SmartMed: A Location-Based Medicine Availability Application

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Abstract

Finding a needed medicine can take time when people have to visit or contact several pharmacies just to check whether it is available and how much it costs. SmartMed was developed to address this problem through a location-based Android mobile application. The application allows users to search for medicines by brand or generic name, check synchronized availability and price information from participating pharmacies, compare prices, and locate nearby pharmacies through an interactive map. The project followed an Agile development approach and used Flutter for the mobile interface, Dart for application logic, Firebase Authentication for account access, Cloud Firestore for real-time cloud data, and the Google Maps API together with device Global Positioning System services for pharmacy mapping and route guidance. The prototype included 20 medicines from two participating pharmacies and provided separate interfaces for regular users, pharmacy staff, and administrators. Functional, integration, and user acceptance testing were carried out. Five selected users completed six core test cases covering medicine search, price sorting, map display, no-result handling, mobile access, and current-location detection. All six test cases passed in the controlled test environment. The results show that SmartMed can make it easier for users to locate medicines and compare prices while giving participating pharmacies a practical way to update inventory information. However, the reliability of the information shown in the application still depends on timely pharmacy updates and internet connectivity.

Keywords: Medicine Availability, Pharmacy Locator, Medicine Price Comparison, Location-Based Services, Mobile Health Application, Pharmacy Inventory Management, Medicine Search

1. Introduction

Access to essential medicines is an important part of healthcare, but finding a specific medicine can still be difficult when it is not available at the first pharmacy a person visits. In many cases, people have to go from one pharmacy to another, make phone calls, or ask pharmacy staff directly just to confirm whether a medicine is in stock. This process takes time and can become more difficult when the medicine is needed urgently.

Price is another concern because the same medicine may be sold at different prices by different pharmacies. Without an easy way to compare available options, a consumer may buy from the first pharmacy they visit even when a lower-priced option is available nearby. This is especially important for people who are trying to manage limited household expenses or who live in areas where pharmacies are located far from one another.

SmartMed was created to bring medicine availability, pricing, and pharmacy location information into one mobile application. Through the application, users can search for a medicine, check whether it is available in participating pharmacies, compare prices, detect their current location, and view directions to a selected pharmacy. Pharmacy personnel can maintain medicine inventory information, while administrators can manage accounts and monitor system activity. By using mobile and cloud technologies to improve access to medicine information, the project is aligned with Sustainable Development Goal 3 on good health and well-being and Sustainable Development Goal 9 on innovation and infrastructure.

1.1 Objectives of the Study

The study aimed to develop a centralized, location-based mobile application that helps users find medicines, check their availability in participating pharmacies, compare prices, and identify nearby pharmacy locations.

1. Create a user-friendly mobile interface where users can search for medicines and view availability, prices, and pharmacy information.
2. Develop an inventory management module that enables authorized pharmacy personnel to add and update medicine records, prices, and stock availability.
3. Integrate location services and the Google Maps API so users can view nearby pharmacies and access route guidance.
4. Provide a price comparison function that allows users to compare the cost of the same medicine across participating pharmacies.

1.2 Scope and Limitations

SmartMed was developed as an Android mobile application intended for students, professionals, and local residents. The prototype included 20 medicines and two participating pharmacies. Users could search by brand or generic name, check medicine availability and prices, compare pharmacy listings, and view pharmacy locations on a map. Pharmacy staff were given tools for updating inventory information, while administrators could manage accounts and review system activity through role-based interfaces.

The prototype was limited to medicine searching, availability checking, price comparison, inventory updating, and location-related functions. It did not include online purchasing, medicine reservation, payment processing, delivery, prescription validation, or teleconsultation. The accuracy of the displayed prices and stock status depended on how complete and up to date the information entered by pharmacy personnel was. SmartMed was also not connected to existing point-of-sale systems, third-party pharmacy databases, or national health databases. Full use of the application required internet access, location permission, and a supported Android device, and only participating pharmacies were shown in the system.

