

Expert System for Diagnosis Pregnancy Disorders using Forward Chaining Method Based on Android

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Research article

Abstract: Technology's rapid evolution has extended its impact into the healthcare field, including the development of artificial intelligence-based expert systems designed to streamline the work processes of nurses and obstetricians. In this research, we use the forward chaining method to build an android-based expert system for diagnosing fetal disorders in pregnant women. This system is made for ease of use on mobile devices by targeting pregnant women where this application provides a self-detection mechanism for pregnancy abnormalities. The test results show a high level of respondent satisfaction with this expert system application, with an average score of 90.16%, indicating a strong acceptance of the quality and functionality of the application. It can be concluded that our proposed expert system application shows a positive response from respondents and is considered successful in providing pregnancy diagnosis services independently.

Keywords: FORWARD CHAINING; EXPERT SYSTEM; FETAL HEALTH; PREGNANCY

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1. Introduction

The rapid evolution of science and technology has extended its influence into the realm of healthcare, incorporating the development of expert systems, a facet of artificial intelligence designed to streamline human work processes and cognitive functions (Lintern and Motavalli, 2018). This paper focuses on the creation of an expert system, specifically tailored for Android platforms, to facilitate the early diagnosis of pregnancy disorders. The targeted disorders include anemia, abortion, urinary tract infection (UTI), mental health conditions, preeclampsia, gestational diabetes, Hyperemesis Gravidarum, and placenta previa.

Maternal mortality stands as a significant concern within the context of the Sustainable Development Goals (SDGs) (Skudder-Hill, 2020). In Indonesia, high maternal mortality rates are attributed, in part, to insufficient access to obstetric services and a lack of health information (Dewi et al., 2023). Consequently, the proposed system aims to serve as a tool empowering a pregnant woman to detect pregnancy disorders early on, contributing to efforts aimed at reducing Maternal Mortality Rates (MMR) (Garapati et al., 2023).

Machine learning applications in diagnosing pregnancy disorders have been widely explored, providing a foundation for selecting appropriate treatment methods (Ilham et al., 2024; Mennickent et al., 2023). For instance (Dairoh et al., 2023), they succeeded in building and

producing a system that is used to diagnose early symptoms in children with mental disorders and later can help provide a decision that is as good as the work of a pediatrician or psychologist. With the forward chaining method used as a learning model, the system easily diagnoses patients. The results show that the community is helped in knowing the type of mental disorder experienced with an accuracy of 86% and is included in the ^Good^ category. In terms of appearance and layout, patients are not confused in using it with UI/UX values resulting in 81% and error/bugs 20%, which means it is in the Very Good category.

In contrast to the work of (Yuliana and Noviyanti, 2021), who focused on psychiatric disorders using a web-based forward chaining method, this research endeavors to develop an Android application tailored to pregnant women. This expert system employs the Forward Chaining method, a technique initiating from established facts, aligning them with IF-THEN rules, and executing applicable rules to augment the database with new facts.

In this paper, the android-based system crafted for ease of use on mobile devices, targets the specific needs of pregnant women, providing a self-detection mechanism for pregnancy disorders. The anticipated outcomes include alleviating the workload on medical professionals and extending digital consultations to pregnant women regarding potential pregnancy-related complications.

This study is organized as follows. In Section 2, there is a presentation of the proposed method. The

experimental results are given in Section 3. Finally, the last section is devoted to concluding the work of this paper.

2. Research Methods

The research stages of designing an expert system for diagnosing pregnancy disorders with the android-based forward chaining method are shown in Fig. 1.

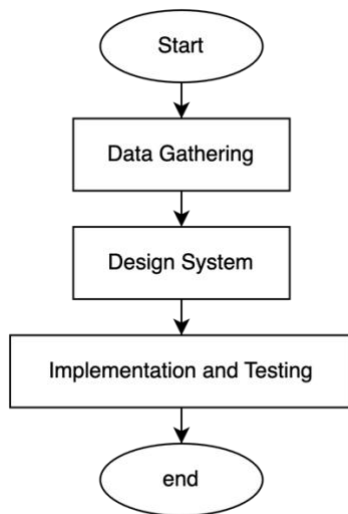


Fig 1. Research stage

2.1 Data gathering

Data gathering aims to get the information needed for the design of diagnosing pregnancy disorders. In this study, we started with an interview with an obstetrician expert where they know a lot about diseases or disorders experienced by pregnant women. There are three data we get such as data on pregnancy disorders symptoms, diseases, and solutions. Based on this, we obtained data on the symptoms of pregnancy disorders, the detailed dataset information is shown in Tables 1, 2, and 3.

