Development of a Technology-Based Immunization Service Information System to Improve Efficiency and Accuracy of Health Services

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Abstract: *The development of information technology has had a significant impact on various sectors, including healthcare. Community Health Centers (Puskesmas), as primary healthcare providers, play an important role in immunization programs but still face challenges in data management and manual record-keeping, which often cause delays and administrative errors. This research aims to design immunization service information system to address these issues, featuring digital record-keeping, automatic reminders, and real-time monitoring. The Prototyping method is used in the development of this system, involving stages of needs analysis, quick design, model creation, prototype implementation, and user evaluation. The expected outcome is an information system that improves the efficiency of immunization services, minimizes administrative errors, and facilitates easier monitoring of immunization status, thus contributing to the enhancement of healthcare service quality at Puskesmas.*

Keywords: *Health Information System, Immunization Service, Prototyping, Community Health Centers*

Introduction

The development of information technology in recent decades has had a significant impact on various sectors, including healthcare. The advancement of technology allows for the management of data and information to be done more quickly, accurately, and efficiently. This is crucial in efforts to improve the quality of healthcare services, especially in primary healthcare facilities such as community health centers (Puskesmas). As the frontline of public healthcare services, Puskesmas plays an important role in providing services related to disease prevention, one of which is through infant immunization programs.

A study by Santoso & Prabowo (2020) shows that the implementation of electronic-based information systems in healthcare can reduce administrative errors and improve the speed of clinical decision-making. The use of Electronic Medical Records (EMR) is also becoming common in hospitals and clinics as part of the efforts to digitize healthcare services. The development of cloud computing technology and the Internet of Things (IoT) is also being integrated into modern healthcare systems to support data sharing and remote patient monitoring.

The community health center (Puskesmas) is a technical health implementing unit under the supervision of the District/City Health Office. In general, Puskesmas must provide promotive, preventive, curative, and rehabilitative services, both for Individual Health Efforts and Community Health Efforts. Puskesmas can also provide inpatient services in addition to outpatient services. Nurses, midwives, and doctors are healthcare workers who provide health services at Puskesmas. Typically, Puskesmas has service sub-units such as assisting Puskesmas, mobile Puskesmas, integrated health posts (Posyandu), village health posts, and village maternity posts (Polindes). Puskesmas is the center for public health services responsible for providing primary healthcare services to the community, especially in disease prevention and health problem control at the local level. The role of Puskesmas in Indonesia

is very strategic, as it serves as the frontline provider of health services for communities in various regions, including remote areas.

However, although Puskesmas is a key institution in providing healthcare services, there are still many challenges faced in data management and immunization services. The widespread use of manual recording often leads to delays in services, human error, and a lack of integrated data that can be used for national monitoring. According to Hidayat & Sari (2019), the lack of an effective information system in Puskesmas is one of the main obstacles in efforts to improve the quality of healthcare services, including immunization programs.

Immunization is one of the national programs aimed at protecting children from various infectious diseases that can be prevented by vaccines, such as measles, polio, and hepatitis B. In Indonesia, the government, through the Ministry of Health, has established a routine immunization schedule for infants and toddlers as part of efforts to achieve Universal Child Immunization (UCI). Although the immunization program has been in place for a long time, challenges in its implementation still exist, including low compliance with the immunization schedule, difficulties in monitoring, and limited access in some areas.

A study by Putra & Nugroho (2021) shows that the manual system still used to record and track infant immunizations causes issues such as unrecorded infants who do not receive vaccinations, delays in immunization implementation, and difficulties in coordinated monitoring at the national level. Therefore, the use of a computerized information system is widely proposed as a solution to improve efficiency, transparency, and accuracy in the recording and reporting of immunizations.

Several previous studies have discussed the importance of implementing technology-based information systems to support immunization programs. For example, Utami & Firmansyah (2020) developed a web-based information system that allows for the recording and monitoring of children's immunizations in urban areas. This system is equipped with automatic reminder features sent via short message service (SMS) or application notifications to parents regarding their children's immunization schedules. The results show that this system can increase parents' compliance with the immunization schedule by up to 30%.

Another study by Kurniawan & Ayu (2019) emphasizes the use of integrated health information systems to create interoperability among healthcare facilities. With centralized data, Puskesmas, clinics, and hospitals can easily access information about infant immunizations, facilitating tracking and monitoring of immunization coverage at regional and national levels. However, the challenges often faced in the development of these information systems include limited infrastructure, such as internet connectivity in remote areas, as well as the readiness of human resources at Puskesmas to operate the new information technology systems.

