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Article

Design of an Immunization Information System for Monitoring the Achievement of Child Immunization Coverage

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Abstract:. Immunization is one of the most effective public health interventions in preventing infectious diseases and reducing mortality and morbidity in the global population, with the potential to prevent 3 to 3.5 million deaths each year from vaccine-preventable diseases. In Low- and Middle-Income Countries (LMICs), including Indonesia, vaccination coverage for children under five years old still shows low numbers. The low vaccination coverage is partly caused by the use of manual recording systems, which leads to delays in decision-making processes in immunization management. This study seeks to address this issue by developing a UI/UX prototype design for a toddler immunization information system. The proposed UI/UX design is equipped with features to monitor and record immunization activities in a particular region in real time, enabling effective, accurate, and integrated decision-making and implementation of immunization programs at both regional and national levels. The UI/UX design was developed using the User-Centered Design (UCD) method, which actively involves users throughout the process. Usability testing was conducted using the System Usability Scale (SUS) method. The results indicate that the designed UI/UX meets the standard requirements of public health centers and achieves satisfactory outcomes from prospective users. The contribution of this research is the proposed UI/UX design for immunization monitoring. In the future, this UI/UX design can serve as a foundation for the development of an Immunization Monitoring Information System.

Keywords: Toddler, Immunization, Monitoring, Recording, Vaccine

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1. Introduction

Immunization is one of the most effective public health interventions in preventing infectious diseases and reducing mortality and morbidity in the global population, with the potential to prevent 3 to 3.5 million deaths each year from vaccine-preventable diseases. However, global immunization coverage has still not reached the optimal target, with diphtheria-tetanus-pertussis coverage falling from 86% in 2019 to 81% in 2021, leaving 25 million children without primary vaccination[1]. In Low- and Middle-Income Countries (LMICs) including Indonesia, vaccination coverage for children under five still shows significant disparities with some regions achieving low levels of coverage [2].

Fundamentally, immunization functions to actively increase a person's immunity to a disease. When a vaccine is introduced into the body, the immune system will form antibodies to fight the pathogens in the vaccine, and the immunological memory system will store it as an experience[3]. The state of Indonesia requires every child to get Complete Basic Immunization (IDL) to prevent various Diseases That Can Be Prevented by Immunization (PD3I). IDL is defined as the basic immunization received by every infant/child before the age of 1 year (9-11 months) through complete vaccination[4]. One of the indicators of the success of the immunization program is the achievement *of*

Universal Child Immunization (UCI) or the basic coverage figure of complete basic immunization in a region[5].

ASIK (Aplikasi Sehat Indonesiaku), as one of the applications developed by the Indonesian Ministry of Health, is intended to support the management of toddler immunization. However, its utilization has not been optimal. Based on interviews conducted by the researchers at one public health center (Puskesmas) in Jember Regency, it was found that the features available in ASIK do not fully meet user needs. As a result, immunization recording processes are still carried out conventionally. This condition leads to negative impacts such as data inaccuracies, incomplete information, and delays in reporting, which subsequently affect surveillance of vaccine-preventable diseases. Manual recording systems also cause difficulties in real-time tracking of individual immunization status, identification of children who miss scheduled vaccinations (defaulters), and coordination among different levels of healthcare services. These conditions hinder accurate data-driven decision-making for effective immunization program planning [6].

To address these issues, there is a need for a system that can facilitate users in managing immunization processes effectively and efficiently. Accordingly, the focus of this study is the development of a prototype in the form of a UI/UX design for an immunization monitoring system equipped with dashboard and immunization reminder features. This prototype serves as a foundation for subsequent system development. The method employed in this study is User-Centered Design (UCD), which was selected due to its effectiveness in eliciting user requirements and ensuring that user needs are adequately accommodated.

2. Materials and Methods

2.1 Immunization

Immunization is one of the most effective public health interventions in preventing millions of deaths, especially in children[7]. Immunization can be done through vaccination, which stimulates the body's immune system to form long-term protection, or passively by administering antibodies that provide immediate but temporary protection[8]. Modern vaccines are made up of different types, such as attenuated viruses or bacteria, inactivated pathogens, or specific components produced in a recombinant manner, and the way the vaccine is administered (e.g., intradermal, subcutaneous, intramuscular) can affect the resulting immune response[9]. With these antibodies, the body will have resistance when one day exposed to the actual disease. Immunization has a certain schedule that is adjusted to the age of the child so that the administration is effective. The complete basic immunization schedule includes: BCG, Polio, Hepatitis B, DPT-HB-Hib, Measles, and additional such as PCV, Rotavirus, and Influenza as recommended by health organizations.

