

## Childcare Digital Book for Infants and Children

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### Abstract

The management of infant and child health examinations in Malaysia traditionally relied on physical record books, leading to challenges like loss and complexity in record management. Addressing this, the project aimed to develop Childcare Digital Book, a mobile application offering a modern alternative. Using Agile development approach, by leveraging Flutter framework and Firebase, the app was developed after extensive research on traditional book limitations and user requirements through interviews, surveys, and market analysis. This app streamlines health records, appointments, and access to child health data, enhancing healthcare efficiency for parents and providers. By modernizing child healthcare, it promises improved access to vital health information besides signifies progress in Malaysia's healthcare and potentially sets a model for modernization in other sectors.

## 1. Introduction

Health examinations for infants and children are essential components of early healthcare and child development. Our country also recognizes the importance of this matter. As example, Ministry of Health Malaysia under Child Health Sector have outlined a national framework to reduce the under-5 mortality and support Child growth and development called "Child Health 2021-2030" [1]. However, in Malaysia, the conventional reliance on physical health record books for the management of infant and child health examinations has posed various challenges. These physical records encountered issues related to loss, damage, and the cumbersome nature of handling multiple records.

Based on the current process, parents must keep the record book and need to bring it to clinics every time they attend scheduled health checkup appointments. All health-related information is recorded in the book by the medical staff. Although this practice holds significant sentimental value, it may no longer be suitable nowadays in this rapidly advancing digital age [2].

Recognizing these limitations, this study aims to address the critical challenges inherent in the existing system by designing, developing, and testing the Childcare Digital Book mobile application, with a primary emphasis on enhancing the efficiency of health check-ups for children. The application will be used by the parents or guardian and medical staffs. There are five modules in this proposed application which are user registration, health assessment, checkup management, health record, and health guideline.

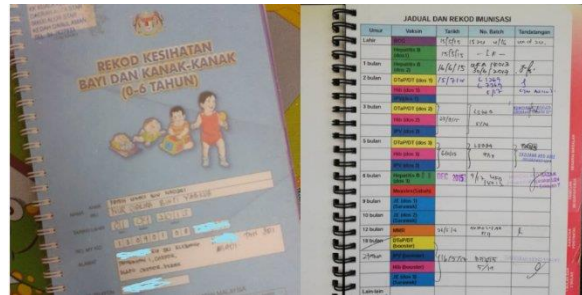
The expected outcomes of this study extend beyond the implementation of a mobile application. It aims to significantly modernize child healthcare in Malaysia, potentially serving as a model for digital transformation in other sectors. At the end of this project, the application will be able to solve the challenges inherent in traditional health record management.

## 2. Related Work

This section explains the traditional physical record book, digital solution in healthcare, and mobile device technology.

## 2.1 Traditional Physical Record Book

The prevailing traditional health record systems utilized for managing infant and child health examinations in Malaysia have been foundational but have encountered significant challenges. Physical health record books distributed to newborns and employed until the age of six [3]. However, these conventional systems are beset with various limitations that hinder efficient record-keeping and accessibility.



**Fig 1** Currently used physical record book.

These books document critical health data, including vaccination schedules, medical history, and appointments. As an example, one of the important records to the children that stored in this book is M-Chat examination record. A study shows that Malaysian M-CHAT-R/F has relatively high sensitivity, specificity, and PPV in screening Malaysian toddlers aged between 18 and 48 months for ASD [4]. Therefore, foremost among these are the susceptibility to damage, loss, or misplacement, leading to potential data loss or incompleteness. The wear and tear experienced by these books over time poses a risk of illegibility or obliteration of crucial health information. Other than that, another significant issue pertains to the cumbersome nature of managing multiple physical records concurrently. Parents often find it challenging to organize and maintain separate books for each child, leading to confusion and potential errors in managing health information.

## 2.2 Digital Solution in Healthcare

Digital solutions in healthcare signify a monumental shift in the delivery and management of healthcare services. These technological innovations encompass a broad spectrum of tools and systems designed to optimize healthcare practices, improve patient care, and enhance health outcomes. Central to this transformation are electronic health records (EHRs), which have revolutionized data management in healthcare settings. EHR systems streamline the documentation, storage, and retrieval of patient health information in a digital format, fostering seamless information exchange among healthcare providers [5]. The adoption of EHRs has demonstrated substantial benefits, including improved care coordination, reduced medical errors, and enhanced patient safety.

