# Designing Indonesian Maternal and Child Health Mobile Applications using User-Centered Design

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## Abstract

*The high maternal mortality rate in Indonesia has led the Indonesian government to develop a mobile application for maternal and child health (MCH). However, this application received a bad rating on the applications distribution platform, and even some of its features could not function properly. Therefore, this study aims to design the MCH application. This study used the user-centered design (UCD) methodology with three iterations and applied Shneiderman's eight golden rules. Participants involved in the data collection and evaluation process were health workers, health experts, and pregnant women. The first iteration's evaluation will produce a low-fidelity prototype (wireframe), whereas the second and third iteration's evaluations will produce a refined high-fidelity clickable prototype. The resulting prototype has several major features, including notes entry, information and education, reminders, a blood supplement tablet tracker, and monitoring of fetal development. Evaluation in the first iteration utilized interviews to validate the wireframe, whereas the second and third iterations utilized usability testing and system usability scale (SUS). In the second iteration, the final SUS score was 71.2, or "good," while in the third iteration, the final SUS score was 85.4, or "excellent." This research is expected to contribute to two areas: serving as a reference for pregnancy application interface designs, especially for MCH applications, as well as the improvement and development of pregnancy health applications using the UCD methodology.*

**Keywords:** maternal health, prenatal care, user-centered design, telemedicine, Indonesia

## Introduction

Maternal death, or maternal mortality, is a major global problem and has existed for a long time (Ngwenya et al. 2022). One of the Sustainable Development Goals (SDGs) is to reduce maternal mortality (United Nations 2023). Maternal mortality is measured using the Maternal Mortality Ratio

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(MMR) (WHO n.d.). MMR is the number of maternal deaths per 100,000 live births (WHO, 2019). SDG 3.1 aims to reduce the global MMR to 70 per 100,000 live births by 2030, with no country having an MMR of more than double this global target (Ngwenya et al. 2022). The World Health Organization (WHO) year 1996 launched a global consensus on the main strategy for reducing the MMR (Ngwenya et al. 2022). This consensus includes (1) family planning that is equipped with health services, (2) guaranteed care during pregnancy and childbirth, (3) timely emergency treatment of pregnancy, and (4) immediate postnatal care (World Health Organization 2016). Based on the WHO (2019), 94% of maternal deaths occur in low- and lower-middle-income countries. The MMR in Indonesia is quite alarming. The Central Statistics Agency (2023) records that MMR in Indonesia reaches 189 deaths per 100,000 live births.

With the progress of e-health in recent years, Indonesia's Ministry of Health launched various e-health applications, starting from PeduliLindungi, SehatPedia, and the Indonesia Health Facility Finder (IHEFF). Recently, Indonesia's Ministry of Health launched a mobile application named Mobile KIA, a digital form of the maternal and child health handbook. Electronic health, commonly referred to as "e-health," is defined as the use of information and communication technology (ICT) to support human needs in the health sector and for more effective, efficient, and safe health services (da Fonseca et al. 2021). E-health has shown rapid development in Indonesia. Nuryadi et al. (2022) shows the potential for the development of the valuation value of the e-health industry from USD 85 million in 2017 to USD 973 million by the end of 2022.

The Mobile KIA application acts as a note-entry tool and a medium of communication, information, and education for pregnant women (Ministry of Health 2020). However, based on our observations, the application has received poor user ratings on the application distribution platform, namely 3.5 out of 5 on the Play Store and 1.0 out of 5 on the App Store. Not only did the application receive negative user feedback, but several features of the Mobile KIA application also didn't function properly.

There is research on policies and actions to reduce the MMR in Nepal (Karkee et al. 2021). Nepal made impressive progress in reducing maternal mortality by 2015 (Karkee et al. 2021). The implementation of several interventions, such as a national program to increase the number of skilled birth attendants (SDAs) and maternity facilities, free maternity care, and enhanced birth preparedness and complication preparedness programs, aided this progress (Karkee et al. 2021). According to Liu and Wang (2021), the use of smart mobile terminals in the management of maternal health care outside of hospitals not only enables medical staff to provide timely personalized media services for pregnant women, but also enables pregnant women to learn about health care through a variety of channels, enhance the quality of health management for pregnant women at home, and significantly improve pregnancy outcomes. Moreover, Kabongo et al. (2021) described that m-health significantly associated with maternal and child healthcare (MCH) outcomes. Then, Venkataramanan et al. (2022) found that m-health interventions can improve access to MCH. Although Liu and Wang (2021) as well as Ilozumba et al. (2018) have discussed mobile applications in supporting maternal health, both of which did not discuss the user interface (UI) and user experience (UX) of mobile applications. Therefore, this study aims to fill this research gap by designing the pregnancy features on the MCH mobile application (mKIA) that suits the needs of pregnant women in Indonesia and provides a better experience using user-centered design (UCD) approach. This research is expected to be a reference for providers and developers of maternal health applications.

## Literature Review

### *Antenatal Care*

WHO (2018) defines antenatal care (ANC) as care provided to pregnant women during pregnancy by skilled healthcare providers, often in first-level health facilities (Bryce et al. 2021). In addition to the WHO definition, there is another definition from the Republic of Indonesia's Ministry of Health. The Ministry of Health (2020) defines ANC as "a series of activities that are carried out from the time of conception until before the start of the delivery process that are comprehensive and of good quality and are given to all pregnant women." The general goal of ANC is that all pregnant women can undergo pregnancy and childbirth with positive experiences and give birth to healthy and quality babies

(Ministry of Health 2020). In addition, ANC also aims to monitor and maintain the health and safety of the mother and fetus, detect all pregnancy complications, and take necessary actions, respond to complaints, prepare for birth, and promote a healthy lifestyle (Laksono et al. 2020). Stakeholders involved in antenatal care are pregnant women and their partners, as well as health workers, such as obstetricians and gynecologists, general practitioners, midwives, nurses, and so on.