Table 1. Pregnancy disorders symptoms dataset

CODE	SYMPTOM
G01	Dizziness
G02	Pallor
G03	Blurred vision
G04	Birth canal blood spots
G05	Lower abdominal cramp
G06	Pain during bowel movements
G07	Frequent urination, but little urine
G08	Turbid urine / mixed with blood
G09	Distress
G10	Anxiety
G11	Headache
G12	Swollen hands
G13	Swollen feet
G14	Convulsions
G15	Nausea

G16	Vomiting
G17	Fever
G18	Birth canal bleeding

Table 2. Diagnosis dataset

CODE	DIAGNOSIS
P01	Anemia
P02	Immediate abortion
P03	Urinary tract infection
P04	Mental health conditions
P05	Preeclampsia
P06	Gestational diabetes
P07	Hyperemesis gravidarum
P08	Placenta previa

Table 3. Treatment solution

CODE	DIAGNOSIS
P01	Treatment of anemia in pregnant women: <ul style="list-style-type: none"> • consume nutritious food • take blood supplement tablets • do not take blood supplement tablets together with milk or • drink blood supplement tablets with orange water
P02	Treatment of pregnancy miscarriage: <ul style="list-style-type: none"> • check for bleeding • perform ultrasound • confirm the possibility of other causes • total bed rest • giving medicine to strengthen the womb
P03	Treatment of urinary tract infection in pregnant women: <ul style="list-style-type: none"> • consume plenty of water • clean intimate organs after urinating properly • giving prescribed antibiotics according to the patient's condition
P04	Treatment of mental health conditions in pregnant women: <ul style="list-style-type: none"> • eat balanced nutritious food • do light exercise • get enough rest • be open to your doctor and partners.
P05	Treatment of preeclampsia in pregnant women: <ul style="list-style-type: none"> • if the pregnancy is less than 37 weeks, an outpatient assessment is conducted • monitoring of blood pressure, urine protein, reflexes, and fetal conditions • counseling of the patient and family about signs of preeclampsia and chlamydia • more rest • usual diet (no salt diet needed) • no medication needed
P06	Treatment of gestational diabetes in pregnant women: <ul style="list-style-type: none"> • eat balanced diet • exercise regularly • checking blood sugar levels • having regular medical check-ups • taking diabediagnosis medication and

insulin injections.

- P07 Treatment of Hyperemesis gravidarum in pregnant women:
 - eat little but often
 - eat biscuits / toast before getting out of bed in the morning
 - avoid oily and strongly seasoned foods
 - get up from sleep slowly and do not move immediately
- P08 Placenta previa treatment in pregnant women: If the placenta does not move laterally or upward, section caesarean delivery is performed.

2.2 Design system

After we obtained in-depth information from the collected data, next, we designed the pregnancy disorder diagnosis expert system. The framework and the workings of the system are shown in Figs. 2 and 3.