The evolution of digital solutions within healthcare showcases a diverse array of applications designed to revolutionize patient care and healthcare management. Several existing applications in the market exemplify the innovative integration of technology to address specific healthcare needs. For instance, a mobile application called MyUBAT, was developed by the Government of Malaysia, focuses on simplifying pharmacy value-added services for patients via smartphones. This application offers remote access to pharmacy services, enabling patients to conveniently access these services remotely. The functionalities offered by MyUBAT, such as remote service access and medication tracking, present opportunities for alignment with the proposed Childcare Digital Book.



**Fig 2** MyUBAT mobile application.

Besides, another application is Asianparent, a comprehensive pregnancy application, caters to expectant mothers, new parents, and those planning for parenthood. It offers a myriad of features covering various stages of pregnancy and early parenthood. The application provides exhaustive pregnancy information, including stage-specific guidance aligned with trimesters, symptoms identification, and weekly pregnancy changes. Moreover, it includes a baby tracker feature enabling parents to monitor their child's growth and development. Leveraging the robust health monitoring capabilities and detailed developmental tracking in Asianparent, the proposed system could enhance similar features related to health monitoring and developmental milestone tracking for infants and children.



**Fig 3** Asianparent mobile application.

Table 1 shows the comparison between the existing system with the proposed system.

**Table 1** Comparison of existing system with proposed system

Features	MyUBAT	Asianparent	Proposed system
Registration and Login	Yes (Phone Number)	Yes (Google, Facebook, Email)	Yes (Email)
Appointment Scheduling	Yes	No	Yes
Health Record Management	Yes	No	Yes
Health Tracking and Reminders	Yes	Yes	Yes
Parental Education	No	Yes	Yes
Development Milestone Tracking	No	Yes	Yes
Community Support	No	Yes	No
Multiple Profile Management	No	No	Yes

### 2.3 Mobile Device Technology

Mobile device constitutes a broad spectrum of portable gadgets, predominantly smartphones and tablets, which offer features and applications catering to diverse functionalities. These devices, equipped with advanced operating systems like Android and iOS [6]. Common attributes inherent in mobile devices encompass accessibility, connectivity, user-friendly interfaces, portability, and the integration of multifunctional capabilities within a unified platform.

The significance of mobile device technology lies in its ability to democratize healthcare access and engagement. Health-related applications not only offer functionalities for managing health records but also encourage active participation in personal health management. Moreover, the portability of these devices ensures convenient access to health information, enabling seamless communication between patients and healthcare providers.

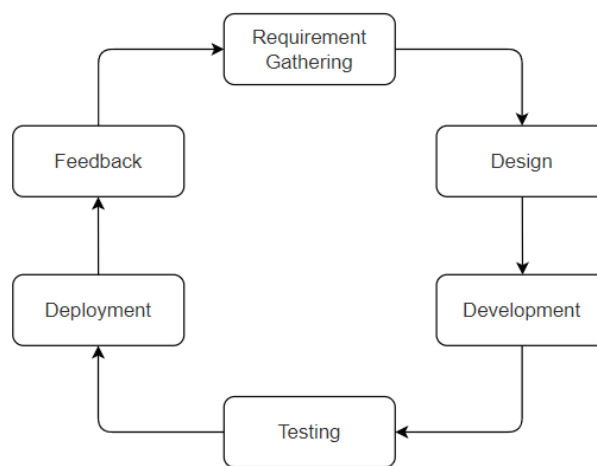
Furthermore, the integration of mobile devices in healthcare settings has transcended traditional boundaries, enabling remote monitoring and consultations. This aspect has become increasingly critical, especially in scenarios requiring immediate medical attention or when patients are located remotely. The role of

mobile technology in enhancing healthcare efficiency, reducing healthcare costs, and improving patient satisfaction has been well-documented [7].

The application of mobile device technology in the development of the Childcare Digital Book aligns with leveraging these advantages. The aim is to harness the accessibility, connectivity, and user-centric design of mobile devices to create a comprehensive and user-friendly platform for managing infant and child health records in Malaysia. By capitalizing on the multifunctional capabilities of mobile devices, this initiative seeks to address the limitations of traditional health record systems and pave the way for a more efficient and accessible healthcare management solution.

