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Web-Based Medical Record System Design Using Waterfall Method

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Abstract. Medical record data is a document containing the medical history, examination, and treatment received by the patient. Given the importance of medical record data, it is necessary to have integrated medical record data processing. This study aims to design a web-based medical record information system in a clinic in Bligo, Sidoarjo. Previously, all medical record data and transactions were processed manually. The development of this medical record information system using the Waterfall method which starts with planning, designing, coding, and testing. The system design uses the concept of a structured programming approach consisting of flow maps, context diagrams, data flow diagrams (DFD), and entity relationship diagrams (ERD). The resulting information system can process all data related to medical record data, master and transaction data, and user access rights.

Keywords: information systems; medical record; waterfall method; structured programming approach

1 Introduction

In the current digital era, information technology is needed by the wider community in various fields. One of them is in the field of health services. In every place of health care, there must be a medical record for each patient, which is called medical record data. Based on the Regulation of the Minister of Health of the Republic of Indonesia Number 269 of 2008 concerning medical records [1], medical records are written information containing documents and records regarding patient identity, medical history, examination, treatment, and other actions and services received by patients.

Medical record data is a very important document for a health agency such as in a doctor's practice clinic with dr. M. Ali Arifin. At the doctor's practice clinic with dr. M. Ali. Arifin is recording patient medical record data is still done manually. So that the administration still needs to provide medical record data cards in recording the dates of visits, examinations, and diagnoses to serve patients when seeking treatment at the place. The more patients who seek treatment at the clinic, the administration must provide a large number of medical record data cards. This causes inefficiency in recording medical record data at the clinic. In addition, another obstacle is that the administration has difficulty finding the old patient's medical record card documents that have been piled up with other medical record data. Not only that, a large number of patient medical record card documents makes it difficult for the administration to record patient visits within a certain period range.

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Therefore, the design of this medical record information system is very necessary to overcome the problems above. The development of this medical record information system aims to replace the medical record recording system to be digitalized. This makes it easier for the clinic to process all data related to medical records in an integrated manner. By designing a web-based medical record information system, this application can run on any device without having to know the type of operating system used. In addition, searching for patient medical record data will be easier and faster.

Several previous studies related to medical record data processing have been carried out. Research by [2] produced a medical record information system in a dental clinic. Next, a web-based medical record information system and transaction recapitulation at a veterinary clinic (house of pet) was produced [3].

Another study entitled Siremis: Medical Record Information System at the Matraman District Health Center, Jakarta [4] produced a medical record information system to record and search for patient medical record data. Another study resulted in a system called Si-Midwife: Maternal and Child Health Information System [5], in the form of a maternal and child health information system that integrates web and mobile applications, to facilitate midwives in recording services, compiling reports, and delivering information to users, so that they can directly monitor the health of mothers and children.

A study entitled Design of Medical Record Information System at Sukamerindu Health Center also created a medical record information system that made it easy for UPTD Sukamerindu Health Center in carrying out patient registration [6]. The next research is entitled Medical Record Information System at the Musirawas District Health Office Based on Mobile Web [7] which produces mobile web-based medical record services that can make it easier for the public to register online, conduct examinations easily and quickly, and can view medical records without having to come to the health center. The last research entitled Application of Medical Record System at Puskesmas Kelurahan Gunung [8] developed a web-based Puskesmas information system to assist the registration process for treatment, and data collection of new patients, and doctors can fill in medical record data systemically.

This study aims to develop a web-based medical record system in a joint practice clinic using the waterfall method. Users in this medical record information system application are divided into three roles, namely the head of the clinic, the admin, and the doctor. Where each role has different user access rights to the system. The goal is to divide functions or tasks according to existing procedures. In addition, in this study, there are features for making patient visit reports and patient medical record reports that can be printed to replace the medical record cards previously recorded in the manual.

2 Method and Material

2.1. Waterfall and Structured Programming Approach

The waterfall method is a classic life cycle that describes a systematic and sequential approach to software development, starting from communication to deployment [8]. This information system was developed using the waterfall method and with a structured programming approach. The information system is a data processing tool consisting of a data network that is connected to get the information needed by an organization [9]. Structured

programming is a programming method that groups programs based on functions or procedures required by computer programs [10].

2.2. System Development

In this study, the system development method used is the waterfall method which starts from the communication stage to deployment can be seen in Figure 1.

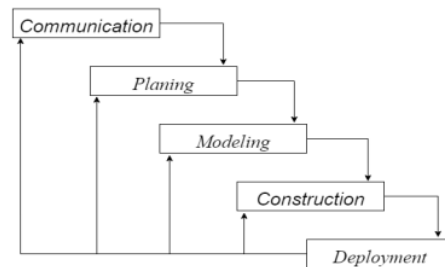


Fig. 1. Waterfall model diagram

The stages of software development using the waterfall method are described as follows [5]:

1. **Communication.** Analysis of software requirements and data collection is carried out at this stage by collecting data in the form of primary data and secondary data. Primary data is data obtained from direct observation or recording of the research object [11]. The primary data in this study were obtained from [12]:
 - Observation of data collection through direct observation of how the service process at the doctor's practice clinic with dr. M. Ali Arifin.
 - Interview data collection through questions and answers about the problems that occur in the clinic with the head of the clinic.