Antenatal care provides an opportunity for pregnant women to identify risk factors for pregnancy through screening, prevent and manage diseases (both pre-existing and pregnancy-related), and provide education and health promotion (Bryce et al. 2021). In addition, ANC also plays a role in reducing perinatal morbidity and mortality by detecting and treating prenatal complications and identifying women who are classified as high risk to ensure delivery takes place in skilled settings (Atukunda et al. 2021). Good quality ANC has been associated with higher rates of facility deliveries (Bryce et al. 2021).

### *Electronic Health*

E-health is the application of information and communication technologies through the internet to empower or improve health services that contribute to a person's quality of life (da Fonseca et al. 2021; Wynn et al. 2020). E-health involves mHealth and telehealth practices that use electronic technology to provide resources, services, and information regarding health care (da Fonseca et al. 2021). The Global Observatory for eHealth defines mHealth as medical and public health practices supported by mobile devices, such as cell phones, patient monitoring devices, personal digital assistance, and other wireless devices (Bradway et al. 2017). Meanwhile, telehealth is the use of telecommunications technology to promote the care and education of patients and professionals working in the area (da Fonseca et al. 2021).

Mobile health, often known as mHealth, enables users to obtain health services electronically, use applications to verify information, and manage or monitor health care or problems (da Fonseca et al. 2021). MHealth provides opportunities to improve healthcare delivery and clinical outcomes (Kabongo et al. 2021, McCurdie et al. 2012). In addition, the mHealth application can increase the interaction between users and the health care system (Kabongo et al. 2021). The consumer health domain is one of the most significant opportunities offered by mHealth as it allows patients to be actively involved in and self-manage their health conditions (Kabongo et al. 2021, McCurdie et al. 2012).

Rhodes et al. (2020) shows that mHealth for maternal health can improve maternal health services. In addition, from the mother's side, it provides greater control for mothers in choosing and utilizing health services during pregnancy (Deave et al. 2022). Similarly, a study conducted in Switzerland showed that the use of mHealth applications for recording related to maternal health can help patient communication with health workers in ANC examination session (Klaic et al. 2022). Another study that conducted in Madagascar, shows that the mHealth system for maternal health can improve the quality of ANC even through minimal intervention (Benski 2020). Apart from that, mHealth can also help patients to get standardized ANC care and has been proven to increase patient compliance (Benski 2020).

## Methodology

### *Data collection and analysis methods*

This research uses mixed methods—a combination of quantitative and qualitative methods. User-centered design (UCD), which involves four stages—understanding the context of usage, defining user requirements, designing solutions, and assessing them against requirements (McCurdie et al. 2012)—is the design development methodology employed in this study. Understanding the context of use is the first stage in the user-centered design process. This stage is carried out to understand the behavior of target users by knowing the difficulties experienced based on their experiences and user needs for a product (Sharp, et al. 2019). During this stage, researchers only use quantitative data collection techniques, which were done by conducting design evaluations, online interviews, and content analysis. During the stage of specifying user requirements, a synthesis of user needs will be carried out based on the results of interviews identifying the needs and behavior of pregnant women. The results will be summarized using content analysis. Determination of user needs is also carried out after going through

a process of independent observation of the mKIA application and heuristic analysis using Shneiderman's 8 Golden Rules to gain context of the current condition of the application. Heuristic analysis is essential in the early stage as it is a broad guideline or principle that designers and evaluators can use to identify potential usability issues in the system we will evaluate (Sharp et al. 2019).

This research implements the user-centered design process in three iterations. A low-fidelity prototype will be created on the first iteration and validated by research participants throughout subsequent interview sessions. During the second iteration, a high-fidelity prototype will be created using input from the first iteration. SUS is one of the most used questionnaires to assess the usability of a product and according to Brooke (1995), SUS has proven to be a valuable, powerful, and reliable evaluation tool. In general, SUS is used after respondents have had the opportunity to use the product or system being evaluated. The researchers will then conduct usability testing and give the SUS questionnaire to participants to gather feedback and suggestions for the third iteration. Lastly, the high-fidelity prototype will be modified during the third iteration depending on the input and feedback from the second iteration. Furthermore, usability testing and distribution of the final SUS questionnaire will be carried out to evaluate the usability of the interface design that has been developed.

### *Research instruments*

In designing interview questions, the research team created several categories of questions for each respondent. Questions for pregnant women and women who have given birth design to take more look at the design of the mKIA application from the user's point of view. These questions will be divided into three categories of questions, namely regarding the antenatal care (ANC) process and the use of the MCH handbook, pain points or constraints experienced by participants during pregnancy and goals that participants want to achieve. Based on these three categories, interview questions for pregnant women and women who have given birth are described in more detail in Appendix A.

## Results

### *First Iteration: Gathering User Requirements and Making a Low Fidelity Design*

In the first iteration, four stages will be carried out in the UCD process, namely understanding the context of use, specifying user requirements, designing solutions, and evaluating against requirements. The respondents' criteria are mothers who are pregnant or have given birth in the past year and health workers. The result of the first iteration is the application interface design framework and evaluation results to be applied in the next iteration. We conducted online interviews to find out and learn more about the user's experiences regarding the constraints, motivations, and expectations of users in using the MCH handbook during pregnancy and using maternal health applications during pregnancy. The interview process was conducted online using the Google Meet application platform. The interview questions given to the users were divided into several segments to explore the participants' behavior in using the MCH handbook and pregnancy application during use. The online interview involved fifteen participants of different ages and backgrounds (Table 1 and Table 2). Twelve of them are mothers who are pregnant or have given birth in the past year, while the other three are public health experts and health workers consisting of general practitioners and midwives.