### 3. Methodology

The methodology chosen for the development of the Childcare Digital Book application is the Agile Development Model. Agile is an iterative and incremental approach to software development that emphasizes flexibility, collaboration, and continuous improvement. The model was chosen due to its adaptability to changing requirements, frequent customer involvement, and its ability to deliver functional software increments rapidly.



**Fig 4** Agile SDLC Model

The application development process was organized into several sprints, each typically lasting 2-4 weeks. Each sprint included the following phases, depicted in Figure 4:

- **Requirement Gathering:** At the beginning of each sprint, requirements were collected and refined for this sprint's goals. This involved understanding the user needs and translating them into actionable user stories.
- **Design:** The architecture and user interfaces for the features to be developed was designed in this sprint. This phase ensured that the planned features were well-defined and could be efficiently implemented.
- **Development:** Using the Flutter framework and Firebase to implement the code and integrate the new functionality.
- **Testing:** Continuous testing was performed throughout the sprint to ensure that the new features were functioning correctly and did not introduce any new issues.
- **Deployment:** After ensuring the new features were tested and stable, prototype was deployed to allow stakeholders to see the progress and provide feedback.
- **Feedback:** At the end of each sprint, the completed work was demonstrated to the stakeholder to discuss what went well, what could be improved, and to plan for the next sprint.

By following this Agile process, the development of the Childcare Digital Book application was flexible and responsive to changes, ensuring that the final product met the users' needs and expectations.

### 3.1 Requirements Gathering

Requirements Gathering involves analysis and prioritization of user needs and project requirements, achieved through stakeholder interactions and detailed documentation. Its core purpose lies in systematically identifying, organizing, and prioritizing both functional and non-functional requirements essential for the application's success.

**Table 2** *Functional requirements*

Modules	Requirements
User Registration	<ul style="list-style-type: none"> <li>• Application should allow users to register as new user with their email.</li> <li>• Application should allow user to verify their email first before signing in.</li> <li>• Application should validate user input and alert user about validation if any.</li> <li>• Application should allow user to log in using their verified email and password.</li> <li>• Application should allow user to change their password in case they forgot it.</li> <li>• Application should allow parents to create and delete their children's profile.</li> </ul>
Health Assessment	<ul style="list-style-type: none"> <li>• Application should allow parents to fill parent observation form before appointment.</li> <li>• Application should allow medical staff to record health assessment details.</li> <li>• Application should allow medical staff to verify children profile.</li> </ul>
Checkup Management	<ul style="list-style-type: none"> <li>• Application should allow medical staff to set appointment date for children.</li> <li>• Application should alert parents for new appointment.</li> <li>• Application should allow user to request for appointment rescheduling.</li> </ul>
Health Records	<ul style="list-style-type: none"> <li>• Application should allow parents to view their children appointment records.</li> <li>• Application should allow parents to view their children vaccination records.</li> <li>• Application should allow parents to view children biodata.</li> <li>• Application should allow parents to view children's M-Chat record.</li> </ul>
Health Guidelines	<ul style="list-style-type: none"> <li>• Application should allow user to view related parents' guidelines.</li> <li>• Application should allow medical staff to create, edit and delete articles for related category.</li> <li>• Application should allow parents to view and search for related articles.</li> </ul>

**Table 3** *Non-Functional requirements*

Requirement	Description
Compatibility	<ul style="list-style-type: none"> <li>Support various devices and screen sizes without compromising usability.</li> <li>Ensure the app functions seamlessly on both Android and iOS platforms.</li> </ul>
Performance	<ul style="list-style-type: none"> <li>The application should respond promptly to user interactions and commands.</li> </ul>
Security	<ul style="list-style-type: none"> <li>Implement secure user authentication methods to prevent unauthorized access.</li> <li>Sensitive information should be encrypted.</li> </ul>
Maintainability	<ul style="list-style-type: none"> <li>The application should be easy for updates and maintenance.</li> </ul>

### 3.2 Design

The Design Phase involves the process of translating gathered requirements into a structured blueprint for the Childcare Digital Book application. This phase aims to conceptualize the application's architecture, user interface, and overall design to ensure alignment with stakeholders' needs and expectations. This phase involves developing wireframes and mock-ups. This step is fundamental, entailing the creation of preliminary visual representations, providing an initial structural layout and design overview.

