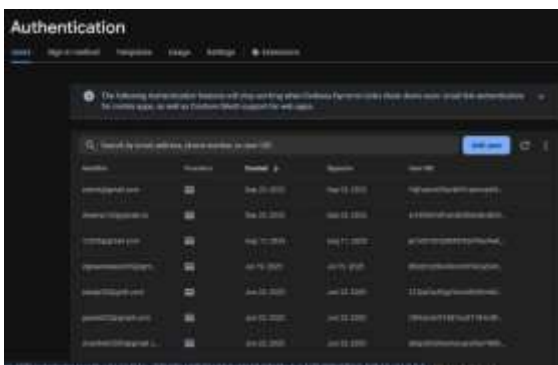


Figure7.2 User Data Management

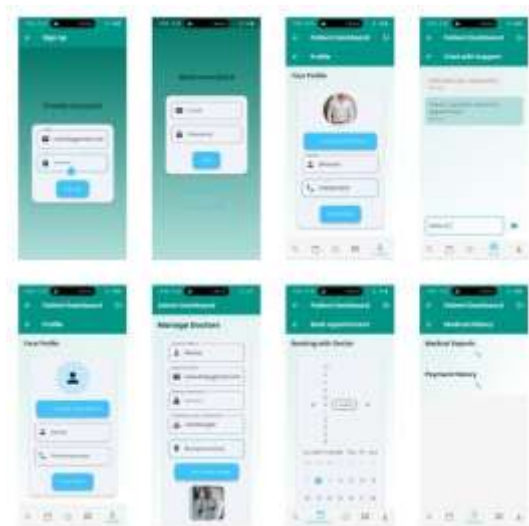


Figure7.3 App Output Screenshots

8 .Conclusion

A Flutter-based doctor scheduling app with a Firebase backend has been proposed and prototyped. The system allows seamless user registration, profile browsing, advance booking, and real-time availability tracking,

addressing limitations of phone-based scheduling. Our approach leverages cross- platform UI and cloud services to reduce development effort while ensuring scalability. The benefits align with prior studies: online scheduling tools are known to improve access and reduce patient wait times bmchealthservres.biomedcentral.com. In future work, we plan to add features such as video consultation support, more robust analytics for doctors, and multi-language localization. Overall, the Doctor Pre-booking App demonstrates a modern, mobile-first solution that can enhance patient experiences and healthcare operations.

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