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Designing Electronic Health Record (EHRs) in a Jember Family Healthy Home Clinic

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***Abstract*—Electronic Health Record systems (EHRs) are increasingly being deployed within healthcare institutions to reduce the problems, but their deployment has been slow due to high investment and maintenance costs. In this study, an Electronic Health Record system (EHRs) was designed, implemented, and tested to record, retrieve, archive, and update patients and other medical records at Jember Family Healthy Home Clinic. This study uses the waterfall method models with a literature review, examining documentation, observation, and interviews. The result achieved from this research is an application of a database management clinic. With a database application, all data and information integrated well to improve the quality of services and facilitate storing and accessing data. The conclusions obtained from this research are that the EHRs help generates quick and accurate information used to support operations and decision-making in the Jember Family Healthy Home Clinic.**

Keywords— clinic, database, EHRs, waterfall

I. INTRODUCTION

Officers at the Jember Family Health Home Clinic (RSK) in carrying out recording, processing, and storing patient medical record data still use conventional methods. For example, when a patient comes for treatment, the officer will look for physical documents of the patient's medical record on the storage rack. This method certainly has problems because it takes a relatively long time, namely an average of 10 minutes/patient. The following is the observation data carried out on the waiting time for the provision of physical files for patient medical records in January 2020:

TABLE I. TIME TO SEARCH PATIENT'S MEDICAL RECORD FILES

No	Patient	Waiting Time (minute)
1	A	14
2	B	15
3	C	12
4	D	11
5	E	13
6	F	17
7	G	15
8	H	14
9	I	13
10	J	13
	Average	**13,7**

Source: Secondary Data, 2020

Table 1 above shows that the average time needed to search for patient medical record documents at the Jember Healthy Home Clinic is 13.7 minutes. This time exceeds the Minimum Service Standard (SPM) that has been determined by the clinic, which is 10 minutes. It follows the Decree of the Minister of Health of the Republic of Indonesia Number 129 / Menkes / SK / II / 2008 concerning Minimum Hospital Service Standards. The maximum time limit for providing outpatient medical record documents is ⩽ 10 minutes.

Previous research states that there is an influence between waiting time on patient satisfaction. The purpose of developing health services is to meet patient needs and satisfaction [1]. In health service management, the main priority is improving the quality of service [2]. Usually, patients will seek comparisons and ask other people's recommendations where the treatment is better [3] [4].

Therefore, the Jember Family Health Home Clinic requires a computerized and integrated EHR design. The Electronic Health Record (EHR) is an electronic database consisting of health data from health service users [5]. The existence of an EHR system design can form a comprehensive

This research uses the Waterfall system development method, which is a sequential software development process, where progress is seen as continuing to flow downward (like a waterfall) through the phases of planning, modeling, implementation (construction), and testing. In its development, the waterfall method has several coherent stages: requirements (needs analysis), system design (system design), coding & testing, implementation (implementation), and maintenance [7].

II. METHODOLOGY

In this study using the Waterfall Method, the stages are as shown below [8]:

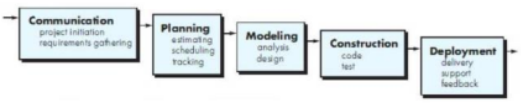

Fig. 1. Waterfall Method

In designing this EHR system, the authors only research up to the Modeling stage, namely designing logically and

physically for the database, Entity Relationship Diagram (ERD), and Data Flow Diagram (DFD) as follows:

A. Communication (Project Initiation and Requirements Gathering)

At this stage, the authors collected data in the form of examples of patient medical record document formats, examples of drug use reports and patient recapitulation formats, and doctor attendance. An analysis of the problem carried out while looking for the appropriate literature from journals, articles, and other sources.

B. Planning (Estimating, Scheduling, Tracking)

At this stage, the authors plan to estimate the technical tasks that will carry out (a division of teamwork), determining the risks that may occur, and explaining the resources needed.

C. Modeling (Analysis and Design)

In this stage, the writer analyzes the required variables and data structures and performs interface design. The design results are database table structures, ERD, DFD, and application interfaces.

D. Construction (Code and Test)

The coding process was carried out or built a system using the required programming language and framework. At the time of writing this paper, the researcher did not reach this stage.