**Table 1. Summary of Respondents' Demographics of Pregnant Women and Mothers Who Have Given Birth**

| No. | Respondents' Name | Age (years) | Domicile | Current or Latest Pregnancy |
|---|---|---|---|---|
| 1. | Respondent 1 | 25 | Jember | First |
| 2. | Respondent 2 | 30 | Madura | Second |
| 3. | Respondent 3 | 29 | Bekasi | First |
| 4. | Respondent 4 | 28 | Bekasi | First |
| 5. | Respondent 5 | 32 | Jember | Third |
| 6. | Respondent 6 | 25 | DKI Jakarta | First |
| 7. | Respondent 7 | 30 | DKI Jakarta | Second |
| 8. | Respondent 8 | 29 | Jember | Fourth |
| 9. | Respondent 9 | 32 | Jember | Third |
| 10. | Respondent 10 | 41 | Yogyakarta | Third |
| 11. | Respondent 11 | 30 | Jember | First |
| 12. | Respondent 12 | 31 | Jember | First |

**Table 2. Summary of Respondents' Demographics of Health Practitioner**

| No. | Respondents' Name | Age (years) | Occupation |
|---|---|---|---|
| 1. | AN | 31 | Midwife |
| 2. | PS | 34 | General Practitioner |
| 3. | SA | 43 | Public Health Expertise |

Based on the results of the content analysis, we able to synthesize and identify the pain points felt by pregnant women. The process of synthesis and identification of pain points is carried out by grouping pain points that have the same topic and giving names to each group or category that has been formed. We obtained three categories of pain points, namely pain points related to using the MCH handbook, using maternal health applications, and while undergoing antenatal care (ANC). We identified eight pain points related to the use of the MCH handbook, four related to the use of maternal health applications, and three related to the implementation of ANC. Figure 1 displays a mind map diagram of pain points felt by pregnant women.

In addition, based on content analysis, we also synthesized and identified goals that pregnant women wanted to achieve. The process of synthesis and identification of goals is carried out by grouping goals that have the same topic and giving a name to each group or category that has been formed. We got three categories of goals, namely, goals related to information, recording, and reminders. We identified three goals related to providing information, two goals related to recording, and two goals related to

reminders. The other four goals cannot be grouped into any category. Figure 2 displays the identified mind map goals.

