International Journal Software Engineering and Computer Science (IJSECS)
4 (1), 2024, 284-292
Published Online April 2024 in IJSECS (http://www.journal.lembagakita.org/index.php/ijsecs)
P-ISSN : 2776-4869, E-ISSN : 2776-3242. DOI: https://doi.org/10.35870/ijsecs.v4i1.2355.

RESEARCH ARTICLE Open Access

Development of an Android-based Application as a Solution for Maternal Health

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Received: February 26, 2024; Accepted: April 1, 2024; Published: April 30, 2024.

Abstract: This research highlights the problem of lack of accessibility of health services for pregnant women, especially in consultations with doctors and access to pregnancy information. To overcome these challenges, the research aims to develop an application that allows pregnant women to access pregnancy information easily, consult with doctors, and monitor pregnancy progress efficiently. This research proposes the development of an Android-based application as a solution for health care for pregnant women, which uses an approach known as Rapid Application Development (RAD). RAD was chosen because of its reputation as a software development approach with rapid development capabilities and readiness to respond to change. Adopting the RAD method aims to create flexible and responsive applications that can adapt to changes that may occur over time. This learning and consultation application for pregnant women is very helpful for them to always know about their pregnancy. This application is also very useful for health workers. Health workers can quickly help patients at any time. Health workers can also provide advice regarding pregnancy by entering it into the application, which will be very helpful for mothers in maintaining their pregnancy. The research addresses the accessibility of health services for pregnant women. It is hoped that with this application, pregnant women will become more educated and guided about pregnancy so that cases of maternal and infant mortality in Indonesia will decrease.

Keywords: Software; Rapid Application Development; Android; Health; Education.

1. Introduction

Health is an important aspect of maintaining the quality of life of every individual. Maintaining health means being free from disease and involves a healthy lifestyle, sufficient physical activity, and a balanced diet [1]. Efforts to prevent and maintain good health are long-term investments in the well-being of individuals and society. Factors influencing a person's health status include environment, diet, genetics, and access to medical services. Therefore, a deep understanding of the importance of health and efforts to improve a healthy lifestyle are the keys to achieving optimal health goals. Pregnancy is a condition in which a mother carries a fetus, which usually lasts for approximately nine months. Pregnancy is an important stage in a woman's life and her family. The journey from early pregnancy to delivery requires special attention and careful monitoring. Even though there has been progress in the medical field [2], there are still many challenges that must be faced, such as difficult access to health services, high maternal and child mortality rates, and a lack of understanding about antenatal care [3]. Data from the World Health Organization (WHO) shows that Indonesia still has an alarming Maternal Mortality Rate (MMR), reaching 189 per 100,000 live births [4].

Meanwhile, the infant mortality rate also shows a serious challenge, with around 16.85 per 1,000 live births [4]. This percentage shows an increase compared to the previous year, especially in rural areas [5]. Factors such as limited access to quality health services, unsafe pregnancy practices, and lack of understanding of appropriate care are still the main causes affecting the death rate of pregnant women and babies in Indonesia. This high death rate shows that there are still many pregnant women who do not receive adequate care during their pregnancy. Various obstacles, such as long distances to health facilities, high costs, and lack of knowledge about the importance of care during pregnancy, often cause this. In addition, social and economic problems also contribute to low access and quality of health care for pregnant women, especially in remote and less developed areas.

Technology can be a potential solution to overcome some of these obstacles. In this context, developing an Android-based application as a consultation and learning medium for pregnant women can effectively provide the information and support needed during pregnancy. This technology is expected to increase pregnant women's understanding of their health and facilitate efficient consultations with medical personnel. The development of this application is based on the need to provide pregnant women with easier and faster access to relevant health information and medical consultation services. This application is designed to provide various features, such as informational articles about pregnancy, health tips, and routine check-up schedules, and a platform for consulting with a doctor or midwife. In this way, pregnant women can gain the knowledge necessary to safeguard their health and that of their fetuses and receive timely medical guidance without facing physical and geographical obstacles. Apart from providing direct benefits to pregnant women, this application is also expected to help medical personnel monitor the health conditions of pregnant women more effectively. With integrated monitoring features, doctors and midwives can more easily monitor pregnancy progress and provide appropriate advice based on existing data. This improves the quality of care and can help identify potential threats, reducing the risk of complications during pregnancy and childbirth.

