

# Information System for Monitoring High-Risk Pregnant Women

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## Article History

Received Jan 1<sup>st</sup>, 2021

Revised Feb 4<sup>th</sup>, 2021

Accepted Feb 8<sup>th</sup>, 2021

Published Jun, 2021

**Abstract**— Maternal mortality rates are still high in several areas, including Bantul Regency, Special Region of Yogyakarta. Based on the data obtained from the Bantul District Health Office, from 2018 to 2019, 28 pregnant women died. Posyandu and Puskesmas cadres often encounter problems in collecting data on pregnant women because they still use manual methods. Manual records using books has disadvantages because sometimes pregnant women forget to bring their books. Therefore, an application for recording pregnancy history is needed to enable convenient monitoring by Posyandu cadres, Puskesmas, doctors, and hospitals in order that pregnant women patients can be handled properly in case of emergency. The application used by pregnant women is Mobile App-based, meanwhile, the Web-based Monitoring Information System is used by Posyandu cadres, Puskesmas, doctors, and hospitals. The application allows displaying the medical history and makes it easier for pregnant women to have counseling or examinations without meeting directly with the doctor. If there are any problems in the womb, the doctor will immediately provide a solution or recommendation. The results of the system testing with 15 respondents as users show that 52,1% strongly agree, 37,7% agree, and 10,2% neutral in response to the system interface. The implementation of the information system for monitoring high-risk pregnant women in the majority is accepted by all actors. Hence, it can be concluded that in an attempt to digitalize manual recording of pregnant women's examinations, this information system for monitoring high-risk pregnant women is reliable to be implemented.

**Keywords**— *Maternal Mortality; Posyandu; Extreme Programming; Mobile-App Development; Web Development*

## 1 INTRODUCTION

The mortality and illness of pregnant women remain serious health issues in Indonesia. While this issue is an indicator of women's well-being, it is also an indicator of a nation's welfare demonstrating the achievements of the country's development [1]. The information on pregnant women's mortality rate is very useful for developing programs for improving pregnant women's health, especially safe pregnancy and childbirth services, program for enhancing the number of childbirth helped by health workers, reference management system in handling pregnancy complications, family preparation including alert husbands in welcoming the childbirth. Such information is intended to decrease the number of pregnant women's mortality rate and improve the reproductive health's level.

Some of the factors that cause the high mortality rate of the pregnant women in Indonesia include bleeding, eclampsia, hazardous abortion, infection, and so on. Moreover, the indirect causes of pregnant woman's death are their low level of education and socioeconomic condition, unsupportive socio-cultural background, and the limited access of pregnant women who live in rural areas in acquiring health services [2] - [3]. These factors that lead to the high mortality rate of pregnant women must be paid attention since the beginning. If a pregnant woman already has history or symptoms, medics will be able to give precautions to avoid risks on the pregnant women and the womb.

Bantul is one of the five districts in the Special Region of Yogyakarta Province with a total area of 506.9 Km<sup>2</sup> and constitutes 15.91% of the total area of the Province. Bantul community health status is indicated by indicators of health status such as life expectancy at birth (Eo), mortality rate, morbidity rate and nutritional status. Bantul Regency's development vision is "the realization of a healthy, smart, and prosperous Bantul Regency community". Health efforts that must be made are health services, access to and quality of health services, community life behaviors, environmental conditions, health resources (health facilities, health workers, and health financing in Bantul Regency [4]-.

The pregnant women's mortality rate in Bantul is very high compared to the surrounding areas such as Sleman, Yogyakarta, Kulonprogo, and Gunung Kidul. It is due to the lack of knowledge pregnant women have on health information and the role of Posyandu, Puskesmas, and hospital cadres for constantly monitoring the health developments of pregnant women. Today, Posyandu cadres still use the manual method to gather information about the conditions of the pregnant women when they visit their houses [5]. Afterwards, the information is recorded manually on an agenda book by the cadres. The information is then delivered to the midwives that will send a report to the Puskesmas. Based on the information that the researcher collected from one of the villages in Bantul, the data of pregnant women's development only reaches Puskesmas, not to the hospitals [6]. This issue has to be fixed considering that if at one point a pregnant woman is experiencing the worst

possibility to her womb, the referral hospital is already prepared with the daily healthy records of the pregnant woman for further actions. The application used by pregnant women is only for womb examinations without providing information to Posyandu, Puskesmas, and hospital cadres.