### 3.3 Development

Development Phase signifies the implementation and coding stage where the Childcare Digital Book application takes shape based on the outlined designs and gathered requirements. The primary goal is to bring the conceptualized designs to life, employing the chosen Flutter framework for front-end development and Firebase as the backend, ensuring a robust and functional application.

### 3.4 Testing

Testing Phase stands as a crucial stage in the developmental lifecycle of the Childcare Digital Book application, aiming to ensure its functionality, reliability, and adherence to specified requirements. The primary goal is to identify and rectify any defects or issues before the application's deployment.

### 3.5 Deployment

Deployment Phase signifies the final stage of the developmental lifecycle where the Childcare Digital Book application is prepared, tested, and made accessible for users. The primary objective is to ensure a smooth and successful launch of the application into a production environment to make sure the application is ready for users' utilization. This phase involves the crucial step of uploading the finalized application onto production servers or dedicated app stores such as Google Play Store or Apple App Store.

### 3.6 Feedback

The Review Phase marks the stage post-deployment where an extensive evaluation of the application's performance, user feedback, and overall effectiveness is conducted. The primary objective is to gather insights and lessons learned from the application's usage in the live environment, facilitating improvements and informing future iterations.

## 4. Result and Discussion

### 4.1 Use Case Diagram

The Use Case Diagram illustrates the main functionalities available to different actors interacting with the system. Figure 5 shows two actors: medical staff and parents or guardians. Users can register and log in using email and password and edit their account details such as username and phone number. Parents can manage their children's profiles, creating and deleting them if unverified. Medical staff can record health assessments, verify children's profiles to prevent deletion, set appointment dates, and manage articles for parents. Parents must fill out observation forms before appointments and can view their children's health records and access health guidelines and articles.



Fig 5 Use Case Diagram

## 4.2 Activity Diagram

Figure 6 below shows the activity diagram of the proposed system. Users must register by providing their email, username, password, and role (parent or medical staff), then verify their email before logging in. If users forget their password, they can reset it with their registered email. The application verifies users and redirects them to the main menu based on their role, displaying different interfaces for parents and medical staff.

Parents can view appointment details, children's health records, articles, guidelines, and manage their child's profile. Medical staff can set appointment dates, record health assessments and vaccination details, verify children's profiles, and write articles. Medical staff accounts must be verified by the head of staff before accessing features to prevent unauthorized access.