2.2 User Centered Design ed

User Centered Design (UCD) is a design approach that puts the user's needs, goals, and experience at the center of the entire product or system development process. UCD actively engages users, both through consultation at the requirements gathering and usability testing stages, as well as a partner in the overall design process, resulting in a product that is easier to use, minimizes documentation needs and increases user satisfaction[10]. This approach is iterative, where design and evaluation are carried out repeatedly with users to ensure the resulting solution truly fits their needs. The key principles of UCD include an in-depth understanding of users, user engagement throughout the development cycle, as well as design adjustments based on user feedback). While UCDs can improve product quality and usability, this process often requires additional time and cost due to intensive iteration and user engagement. UCD is not only

applied to interface design, but also to other aspects such as documentation, data structure, and system integration within organizations. In the context of architecture, for example, UCD helps to design buildings that are more functional and satisfy the needs of users by taking into account aesthetics, functionality, and environmental quality aspects [11]

2.3 Research Stage

The creation of UI / UX design on the immunization information system in toddlers was made using the User Centred Design method. Which consists of four main stages. The process of each stage is described as follows.

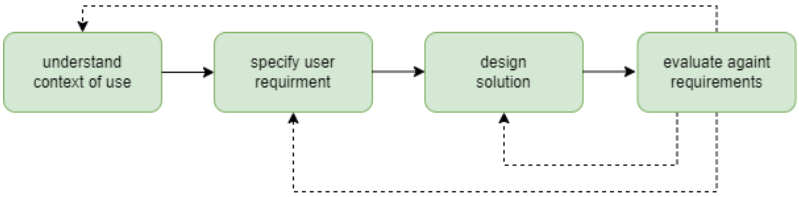


Figure 1. UCD Stage

1. Understand Context of Use
   At this stage, the author excavates information related to the problems found in the immunization process
2. Specify User Requirements
   At this stage, the researcher compiles a needs analysis. The needs analysis is based on problems that have been obtained previously through the understand context of use stage.
3. Design Solutions
   The next process is to design a solution from the *User Requirements* that have been described in the previous process, this design process will go through several stages ranging from rough concept, prototype to complete design.
4. Evaluation Against Requirements
   Evaluation will be carried out by involving *the user* who will use, evaluation is carried out starting from 1 process and continued to the next process.

2.4 Method

This study took a sample of data from one of the Community Health Centers in Jember Regency. The method used is qualitative for the needs analysis process. Respondents in this study include, regional midwives, heads of health centers, parents of toddlers. For the creation of UI/UX Design, the method used is User Centered Design (UCD)

3. Results

3.1 Understand Context of Use

At this stage, the researcher conducted information about the needs of the application. This process is carried out with in-depth interviews to find out the user's needs. Based on the results of the interview, the following user story was obtained

Tabel 1. *Tabel user story*

User	User Story
Admin	As an admin, I can add data related to Community Health Centre data, and user data, including the head of Community Health Centre, midwives, parents, so that I can manage the system user
Parents	As a parent, I can see the development of children's data

User	User Story
Regional midwives	As a regional midwife, I can enter the data of parents and children, enter immunization data so that the data entered can be used as reporting.
Midwives of the Health Centre	As a midwife of the health centre, I can enter immunization data, see immunization achievement reports, so that it can be used to make decisions
Head of Health Centre	As the head of the health centre, I can see the dashboard of immunization achievement, so from this dashboard I can take satisfaction with the immunization program.

3.2. Specify User Requirements

Based on the previous steps, various kinds of problems related to the immunization process were obtained. This problem can be analysed to be used as a list of functional needs. Some users can be identified through this stage, including the following:

a) Admin: Admin users can enter user data, Community Health Centre data
b) Head of Community Health Centre: The Head of the Health Centre can see the dashboard of the achievement of immunization development in one area
c) Midwives of the Health Centre: View the dashboard or immunization report
d) Regional Midwives: Entering Toddler Immunization Data
e) Parents: Seeing the development of toddler immunization

3.3. Design Solution

The next process is to design the design of the solution that has been offered. The solutions offered are in the form of designing a UI/UX Information System for toddlers with main features, master data, immunization inputs, dashboards/reports, and automatic reminders. These automatic reminders make use of the WhatsApp API . The following is the result of the UI/UX design of the information system