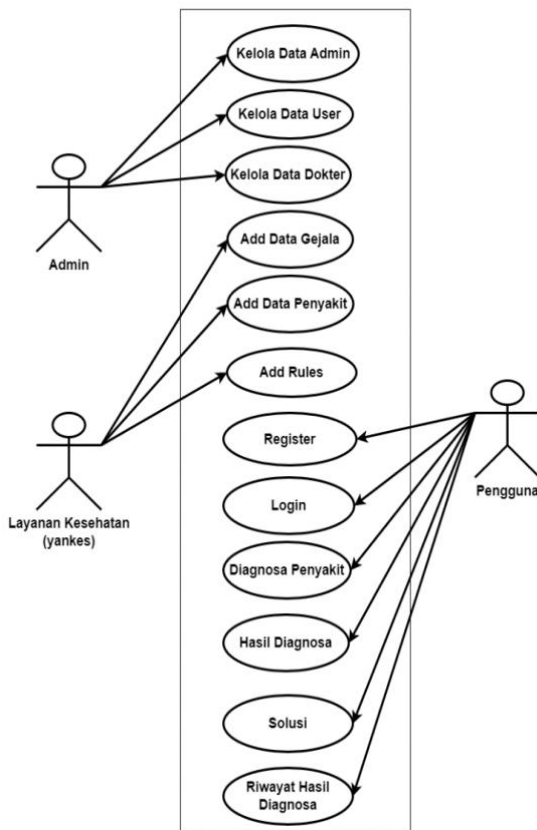


Fig 2. Proposed system design framework for expert s system in diagnosis pregnancy disorders

As shown in Fig. 2, there are 3 categories of users such as admin, doctor, and users. Each of these users has their own access rights.

- a. admin, has an access role that can only perform Manage Admin Data, Manage User Data, and Manage Doctor Data actions.
- b. doctor, has the role of managing Symptom Data, Disease Data, and Rules.
- c. user, has a limited access role that can only perform consultation or disease diagnosis actions by inputting symptoms on the diagnosis form.

Fig. 3 illustrates how the expert system works, where when the admin (obstetrician) opens, the application will be directed to the login page. When the admin fills in the wrong username and password, the application display will return to the login form. Conversely, if it is correct, it will be directed to the user's main menu page. On this page, there are six menus including the diagnosis menu, list of diseases, diagnosis overview, help, about, and logout. An illustration of the system main menu page is shown in Fig. 4.

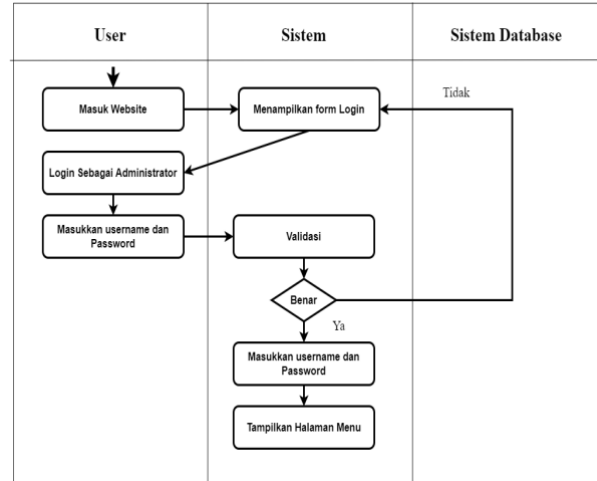


Fig 3. Activity diagram of working of the system



Fig 4. Main page of our expert system to diagnose diseases in patients with fetal pregnancy disorders

This system starts from the user who will input patient data with the aim of seeing the diagnosis of pregnancy risk symptoms experienced by the patient. System activity on the "Diagnosis" menu is shown in Fig. 5.

Fig. 5 illustrates that when the user opens the "Diagnosa" menu, the user will be directed to input data on the symptoms experienced by the patient, so that the diagnosis results are obtained, then the user can select the "Solution" menu to display what treatment is suitable for

the symptoms of pregnancy risk experienced by the patient.

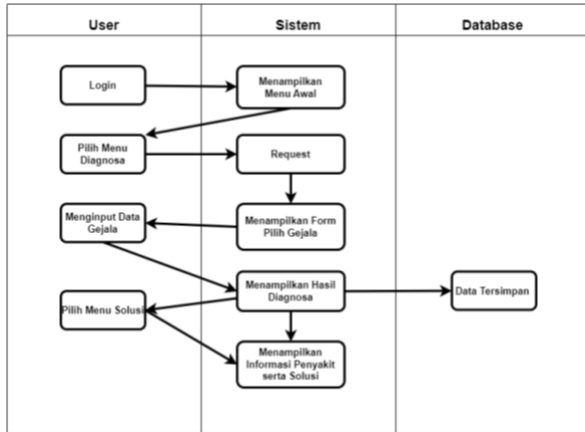


Fig 5. Activity diagram of “Diagnosa” menu

2.2 Implementation and testing

a. Forward chaining method

In this study, we designed and built an expert system with a forward chaining method approach. The forward chaining method is a strategy in knowledge processing and artificial intelligence used to reach a conclusion or solution. In this method, the process starts with the initial facts or input data available. The system then tries to determine whether those facts match certain predefined conditions or rules. The disease rule conditions are shown in Table 4, while the tree-based rules are shown in Fig. 6.