Based on the existing literature review, the use of information technology in managing infant immunization services at Puskesmas is crucial for improving efficiency, accuracy, and the quality of healthcare services. Web-based technology used for immunization recording, automatic reminders, and real-time monitoring can minimize administrative errors and enhance compliance with the immunization schedule. With the existence of an integrated information system, it is hoped that the national immunization program can operate more effectively, allowing Puskesmas to optimally fulfill its role as a primary healthcare service center.

This study aims to design an information system for infant immunization services at Puskesmas that can minimize administrative errors, expedite service processes, and facilitate monitoring of infants' immunization status. With this information system, it is hoped that Puskesmas can provide more organized, structured, and easily accessible services for healthcare workers and parents of infants.

Literature Review

Immunization is the process of administering vaccines to individuals to enhance their immunity against specific infectious diseases. The goal of immunization is to prevent the transmission of diseases and reduce morbidity and mortality from vaccine-preventable diseases. Infant immunization programs typically include vaccines for diseases such as measles, polio, and hepatitis B (WHO, 2019).

In Law No. 36 of 2009 on Health, Article 130 states that 'The government is obligated to provide complete immunization to every infant and child.' The following are the types of immunizations included in the government program, funded by the government, for infants under the age of 1 year in Indonesia: 1) At 0 months: BCG, HB-0, Polio-0; 2) At 2 months: DPT/HB/Hib-1, Polio-1; 3) At 3 months: DPT/HB/Hib-2, Polio-2; 4) At 4 months: DPT/HB/Hib-3, Polio-3; 5) At 9 months: Measles. The following are the recommended types of immunizations based on age groups: 1) Under 1 year: BCG, hepatitis B, polio, DPT, measles, Hib, pneumococcal, rotavirus; 2) Age 1-4 years: DPT, polio, MMR, typhoid, hepatitis A, varicella, influenza, Hib, pneumococcal; 3) Age 5-12 years: DPT, polio, measles, MMR, typhoid, hepatitis A, varicella, influenza, pneumococcal; 4) Age 12-18 years: Td, hepatitis B, MMR, typhoid, hepatitis A, varicella, influenza, pneumococcal, HPV; 5) Elderly: influenza, pneumococcal.

Healthcare services are efforts made by healthcare professionals to improve, maintain, and restore the health of individuals or communities. Healthcare services encompass various aspects, including prevention, treatment, and rehabilitation. In the context of immunization, healthcare services include administering vaccines, recording immunizations, and monitoring immunization coverage (Ministry of Health of the Republic of Indonesia, 2019).

Information Systems (IS) are a combination of technology, people, and processes that collect, process, store, and distribute information. Health Information Systems (HIS) are specifically designed to support the management of data and information in the health sector, including immunization data management (Laudon & Laudon, 2018).

Information Technology (IT) refers to all technologies used to process and deliver information, including hardware, software, and network systems. In the context of health, IT includes the use of health information systems, electronic medical records (EMR), and mobile applications for managing health data (Stair & Reynolds, 2017).

Health information systems are designed to collect, store, and manage information related to health. These systems include various components such as databases, software, and procedures that support decision-making, planning, and evaluation of health programs, including immunization (Bajpai & Bajpai, 2018).

Methodology

In addressing the above issues, the author employs a qualitative research method with a descriptive approach, focusing on describing and analyzing the procedures and mechanisms of the immunization service system in Puskesmas X, and then seeking solutions to resolve the identified problems.

For the software development method in this research, the author uses the Prototyping Method, which is based on rapidly and gradually breaking down the system's problems into smaller modules, followed by evaluation and documentation. The stages of the Prototyping Method (Abdussalaam & Oktaviani, 2020) are described as follows:

1. ***Requirement and Analysis***: This is the first stage, where the system analyst interacts and communicates with users about the issues of the existing system and analyzes the requirements for the system to be developed.

   In this stage, the author communicates with stakeholders regarding the immunization service system at Puskesmas X that has been in operation, analyzes the problems arising from that system, and determines the requirements for the system to be built.

2. ***Quick Design***: This stage involves global planning regarding what will be created based on the system's requirements.
   The author proposes a plan to Puskesmas to create immunization service information system using VB.Net programming language and MySQL that can be accessed to provide real-time immunization service information.
3. ***Modeling of Quick Design***: This involves the depiction and creation of sketches or arrangements of several elements into a cohesive and functional unit, considering user comfort and ease of use.
   At this stage, the author presents to users an overview of the development of the new goods inspection information system, using Flowmap Diagrams, Context Diagrams, and Data Flow Diagrams (DFD) for the immunization service information system, to accommodate the needs for processing and presenting immunization service information, including patient data management, immunization services, and reporting.
4. ***Construction Of Prototype***: This stage involves the implementation of the information system by creating code according to the system's requirements.
   The author performs coding for the immunization service information system based on the needs and designs that have been previously determined.
5. ***Deployment Delivery and Customer Feedback***: This stage is about testing the created system and gathering user feedback on whether it meets their expectations and is easy to use.
   The author conducts a simulation of the implementation of the developed immunization service information system and then requests feedback from users.