2. Review of Related Literature and Systems

Digital health applications have been used to improve access to healthcare resources and medication information. Samrin et al. developed a medical resources locator application that allowed users to search for health facilities and filter available services by location, demonstrating the usefulness of centralized and location-based information [1]. García-Sánchez et al. reviewed mobile applications that provide emergency drug information and emphasized the importance of complete, current, and accessible medication content for health professionals [2]. These studies support the use of mobile interfaces as practical channels for delivering time-sensitive healthcare information.

Medicine availability also depends on the quality of inventory management. Demessie et al. identified stock-outs, incomplete logistics records, and inconsistencies between physical counts and inventory records in public health facilities [3]. Their findings indicate that the usefulness of any public-facing medicine locator depends on consistent inventory updating. SmartMed addresses this requirement by allowing authorized pharmacy personnel to update medicine quantities, prices, and availability through a dedicated interface connected to Cloud Firestore.

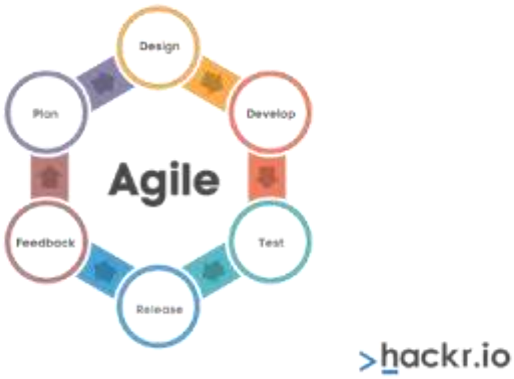
Bata et al. developed a mobile-based intelligent drug search engine to help patients identify pharmacies with prescribed medicines [4]. Although the system applied machine learning, its main objective of improving medicine discovery is closely related to SmartMed. Rehman et al. reported generally positive perceptions of medication-related mobile applications among pharmacists and pharmacy students despite gaps in knowledge and awareness [5]. Ilkic et al. likewise found that mobile health applications can support access to current medical information, education, and patient care, while user experience remains an important design consideration [6].

The acceptance of mobile health systems by pharmacy operators is influenced by trust, education, cooperation, and confidence in technology, as discussed by Cobelli and Chiarini [7]. Ghodeswar et al. reviewed an Android application for medicine availability and location finding that used location services to help users locate medicines [8]. These works show that a pharmacy locator should combine accurate inventory information, usable mobile interfaces, and reliable mapping. SmartMed extends these concepts through role-based Firebase Authentication, synchronized Cloud Firestore records, price comparison, and direct Google Maps API integration.

3. Methodology

The project followed an Agile development process so that the application could be planned, built, tested, and improved in smaller cycles. Requirements were identified through informal interviews, observation of pharmacy operations, and feedback from prospective users and pharmacy personnel. Instead of developing every feature at once, each cycle focused on a manageable set of functions. Problems found during testing or feedback were addressed before moving to the next development cycle.