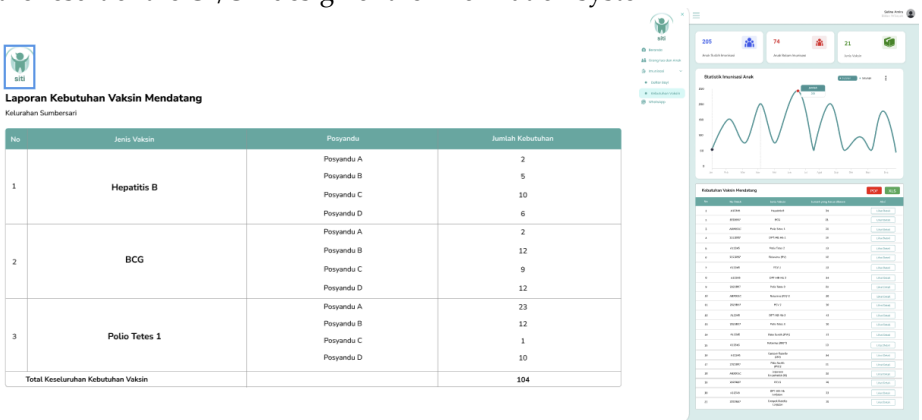


Figure 2. Vaccine Needs Dashboard Page

Figure 2 is a dashboard page that can be accessed by the Midwives of the Community Health Centre and the Head of the Community Health Centre. The dashboard contains a recapitulation of the needs of each vaccine. This feature serves to help in making decisions in vaccine procurement.

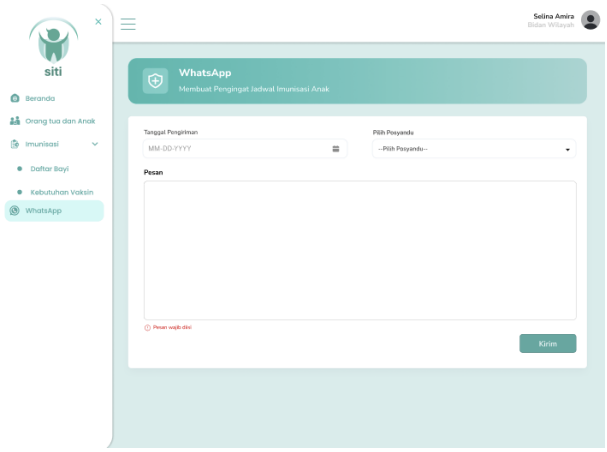


Figure 3. Automatic Message Setting Page via WA.

Figure 3 is a page feature used to set automatic messages through WhatsApp. This feature will later be designed as an automatic feature that is used as a reminder of messages that are automatically sent to the baby's parents from the health centre.

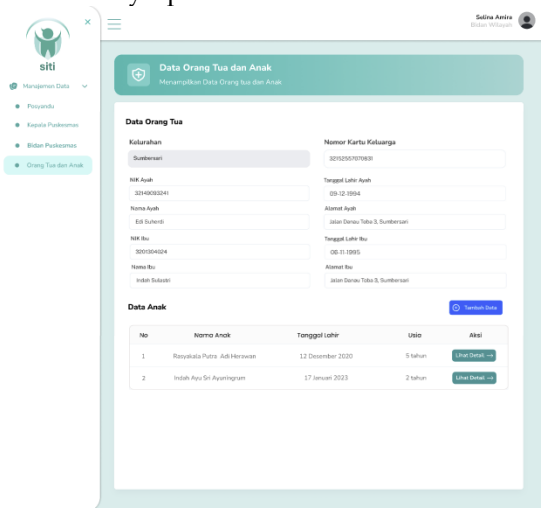


Figure 4. Parent data input page

Figure 4 shows one of the pages contained in the master data. This page is the page for data master inputs. Where in this master data feature, users can enter posyandu, Community Health Centre, child and parent data.

4. Discussion

Evaluation is carried out by involving *users* who will use it. In this case, the researcher took one of the samples at one of the health centres in Jember Regency consisting of health centre midwives, regional midwives, head of health centres and posyandu cadres. Evaluation is used to assess whether the design has met the user's wishes or vice versa. The evaluation uses the SUS (System Usability Scale) research framework. The following are the SUS question items[12].