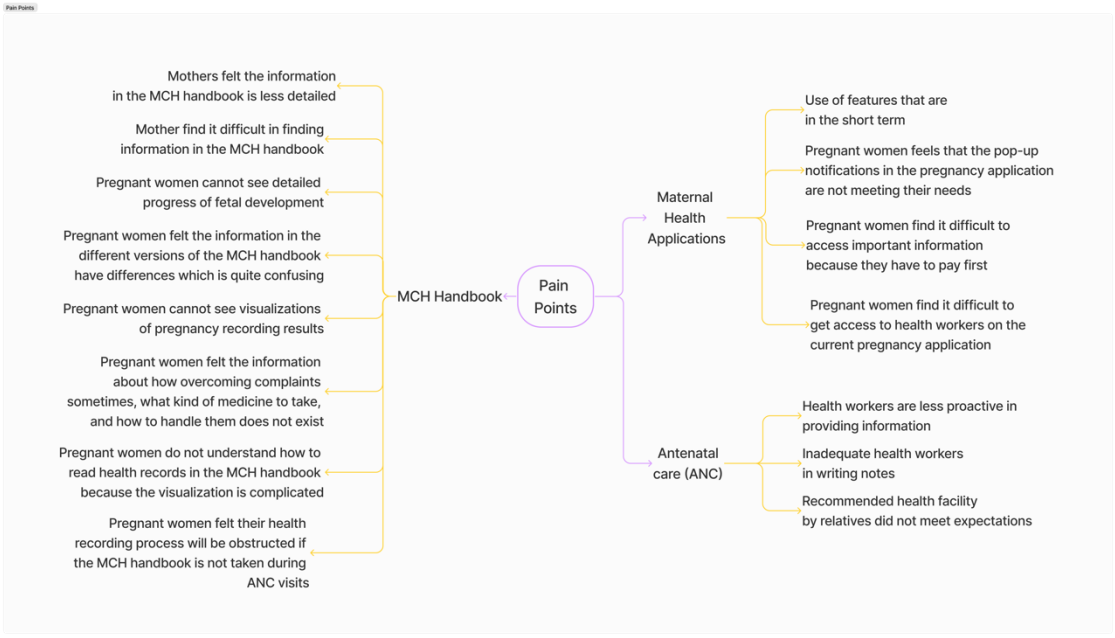


**Figure 1. Pain Points Mind Map Diagram**

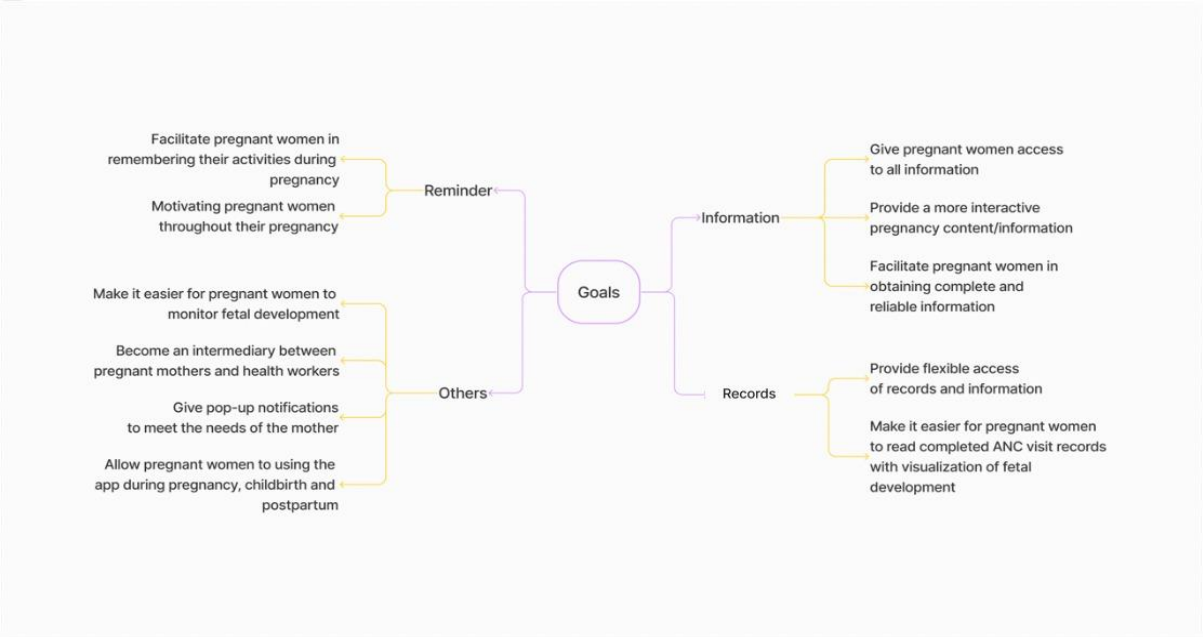


**Figure 2 Goals Mind Map Diagram**

We created two personas that represent the two types of pregnant women, each with different characteristics and motivations for undergoing pregnancy. These personas were created to help us create the best solution for our targeted user. Through these personas, it will help us to give features constraint and prioritization mapping (Siika-aho 2016). The first persona is the type of pregnant woman who is active in seeking information and exercising, while the second persona is the opposite. The first persona represents pregnant women who are active in seeking information about the health of the mother and fetus during pregnancy. The first persona also regularly exercises by taking a morning walk to maintain her body fitness. In the first persona, it is told that a housewife named Amira is undergoing her first pregnancy. Amira knows the importance of light exercise, so she often goes for her morning walks. In addition, during pregnancy, Amira educated herself by using MCH books and maternal health

applications. Amira also didn't hesitate to ask the doctor either personally or via telemedicine.

In carrying out her pregnancy, Amira has a goal to monitor the development of the fetus every week. In addition, Amira wants to have a trusted source of information that discusses complaints in pregnancy in a complete and clear manner. Lastly, Amira wants to get information that is appropriate for her gestational age. Despite Amira's being active in educating herself and moving her body during pregnancy, she also experienced difficulties. When Amira has a complaint, she cannot find a specific solution in the MCH handbook regarding how to handle the complaint. In addition, sometimes Amira finds it difficult to understand the recording in the MCH book.

The second persona represents pregnant women who are less active in seeking information about the health of the mother and fetus during pregnancy. This persona is also not motivated to actively move its body. This is because this type of user feels busy with her daily life as a career woman. In the second persona, it is said that a state-owned enterprises employee named Nabila is undergoing her second pregnancy. During her pregnancy, Nabila used the Ministry of Health and hospital versions of the MCH handbook as a source of education, information, and record keeping.

In carrying out her second pregnancy, Nabila has a goal of remembering routine activities that must be carried out during pregnancy, such as taking vitamins, taking iron tablets (TTD), or attending antenatal care (ANC) visits. Nabila also wants to have a trusted source of information that is complete, easy to access, and provides audio-visual content. Lastly, Nabila wants to be able to consult with health workers through maternal health applications. During her pregnancy, Nabila experienced difficulties, as she felt that the explanations contained in the MCH handbook were incomplete. In addition, her busy life as a career woman makes Nabila often unable to remember and less motivated to carry out her routine activities.

In the process of thinking about potential solutions, the researcher team conducted benchmarking and design reviews on similar applications, especially those that were frequently used by pregnant women, which we found during the online interview stage. We also compare all the features that already exist in the current mKIA application to ensure the completeness of the features in the application design. From the results of the problem-solution mapping, we found several new feature solutions that previously did not exist in the mKIA application namely monitoring of fetal development, reminder and notification, ANC note entry and telemedicine.

In addition to new features, we also formulated solutions that are design improvements to the current mKIA application interface. This design improvement aims to increase the motivation of pregnant women to use the application when they need information about pregnancy. The proposed solution is to provide personalized information with an interactive display. Personalized information aims to adjust information to accommodate the needs of users at a certain gestational age, while interactive displays aim to increase the motivation of pregnant women to read and obtain information, increase engagement, and provide a good overall experience.

The information architecture (IA) is designed to map information systems to applications. From IA, we can see what pages need to be designed in the application, as well as what information is contained on those pages. The hierarchy on the page will also be visible based on the color of the components. The IA created with Figma will be used as a guide for creating user flow, design, and prototypes at a later stage. Figures 3, Figure 4, and Figure 5 illustrate the IA of the mKIA application to be designed.