Figure 1: Agile Development Model Used for SmartMed



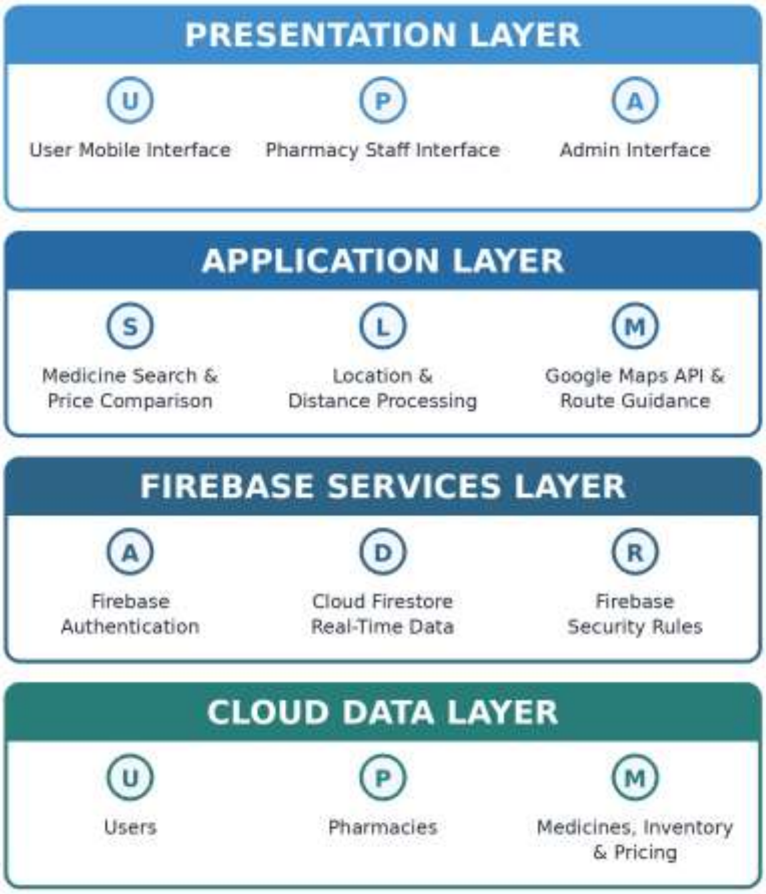
3.1 Planning and Requirements Analysis

During planning, the system requirements were grouped according to three main user roles: regular users, pharmacy staff, and administrators. Regular users needed functions for medicine search, availability checking, price comparison, nearby pharmacy listing, and map-based navigation. Pharmacy personnel needed secure controls for managing inventory and prices, while administrators needed tools for user management and activity monitoring. The project also considered non-functional requirements such as a responsive mobile interface, secure authentication, reliable cloud synchronization, compatibility with supported Android devices, and reasonable response time during normal use.

3.2 System Design and Architecture

SmartMed was arranged into four main layers. The presentation layer contains the Flutter interfaces used by regular users, pharmacy staff, and administrators. The application layer, developed in Dart, handles navigation, input validation, medicine searching, price sorting, role-based behavior, and location processing. Firebase Authentication, Cloud Firestore, and Firebase Security Rules make up the Firebase services layer. The cloud data layer stores user profiles, pharmacy records, medicines, inventory information, prices, and activity data. The application also connects to the Google Maps API and device location services to show pharmacy markers, determine the user's location, and provide route guidance.

Figure 2: Layered System Architecture of SmartMed



3.3 Development Technologies

Flutter was used to build the mobile interfaces through reusable widgets, while Dart handled the application logic, asynchronous operations, searching, sorting, validation, and communication with backend services. Firebase Authentication managed user registration and login. Cloud Firestore stored medicine, pharmacy, user, inventory, price, and activity records and provided real-time data synchronization. Firebase Security Rules were configured to control access based on the authenticated user's role.

The Google Maps API was used to show pharmacy markers, the user's location, and route guidance. Device Global Positioning System and location services were used to determine the user's position and nearby pharmacies when location permission was granted. Development and testing were carried out using Android Studio and Visual Studio Code for coding, dependency management, emulator testing, debugging, and application building. The application was also tested on physical Android devices.

3.4 Interface and Functional Development

The interface was designed so that users could find medicine information without going through many steps. The home screen provides a search field and a list of available medicines. When a medicine is selected, the application shows its name, price, stock status, participating pharmacy, and available navigation options. The pharmacy map displays nearby pharmacy locations and route information. Separate dashboards were provided for pharmacy staff and administrators so that inventory management and system administration functions were kept separate from the regular user interface.