While secondary data is data obtained from the analysis of several journals, literature, and documentation related to medical record system problems [11]. In this study, secondary data obtained from the analysis of various journals regarding medical record information systems as well as patient record card documents, patient visit logbooks, patient registration cards, and patient visit report documents are also used for analyzing software requirements for this study.

2. **Planning.** From the analysis of data collection through direct observation, interviews with clinic heads, and document collection, it was concluded that an information system is needed that can facilitate the recording, processing, and storage of medical record data by integrating three users who have different access rights roles in the system. the. Users in this medical record information system include clinic heads, admins, and doctors. The clinic head can access the management of system user access rights, menu management, handling data, and report data. Meanwhile, the admin can access visit data, master data, transaction processing, and report generation. Medical record data is recorded by a doctor. This medical record information system uses a web-based application where the application developer in this case the author does not need to pay attention to the platform of prospective users or the

clinic. Because to run a web-based application only a web browser application is needed to access the web page where the application is stored.

3. **Modeling.** At this stage, the design of the medical record information system was compiled using the concept of structured programming. Functions or procedures are written sequentially by adjusting the relationship between the functions or procedures below them. Therefore, the design of this medical record information system is more focused on making data modeling and the functions or procedures that support the creation of the system. The design of this medical record information system is based on a structured programming approach using tools consisting of flow maps, context diagrams, DFD (Data Flow Diagrams) designs, and ERD (Entity Relationship Diagrams).
4. **Construction.** In this section, the author builds a web-based medical record information system using one of the PHP programming language frameworks, namely Codeigniter. As well as making this medical record application database using a DBMS (Database Management System) from the MySQL application. Furthermore, the system is tested using the black-box testing method involving the administration and doctors where the test results are used as a reference for system improvements.
5. **Deployment.** In this stage, the system is implemented for use by the clinic. Where the system has gone through a testing process and produces a system that meets functional requirements in recording, processing, and storing medical record data. The database of the medical record information system has also been filled with data from previous health service transactions by the clinic.

2.3. System Design

For system design in this study, the author uses a structured programming approach as described above. In structured programming using tools such as Flowmap, Context Diagram, Data Flow Diagram (DFD), and Entity Relationship Diagram (ERD). The following is the design of the medical record information system design:

1. **Flow map.** Figure 2 is a design flow map [10] which is a flowchart depiction of a process in a system with certain symbols.
2. **Diagram Context.** The context diagram of the design of this medical record information system can be seen in Figure 3 [6] which is a description of the relationship of a system in one environment with external entities.
3. **DFD (Data Flow Diagram).** The design of this medical record information system DFD consists of a Level 1 DFD which we can see in Figure 4. This Level 1 DFD is the main design of all processes in the medical record information system. With ten processes including the registration process, login, access rights process, processing drug data, processing doctor data, processing patient data, processing handling data, visiting process, logging out, and checking login status.

- 1
4. **Entity Relationship Diagram.** An **entity Relationship Diagram (ERD)** is a way of describing a data requirement to connect between entities of a system [10]. Before making a database design in PHP MySQL, first, make an ERD design because the database design is an implementation of the ERD diagram created. After the ERD diagram is made, the resulting database design as shown in **Figure 5** consists of 17 tables that are related to each other.

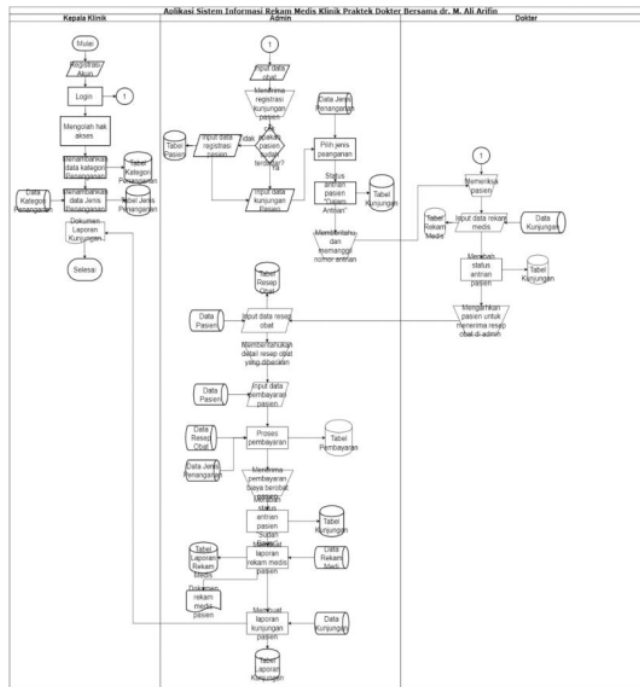


Fig. 2. Flowmap

3 Results

3.1 Interface

After going through the system design process using structured programming methods, a user interface can be produced which is a liaison between the user and the system. The following is a display of several face-to-face pages of the clinical medical record information system.