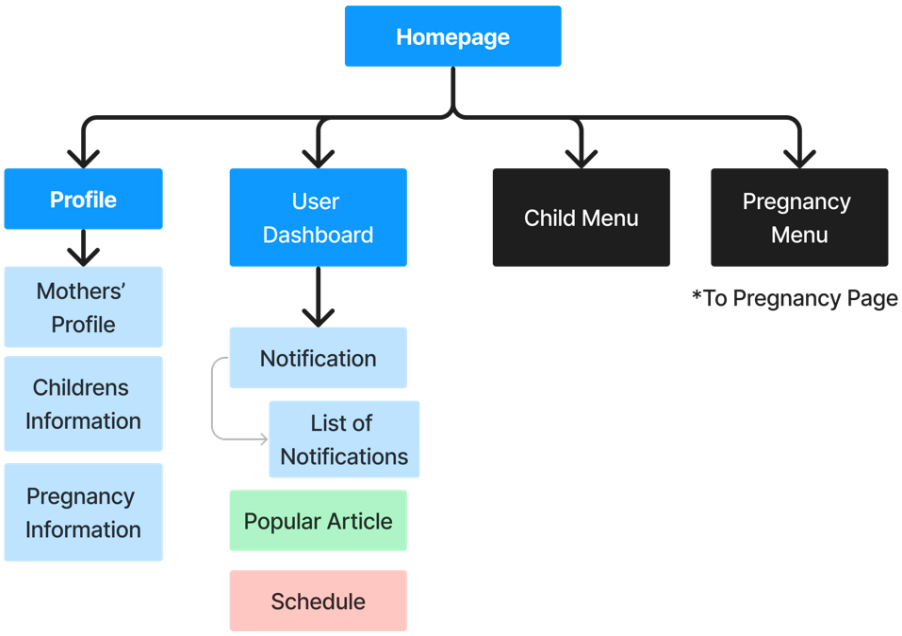


**Figure 3. Information Architecture Homepage**

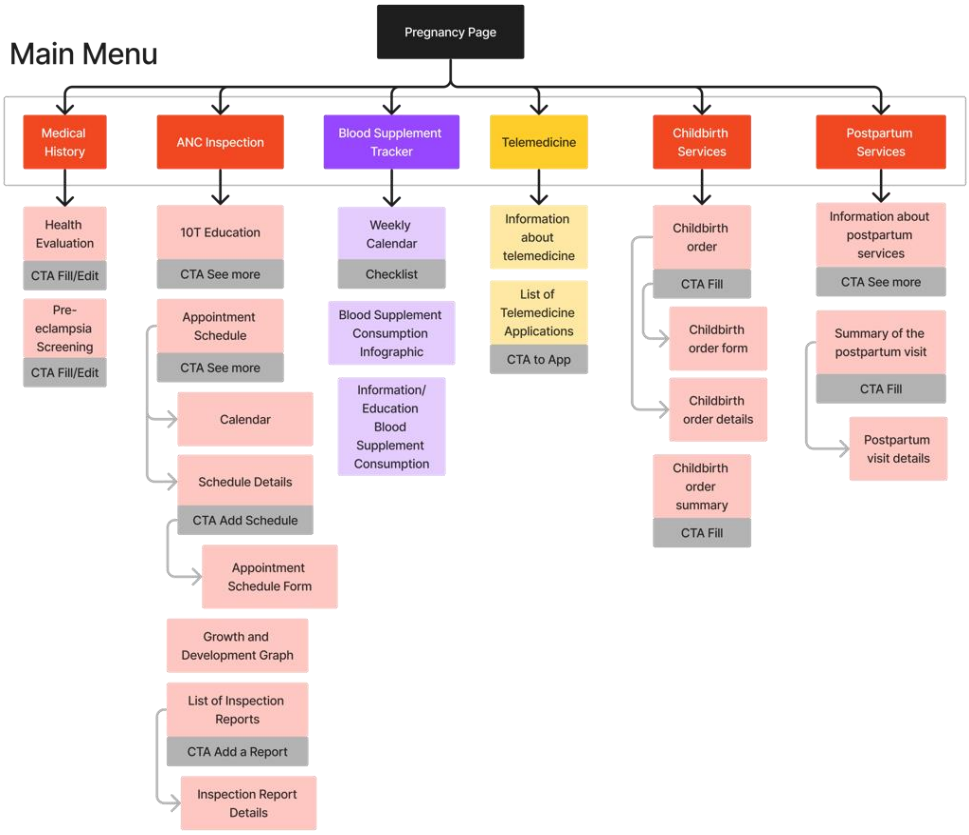


**Figure 4. Information Architecture Main Menu for Pregnancy Page**

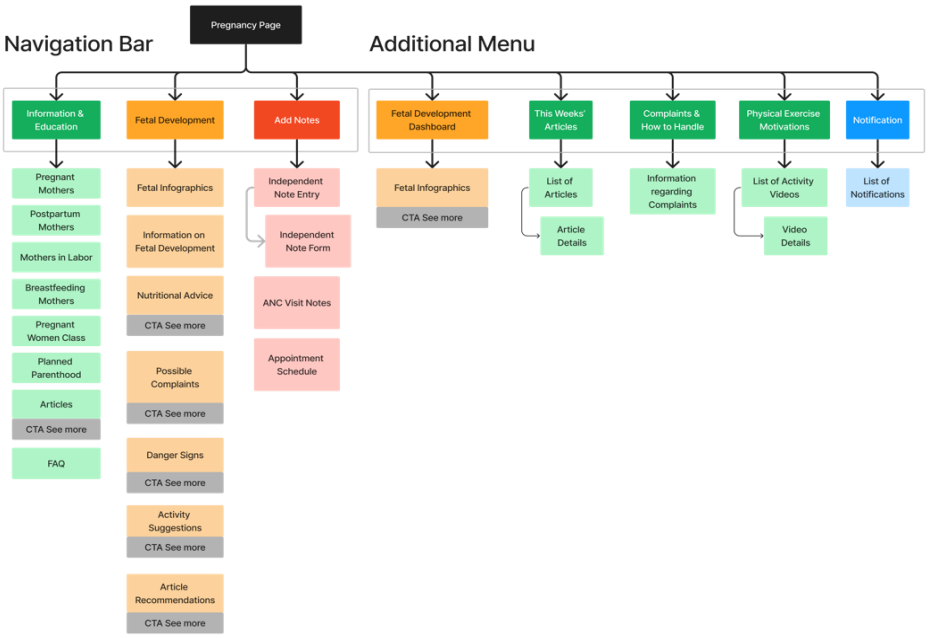


**Figure 5. Information Architecture Navigation Bar and Additional Menu in the Pregnancy Page**

The homepage is displayed after the user has successfully authenticated. On this page there is a user dashboard, a pregnancy menu, a children's menu, articles, and profiles. There are two menus that are branching points for this application, namely the pregnancy menu for users who are pregnant women and the child or toddler menu for users who have given birth or are already parents. The user dashboard will contain information regarding gestational age, namely if the user is a pregnant woman, and/or information regarding the number of children and their ages, namely if the user has given birth. In addition to these two menus, the researcher team has also included a shortcut menu for popular articles to make the information accessible to users who only want to do light reading. Furthermore, a list of notifications and reminders can be accessed on the homepage. This is because the homepage is the first page that the user will see when opening the application, so the user can be immediately informed if there is an urgent reminder or notification. All the information contained on the homepage is sourced from both the pregnancy and children's menus.

The red component indicates that the page contains the recording feature. In the IA designed, pages with recording features are the ANC examination pages, the health history pages, the delivery services pages, and the postpartum services pages. The ANC examination page contains a schedule of ANC visits where users can schedule and view ANC visit schedules in each trimester, graphs of the progress of each component of the 10T examination recorded at each visit along with normal and abnormal indicators, and a form for entering 10T examination data at ANC visits. Furthermore, users are also given a shortcut to add their notes from the navigation bar located on the homepage. This shortcut gives the user the option to add ANC visit records or independent records.

The green component indicates that the page contains informational and educational features. The sources of information that the researcher team plans to use are, of course, MCH books and third-party organizations in the health sector that work closely with the Indonesian Ministry of Health to ensure that all information provided is credible. In IA, which we designed, information and education pages consist of health articles for pregnant women, symptoms and risks for pregnant women, exercise motivation for pregnant women, nutrition and nutrition, information during pregnancy, information during childbirth, information on breastfeeding, and family planning. Information sourced from the MCH handbook includes information on pregnancy, puerperium, childbirth, breastfeeding, and family planning. The researcher team plans to collect other information from a collection of Indonesian third-party organizations in the health sector.

The components in orange are the pages for fetal development and gestational age. This page is also