In this research, the development method used is Rapid Application Development (RAD), which is known for its ability to develop applications quickly and respond to changes. This method was chosen because it allows for an iterative and collaborative development process. The resulting application can be better suited to user needs and immediately tested and improved based on feedback. With this approach, it is hoped that the application developed can be implemented immediately and provide real benefits for pregnant women in Indonesia. The development of this Android-based application aims to be an innovative solution in improving access and quality of health care for pregnant women. Utilizing modern technology, this application is expected to provide the necessary support for pregnant women to maintain their health and fetuses and assist medical personnel in providing more effective and efficient care. Through this effort, it is hoped that it can contribute to reducing maternal and infant mortality rates in Indonesia, as well as improving the welfare of pregnant women and their families.

2. Research Method

This Android-based application, a health solution for pregnant women, was developed using the Rapid Application Development (RAD) method. The RAD method is one of many approaches in software development. This approach is focused on rapid development and responsiveness to change [6]. This research chose Rapid Application Development as a development method with the main aim of creating applications

that are responsive to changing user needs. This approach was chosen because it facilitates rapid and iterative development, allowing more efficient adaptation to changing user needs [7].

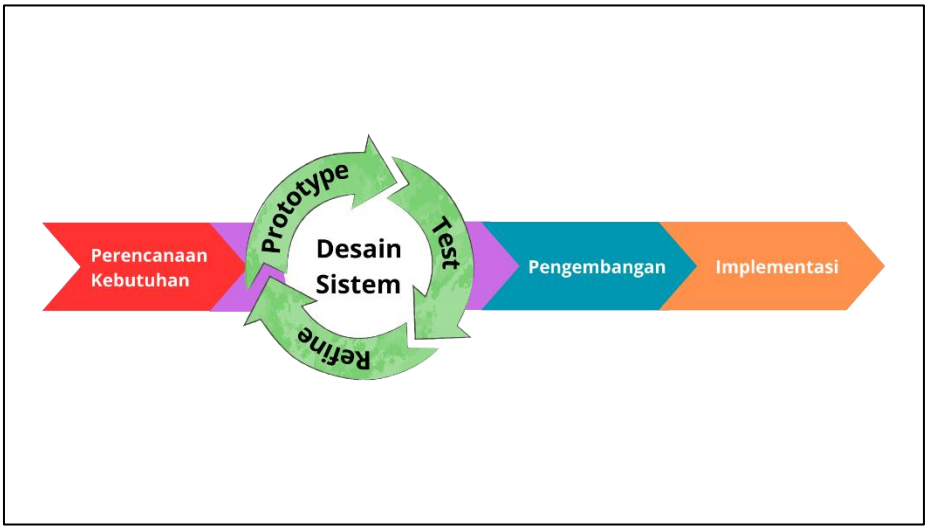


Figure 1. Rapid Application Development Method

In adopting Rapid Application Development (RAD) in software development, a series of stages need to be considered. The first stage is Needs Planning, where the process begins with problem recognition and gathering information from clients or relevant partners who are directly involved. The main focus is understanding the end goal or application requirements that may change over time. Contributions from both parties are crucial in identifying the needs that will shape software development. After that, in the System Design phase, design is carried out continuously by integrating user feedback and previously identified needs. User involvement in this process ensures that the system design meets requirements appropriately. The next step is the Development and Feedback Collection Process, where the approved system design is implemented into a beta application, which is then developed into the final version. Developers engage in continuous development while listening and paying attention to input and feedback from users or clients. If the application cannot meet the desired expectations, the process can be repeated from the system design stage. The final stage is Implementation, where the approved system design is converted into a running application after intensive testing. With this approach, application development continues to progress with the determined research focus. In addition, within the research framework, pregnant women often face access obstacles and long distances in getting the health care they need. Therefore, it is proposed that an application that allows pregnant women to obtain information about pregnancy and consult with midwives online be created. This application enables pregnant women to receive health care easily and efficiently and monitor the progress of their pregnancy. This research framework has been successfully developed and can be seen fully in the figure.

