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# Development of an Expert System to Detect Mental Disorders in Pregnant Women using Forward and Backward Chaining Methods

**Monisa Dela, Eva Darnila*, Lidya Rosnita**

Faculty of Engineering, Informatics Engineering Study Program, Malikussaleh University, Lhokseumawe, Indonesia
Email: [1]monisa.210170160 @ mhs.unimal.ac.id, [2,*]eva.darnila@unimal.ac.id, [3]lidyarosnita@unimal.ac.id
Corresponding Author Email: eva.darnila@unimal.ac.id
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**Abstract**−Mental health during pregnancy plays a critical role in fetal development and maternal well-being. However, psychological conditions such as depression, stress, and anxiety in pregnant women often go undetected, especially in primary healthcare settings. This research aims to design and develop a web-based expert system capable of diagnosing the mental health conditions of pregnant women using Forward Chaining and Backward Chaining inference techniques. Forward Chaining is applied to infer possible conditions based on reported symptoms, while Backward Chaining is used to validate hypotheses by tracing required supporting symptoms. The system was developed using patient data collected from three health centers in Lhokseumawe City, totaling 500 records with parameters including name, age, gestational age, number of children, and reported complaints. It incorporates 30 symptoms and 9 diagnostic rules to classify the mental condition and its severity.The results indicate that 179 women were diagnosed with depression (mild 107, moderate 33, severe 39), 150 with anxiety (mild 24, moderate 91, severe 35), and 171 with stress (mild 82, moderate 50, severe 39). The system also demonstrates diagnostic probability (e.g., 66.67% in a specific case). Validation using 20 test cases yielded an accuracy of 85%, showing the system performs reliably in aligning symptoms with diagnostic outcomes. This study makes two significant contributions. Practically, it offers a decision-support tool for midwives and general practitioners to perform early mental health screening of pregnant women, especially in regions lacking access to psychiatric specialists. Scientifically, it demonstrates the effectiveness of a hybrid reasoning approach in handling overlapping psychological symptoms and in assessing severity levels, thereby enriching the development of domain-specific expert systems in maternal mental health. In conclusion, this system provides a practical and accessible solution to support early detection and intervention in maternal mental health, ultimately contributing to improved health outcomes for both mothers and their babies.

**Keywords**: Expert System; Pregnancy; Mental Health; Forward Chaining; Backward Chaining

## 1. INTRODUCTION

Maternal and infant mortality rates in Indonesia remain high. Data from the Ministry of Health shows that maternal deaths increased from 4,005 in 2022 to 4,129 in 2023, while infant deaths reached 29,945 cases [1]. Mental health issues among pregnant women—such as depression, stress, and anxiety—are often overlooked during antenatal care (ANC). These mental disorders can adversely affect the labor process, fetal development, and overall pregnancy outcomes[2]. According to the World Health Organization (WHO), the prevalence of depression in pregnant women in developing countries reaches 15.6%[3]. Furthermore, perinatal anxiety affects around 17% of women, and up to 84% of pregnant women experience stress during the perinatal period [4].

In Lhokseumawe City, cases of maternal and infant mortality also show a concerning trend. Many pregnant women are unaware of the symptoms of mental disorders due to limited health literacy and lack of support from the surrounding environment[5]. This condition underlines the importance of early identification of mental health issues during pregnancy, which can be facilitated through technological interventions. A system that is capable of detecting mental health conditions early is needed to support more comprehensive ANC services, especially in under-resourced areas[6].

Various studies have demonstrated the effectiveness of expert systems using Forward Chaining and Backward Chaining inference methods in the medical domain. Suci Hardianti et al. (2021) successfully developed a system to diagnose infectious diseases in children using both methods and found that it functioned correctly using Black-box testing[7]. Untung Surapati and Ervandi Gautama showed that expert systems could provide accurate diagnoses and treatment suggestions for childhood illnesses using the same dual-method approach [7]. Meanwhile, Retno Apriliyani et al. compared both inference methods and found that Forward Chaining was more accurate (95%) and user-friendly, while Backward Chaining offered better process efficiency, although with lower accuracy (87.5%)[5]. Similarly, Rokhimatul Wakhidah et al. applied both methods to detect emotional disorders and achieved an overall accuracy of 86.6%. They used Forward Chaining to identify patient symptoms and Backward Chaining to determine diagnoses and treatment options[8],[7]. In another related study, Gusti Putu Rudi Pratama et al. implemented Forward Chaining on an Android-based expert system for obstetrical disease detection and achieved 90% accuracy [9].