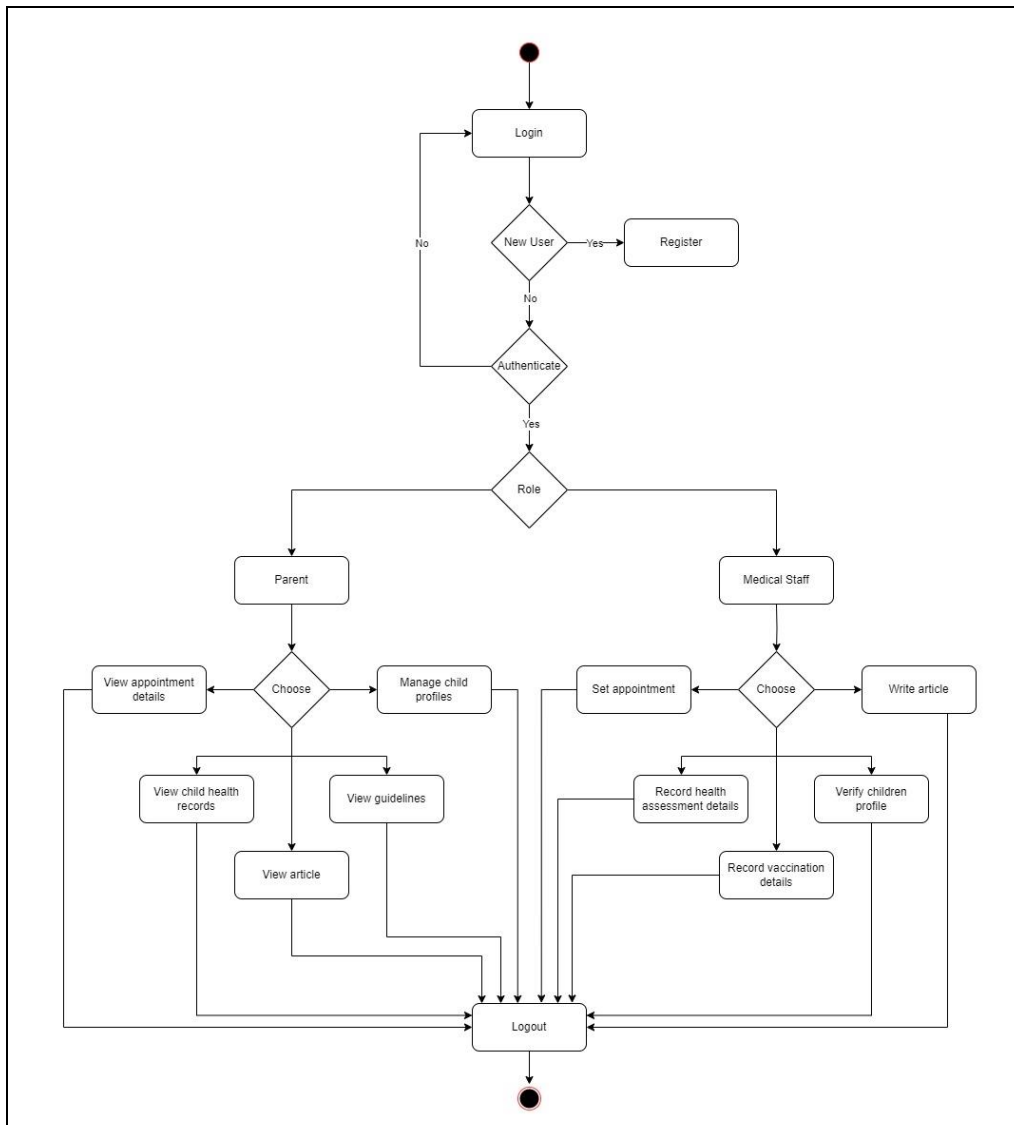


Fig 6 Activity Diagram

## 4.3 User Interface Design

The User Interface (UI) design for the Childcare Digital Book is a crucial element of the application's functionality and appeal. The UI design employs a user-centric approach, strategically organizing health-related data to be easy to understand and navigate.

### 4.3.1 Registration and Login

Figure 7 shows the interface for user registration and login.

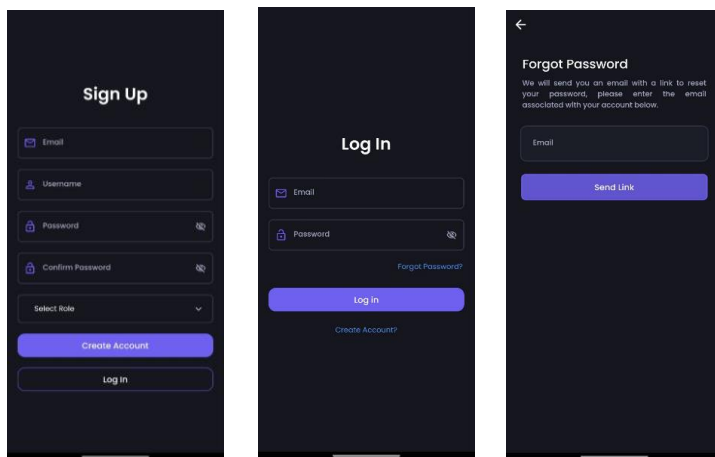


Fig 7 Registration and Login interface

### 4.3.2 Health Assessment

Figure 8 below shows the interface for health assessment module.