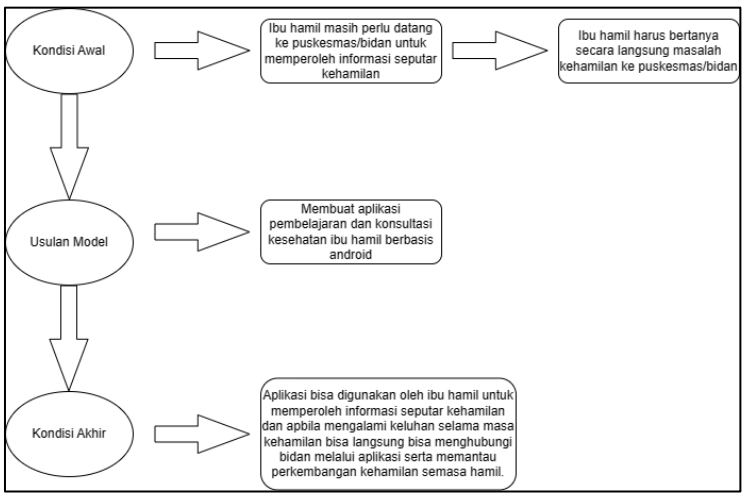


Figure 2. Research Framework

The research concept is an application that can be a learning and consultation medium for pregnant women. Through this application, pregnant women only need to press a button; then, the application will send a request to the application server according to the button or command made. For example, if a pregnant woman presses the chart button, a page will appear showing a graphic representation of the pregnant woman's development over time. The model architecture can be seen in more detail in Figure 3. Figure 2. Research Framework.