Although these studies show the potential of Forward and Backward Chaining in medical expert systems, most focus on general diseases or emotional disorders without integrating both methods in a single system for mental health assessment during pregnancy[3]. Furthermore, the complexity of mental disorders and their impact on maternal health require a more comprehensive and tailored approach[10]. Prior studies also tend to highlight performance metrics without exploring the combined diagnostic advantages of both inference techniques.

This study aims to fill that gap by developing an expert system that uses both Forward and Backward Chaining to detect stress, depression, and anxiety in pregnant women[8]. The system is designed to assist healthcare workers by providing early mental health screening and treatment suggestions based on identified symptoms. Unlike previous

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works, this research integrates both inference methods within one system and specifically addresses maternal mental health, which is often neglected in ANC services[7]. Thus, this study contributes to improving early detection and supporting better pregnancy outcomes through intelligent decision support.

# 2. RESEARCH METHODOLOGY

## 2.1 Expert Systems

Expert systems are a branch of artificial intelligence (AI) designed to mimic the decision-making abilities of an expert[11]. Their primary goal is to transfer expert knowledge into a computer system so that it can be used by non-expert users[5]. These systems operate based on inputted facts and rules, then perform reasoning to provide a diagnosis or solution to a problem. Expert systems consist of three main components: a knowledge base, an inference engine, and a user interface[12]. Furthermore, expert systems also simplify the consultation process through a systematic and user-friendly analytical approach.

## 2.2 Mental Health

Mental health is an important aspect of life, including during pregnancy. According to the WHO, mental health is a state of well-being when an individual is able to realize their potential, manage life's stresses, work productively, and contribute to the community[5], [10]. For pregnant women, this condition is crucial because it directly impacts maternal health and fetal development. Pregnant women with good mental health tend to be better able to cope with the physical, emotional, and social changes during pregnancy[13]. However, in many developing countries, the mental health of pregnant women is often overlooked compared to physical health issues. The three most common mental disorders experienced by pregnant women are depression, anxiety, and stress[10] .

a. Depression in pregnant women is characterized by prolonged feelings of sadness, fatigue, loss of interest, and sleep disturbances. This condition can be triggered by hormonal changes, mental health history, and social and economic pressures[4].
b. Anxiety manifests as excessive worry about the pregnancy, the delivery process, and the baby's condition. Anxiety can be accompanied by physical symptoms such as heart palpitations or difficulty sleeping, and if left untreated, can negatively impact both the mother and the fetus[4], [14].
c. Stress in pregnant women is a response to pressure from various factors, such as financial conditions, marital relationships, or concerns about parenthood. Approximately 33.93% of pregnant women experience stress, especially in the third trimester. If left unmanaged, stress can affect the mother's physical and emotional health and fetal development[12].
d. The Hopkins Symptom Checklist (HSCL) is a self-report-based psychometric instrument designed to measure a person's level of emotional distress, particularly symptoms of depression and anxiety[10]. The HSCL was originally developed at Johns Hopkins University as part of a clinical effort to evaluate patient response to psychological and psychiatric therapy. Each item is rated on a 4-point Likert scale: 1 = Not at all, 2 = Rarely, 3 = Often, and 4 = Always[1].

$$\text{Total Scpre} = \sum_{i=1}^{n} (\textit{Item Score}_i \times \textit{Bobot}_i) \quad (1)$$

$$\text{Maximal Score} = \sum_{i=1}^{n} (4 \times \textit{Bobot}_i) \quad (2)$$

$$\text{Percentage Score} = \left(\frac{\textit{Skor Total}}{\textit{Skor Maksimal}}\right) \times 100 \quad (3)$$

## 2.3 *Forward Chaining*

Forward Chaining is a reasoning method in expert systems that starts with initial facts to reach a conclusion[11], [15]. This process works by matching known facts with the IF part of an IF-THEN rule in the knowledge base. If the rule matches, the THEN part is executed and a new fact is added to the database[16]. This process continues until a final conclusion is reached. Forward Chaining is deductive and suitable for use in systems that require a diagnostic process based on symptoms provided by the user. A rule is triggered when a fact satisfies the condition specified in the IF clause. Upon execution, the conclusion in the THEN clause is asserted into the knowledge base. The matching process is carried out sequentially, starting from the first rule in the rule base[17]. The working strategy of this system begins by inputting a set of facts, then matching those facts with relevant rules in the knowledge base, and executing the process until a suitable conclusion is reached. Forward Chaining can be understood as a form of deductive reasoning[18].