E. Deployment (Delivery, Support, Feedback)

This stage is the implementation and maintenance of the system to be built. The author has not discussed this stage at the time of writing this paper.

III. Results And Discussion

From the research conducted, it can be seen that before building the system to the coding stage, a system design process is needed in the form of a logical and physical design. Logical design is meant to make ERD and DAD. Meanwhile, the physical design that is done is to create databases and tables following the ERD design.

ERD shows the tables that make up the EHR system database related to each other as needed. Therefore, ERD can assist database administrators in physically creating databases using a Database Management System (DBMS) such as MySQL and others. In designing the EHR system in this study, several tables form database relations, namely tables of patients, doctors, drugs, diagnoses, and rates. The result of ERD design is a table structure equipped with attributes or fields shown in tables 2-6.

If ERD maps the relationships between tables in the formation of the EHR database as shown in Figure 2, then the DAD created in this study shows the flow of data flowing from the components that make up the system (external entities) or vice versa. It is essential to facilitate the process of making the system (interface design and coding) because the input, processing, and reporting processes will be seen. In this study, the Data Flow Diagram (DFD), which shows an overview of the EHR system created, is shown in Figure 3.

After making ERD and DFD, the next process in this study is to design an application interface to support input, process, and output activities, as shown in Figure 4-12.

The following are the results of designing tables, ERD, DFD, and interfaces on EHR systems:

A. Structure Table Database

The following are some tables formed from the results of the system analysis:

TABLE II. PATIENT ATTRIBUTES TABLE

id	no_rm	no_identitas	nm_lengkap	umur	tlahir	jk	status
..	.....	.....	.....	.....	.....	....	...

agama	goldar	alamat	hp	suku	pddk	pkjaan	akses	tb	bb
..	.....	.....	.....	.....	.....	....	...	....	.....

Table 2 above serves as a master table for storing new patient data. It means that for every patient who comes to the clinic for treatment, while the data is not in the system, the officer will first enter the database. The patient table above consists of 18 attributes starting from the id - bb column.

Next is the doctor's table structure, as shown below:

TABLE III. DOCTOR TABLE ATTRIBUTES

id	nik	nm_lengkap	jk	agama	alamat	kategori	avatar
..	.....	.....	.....	.....	.....	....	...
..	.....	.....	.....	.....	.....	....	...

Table 3 above also functions as a master table for storing doctor data. Before providing medical services, all doctors in a healthy home clinic must first have their data stored in the database. The doctor table structure consists of 8 attributes starting from the id column - avatar.

Next is a drug table that serves as a master table for storing drug data available in the clinic with the following table structure:

TABLE IV. DRUG ATTRIBUTES TABLE

id	kode	nama	stock	satuan	jenis	hbeli	hjual
..	.....	.....	.....	.....	.....	....	...
..	.....	.....	.....	.....	.....	....	...

Table 4 above consists of 8 attributes starting from the "id – hjual" column.

While the structure of the diagnosis table is like the table below:

TABLE V. ATTRIBUTES OF DIAGNOSIS TABLE

id	kd_icd	diagnosis	keterangan
..	.....	.....	.....
..	.....	.....	.....

Table 5 above also functions as a master table to store or organize diagnostic data based on predetermined standards. Every time there is new diagnostic data, the officer will enter the data into this table. The diagnosis table consists of 4 attributes starting from the id column - description.

Also, a tariff table functions to store and manage the cost rates applied to healthy home clinics. Every time there is a change, and new tariff data will be easily managed with this table. The following is the tariff table structure:

TABLE VI. RATE ATTRIBUTES

id	kode	uraian	tarif	keterangan
..	.....	.....	.....	
..	.....	.....	.....	

Table 6 above shows that the tariff table structure consists of 5 attributes starting from the id column - information (note).

B. Design of Entity Relationship Diagram (ERD)

Then the ERD design results are as shown below:

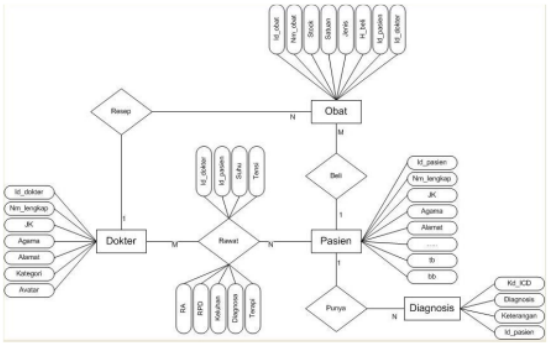

Fig. 2. ERD of EHR System

Figure 1 above describes the relationship between the tables in the database. There are four related tables, namely tables of patients, doctors, drugs, and diagnosis. ERD design is essential to know the relationship between tables, making it easier to implement using a Database Management System (DBMS).