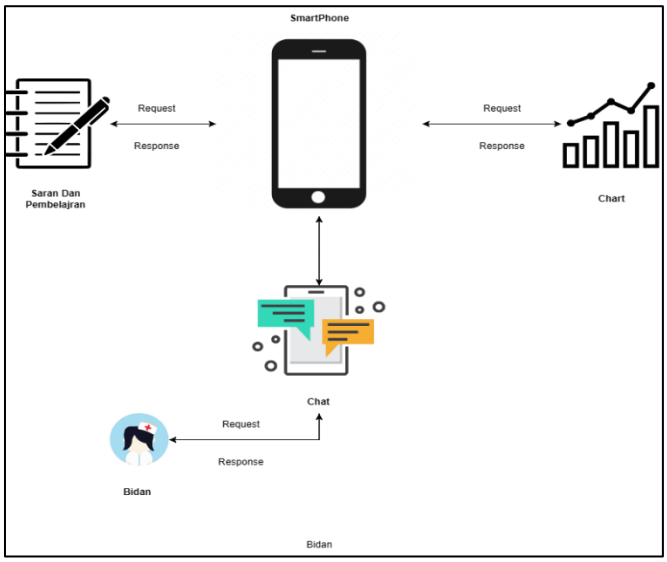


Figure 3. Model Architecture

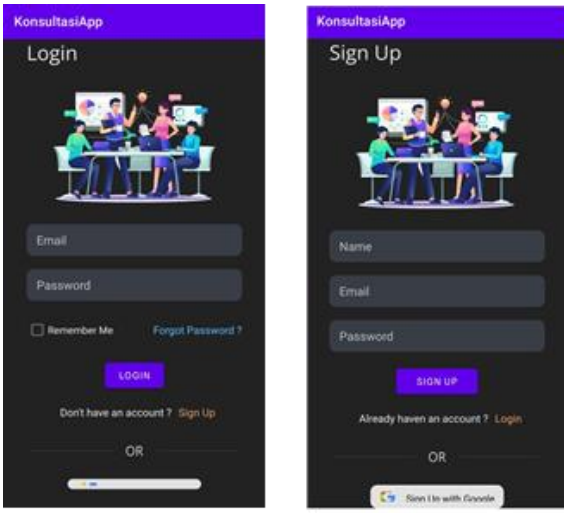
Figure 3. Architecture model Firebase is a platform created by Google that provides various tools and services to help developers develop applications (web and mobile) more quickly [10]. Meanwhile, in research by Sonita & Fardianitama (2018), Firebase is a provider of real-time database and backend services as a service. An application that allows developers to create APIs to be synchronized for different clients and stored in the Firebase cloud [11]. In this research, Firebase is used as an application database provider.

3. Result and Discussion

3.1 Results

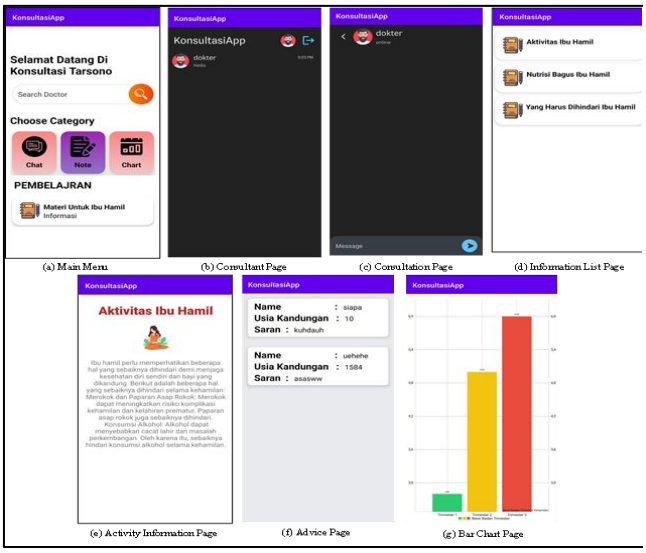
The research outcomes manifest as an application crafted utilizing Android Studio, Firebase as the database provider, and Kotlin programming language. This amalgamation of technologies ensures a robust, user-friendly, and efficient platform for expectant mothers. The application interface comprises various sections such as a login page, register page, main page, consultant list page, consultation page, information list page, activity information page, suggestion page, bar chart page, and admin page. Each section aims to facilitate comprehensive healthcare services for pregnant women. The login and register pages ensure secure access and a personalized user experience. Upon successful authentication, users are directed to the main page, which serves as the central hub offering navigation to different functionalities of the application. The consultant list page provides expectant mothers access to a directory of healthcare professionals they can consult for guidance and assistance. The consultation page enables seamless communication between users and healthcare providers, facilitating real-time discussions on pregnancy-related concerns.

Moreover, the information list page offers educational materials and resources covering various aspects of pregnancy, childbirth, and postpartum care. The activity information page provides insights into recommended physical activities and exercises suitable for pregnant women to maintain their health and well-being. The suggestion page allows users to give feedback and suggestions for improving the application's functionality and content. The bar chart page also presents graphical representations of essential health metrics and indicators, allowing users to track their progress and monitor any changes over time. Lastly, the admin page is a backend interface for administrators to manage user accounts, monitor application usage, and analyze data to enhance service delivery and user satisfaction.



(a) Login Page (b) Register Page

Figure 4. Authentication page



(a) Main Menu (b) Consultant Page (c) Consultation Page (d) Information List Page
(e) Activity Information Page (f) Advice Page (g) Bar Chart Page

Figure 5. Main Navigation

The authentication page in Figure 4 displays the login and registration pages. The login page appears when a new user opens the application, where the user is asked to enter the email and password that has been registered on the application server. A persistent login session feature is provided, allowing users to stay logged in without needing to log in every time they open the application. In addition, users can log in using their Google account directly for convenience. If the email is not registered, users can go to the register page to register, which only requires a username, email, and password.