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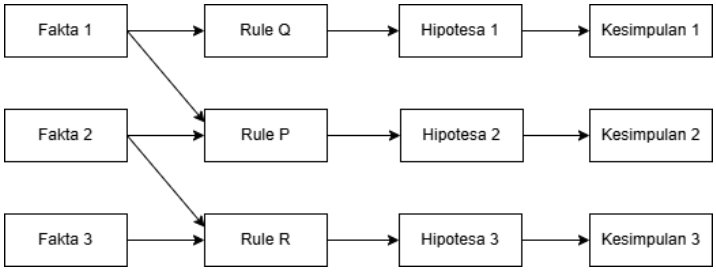


**Figure 1.** Forward Chaining Method

To calculate the probability of event A resulting from fact F and rule R, you can use the following mathematical formula in the context of probability:

$$P(A|F)=\frac{P(A\cap F)}{P(F)} \tag{4}$$

### 2.4 *Backward Chaining*

Backward Chaining is a goal-driven reasoning method, where the process begins with a hypothesis or expected conclusion (THEN) and then traces backwards to find supporting facts in the knowledge base[2], [9]. This method is suitable for systems with narrow and deep decision structures and often involves testing tentative hypotheses to confirm the validity of the conclusion[1]. Backward chaining is a goal-driven reasoning technique that starts from a conclusion or hypothesis and traces backward to determine the supporting initial conditions. Utilizing the available rules, the system attempts to identify relevant facts that justify the hypothesis. The matching process begins with the THEN part of the rule, focusing on the desired outcome[9].

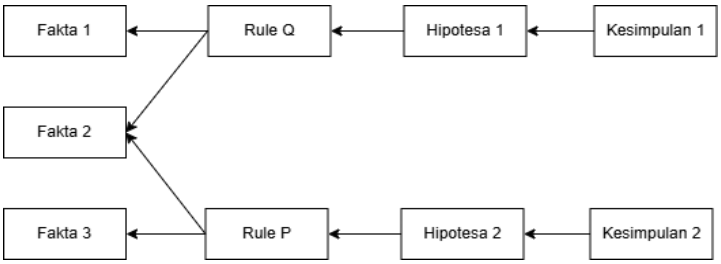


**Figure 2.** Backward Chaining Method

The process of the backward chaining method in the mathematical context of probability can be explained using the following formula:

$$P(H|F)\frac{P(H\cap F)}{P(F)} \tag{5}$$

### 2.5 Flowchart

This section provides a comprehensive explanation of the flowchart used in the expert system designed to identify the mental health conditions of pregnant women[19]. The expert system applies two primary reasoning techniques—forward chaining and backward chaining—to diagnose based on symptoms provided by users. These reasoning methods are essential components of the system's inference engine, enabling it to process user inputs and match them with pre-defined rules derived from expert knowledge. In the forward chaining method, the diagnostic process begins with the collection of initial data or facts, which in this case are the symptoms experienced by the pregnant woman[20], [21]. The system presents a series of questions to the user, each pertaining to specific symptoms commonly associated with mental health disorders such as depression, anxiety, and stress. The user responds to these questions by indicating which symptoms they are experiencing. As the user provides answers, the system systematically checks whether the combination of reported symptoms satisfies any of the rules stored in its knowledge base. Each rule represents a specific pattern of symptoms that correspond to a particular mental health condition. If the current set of symptoms is insufficient to meet the criteria of any rule, the system continues by asking additional questions, aiming to gather enough information to reach a conclusion[7]. Once a sufficient number of matching symptoms are identified, and a rule is fulfilled, the system generates a diagnosis result. For instance, it might indicate that the user is experiencing mild depression, moderate anxiety, or severe stress, depending on the matched rule[10]. This outcome is then displayed to the user as the final result of the consultation process. This means that, based on the information provided, the user does not meet the conditions for any of the disorders the system is designed to detect. The entire forward chaining process is illustrated in Figure 5, which presents a flowchart detailing each step—from the initial user input, through the rule evaluation, to the final diagnosis or the absence thereof.