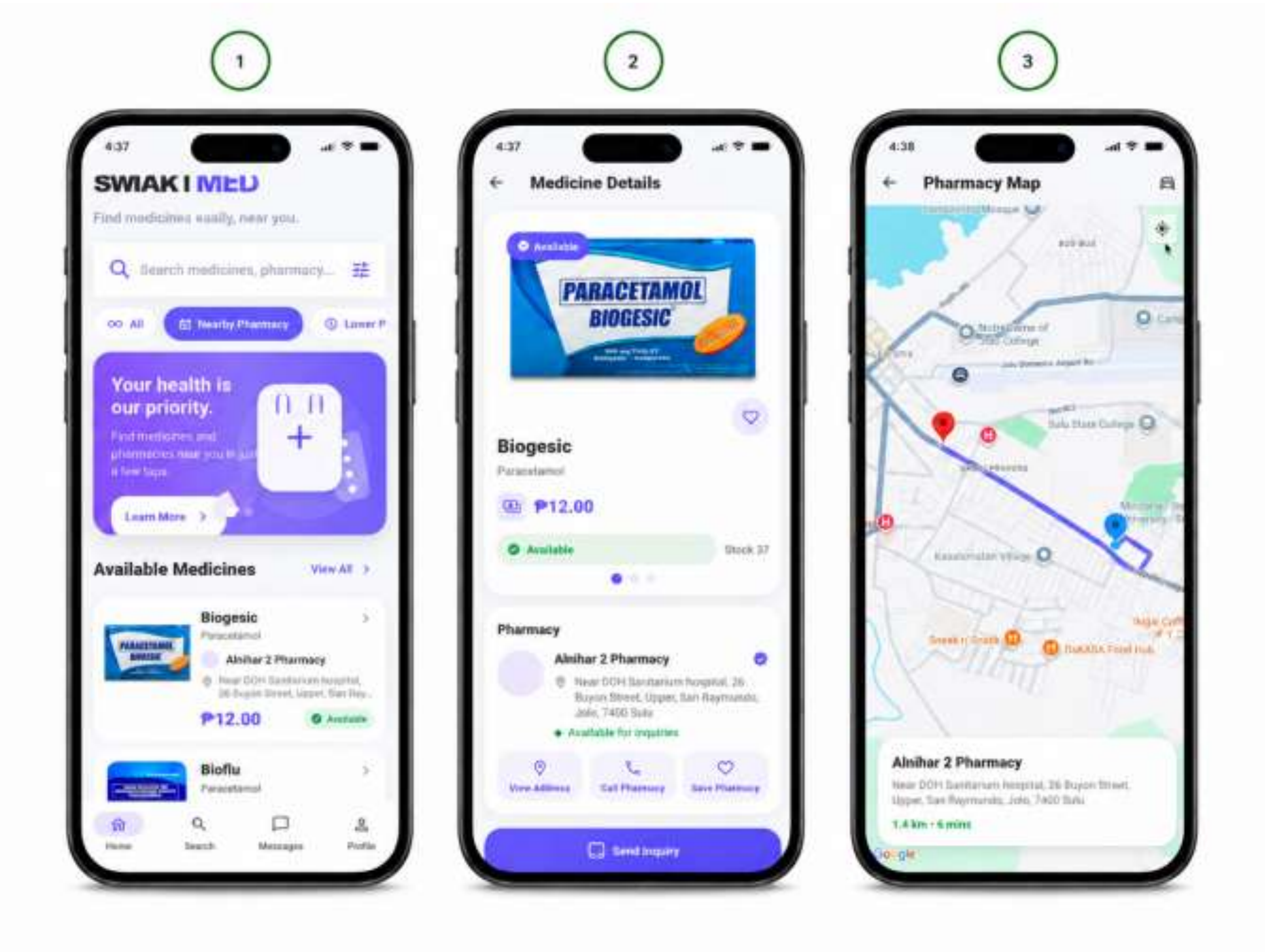


Figure 3: Main User Interfaces for Medicine Search, Details, and Pharmacy Mapping

Figure 3 shows the three main user-facing interfaces of SmartMed. The first interface is the home page, where users can search for medicines, view available products, filter nearby pharmacies, and check prices and availability. The second interface presents detailed medicine information, including the medicine name, generic name, price, stock status, pharmacy name, address, and contact options. The third interface shows the pharmacy map, which uses the user's current location and Google Maps to display the route, distance, and estimated travel time to the selected pharmacy. Together, these interfaces guide the user from searching for a medicine to reviewing its details and locating a participating pharmacy.

3.5 Testing Procedures

Testing was carried out during the different stages of development rather than only after the application was completed. Unit testing focused on individual functions such as medicine search, price sorting, authentication handling, inventory updates, map rendering, and location-based filtering. Integration testing checked whether the Flutter screens, Dart services, Firebase Authentication, Cloud Firestore, and Google Maps services worked properly together. The test process also covered situations such as unavailable medicines, denied location permission, invalid credentials, empty search results, and interrupted connectivity.

For user acceptance testing, five selected users composed of students and faculty members used the application and completed six core scenarios. These included searching for a medicine, sorting results by the lowest price, viewing a pharmacy on the map, handling a search with no result, using the application on a mobile device, and using the current-location function. For each scenario, the expected result was compared with what actually happened in the application, after which the test case was marked as passed or failed.