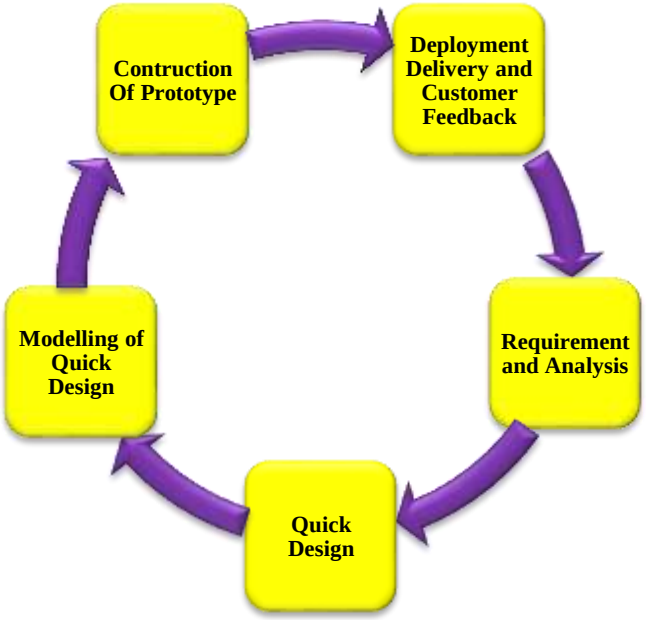

Figure 1. Metode Prototyping

Results & Discussion

A. *Requirement and Analysis*

The results of the analysis and requirements for the immunization service information system at Puskesmas X are described as follows:

1. The current Immunization Service Information System for infants is not yet optimal, as it still uses a manual writing method in a ledger (Kohort). Differences in patient data are often found between the registration section and the patients examined by the midwife. Additionally, there is no automated reporting facility (data that has been written in the Cohort book is then re-compiled and entered into a Microsoft Excel application).

2. A processing medium for immunization services is needed that is easy to use and can display information automatically and accurately, minimizing administrative errors, speeding up service processes, and facilitating monitoring of infants' immunization status. With this information system, it is hoped that Puskesmas can provide more organized, structured, and easily accessible services for healthcare providers and parents of infants.

B. *Quick Design*

Based on the results of the observations, the author proposes the design of an Immunization Service Information System using VB.Net as the programming language and MySQL as the database, which can be accessed to provide real-time immunization service information, thereby facilitating the monitoring of immunization status. To accommodate the system's requirements, the author outlines the input design and output design as follows.

Input Design

The input design is used to identify and describe the system's input data, functions, attributes, and descriptions. The input design for the Immunization Service Information System is outlined in Table 1.

Table 1. Input Design

No	Input Name	Function	Attributes	Description
1	User Data	Used for storing staff data	ID, Name, NIP, Gender, Username, Password, Email, Phone_Number	Place to store staff data
2	Patient Data	Used for storing patient data	Medical Record Number, Baby Name, Registration Date, Place of Birth, Date of Birth, Gender, Mother's Name, Phone Number, Occupation, Address, RT, RW, Village, Subdistrict, City, Province	Place to store patient data
3	Immunization Service Data	Used for storing data of patients receiving immunization	Medical Record Number, Baby Name, Examination Date, Place of Birth, Date of Birth, Age, Gender, Mother's Name, Address, Village, Subdistrict, Weight, Height, Immunization Classification, Type of Immunization, Vaccine	Place to store immunization service data

Output Design

Contains all information that comes out of a process, which can be in the form of printed results or displayed on a monitor screen in a specific standard format. The output design for the Immunization Service Information System is outlined in Table 2.