Table 4. Coding rules

ROLE	SYMPTOM	DIGANOSIS
A01	G01, G02, G03	P01
A02	G04, G05	P02
A03	G06, G07, G08	P03
A04	G09, G10	P04
A05	G11, G12, G13, G14, G15	P05
A06	G16, G17, G11, G03	P06
A07	G16, G17	P07
A08	G18	P08

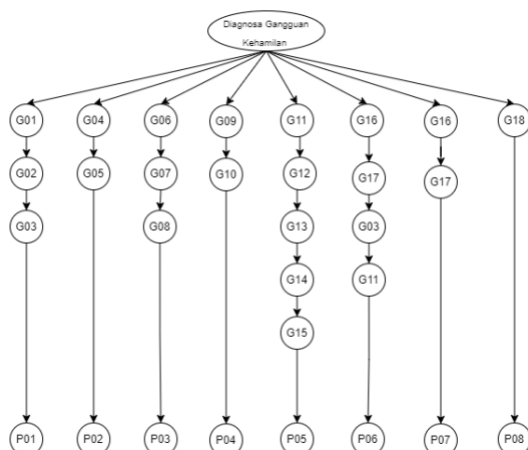


Fig 6. Decision tree for diagnosing diseases in patients (Dina Safitri)

with fetal pregnancy disorders

As shown in Table 4, this rule coding is based on the data in Tables 1 and 2, resulting in eight coding rules. Furthermore, the eight coding rules will be input to the forward chaining method. The stages of the forward chaining method are shown in Fig. 7.

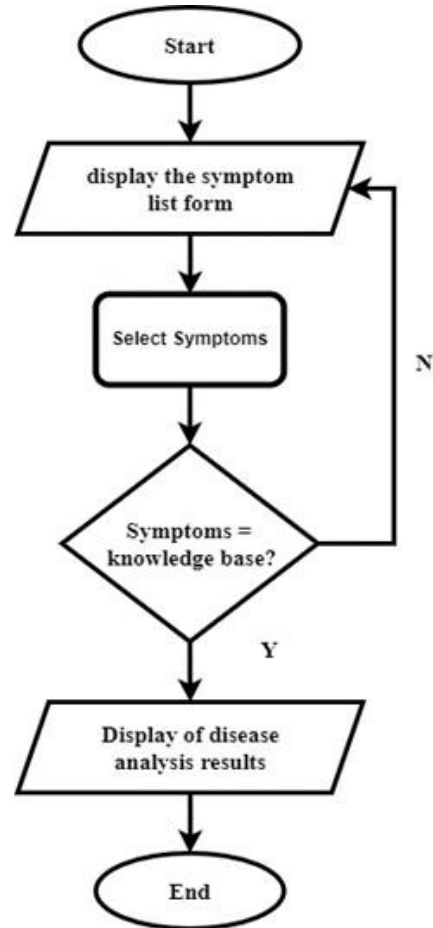


Fig 7. Flowchart of the forward chaining method for diagnosing diseases in patients with fetal pregnancy disorders

b. Tools and testing

Several tools are used in building an expert system for diagnosing pregnancy disorders such as hypertext processor (PHP) and Android studio based on Java programming. PHP is used to build web-based applications and Android Studio is used as a text editor based on Java programming. The specifications of the devices used in building this system are shown in Table 5.