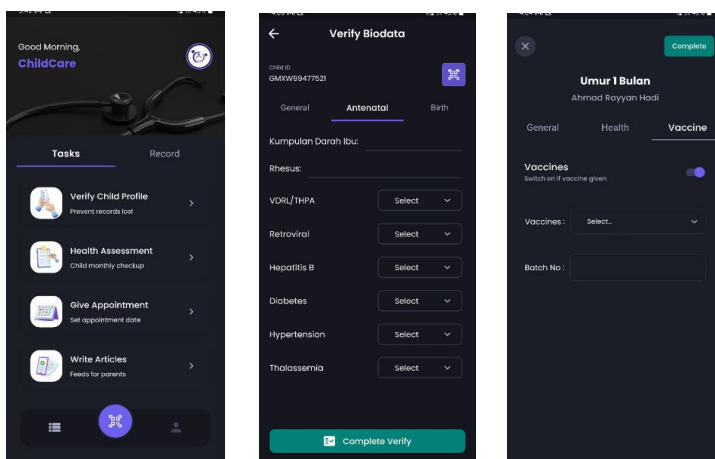


Fig 8 Health assessment interface

### 4.3.3 Checkup Management

Figure 9 below shows the interface for checkup management module.

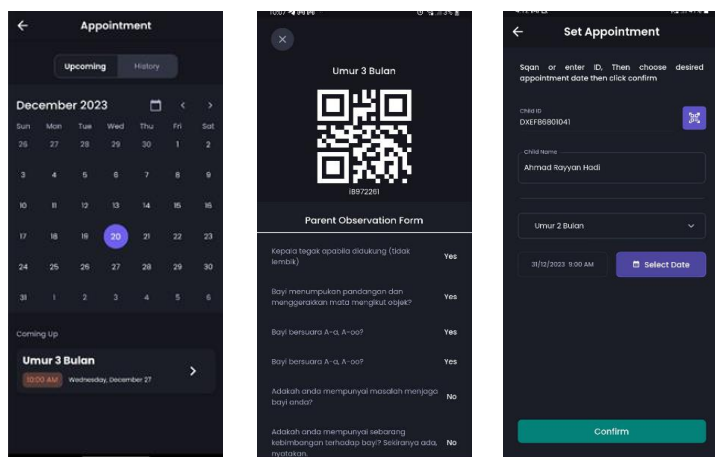


Fig 9 Checkup management interface

### 4.3.4 Health Records

Figure 10 below shows the interface for health records module.

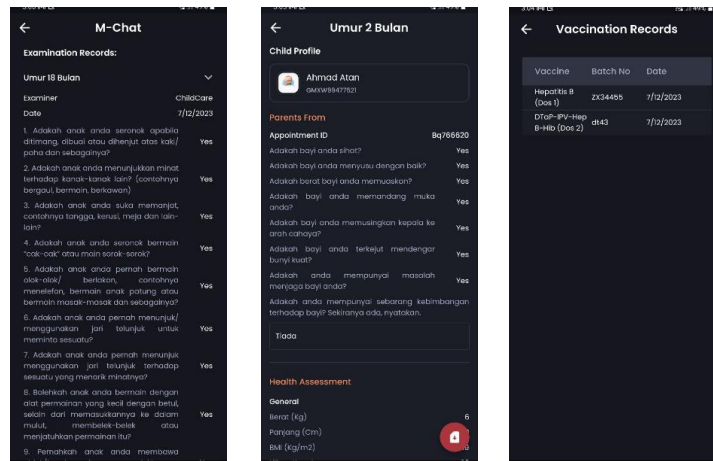


Fig 10 Health records interface

### 4.3.5 Health Guideline

Figure 11 below shows the interface for health guideline module.

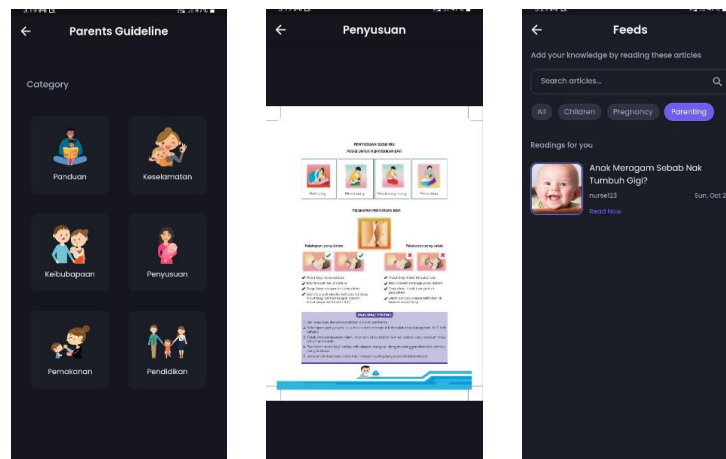


Fig 11 Health guideline interface

## 4.4 Implementation

In the implementation phase, the chosen technologies, Flutter and Firebase, were utilized to bring the Childcare Digital Book application to life. Flutter, being an open-source UI software developer, provided a robust framework for building visually appealing and cross-platform applications. Firebase, on the other hand, served as the backend infrastructure for the application, offering a suite of services such as authentication, real-time database, and cloud storage.