Table 2. Output Design

No	Output Name	Function	Attributes	Description
1	Patient Report	Used to display the Patient Data Report	Medical Record Number, Baby Name, Registration Date, Place of Birth, Date of Birth, Gender, Mother's Name, Phone Number, Occupation, Address, RT, RW, Village, Subdistrict, City, Province	Operator prints the patient data report
2	Immunization Service Report	Used to display the Immunizati	Medical Record Number, Baby Name, Examination Date, Place of Birth, Date of Birth, Age, Gender, Mother's Name,	Operator prints the immunization

No	Output Name	Function	Attributes	Description
		on Service Report	Address, Village, Subdistrict, Weight, Height, Immunization Classification, Type of Immunization, Vaccine	service report

C. *Modeling of Quick Design*

This process provides users with an overview of the development of the new immunization service information system, using tools such as Flowmap Diagram, Context Diagram, and Data Flow Diagram (DFD).

Flowmap Diagram

Flowmap diagram is a combination of a map and flowchart symbols that depict the activities and document flow of a system. The Flowmap diagram for the immunization service information system is described by the author as follows:

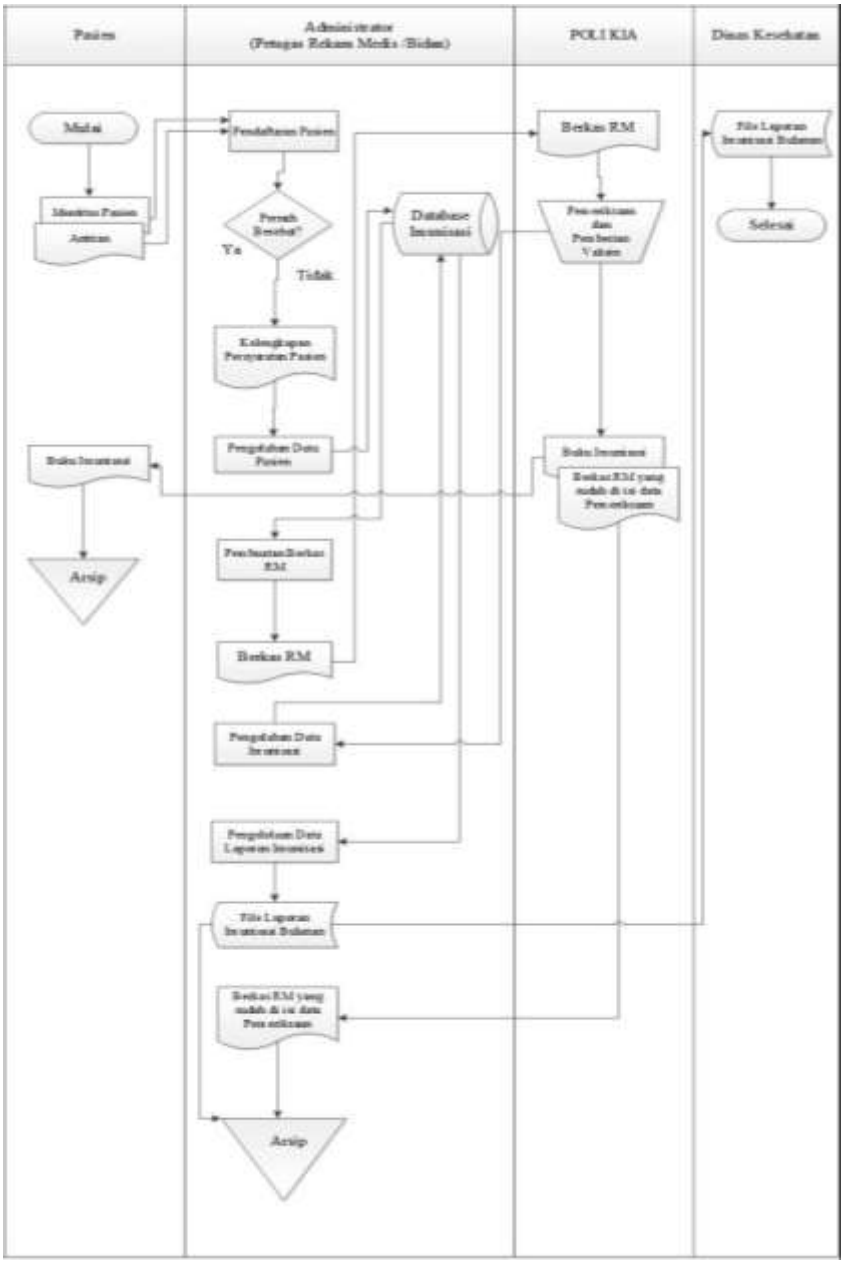

Figure 2. Flowmap Diagram

Context Diagram

Context diagram is a diagram that consists of a single process and illustrates the scope of a system.