included in the information and education category, but due to the large amount of information on that page, the researcher team decided to separate this page from the educational information page. Fetal development will display, among other things, visualizations of the fetus such as analogies and descriptions of their sizes, counters for pregnant women's gestational age, information on changes that occur in pregnant women at that gestational age, nutritional advice for pregnant women at that gestational age, activity suggestions, symptoms that may occur, as well as health articles that can be read.

The next component is the purple one, which is the iron supplement tracker page. Iron supplements are one of the nutritional services provided during ANC visits. The consumption of iron tablets is important to meet the iron needs of the fetus and placenta during pregnancy. The iron supplement tracker will remember every day the consumption of iron supplements by pregnant women. Then, at the end of the week, pregnant women can see the completeness of their iron supplement consumption.

The last component is the one in yellow, which is telemedicine. This page contains a feature where pregnant women can consult with health workers through third-party applications in the health sector and in collaboration with the Indonesian Ministry of Health. The system will take the user to a health application where they can consult about their pregnancy. Wireframes are created to provide a rough overview and structure related to the interface design being developed. Figure 6 shows the examples of wireframe of pregnancy page.

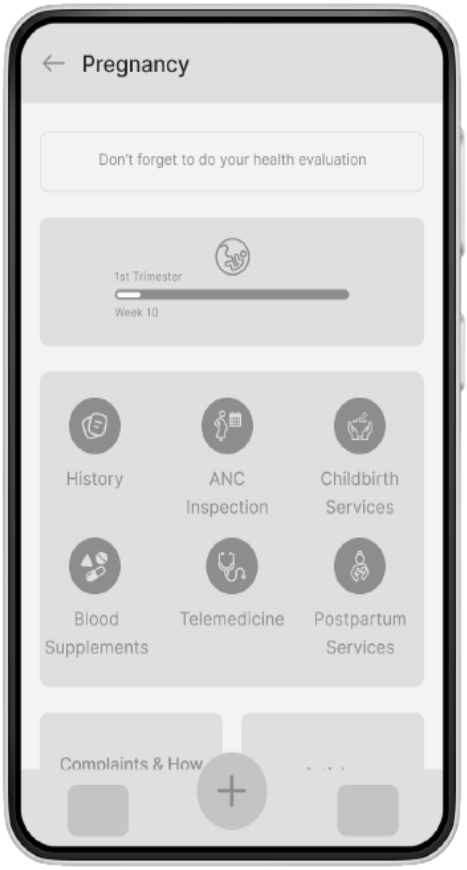


**Figure 6. Wireframe Pregnancy Page**

### *Second Iteration: Development of High-Fidelity Design*

In the second iteration, a high-fidelity design will be made to continue and refine the application design in the previous iteration (Figure 7). The result of the second iteration is a high-fidelity application design, and evaluation results will be implemented in the next iteration. The main high-fidelity design gives coloring to the wireframe development using the primary color pink, which refers to the basic

color of the MCH book, which is the book's trademark. The uniqueness of the primary color of the KIA book also makes its users call this book the 'pink book,' which is then used as the primary color in the mKIA application. The use of this color is in line with one of the rules of Shneiderman's 8 Golden Rules for the strive for consistency rule where the use of pink will remind the user of the MCH handbook and increase the user's familiarity with the mKIA system so that it can build sufficient context for the user. In addition, the neutral purple secondary color chosen was intended to provide contrast to the primary color, which is used for several components that require more attention, such as buttons and alerts. Apart from adding colors and improving the features of the low-fidelity phase, there are additional pages on prerequisites features that are not included in the low-fidelity design. The page additions include a splash screen, login page, and onboarding page. In addition, a sub-feature is added to the fetal development feature, namely, recording the fetal heart rate.