The research to be conducted is to design web-based and mobile app-based monitoring information systems for pregnant women. Web-based technology is going to be used by the Posyandu, Puskesmas, doctors, and hospital cadres for examining the pregnant women's health records based on the symptoms she experiences. Meanwhile, the mobile-based application is going to be used daily by the pregnant women to report the condition of their womb, and pregnant women can find the proper health information for their womb based on the gestational age.

The model in designing this monitoring information system uses the Extreme Programming (XP) model. This model was chosen because it is ideal for manufacturing systems that are transitioning from manual to computerized systems. In other words, it is good for users who are familiar with manual systems but want to ask the programmer to make a computer system that is in accordance with the existing manual system.

## 2 METHOD

### 2.1 Data Collection Methodology

The data were collected from various sources. The data collection methodologies carried out in this study included:

- Literature review by collecting information from pregnant women's health books, articles, journals and other sources related to the health of pregnant women.
- Interviews were conducted with an expert in obstetrics and gynecology, namely dr. Yasmini Fitriyati.Sp.Og., to find out the most common problems faced by pregnant women.
- Questionnaire and a series of data related to the appropriate interface for pregnant women.

### 2.2 Application Development

The system development method used in this research is the Extreme Programming Method. The sequential system extreme programming consists of [7]:

#### 2.2.1 Planning

At this stage, the scope during the research was defined and the current system and problems were analyzed. It was then continued with the need analysis of the system to be designed.

#### 2.2.2 Design

At this stage, the system's work process and database were designed in accordance with the results of the analysis that had been carried out beforehand. In designing this work process system, DFD was used for designing a system.



2.2.3 Coding

This is the stage where the system was made based on the results of the previously made designs. The design was implemented in the form of codes that can be understood by a computer with a programming language. The coding process was carried out repeatedly to check if there were corrections from the system user (refactoring).

2.2.4 Testing

At this stage, each module to be developed was tested. If it still did not match the standard, it would be fixed in the referred part. If it was as requested, the system could be implemented.

3 RESULT AND DISCUSSION

The system development using the Extreme Programming method was in three stages of development. The explanation of each of these stages can be seen below.

3.1 The First Cycle

This first cycle focused on the main objectives and functionality of the system being developed.

3.1.1 First Stage Planning

In this stage, the researcher analyzed the requirements of the system being developed. The analysis was done by means of interviews. The results obtained include who wants to use the system later and how the system works. Users involved in the system can be seen in Table 1.

Table 1. List of Actors using the System

No	Actor
1	Admin
2	Posyandu Cadres
3	Public health center staff
4	Hospital staff
5	Patient

Based on Tabel 1, the next step was to define and analyze the system's functional requirements which aimed to determine what the developed system can do. The functional requirements are:

- Admin can manage user's account (CRUD).
- Posyandu cadres can view the pregnant women's note describing their condition including any discomfort, provide health information, and view the consultation reports.
- Puskesmas can view the pregnant women's note, know the risk level of the pregnant women, and view the consultation reports.

- The hospital can view the pregnant women's note, find out the risk level of the pregnant women, and view the consultation reports.
- The patients (pregnant women) can read their gynecological conditions, know information about the health of the womb, and see the gynecological consultation history.

3.1.2 Designing Stage One

The results of the analysis on the functional requirements in the first cycle were then formulated into a design using the Context Diagram and Level 1 DFD to find out whether the design was as expected or still needed correction.

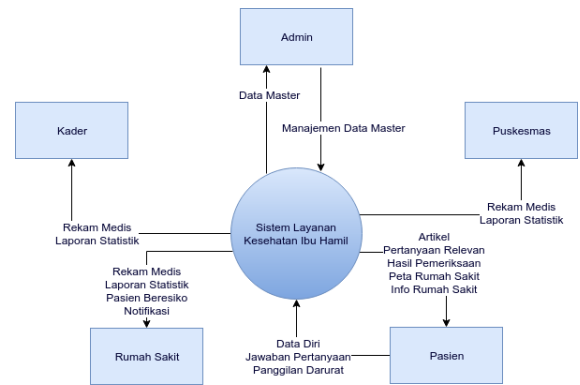


Figure 1. Context diagram

From Figure 1, it can be seen that there are 5 types of entities: Admin, Posyandu cadres, Puskesmas staff, hospital staff, and patients (pregnant women). In this case the admin is an entity that has full authority from every feature of the existing system.