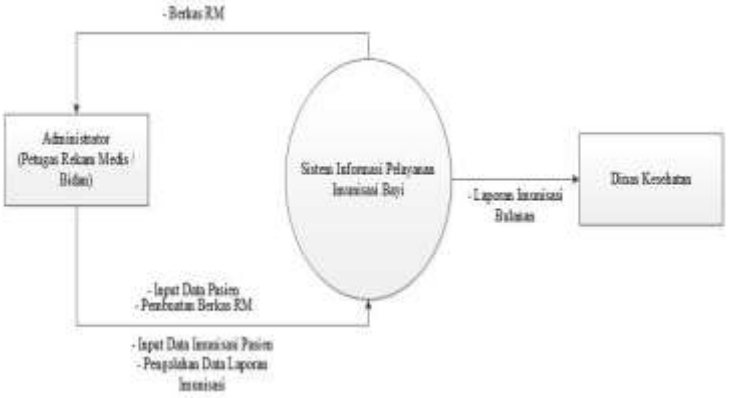

Figure 3. Context Diagram

Data Flow Diagram

Data Flow Diagram (DFD) is a network that describes a computerized system, a manual system, or a combination of both, structured as a collection of components that are interconnected according to specific rules.

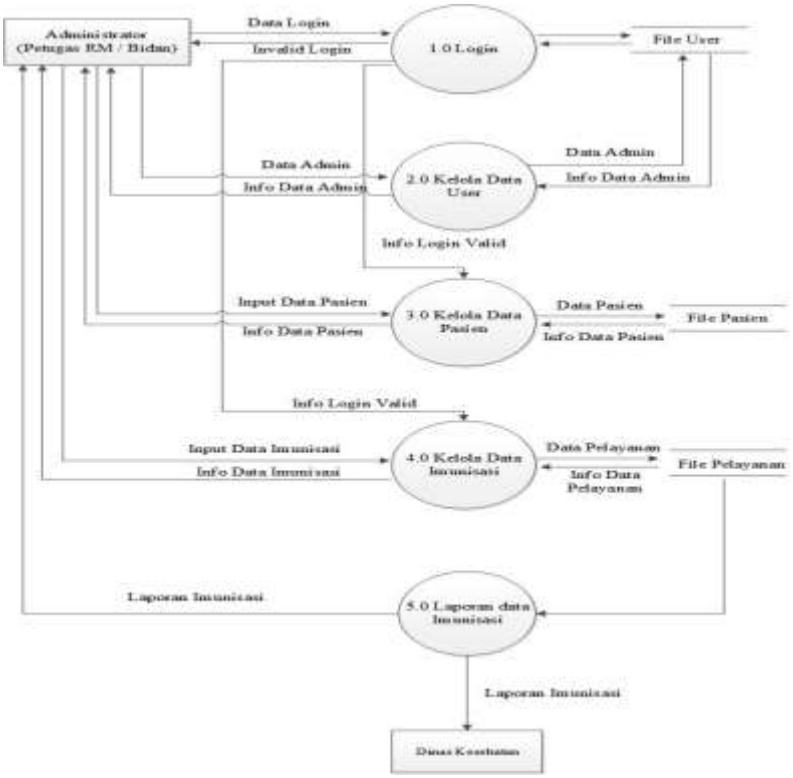

Figure 3. Data Flow Diagram

D. *Contruction Of Prototype*

This stage outlines the results of the immunization service information system design in the form of an interface. The author will describe several interfaces from the system that has been designed as follows:

1. System Login Interface

Figure 4. System Login Interface

2. Main Menu Interface

Figure 5. Main Menu Interface

3. User Form interface

Figure 6. User Form Interface

4. Patient Form interface

Figure 7. Patient Form Interface

5. Immunization Form interface

Figure 8. Immunization Form Interface

6. Report Form interface

Figure 9. Report Form Interface

7. Immunization Service Report

Figure 10. Immunization Service Report

8. Interface of the About Us

Figure 11. Interface of the About Us

E. *Deployment Delivery and Customer Feedback*

The simulation of the implementation of the immunization service information system was carried out with stakeholders, starting from inputting user data, patient data, immunization services, up to printing reports. The result was positive feedback, as the automatic reporting feature provides information on immunization status and the progress of their children to the parents.

The use of information technology in managing immunization services at community health centers (Puskesmas) has been proven to improve efficiency, accuracy, and service quality. The information system designed in this research provides a practical solution to address issues related to manual record-keeping and administrative errors. With features such as

automatic reminders and real-time monitoring, this system can help increase compliance with immunization schedules and facilitate the supervision of the national immunization program. Implementation challenges, such as technology infrastructure and human resource readiness, need to be addressed to ensure the successful adoption of this system in various regions.

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