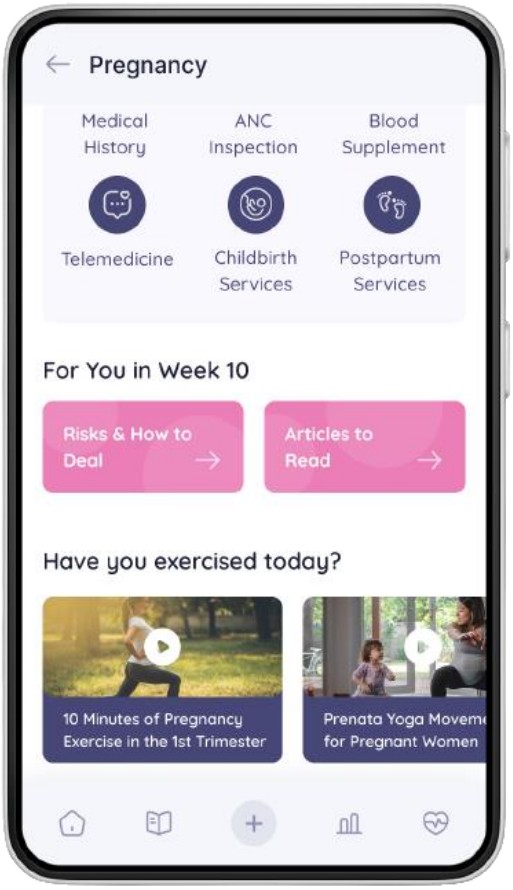


**Figure 7. Homepage Feature**

During this stage, the research team conducted usability testing and distributed the System Usability Scale (SUS) questionnaire. Usability testing is a qualitative evaluation method by observing user behavior when using an application and gathering feedback about usability issues or user insights. Meanwhile, SUS is used to measure the usability of applications at the design evaluation stage.

The quantitative evaluation method used by the research team is the System Usability Scale (SUS). Data is collected through the online questionnaire, which is given to each usability testing participant (Table 3). Participants are asked to fill out the SUS form when the UT session is over. The SUS questionnaire consists of ten statements that UT participants will respond to measure their perceptions of the usability of the designed application. The SUS overall score can be calculated by responding to each question with a rating of 1 to 5 how strongly they agree or disagree with the statement, the SUS overall score can be calculated. In addition, there is one qualitative question in the SUS questionnaire which aims to get overall feedback for the application interface design. Quantitative evaluation using SUS was carried out twice, namely in the first and second iterations. The UT session was held in three weeks with 6 participants from the previous session. The evaluation was carried out twice in this

iteration and the upcoming iteration to see the difference in SUS scores when the prototype was refined after the first usability testing session.

**Table 3. Summary of Respondents' Demographics of Pregnant Women and Mothers Who Have Given Birth**

| No. | Respondents' Name | Pregnancy Status | Type of Persona |
|---|---|---|---|
| 1. | Respondent 1 | Have given birth | First Persona |
| 2. | Respondent 2 | Ongoing pregnancy | |
| 3. | Respondent 3 | Have given birth | |
| 4. | Respondent 4 | Have given birth | Second Persona |
| 5. | Respondent 5 | Ongoing pregnancy | |
| 6. | Respondent 6 | Ongoing pregnancy | |

Based on the SUS evaluation, a score of 72.1 was obtained, where the interpretation indicated that the application interface design could be grade B with an adjective rating of 'Good' (Bangor et al. 2009). Hence, there is still some room for improvement for the next iteration. The target score is to get a score of 85, which is a minimum score for grade A, and an adjective rating of 'Excellent' in the next iteration.

### *Third Iteration: Finalization of High-Fidelity Design*

In the third iteration, improvements to the high-fidelity design will be carried out based on input and feedback in the second iteration. The result of the third iteration is the final high-fidelity application design and the final evaluation results of the application (Figure 8). Improvements to the high-fidelity design were carried out based on the feedback that the research team received in the usability testing session in the second iteration. Improvements are grouped based on core features, and the designed solutions are selected based on suggestions from participants in usability testing and by benchmarking on pregnancy applications that are often mentioned by participants.

We used the system usability scale (SUS) questionnaire to measure the usability aspects of the application in evaluating the design in the third iteration. Like the second iteration process, we distributed online the SUS questionnaire to each UT participant. The final SUS score in the third iteration was 85.4. Therefore, we achieved the target SUS score of 85 which can be categorized into the highest adjective rating, namely excellence (Bangor et al. 2009). This indicates that the design improvements made in the third iteration have almost entirely met the needs and expectations of users. Other usability aspects such as usability, efficiency, effectiveness, satisfaction, ability to learn, and ease of access are also fulfilled.


**Figure 8. High-Fidelity Design Refinement for Note Entry Feature**

## Discussion

Research conducted by Stevenson and Oscarsson (2021) discusses application development, specifically regarding the development of maternal health applications for immigrant pregnant women who have difficulty communicating with health workers in Sweden. Stevenson and Oscarsson (2021) develops a system that can facilitate pregnant women's communication during antenatal care and helps pregnant women get health facilities in remote areas that apply a user-centered design process. The application developed in Stevenson and Oscarsson (2021) focuses on providing applications for note-entry and communication media between health workers and Arabic Speaking Women patients. Thus, this study can fill the gap in the research conducted by Stevenson and Oscarsson (2021) by carrying out three UCD iterations complemented by a heuristic evaluation of Shneiderman's 8's Golden Rules (Shneiderman and Plaisant 2005). The mKIA that is designed in this research also answers a research gap conducted by Haddad et al. (2019) regarding the development of applications that must be based on user needs and compliance with applicable health regulations.