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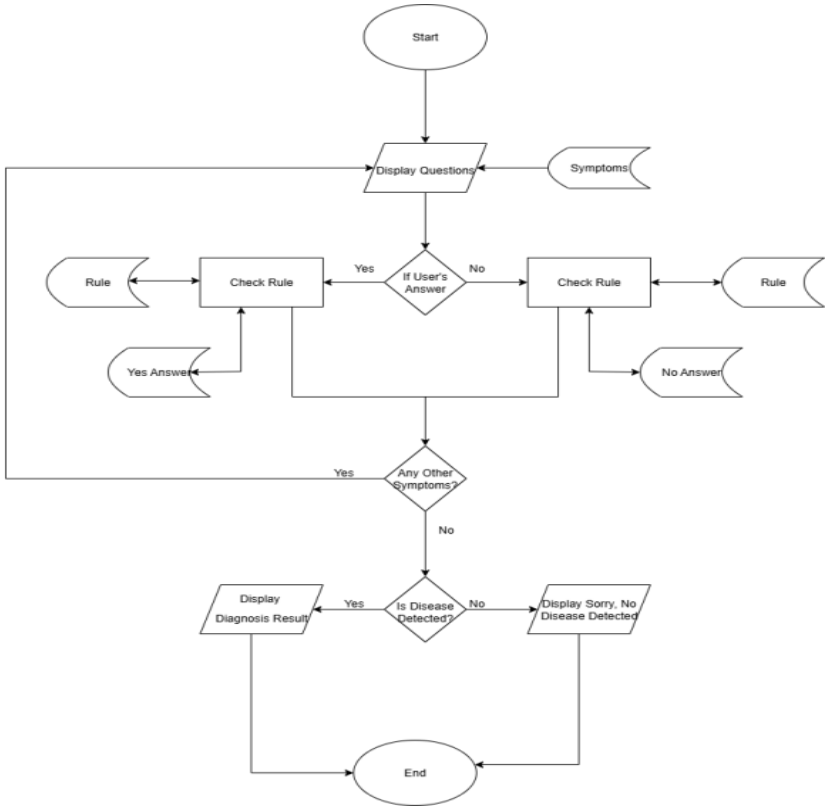


**Figure 3** Forward chaining Flowchart

Meanwhile, the backward chaining flowchart starts with the assumption of a specific disease, and the system then tries to confirm whether the user has the required symptoms to support that hypothesis. The system checks rules associated with each disease by asking the user targeted questions. If all the conditions of a rule are satisfied, the system confirms the diagnosis and displays the result along with suggestions for treatment. If the conditions are not met, the system will notify the user that the disease was not detected.