### 4.4.1 Firebase Configuration

Firebase is a comprehensive platform provided by Google that offers a suite of cloud-based services, including real-time databases, authentication, cloud storage, and more. For Childcare Digital Book application, Firebase was selected to serve as the backend infrastructure due to its scalability, reliability, and ease of integration with Flutter. This section details the configuration of Firebase to support the application's backend requirements.

Firstly, the Firebase project is created in the Firebase console and the development platform is configured to Android and iOS. Then, necessary Firebase dependencies must be added to allow the program to work.

```
23 dependencies:
24   flutter:
25     sdk: flutter
26   flutter_localizations:
27     sdk: flutter
28   cloud_firestore: 4.15.7
29   cloud_functions: 4.6.7
30   firebase_auth: 4.17.7
31   firebase_core: 2.26.0
32   firebase_messaging: 14.7.18
33   firebase_storage: 11.6.8
```

**Fig 12** Added Firebase dependencies.

Figure 5.2 shows Firebase SDK was then initialized in the main entry point of the Flutter application, ensuring Firebase was properly set up before running the app. Lastly, required Firebase services is configured in the Firebase console which are Firebase authentication, Firebase storage, Firestore database, and Firebase messaging.

```
4 Future initFirebase() async {
5   if (kIsWeb) {
6     await Firebase.initializeApp(
7       options: const FirebaseOptions(
8         apiKey: "AIzaSyDZvZCK5rNsmQ-P6TmQsGid9gMb_Zr0Uas",
9         authDomain: "child-d8c69.firebaseio.com",
10        projectId: "child-d8c69",
11        storageBucket: "child-d8c69.appspot.com",
12        messagingSenderId: "1012812603044",
13        appId: "1:1012812603044:web:71f2233f7f5fd520ded031"));
14   } else {
15     await Firebase.initializeApp();
16   }
17 }
```

**Fig 13** Initialize Firebase using `initFirebase()` function.

#### 4.4.2 Implementation Using Flutter Framework

The front-end implementation of the Childcare Digital Book application was carried out using the Flutter framework. Flutter, known for its capability to create natively compiled applications for mobile from a single codebase, was chosen to ensure a seamless and visually appealing user experience across both Android and iOS platforms [8]. Visual Studio Code is used as the primary Integrated Development Environment (IDE) due to its extensive plugin support and development tools tailored for Flutter.

The development process began with designing the application's user interface (UI). Using Flutter's widget-based architecture to construct a series of reusable UI components. The application's design focused on simplicity and ease of use, with clear navigation paths and accessible features. Key interfaces implemented included the login and registration screens, user profile management, child profile management, health records display, and appointment scheduling interfaces. Each interface was developed to provide intuitive interactions and quick access to essential features.

Additionally, state management was implemented using the provider package to handle the application's state efficiently. This allowed for a responsive and reactive UI, where changes in the backend data were immediately reflected in the front-end interface. Error handling mechanisms were put in place to manage network issues and other potential disruptions.

Overall, the implementation phase leveraged the strengths of both Firebase and Flutter to create a comprehensive and user-friendly digital health record application. The combined capabilities of these

technologies make it easier to build an application that meets the functional requirements and non-functional requirements.

## 4.5 Testing

Text After the implementation, testing phases involving Alpha and Beta testing are carried out. This is to ensure the application runs normally as intended and meets the requirements. Several test plans consist of test cases, expected output and actual output for the test case and were designed to serve as a checklist for the testing purpose.