C. Design of Data Flow Diagram (DFD)

To describe the flow of data in the system, it is essential to design the process using DFD logically. The following is the DFD level 0 design of the EHR system that developed:

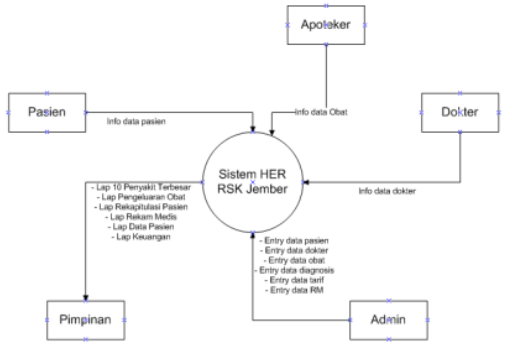

Fig. 3. DFD of EHR System

DFD level 0 above describes the description or model of system data flow in general. The system components are also visible, namely doctors, patients, pharmacists, administrators, and leaders.

D. Interface Design

This section will display the results of the system interface design that developed as Figure 4.

Figure 4 above shows the EHR clinic's home page design for a healthy home consisting of the main menu, namely archives, blogs, and logins. Archives and blogs are additional features requested by the clinic. The archive serves to point to the clinic digital archive subdomain, while the blog serves to point to the clinic blog subdomain, which contains information about clinical activities. Meanwhile, login functions to redirect to the EHR application page.

Fig. 4. Home Page Design

For the HER application login form design, it looks like Figure 5 below:

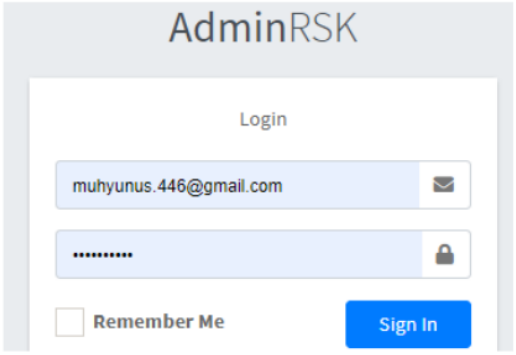

Fig. 5. Login Form Design

The picture above shows the EHR application login form using a user in an email and password. Later in this form, there will be user validation to ensure that the user who is logged in is verified or not.

Then for the application dashboard design, as shown in Figure 6 below :

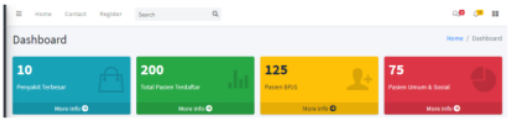

Fig. 6. Design of Dashboard Page

Figure 6 above shows a dashboard page display that functions to display summary reports such as the ten most extensive diseases, total registered patients, total BPJS patients, and total general patients.

Furthermore, Figure 7 shows the appearance of the patient data input format the Jember Health Home Clinic:

The patient data entry form functions to add new patient data to the database. In this process, each new patient will be given a unique identity in the form of a medical record number (No. RM).

Fig. 7. Design of Patient Entry Data Form

For the doctor entry form design, it looks like Figure 8 below:

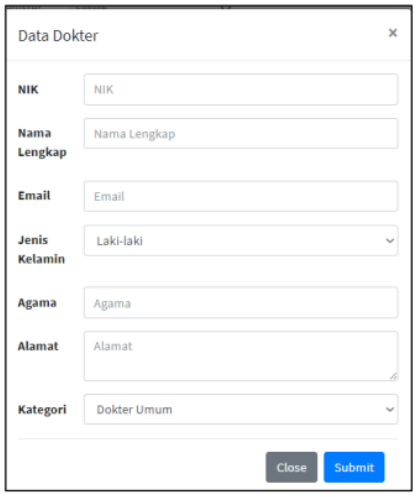

Fig. 8. Design of Doctor Data Filling Form

The doctor entry form, as shown above, functions to save doctor data into the database. Every time there is a new doctor, the officer will input the data into the system.