Figure 5 shows the Main Navigation, which consists of several pages. The main page, or main menu, is the page after the user has successfully logged in, where the user can view the application features and select one of them. At the app's top is a welcome message for users, followed by a consultant search box. Below that, there are several categories that users can choose from and available learning materials. The consultant page contains the name and data of the registered consultant. Users can access this page and switch to the consultation page to consult a consultant. The consultation page is designed like an instant messaging application to make it easier for users to interact. This page can be accessed from the main menu by pressing the chat option. The information list page can be accessed when the user presses "note" on the main page. Three types of information are useful for pregnant women, including pregnant women's activities, good nutrition, and what should be avoided. Each selection will take users to a related page, such as a pregnancy activity page. This application also has an advice page (Advice Page), which contains advice from doctors for pregnant women and information on pregnancy progress. A bar chart page also displays a graph of the patient's weight development, allowing health workers to monitor it in more detail. The admin page has functions similar to the user page, but the admin has special access rights to change patient information.

Black box testing is one of the methods in software testing [12]. This test is carried out to ensure the software is functioning properly. People in charge of testing usually use user interfaces to perform testing tasks, so this testing is also called interface-level testing. Testers usually do not know about the application [13]. Even though this method has limited scope, it takes the least amount of time to implement and is perceived as a very simple test. The test results using the Black Box testing method on the Android-based pregnant women's health solution application are in Table 1 below:

Table 1. Black Box Testing

No.	Testing	Hope	Results
1	Users register an account on the application by entering their name, email and password.	User has successfully registered	Succeed
2	Users enter the application using the wrong email and password.	Users cannot enter the application.	Succeed
3	Users enter the application using the email and password that they have previously registered correctly.	Users can enter the application.	Succeed

4	Users select features on the main page.	The feature selected by the user can display a page according to the selected feature.	Succeed
5	Users send messages to doctors/midwives.	The message is sent and conveyed to the doctor/midwife.	Succeed
6	Users choose material for pregnant women.	The user's smartphone display displays a learning list.	Succeed
7	User selects Chart.	The user's smartphone display displays a Bar Chart.	Succeed
8	Admin Page.	Display for editing, deleting and adding.	Succeed
9	The doctor/midwife sends a message to the patient.	the message is sent and delivered to the patient.	Succeed

Device testing is a process that must be carried out during application development. This aims to determine the performance limits of a device in running applications. In this process, various device specifications are used during testing. It is hoped that by carrying out this test, it will be known that the application can run properly and the limitations and obstacles experienced by the device when running it.

Table 2. Test Results on Android Devices

No.	Device	Device Specifications	Status	Information
1	Samsung Galxy J3 (2016)	Android 5.1.1 (Lollipop), 16GB storage, 2GB RAM, resolusi 720 x 1280 pixels.	Success	The application is installed and can run on the device. However, it takes a relatively long time to open the application and experiences lagging problems when switching between pages.
2	Vivo S1	Android 9.0 (Pie), 64GB storage, 6GB RAM, resolusi 1080 x 2340 pixels	Success	The application runs smoothly and there are no problems when switching between pages.
3	Samsung Galaxy M21	Android 11, 64GB Storage, 4GB RAM, resolusi 1080 x 2340 pixels	Success	The application runs smoothly and there are no problems when switching between pages.
4	Infinix Note 30	Android 13, 128GB Storage, 8GB RAM, resolusi 1080 x 2460 pixels	Success	The application runs smoothly and there are no problems when switching between pages.

3.2 Discussion

The successful development of a learning and consultation application for pregnant women using the Rapid Application Development (RAD) method marks a significant advancement in maternal healthcare technology. This application represents a pivotal solution to the accessibility and information gap expectant mothers face, particularly in underserved rural areas. By leveraging the convenience of mobile technology, pregnant women now have seamless access to vital pregnancy-related information and expert consultation services at their fingertips. The convenience and accessibility afforded by this application are particularly crucial during emergencies, where immediate access to medical guidance can make a life-saving difference, especially for pregnant women residing in remote regions with limited healthcare infrastructure. Pregnant women can swiftly obtain the information they need through simple button presses, reducing physical visits to healthcare facilities and overcoming geographical barriers.