### 4.5.1 Alpha Testing

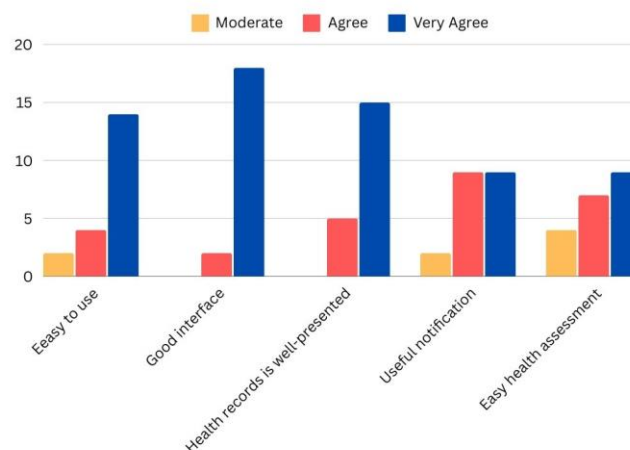
Alpha testing is an essential phase in the development process, aimed at identifying and fixing bugs before the application is released to a broader audience. For the Childcare Digital Book application, alpha testing involved internal testing to ensure that the application functions correctly and meets the specified requirements as shown in Table 5. From the test criteria, all test results are passed.

**Table 4** Test result for the proposed system

Test Plan	Expected	Result
User Registration	User can register and login with their email and password.	Pass
Health Assessment	Medical staff able to perform and record health assessment details.	Pass
Checkup Management	Medical staff can set appointment date and parents should be notified.	Pass
Health Records	Parents can view children's health records.	Pass
Health Guidelines	Parents can view the health guidelines.	Pass

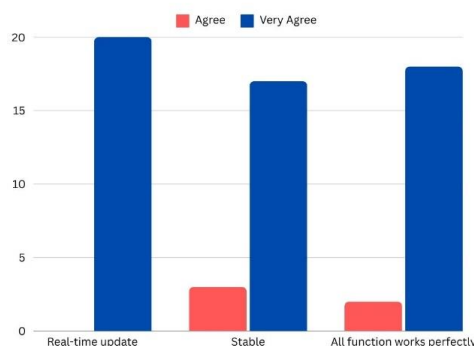
### 4.5.2 Beta Testing

Beta testing involves deploying the Childcare Digital Book application to a wider audience to gather feedback and identify any remaining issues before the final release. During beta testing phase, the Childcare Digital Book application was made available to a group of 20 users representing various stakeholders, including parents, and medical staff.



**Fig 14** Testing result of user acceptance for Childcare Digital Book.

Figure 14 shows the testing result of user acceptance for Childcare Digital Book. Overall, more than 15 respondents strongly agree that application interface is good. Most users found the application easy to navigate and use. However, some minor usability issues were identified, which is inconsistent labeling. Meanwhile, more than 10 respondents strongly agree that the application is easy to use, and the health records are well-presented. For useful notification criteria, equal amount of respondent's state that they are agree and strongly agree while precisely 9 respondents strongly agree that health assessment process is easy.



**Fig 15** Testing result for functionality of Childcare Digital Book.

Figure 15 shows the test result for functionality of Childcare Digital Book. Most respondents agree that Childcare Digital Book performed well in terms of stability and responsiveness. Besides, all respondents agree that the application functions well with real-time update feature. Lastly, precisely 18 respondents strongly agree that functions in application works perfectly as intended.

## 5. Conclusion

In conclusion, the proposed Childcare Digital Book aims to revolutionize healthcare accessibility and record-keeping for parents and healthcare providers. Through innovative functionalities and a user-centric approach, this application introduces an efficient and accessible way to manage child health records, promising to modernize child healthcare management in Malaysia and potentially serve as a model for modernization in other fields.

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## Conflict of Interest

Authors declare that there is no conflict of interests regarding the publication of the paper.

## Author Contribution

The authors confirm contribution to the paper as follows: **study conception and design:** Ahmad Fakhrol Hadi Bin Azrie, Mazidah Binti Mat Rejab; **data collection:** Ahmad Fakhrol Hadi Bin Azrie, Mazidah Binti Mat Rejab; **analysis and interpretation of results:** Ahmad Fakhrol Hadi Bin Azrie, Mazidah Binti Mat Rejab; **draft manuscript preparation:** Ahmad Fakhrol Hadi Bin Azrie, Mazidah Binti Mat Rejab. All authors reviewed the results and approved the final version of the manuscript.

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