DFD level 1 describes the further process of the context diagram. The DFD Level 1 design is shown in Figure 2.

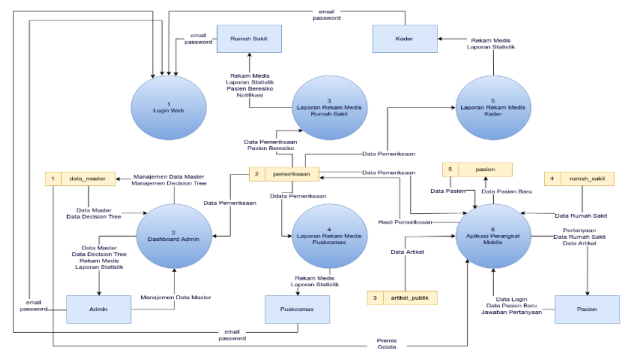


Figure 2. DFD level 1

Based on figure 2, the DFD Level 1 design above shows that each process is divided into 7 parts. These processes are explained in Table 2 below:

Table 2. DFD Level 1: First Cycle of Design Processes

Process Code	Name of Process	Description
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1	Web Login	In this process, the user is able to log into the system. The access rights varied based on the type of user.
2	Admin's Dashboard.	In this process, the admin can see all activities of each actor and also add, edit, and delete user.
3	Hospital Medical Records	In this process, hospital user is able to see the whole recaps or activities.
4	Puskesmas Medical Records	In this process, Puskesmas user is able to see the whole recaps or activities.
5	Cadres Medical Records	In this process, cadre user is able to see the development of pregnant women's health.
6	Mobile-based application	In this process, user (patient) is able to have consultations and find information about pregnant women.

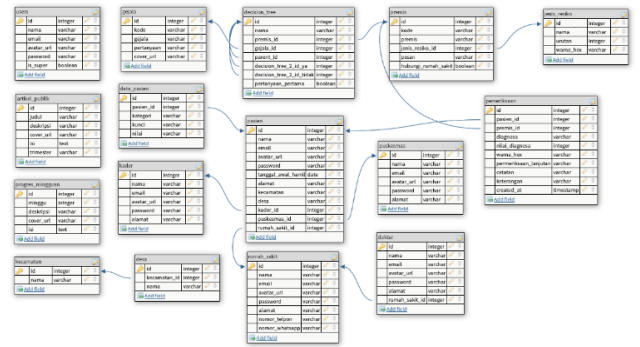


Figure 3. ERD of the first cycle

Figure 3 show up the ERD diagram of implementation of monitoring information system.

Table 2 is a further explanation of Figure 1 in the table that shows all the components in DFD.

### 3.1.3 Coding Stage One

In this first stage, several implementations were carried out including database implementation and the implementation of the interface design that had been made. In a database, there were many table names used. A list of table names in the database can be seen in Table 3 below.

Table 3. Database

No	Table Name	No	Table Name
1	Users	9	Decision tree
2	Artikel_publick	10	Pasien
3	Progress_mingguan	11	Rumah_sakit
4	Kecamatan	12	Premis
5	Gejala	13	Puskesmas
6	Data_pasien	14	Jenis_resiko
7	Kader	15	pemeriksaan
8	Desa		

Based from table 3, ERD (*Entity Relationship Diagram*) Cycle I describes the relation between one data to another. From the figure of ERD below, the tables needed by the monitoring information system to be built are shown as follow.

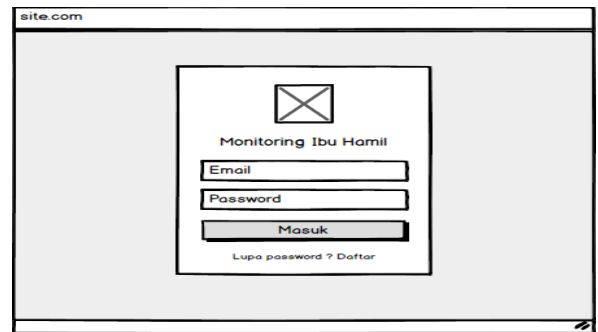


Figure 4. Login page interface design for web-based monitoring

Figure 4 illustrates the home page of system web page that shows up the login page interface design for web-based monitoring.