Moreover, the application's benefits extend beyond expectant mothers to healthcare workers, who can efficiently assist and support pregnant women remotely. With the ability to provide timely advice and guidance through the application interface, healthcare workers can enhance the quality of care and support pregnant women in maintaining their health throughout their pregnancy journey. This streamlined communication

between healthcare providers and pregnant women fosters a collaborative approach to maternal healthcare, ensuring comprehensive support and guidance for mothers-to-be.

Furthermore, the application's role in facilitating communication and information exchange between pregnant women and healthcare providers underscores its potential to improve maternal health outcomes. By enabling healthcare workers to enter relevant advice and guidance directly into the application, mothers receive personalized support tailored to their specific needs, enhancing their ability to navigate pregnancy confidently and confidently.

The development of this learning and consultation application represents a significant stride towards addressing the healthcare challenges pregnant women face, particularly in resource-constrained settings. By harnessing the power of technology and adopting a user-centric approach through RAD methodology, this application empowers pregnant women with essential information and support, ultimately contributing to improved maternal and infant health outcomes. Through ongoing refinement and adoption, such innovative solutions have the potential to revolutionize maternal healthcare delivery, ensuring that every expectant mother receives the care and support she deserves, regardless of her geographical location or socio-economic status.

4. Related Work

Significant contributions have emerged in maternal healthcare and technology integration, addressing diverse facets of pregnancy monitoring and support. Among these, the study conducted by M. Alhari *et al*. (2021) stands out with its focus on designing a Smart Village Educational Application Platform for Stunting Alleviation and Monitoring the Health of Pregnant Women. This research endeavors to develop an application, Smart Village, serving as a comprehensive educational tool aimed at combatting stunting in Indonesia, specifically targeting pregnant women across all societal strata. Employing a robust survey methodology involving relevant stakeholders, the study seeks to create an authoritative educational resource to elevate awareness regarding stunting and its consequential impact on maternal and child health [14].

Similarly, the research undertaken by Kholisotin *et al*. (2021) contributes significantly to the Application of Monitoring the Amount of Nutrients Required by Pregnant Women to Reduce the Risk of Fetal Physical and Mental Disorders. This study seeks to develop an application tailored to monitoring the nutritional needs of pregnant women, thereby mitigating the risk of physical and mental disorders in the fetus. Using the prototyping method, the researchers aspire to create a user-centric tool for tracking and managing maternal nutrition throughout pregnancy [15].

Furthermore, Pambudi *et al*. (2020) led an investigation into maternal health technology with their research on an Android-based pregnancy Health Application. This study aims to bridge the communication gap between pregnant women and midwives by offering a dedicated health application. Leveraging the Rapid Application Development (RAD) approach, the researchers aspire to craft an intuitive and accessible platform for expectant mothers to access essential information and guidance throughout their pregnancy [16].

These scholarly pursuits underscore the burgeoning importance of technology in augmenting maternal healthcare delivery and support. Through innovative methodologies and approaches, researchers are endeavoring to develop solutions centered around user needs, addressing the unique challenges pregnant women face. By advancing continued research and development endeavors, these initiatives hold the potential to redefine maternal healthcare paradigms and foster improved outcomes for both mothers and infants.

5. Conclusion

Based on the results of the application testing and analysis that has been carried out, several conclusions can be drawn:

1) The app successfully showcases all available features, allowing users to utilize them as needed.
2) The chat feature allows users to consult with doctors directly, increasing the accessibility of health services for pregnant women.
3) Pregnancy-related information, such as suggested activity guides and food recommendations, can be easily accessed by users, providing additional support during pregnancy. Pregnancy progress charts are also available to help users visually monitor their pregnancy process.
4) After a consultation, users can receive direct advice from doctors, demonstrating the effective integration of technology and medical services in this application.

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