Table 5. Tools specification

DEVICES & LANGUAGE	DESCRIPTIONS
Processor	Intel® Core™ i3-1005G1 CPU@1.20Ghz(4CPU's)
RAM	16GB
Operating System	Windows 10 Home Single Language 64-Bit
GUI	Android studio
Language Programming	Java programming

In this study, system testing was conducted to diagnose pregnancy disorders using the questionnaire method. This questionnaire is addressed to pregnant women at the Pulokulon Health Center Health Service Agency, Semarang, Central Java, Indonesia.

3. Results and Discussion

The expert system for diagnosing pregnancy disorders has been implemented into an android-based program for users using the Forward chaining method, web for admin interface and health services. The main page and the results test of the expert system are shown in Figs. 4 and 8.

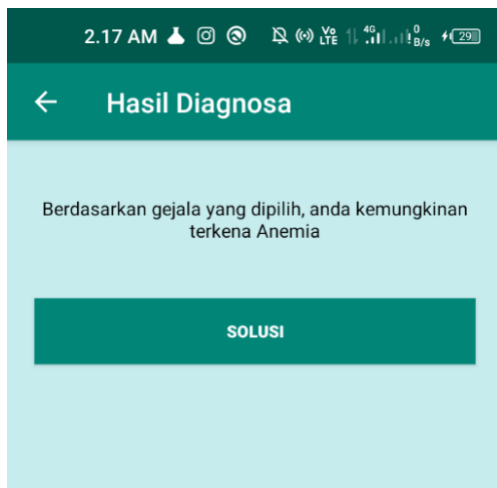


Fig 8. Results of diagnosis of disease symptoms of patients with fetal pregnancy disorders

The diagnosis results shown as shown in Fig. 8 can be continued by pressing the "SOLUTION" button which serves to get the treatment information that can be selected, as shown in Fig. 9.

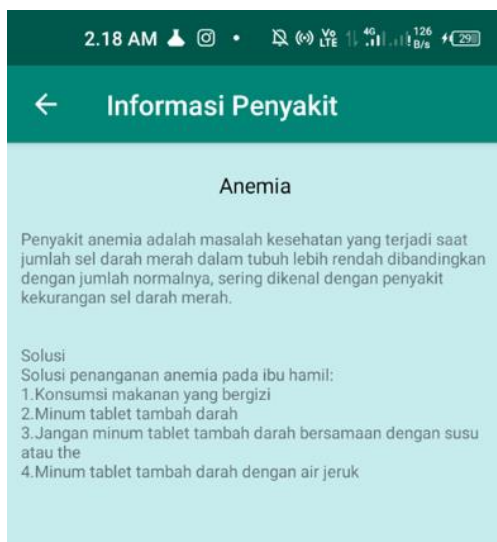


Fig 9. Information results of selected disease solutions of patients with fetal pregnancy disorders

After making a diagnosis, this expert system application can display a diagnosis history. The results of the diagnosis history menu based on the symptoms

experienced by opening the "Diagnosis History" menu are shown in Fig. 10.

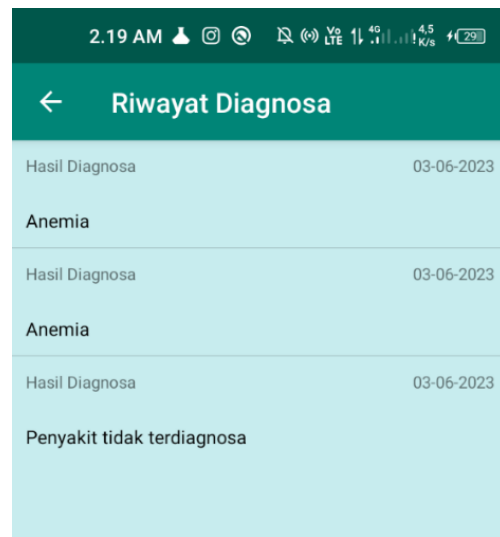


Fig 10. Results of diagnosis history

After testing the expert application system for diagnosing pregnancy disorders using the forward chaining method, respondents can provide opinions about the application through a questionnaire with questions that have been prepared as many as ten questions. The results of system performance through respondents to the questionnaires are shown in Tables 6 and 7.