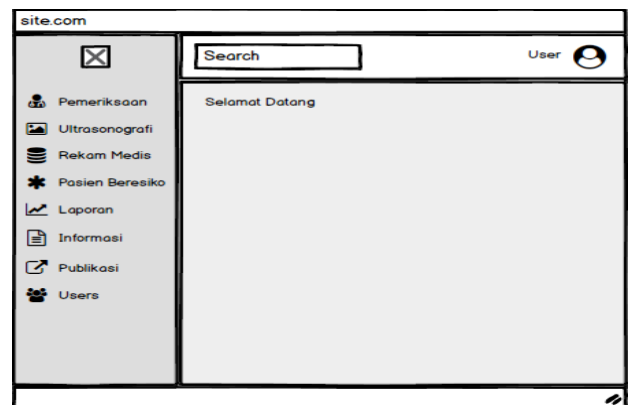


Figure 5. Patient monitoring page design

Figure 5 illustrates the home page of system web page that shows up the page of patient monitoring page design. The system that is going to be used by the pregnant women is Mobile App-based. Below is the login screen on the application.





Figure 6. Application login page

Figure 6 illustrates the mobile application interface design that shows up the login page.

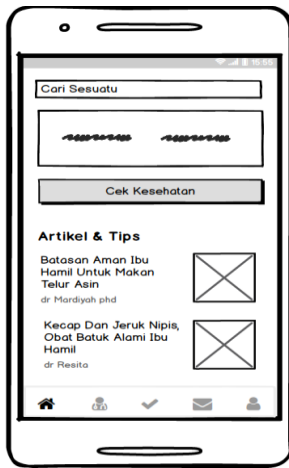


Figure 7. Homepage

Figure 7 illustrates the mobile application interface design that shows up the Homepage.

### 3.1.4 First Stage Testing

In this first stage of testing, the researcher involved all system users and focused on the functionality of the system being developed. During the testing process, researchers received requests for new features such as the followings:

- To add filter module and doctor as actor on the monitoring page.
- To provide weekly progress to determine the gestational age of the pregnant woman.
- To add features to hospital staff as actor to give advice, feedback for pregnant women after consultation.

During this stage, the database structure added table names such as doctor and weekly progress. Changes and additions were made on the page design, that is, a page for doctor and a page for hospital staff where they can provide feedback to patients (pregnant women).



## 3.2 Second Stage

### 3.2.1 The second Stage Planning

After testing the Cycle I system to Posyandu cadres, Puskesmas staff, hospital staff, and pregnant women, the researchers received some feedback on the design of the first cycle. The doctor as actor needed to provide the results of the consultation or examination to the patient (pregnant woman). In addition, a data filter feature was also needed on the patient risk monitoring menu.

This context diagram is the correction of the first stage context diagram. This context diagram is also the final result that would be used in the design of DFD level 1. The context diagram can be seen in the figure.

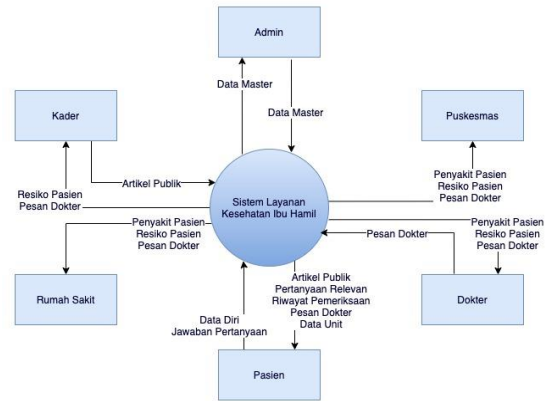


Figure 8. DFD context of the second Cycle

From Figure 8, it can be seen that there is an additional entity, that is, a doctor. The doctor entity allows sending a message to the patient (pregnant woman) after conducting the examination.

### 3.2.2 The second stage design

The researcher used the results of the analysis in the planning stage of the second cycle to make additions and changes to the features described in the planning stage of cycle II context diagrams and Level 1 DFD.

Additions and changes included designing new tables in the database and doing the interface design for the doctor's page.

### 3.2.3 The second stage of coding

After analyzing and redesigning it, the researcher implemented the developed system. In this phase the change in code structure is called refactoring.