Figure 6 is the initial view of the clinical medical record information system page where the user enters the user account data first to be able to enter the system. After entering the user account data, the system directs the user into menus that can be accessed by the user account based on the role they have.

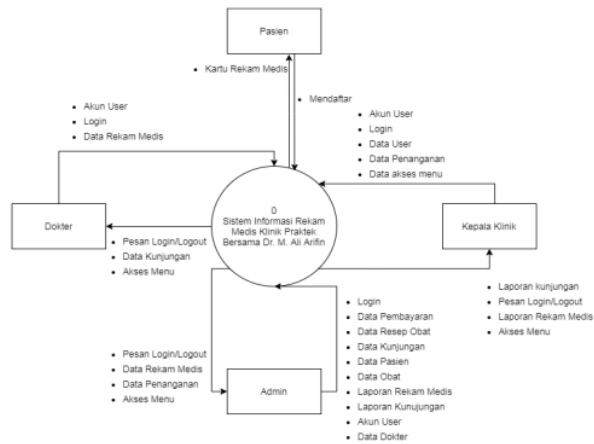


Fig. 3. Diagram Context

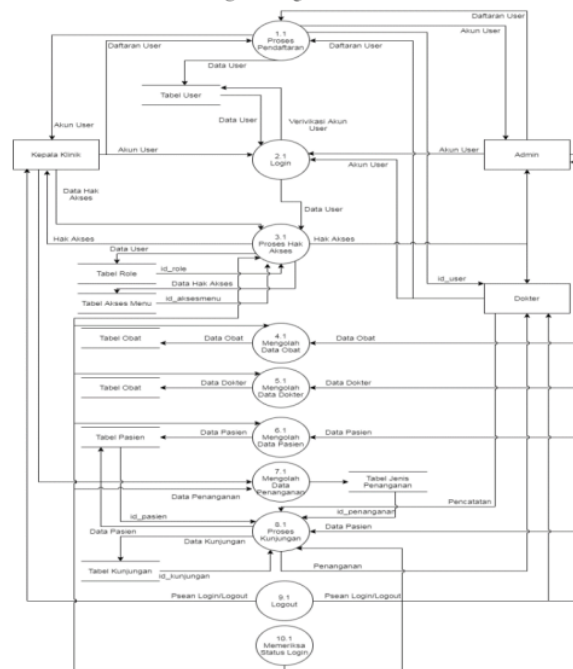
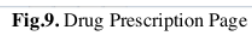


Fig. 4. DFD Level 1



In the drug prescription sub-menu shown in **Figure 9**, it contains information regarding patient data and related patient medical record data, the number of types of drugs, names of types of drugs, the amount of each type of drug given, the price of the type of drug, and the total cost of prescription drugs.



Next is the payment feature page from the payment sub-menu in **Figure 10** which displays details of the patient's treatment costs in the form of information related to patient data, the therapy is given, the total cost of drug prescriptions, treatment costs, and the total cost of

treatment. In this payment feature, the admin changes the status of the patient's visit to "Already Paid" if the patient has paid for his medical expenses.



Fig. 10. Payment Page

3.2 System Testing

At this stage, the system ¹testing process is carried out using the black box testing method. This test aims to determine whether the system that has been made is to the design objectives of the system being built. Testing of this system is carried out on each user with a predetermined role, namely a user with a clinic head role, a user with an admin role, and a user with a doctor role. The test results can be seen in **Table 1**.

Table 1. Test Results

Test menu	Test scenario	Expected results	Conclusion
Login	Entering username and password	Entering the main page according to the role	Successful
Report	View report data	Display report data	Successful
My Profile	View profile details	Show profile details	Successful
Change Profile	Change, name, picture, and username profile	Data can be changed and saved	Successful
Change Password	Change profile password	Password can be changed	Successful
Management Access	Process user access data	Provide information on access data for each user	Successful
Management User	Process user data	Provide user data information	Successful
Handling Management	Processing handling data	Providing data handling information	Successful
Logout	Press the exit button	Exit the system	Successful
Master Data	Processing master data including doctor data, patient data, drug data	Providing master data information	Successful
Visit Management	Process visit data	Provide information on patient visit data	Successful

Drug Prescription Management	Process drug prescription data	Provide information on drug prescription data for each patient	Successful
Payment Management	Processing payment data	Providing information on payment data for each patient	Successful
Medical Management	Processing medical record data	Provide information on each patient's medical record	Successful

4 Conclusions

Based on the results and discussion above, it can be concluded that all menus and features of master data processing and transactions in this medical record information system have been running well. In this system, there are also three user roles that can access the system, namely the head of the clinic, admin, and doctor, so that all data related to medical records is well integrated. This system can still be developed with different platforms with the addition of more complete reporting features.

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