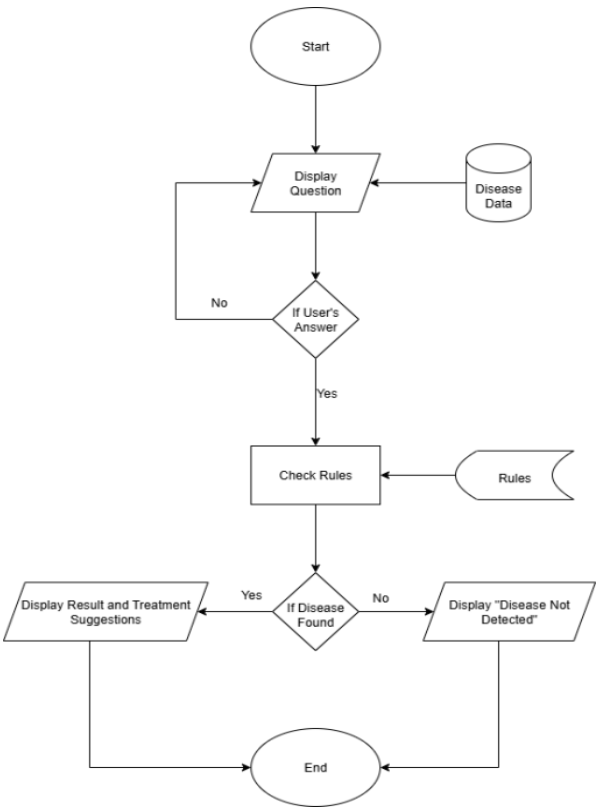


**Figure 4** Backward chaining Flowchart

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# 3. RESULT AND DISCUSSION

## 3.1 Knowledge Base

In the forward chaining method, the system starts reasoning from data or facts provided by the user, namely the symptoms selected or felt. The system then matches the symptoms with the rules available in the knowledge base to calculate the total score for each disease. In the backward chaining method, the process starts from the initial hypothesis or assumption, namely a certain type of disease. The system will evaluate whether the disease is true by tracing back the symptoms that must be met to prove that the hypothesis is valid. The system asks or checks whether the user experiences the symptoms that are prerequisites (rules) for a particular disease.

**Table 1.** Disease Data

| No | Disease Code | Name of Disease | Weight |
|---|---|---|---|
| 1 | KP01 | Depression | 7 |
| 2 | KP02 | Stres | 7.5 |
| 3 | KP03 | Anxiety | 7 |

As presented in Table 1, the system focuses on three main mental health conditions: Depression, Stress, and Anxiety. Each condition is assigned a specific threshold weight which must be met or exceeded for the diagnosis to be concluded as positive. These weights are based on expert judgment obtained through consultation with mental health professionals and cross-referenced with mental health literature to reflect the minimum severity level of symptoms required for diagnosis.This weighting system plays a critical role in supporting the reasoning mechanism of the expert system and enables a more precise and reliable identification of mental health disorders in pregnant women.

**Table 2.** Symptom Data

| No | Symptom Code | Symptom | symptom weight |
|---|---|---|---|
| 1 | G01 | Feeling sad or depressed most of the time | 1 |
| 2 | G02 | Often feel sad or unmotivated | 0.9 |
| 3 | G03 | Can't enjoy things as usual | 1 |
| 4 | G04 | Feeling tired or having no energy | 0.8 |
| 5 | G05 | Feeling guilty for no apparent reason | 0.7 |
| 6 | G06 | Feeling like crying without wanting to control it | 0.6 |
| 7 | G07 | Difficulty sleeping due to anxiety | 0.7 |
| 8 | G08 | Everything feels heavy | 0.8 |
| 9 | G09 | It's hard to rise from adversity | 0.9 |
| 10 | G10 | Feeling like life has no hope | 1 |
| 11 | G11 | Difficulty controlling the important things in life | 1 |
| 12 | G12 | Feeling stressed in the last month | 0.9 |
| 13 | G13 | Difficulty dealing with personal problems | 0.9 |
| 14 | G14 | Everything is not as expected | 0.8 |
| 15 | G15 | Stressed by many responsibilities | 1 |
| 16 | G16 | Easily angered by small things | 0.7 |
| 17 | G17 | Loss of self-confidence | 0.9 |
| 18 | G18 | Stress due to work/household demands | 1 |
| 19 | G19 | Problems are growing faster than our capabilities | 1 |
| 20 | G20 | Can't cope with all of life's challenges | 0.9 |
| 21 | G21 | Feeling nervous, anxious, or restless almost every day | 1 |
| 22 | G22 | Unable to control worry | 1 |
| 23 | G23 | Worrying too much about small things | 0.9 |
| 24 | G24 | So restless that it's hard to sit still | 0.8 |
| 25 | G25 | Feeling afraid as if something bad is going to happen | 0.9 |
| 26 | G26 | Anxiety about baby's health (perinatal) | 1 |
| 27 | G27 | Avoid activities due to excessive fear | 0.9 |
| 28 | G28 | Sleep disturbance due to worry | 1 |
| 29 | G29 | Panic attacks or physical symptoms of anxiety | 1 |
| 30 | G30 | Anxious about being a mother | 0.8 |

Table 2 presents a list of symptoms used in the mental state expert system. The symptom categories include Depression, Stress, and Anxiety. The use of symptom codes is intended to facilitate the identification process during data analysis and the implementation of diagnostic methods within the expert system. Each symptom is assigned a weight; the higher the weight value, the greater its influence on the diagnosis.