In the end, this research was able to achieve the expected goals, i.e., producing a mKIA design with a better user experience while maintaining the function of the MCH handbook. This research is expected to be able to provide theoretical benefits in the form of enriching the literature regarding the development of mobile applications for maternal health with the UCD approach. In addition, this research is also expected to provide practical benefits by becoming a reference that can be used by maternal health application developers, especially the Ministry of Health as the Mobile KIA application developer.

The research conducted by Haddad et al. (2022) and da Foncesca et al. (2021), which discussed the review of maternal health application development, are too focused on technology utilization and sometimes still disregards applicable health guidelines and the experience of pregnant women as users. Therefore, this research is expected to contribute to the research topic of developing maternal health

applications through designing interface designs that put the user at the center. This research made a theoretical contribution by redesigning the Mobile KIA application while maintaining the function of the MCH handbook as a medium for note entry, communication, information, and education. In addition, this research used the interaction design heuristics as a guideline to ensure that the usability aspect of the redesigned application is achieved. Thus, this research contributes by increasing knowledge about the application of heuristics that can be carried out in maternal applications using the user-centered design method.

This research is expected to provide practical benefits by providing a reference for the implementation of designs for providers and developers of maternal health applications using a user-centered design approach. It is hoped that application developers can find out the mechanism for implementing features contained in maternal health applications that can meet existing health standards, as well as address the problems experienced by pregnant women during their pregnancy. The expectancy is that maternal health application developers can develop features that suit the needs of pregnant women and pay more attention to user experience in their implementation. Thus, this research is expected to assist developers in developing appropriate maternal health applications and be the first step in advancing maternal health in Indonesia.

## Conclusion

The redesign process shows that many functionalities from the MCH guidebook can be synergized in mKIA. These added functionalities were aligned with the Ministry of Health's mission to reduce maternal death. The design results of the mKIA application received good feedback from users. The features of mKIA application include maternal information, education, record keeping, pregnancy growth and development charts, fetal development progress, and recording of fetal movements. This study can also play a role as a pregnancy support application and complement the MCH handbook especially in developing countries. Further studies need to pay more attention to the potential user in rural areas. Finally, further studies should also be creating a design solution for health workers regarding antenatal care.

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## Appendix A. Interview Questions for Pregnant Women and Mothers Who Have Given Birth

| Category | Interview Question |
|---|---|
| Demographic Question | Please tell us a little about yourself (name, age, domicile, and occupation). |
| | Is the current pregnancy the first pregnancy? If not, how many times are you currently pregnant? |
| | During the pregnancy process, did you ever use the MCH handbook? If so, can you state which version? |
| | During the pregnancy process, have you ever used a pregnancy app? If so, can you state the name of the application? |
| Process of Antenatal Care (ANC) and Use of the MCH Handbook | What do you know about antenatal care? |
| | How often do you make antenatal care visits? |
| | Under what circumstances and conditions did you attend the antenatal care session, and did anyone remind you to attend? |
| | Please tell us about your experience when doing antenatal care visits, including travel, waiting time, and the facilities and treatment you received. |
| | How long have you been using the MCH handbook? |
| | How do you use the MCH handbook? |
| | What parts of the MCH handbook have you used? |
| | In your opinion, how has the experience of using the MCH handbook been so far? |
| | How complete is the information in the MCH handbook? |
| | [If the xth pregnancy (x> 1)] Are you quite familiar with the use of the MCH handbook? |
| | [If the x-th pregnancy (x> 1)] Do you still use the MCH handbook as a reference for information on your last pregnancy? |
| Pain Points | So far, have you experienced any problems when searching for information in the MCH handbook? |
| | Can you tell me how often you experience this problem? |
| | What problems do you often experience during pregnancy, both health problems and other problems? |
| | Do you use the MCH handbook as a reference in finding solutions to the problems mentioned? |
| | How do you find solutions to the problems you experienced during pregnancy? |
| Goals | In your opinion, is the utilization of the MCH handbook sufficiently optimal in terms of information, method of delivery, and how to use it? |
| | In your opinion, is the information in the MCH handbook enough to meet your needs as a father or a pregnant woman? Why? |
| | Have you ever looked for or obtained an alternative to the current MCH handbook (in terms of delivery and use)? |
| | What are the solutions or alternatives? |
| | How has the process of recording information in the MCH handbook when visiting health facilities been so far? Is the recording process |

| Category | Interview Question |
|---|---|
| | running effectively? |
| | Do you use pregnancy apps to support the pregnancy process? If yes, what application did you use, and why did you choose the application? |
| | How can this application support your pregnancy? |
| | What do you get from the application? |
| | What features need to be developed for the application? |
| | Is the application a substitute for the MCH handbook or a complement to the MCH handbook? |
| | In your opinion, what things from the MCH handbook can be replaced by the MCH app? |
| | Would you suggest other pregnant women use the pregnancy app instead of the MCH handbook? Why? |
| | What information do you need during pregnancy, and how do you find it? |
| | Did you keep an independent health record during pregnancy? If yes, why and how did you do the self-recording? |
| | Do you have a regular daily or weekly health-related activity during pregnancy? If yes, how do you remember the activity? |
| | How do you determine which health facility to choose during pregnancy? Do you plan to or have time to change health facilities during your pregnancy? |
| | Do you often use digital content for activities during pregnancy? If so, where did it come from? |
| | Do you feel that providing information in the form of audio is more helpful for certain conditions? |
| | If there is an application that carries features from the MCH handbook, what features do you hope to have? |

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