Table 2. System Usability scale questions

Yes	Question
1	I think I'll use this UI/UX design again.
2	I find this UI/UX design complicated to use.
3	I feel that this UI/UX design is easy to use.
4	I need help from other people or technicians in using this UI/UX design.

Yes	Question
5	I feel that these UI/UX design features are as expected.
6	I feel that there are a lot of things that are inconsistent (incompatible) in this UI/UX design.
7	I feel like others will understand how to use this UI/UX design quickly.
8	I find this UI/UX design confusing.
9	I feel that there are no obstacles in using this UI/UX design.
10	I need to get used to it first before using this UI/UX design.

Each question is answered by uses a Likert scale from one to five, where 1 represents "Strongly Disagree," 2 is "Disagree," 3 is "Neutral," 4 is "Agree," and 5 is "Strongly Agree."[13]. Based on questionnaires from several users, the following results were obtained.

Table 3. The Usability Test Result

Respondent	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	∑	Value
1	2	2	3	3	3	3	3	3	3	3	28	70
2	3	4	4	4	3	4	4	3	3	3	35	87,5
3	3	4	4	3	4	4	4	3	3	3	35	87,5
4	2	3	3	2	3	3	3	3	3	2	27	67,5
5	3	3	3	2	3	3	3	3	3	2	28	70
6	2	2	3	3	3	3	3	2	3	3	27	67,5
7	3	3	3	2	3	2	4	3	3	3	29	72,5
8	3	3	2	2	3	3	4	3	4	3	30	75
9	3	4	3	3	3	2	3	4	3	3	31	77,5
10	3	3	4	3	3	4	2	3	3	3	31	77,5
Mean												**75,25**

Table 3 above shows the results of the calculation of the useability scale from 10 respondents. Respondents were taken prospective users who mostly consisted of midwives and heads of health centres. The final result showed that the score obtained was 75.25. This value is quite good because the above shows a value above the threshold, which is as large as 68[14]. A score below 68 generally indicates unsatisfactory usability and requires improvement, while a score above 68 is considered good[15]. In the research, Hyzy also argued that for applications in the health sector, the 68 sector is still relevant by using the aforementioned threshold [16]. Thus, this UI/UX design can be recommended to be used for the next development process. . The main focus of this study is the design of an automated reminder feature using WhatsApp messages. Through this feature, midwives can more easily provide information to parents of toddlers regarding immunization schedules and Posyandu activities. As a result, this model indirectly functions as an automatic reminder system. This concept distinguishes the present study from previous research conducted by Riyadi et al., in which the primary focus was the development of features for schedule management and online [17]. In addition, such an automated WhatsApp-based reminder feature is not yet available in the ASIK application released by the Indonesian Ministry of Health. [17].

5. Conclusions

Based on the discussion, it can be obtained that the system consists of main features, namely the master data feature, Manage immunizations, immunization dashboard and automatic reminder manager. The evaluation of interface design was carried out using the SUS method where in this test respondents were taken from the health center. The test

results show that the system is quite good by getting a value above the thresholds that has been set. It can be concluded that the User Centered Design method can be used well to explore the needs in detail so that the design made can meet the needs of users. A combination of data collection techniques in the form of interviews and documentation is needed so that needs can be clearly defined. The design made has advantages compared to other immunization monitoring systems. namely the design of automatic reminders through WA messages. The limitation in this study is that there is a sample of data collection that is centralized in one health center where it cannot describe the problems faced as a whole. Even so, this study can illustrate a few problems and solutions that can be offered to deal with immunization problems. In the future, this UI/UX can be used as the basis for creating a web-based and mobile-based monitoring information system.

6. Patents

This section is not mandatory but may be added if there are patents resulting from the work reported in this manuscript.

Supplementary Materials: -

Author Contributions: Bakhtiyar Hadi Prakoso, Veronika Vestine, Muhaammad Yunus, and Gandu Eko Julianto Suyoso; methodology, Bakhtiyar Hadi Prakoso, Muhaammad Yunus, and Gandu Eko Julianto Suyoso; software, Bakhtiyar Hadi Prakoso, Muhammad Yunus; validation, Gandu Eko Julianto Suyoso; writing—original draft preparation, Veronika Vestine; writing—review and editing, Veronika Vestine. All authors have read and agreed to the published version of the manuscript.

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Conflicts of Interest: The authors declare no conflict of interest

Appendix A

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Appendix B

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