Next is making a form for the patient's medical record data entry process, as shown in Figure 9 below. As with the ERD design, this form can only be processed if there is a relationship between the patient, doctor, diagnostic, and drug tables. The existence of a relationship between the appropriate tables makes the resulting information accurate and integrated. The data entered in this table will be stored in the patient's medical record table.

Fig. 9. Design of Patient Medical Record Form

The form design for entering diagnostic data looks like Figure 10 below:

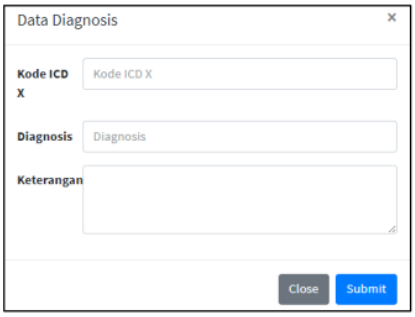

Fig. 10. Design of Diagnosis Content Form

Figure 10 above shows that the data entered following the ICD-X-based disease coding standard is stored in the system database.

Meanwhile, to support drug management and storage services at the clinic, a drug table is also made, as shown in Figure 11 below. This form serves as a place to enter drug data and store it in the system database. In this form, there is also a feature to make it easier for officers to update and delete data that is not needed or is wrong. The design form is as follows:

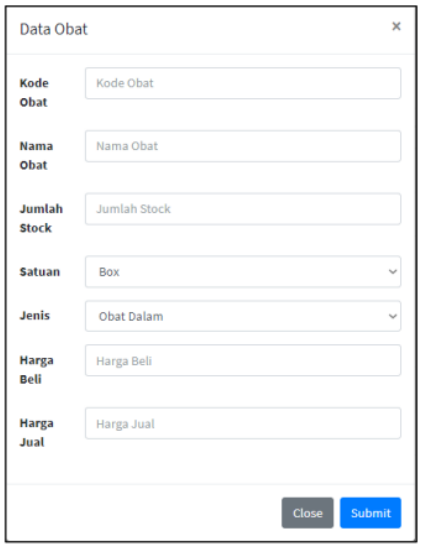

Fig. 11. Design of Drug Data Form

Finally, making a form design for the entry process and data storage of fee rates applied to the clinic as follows:

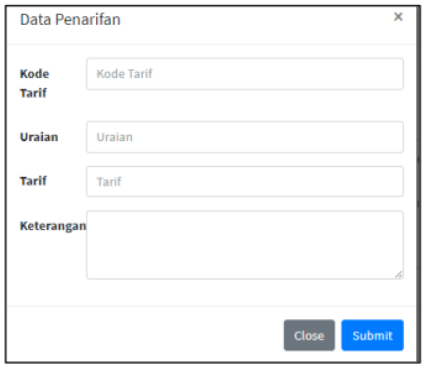

Fig. 12. Design of Rate Form

Figure 12 above shows that officers can enter tariff data according to the provisions applicable to the clinic. There is a tariff code attribute that will keep data neatly stored and avoid duplicate data.

IV. Conclusion

This research concludes that in building a system, especially EHR, one method of system development is Waterfall. In this method, before carrying out the coding (construction) process, what needs to be done and confirmed first is the logical database design in the form of ERD and system modeling in DFD. Then proceed with the application interface design. In this study, the ERD of the EHR system shows the relationship between tables in the database, DFD design, and interfaces. ERD logically can facilitate the physical database creation process using a DBMS. The patient medical record data entry form's design shows that the importance of table relations in the database is to maintain the integrity of the data in the database so that the system to be built is of high quality and accurate.

Meanwhile, DFD can make it easier to understand the system's data flow patterns, especially for input, process, and output. It is a course that will significantly affect the ass of making application interface design because the source or reference is the DFD design.

The tables related to forming ERD in this EHR application are tables of patients, doctors, diagnoses, drugs, and rates. Meanwhile, one of the relationships between these tables is the emergence of a data entry form design for patient medical records. Data on patients, doctors, diseases, therapies, and rates are stored. Therefore, it is hoped that this research can become a reference during the system coding process up to the implementation stage to provide convenience in the process of information distribution and decision making.

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