Table 6. Performance system results

SCALE PROCESSING		
NO	PERCENTAGE SCORE	DESCRIPTION
1	88,80%	Strongly Agree
2	90%	Strongly Agree
3	87,60%	Strongly Agree
4	89,60%	Strongly Agree
5	90%	Strongly Agree
6	92,80%	Strongly Agree
7	90,80%	Strongly Agree
8	88,40%	Strongly Agree
9	91,60%	Strongly Agree
10	92%	Strongly Agree
Total	901,60%	Strongly Agree
Average		90,16%

Based on the test results of the expert system for diagnosing pregnancy disorders using the forward chaining method in Table 6, several analyses can be taken.

First (respondent satisfaction), the overall results show a high level of satisfaction from respondents with the expert system application, with an average value of 90.16%. Specifically, all ten questions on the questionnaire received responses of "Strongly Agree," indicating strong acceptance of the quality and functionality of the application.

Second (system reliability), the high percentage of each question reflects that respondents perceived the reliability of the expert system in providing the diagnosis of

pregnancy disorders. This can be interpreted that the forward chaining method applied in the application provides reliable and satisfactory results.

Third (ease of use), the high percentage of "Strongly Agree" on each question also shows that this application is considered easy to use by respondents. This indicates that the user interface, navigation, and features in the application are considered user-friendly.

Fourth (the success of forward chaining), assuming that the forward chaining method is used effectively in the application, positive results from respondents can reflect the success of this method in providing solutions or diagnosis.

Fifth (recommendations and system development), with a high level of satisfaction, there may be potential to recommend and develop this application further. Receiving further feedback from potential users can help in improving certain aspects that may not have been optimized. Then we conducted system testing on application users through respondents where the results are shown in Table 7.

Table 7. Respondent testing results

NO	ACTION	RESULT
1	Empty registration/Login	Users cannot switch to the main menu so they cannot perform diagnostics
2	During symptom input	Symptoms will appear in the form of a checklist so that users can select the symptoms experienced
3	During disease diagnosis	Users who diagnose with symptoms that are different from the rules that have been listed in the database will not appear disease information
4	After diagnosing	After performing the diagnosis, the user can view the history on the diagnosis history menu

Based on the analysis of the results shown in Table 7, we highlighted several aspects of testing the pregnancy disorder diagnosis expert system application, a number of findings were obtained. First, in the situation of "Empty Registration/Login," it was identified that users who did not fill in the registration or login form were unable to switch to the main menu, which resulted in the inability to perform diagnosis. This suggests that problems with the registration or login process may be a major barrier to use of the app. For improvement, it is recommended to ensure users can access the main features seamlessly. Furthermore, in the during "Symptom Input" phase, positive results showed that the system responded well to user symptom input, presenting symptoms in the form of a checklist for easy selection by the user. However, in the trial of during "Disease Diagnosis," it was found that users who diagnosed with symptoms that did not match the rules registered in the database would not see the disease information. It is recommended to improve the feedback mechanism to users so that they understand the reason for the mismatch of symptoms. Finally, in the "After Diagnosing" step, positive results showed that users could view their diagnosis history after diagnosing. Overall

(Dina Safitri)

recommendations included improvements to the registration/login process, improved feedback at the diagnosis stage, and better understanding for users regarding errors or non-compliance with the rules in the database.

However, overall, the results obtained from testing show that the expert system application for diagnosing pregnancy disorders using the forward chaining method received a positive response from respondents and can be considered successful in providing pregnancy diagnosis services.

4. Conclusion

In this study, an Android-based expert system using the forward chaining method has been successfully designed and built for early detection of pregnancy disorders. Test results showed a high level of satisfaction from the respondents, with an average score of 90.16%, indicating strong acceptance of the quality and functionality of the application. However, the findings from the testing also highlighted some issues, mainly related to the registration/login process and the mismatch of symptoms at the diagnosis stage. Recommendations for improvement involved enhancing the registration/login process, improving feedback to users regarding symptom matching, and gathering further feedback from users for future development. As such, this research successfully provided a technology-based solution to support early detection of pregnancy disorders, with the potential for further development and refinement.

Conflict of interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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