### 3.2.4 The second stage of testing

In the second stage, the testing was carried out on all actors. Afterwards, several requests for the system and feature improvements include the followings:

- In the monitoring system, it is necessary to add data aggregation/grouping of patient data to districts.
- The main inspection interface on mobile apps should be made more interesting.



- Email notification for each actor should be enabled, particularly when the patient (pregnant woman) is having a consultation.

### 3.3 Third Stage

In this third stage, further development was carried out by adding menu or features based on requests from several actors. This feature is more effective when applied to the system.

#### 3.3.1 The third stage planning

3.3.2 In the planning stage of the third cycle, the researchers conducted an analysis based on the results of the second cycle testing. The result of the analysis is the addition of the patient data aggregation area that has been described in the second testing cycle stage.

3.3.3 The reason for the addition of the patient data grouping feature is to make it easier to monitor patients in each region. In addition, the existence of email notifications for each actor makes it easier for patients to have their womb examinations.

#### 3.3.3.1 The third stage design

At this stage, the researcher returned to designing a context diagram and DFD Level 1 and then proceed with designing the interface for the mobile apps to appear more attractive and neat.

#### 3.3.3.2 The third stage of coding

After doing the testing, the third cycle system to the client, the researcher received a little correction. The correction obtained was that the filter in each menu on the monitoring had not been functioning properly. In the coding stage of the third cycle the writer added a little coding to fix the filter that was not yet functioning.

#### 3.3.4 The third stage of testing

After applying the additions in the previous stage, the researcher re-tested the system to all actors. The results of this third stage of testing were in accordance with the planning that has been done by previous researchers, and the output produced was in accordance with user requests. Therefore, the system that has been developed is ready to be released.

### 3.4 Test Results for System Functionality and Usability

Testing in this system involved several respondents, namely 1 root admin, 3 Posyandu cadres, 1 health center staff, 1 doctor, 1 hospital staff and 15 pregnant women.

From the results of system testing with 15 respondents as users (users), it is found that 52.1% strongly agree, 37.7% agree, 10.2% are neutral about the system interface. Most of the actors accepted the implementation of the monitoring information system for pregnant women at high risk. However, based on the test results on the interface, several actors are neutral regarding whether the interface of this system is attractive to actors or not. Therefore, it can be

concluded that in an effort to digitize manual recording of pregnant women examinations, this monitoring information system for high-risk pregnant women is feasible to be implemented in the community.

## 4 CONCLUSION

After identifying the causes and death risk of pregnant women, the researcher designed a system using the extreme programming model. The system design went through 3 cycles, in which each cycle having 4 stages to go through, namely planning, design, coding and testing. In the first cycle, the researchers focused on designing the system. Then the researcher did the design and coding to build this system. After that, testing was carried out with each actor to find out whether the information system designed was deemed sufficient or still needed to be improved. Extreme programming modeling used by this researcher is the most appropriate model in designing this system, particularly due to its convenience in making systems that are transitioning from manual to computerized systems. In other words, it is suitable for users who are familiar with manual systems but want to ask the programmer to make a computer system that is in accordance with the existing manual system.

Based on the results of testing on each actor such as Posyandu cadres, health center staffs, doctors and hospital staffs, the researcher received several suggestions. For examples in Cycle 1, it was suggested to add a filter module and doctor as actor on the monitoring page. Also, it was suggested that there would be a weekly progress to determine the pregnancy age of pregnant women. In Cycle II, the researcher was informed of the need for data aggregation/grouping of sub-district patient data in the monitoring system. It was also suggested that the inspection display on the mobile apps be made more interesting. After passing the test in Cycle II, the researcher proceeded to Cycle III. In this third cycle testing, there was no criticism or input from each actor, and that way the system design process could be considered as complete.

In short, it can be concluded that the monitoring information system design with the extreme programming method can be implemented. This system can be accessed anywhere without being constrained by space and time. In addition, the monitoring information system can simplify the management process and provide monitoring information for pregnant women. This monitoring system model has also been evaluated in terms of user experience. By means of online questionnaires with 15 respondents, it is found that more than 90% agree to accept the system interface design. In addition, respondents also considered the interface of this system attractive. From the results of this evaluation, it can be summed up that the monitoring information system for pregnant women at high risk has the potential to be implemented in the community.



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