4. Results and Discussion

4.1 Medicine Search and Availability

The medicine search function retrieved records that included the product name, price, stock status, and pharmacy details. The information came from inventory records stored in Cloud Firestore and updated by pharmacy personnel. During controlled testing, users were able to determine whether a listed medicine was available without having to visit several pharmacies. This directly addressed the manual medicine-search process identified during requirements gathering.

4.2 Price Comparison and Location Services

When the same medicine was available in more than one participating pharmacy, the listings could be arranged by price so users could identify the lower-cost option. The Google Maps API displayed pharmacy markers and route guidance, while current-location access helped the application identify nearby pharmacy options. These functions reflect the centralized information approach described by Samrin et al. [1] and the location-finding purpose discussed by Ghodeswar et al. [8].

4.3 Role-Based Data Management

Pharmacy personnel could add or update medicine names, prices, quantities, and availability through their assigned interface. After a successful update, the changes were synchronized through Cloud Firestore and became available to regular users. Administrators could manage user accounts and review activity information. Firebase Authentication together with role information was used to keep regular-user access separate from pharmacy and administrative functions, helping prevent unauthorized changes to inventory records.

4.4 User Acceptance Testing Results

Table 1: User Acceptance Testing Results

Test Case	Description	Expected Result	Actual Result	Status
TC01	Search for a medicine	Displays results with prices and pharmacy locations	Matching medicine records were displayed correctly	Passed
TC02	Sort by lowest price	Lists results from lowest to highest price	Price sorting worked as intended	Passed
TC03	View on map	Displays pharmacy markers and route information	Map and pharmacy markers were displayed	Passed
TC04	No result found	Displays an appropriate no-result message	No-result message was shown	Passed
TC05	Access on mobile	Interface remains responsive and functional	Mobile layout and functions operated correctly	Passed
TC06	Use current location	Detects the user and displays nearby options	Location was detected and nearby options were displayed	Passed

All six user acceptance test cases passed. The participants were able to search for medicines, compare prices, open pharmacy locations, and use the current-location feature on the Android devices used for testing. No major functional or usability problem was reported during the controlled evaluation. Under the tested conditions, key functions responded in approximately three seconds, based on the timing recorded in the source project documentation.

The testing results show that the selected combination of Flutter, Dart, Firebase, and the Google Maps API was workable for the SmartMed prototype. At the same time, the results should be viewed within the actual size of the evaluation: five users, 20 medicines, and two participating pharmacies. Testing with more users, larger inventories, additional pharmacies, and less stable network conditions would be needed before making broader conclusions about the application’s performance.

5. Conclusion

SmartMed was completed as a location-based Android application for checking medicine availability, comparing prices, and locating participating pharmacies. Flutter and Dart were used for the mobile application, Firebase Authentication and Cloud Firestore handled account access and synchronized cloud data, and the Google Maps API together with device location services supported pharmacy mapping and route guidance. The final prototype included medicine search, availability display, price comparison, pharmacy location, pharmacy inventory management, and administrative functions.

In the controlled evaluation, all six user acceptance test cases passed. Participants were able to find listed medicines, compare available prices, and view nearby pharmacy information without first visiting each pharmacy. These results indicate that SmartMed can serve as a practical starting point for improving access to local medicine information. Its usefulness still depends on active pharmacy participation, timely inventory updates, reliable internet access, and accurate location and pricing data.

6. Recommendations

Future testing should involve more pharmacies, a larger medicine inventory, and users from different communities. Connecting SmartMed with pharmacy point-of-sale or inventory systems could also be explored to reduce manual updating and improve data accuracy. A verification feature for pharmacy listings, stock-update timestamps, and price changes would further help users judge how current the displayed information is.

Other features that may be considered include user reporting for inaccurate information, pharmacy ratings, multilingual support, adjustable text sizes, voice search, prescription upload with appropriate privacy controls, and optional reservation or delivery services. A web version could also be developed for users who cannot install the Android application. Before wider deployment, the system should undergo broader security and privacy assessment, offline-behavior testing, and performance testing using larger datasets.

8. Acknowledgement

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