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**Table 3.** Solution Table

| Solution code | Disease | Solutions and Treatment |
|---|---|---|
| P01 | Mild Depression | Do fun activities like hobbies |
| | | Talking to close people or family |
| | | Try light exercise like walking or yoga |
| P02 | Moderate Depression | Attend a counseling session with a psychologist |
| | | Regular sleep and eating patterns |
| | | Limit negative use of social media |
| P03 | Major Depression | Consult a psychiatrist immediately |
| | | Consider medical therapy if recommended |
| | | Involve family or close friends for support |
| P04 | Mild Stress | Try meditation or deep breathing |
| | | Take enough rest time |
| | | Reduce caffeine consumption |
| P05 | Moderate Stress | Evaluate the main causes of stress |
| | | Discuss the problem with a close friend or professional |
| | | Try *time management* and *journaling techniques* |
| P06 | Severe Stress | Seek professional help such as a psychologist |
| | | Avoid major decisions when conditions are unstable. |
| | | Take relaxation therapy or cognitive therapy |
| P07 | Mild Anxiety | Use grounding or mindfulness techniques |
| | | Avoid excessive news consumption |
| | | Do light physical activity every day |
| P08 | Moderate Anxiety | Attend regular counseling sessions |
| | | Write down feelings in a daily journal |
| | | Reduce exposure to stressors such as overwork |
| P09 | Severe Anxiety | Consult a psychiatrist immediately |
| | | Consider using anti-anxiety medication if necessary. |
| | | Involve family for guidance and support |

Table 3 shows a list of solutions based on the level of disturbance in the mental state expert system. In this table, the disease symptoms are Depression, Stress, and Anxiety. The application of codes aims to facilitate the process of identifying disease symptoms in data analysis and the application of diagnostic methods in expert systems.

### 3.1.1 Expert System Rules

Based on the symptoms and types of mental disorders presented in the application, the expert system uses forward and backward chain analysis procedures to make decisions regarding mental illness detection. The system's knowledge base consists of nine IF-THEN rules, as shown in Table 4. These rules represent combinations of symptoms that suggest a specific type of mental disorder. In cases where a user exhibits symptoms from multiple disorder categories simultaneously, the system applies an IF-THEN reasoning mechanism based on conditional rules. For example:

a. Symptoms G01–G10 are mapped to depression
b. Symptoms G11–G20 are mapped to stress
c. Symptoms G21–G30 are mapped to anxiety

This allows the system to determine the most likely diagnosis while simultaneously recognizing the presence of other possible disorders. The system ranks the results and presents the top results (highest probability) to the user, along with supporting percentages for transparency. This approach ensures multi-diagnosis awareness, which is particularly relevant in complex mental health scenarios.

**Table 4.** Diagnosis Rule Table

| *Rules* | *Rule (IF..THEN)* |
|---|---|
| R1 | *If* G01 *and* G03 *and* G04 *and* G10 *then* KP01 |
| R2 | *If* G02 *and* G06 *and* G08 *then* KP01 |
| R3 | *If* G05 *and* G07 *and* G09 *then* KP01 |
| R4 | *If* G11 *and* G12 *and* G15 *then* KP02 |
| R5 | *If* G13 *and* G16 *and* G18 *then* KP02 |
| R6 | *If* G14 *and* G17 *and* G19 *and* G20 *then* KP02 |
| R7 | *If* G21 *and* G22 *and* G23 *then* KP03 |
| R8 | *If* G24 *and* G25 *and* G28 *then* KP03 |
| R9 | *If* G26 *and* G27 *and* G29 *and* G30 *then* KP03 |

Table 4 shows a list of rules for the mental state expert system. The application of codes aims to facilitate the process of identifying disease symptoms in data analysis and the application of diagnostic methods in expert systems.

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There are 9 rules in the system, consisting of 3 mental disorders and 3 levels of disorders, which we see in the table above

**Table 5.** Level of Disorders

| *Percentage* | Level of Disturbance |
|---|---|
| < 50% | Light |
| 50 – 74% | Currently |
| >= 75% | Heavy |

Table 5 shows the percentage of the level of mental state expert system disorders. In this table, it can be seen that this expert system has a level of disorder, namely, mild with a percentage of <50%, moderate with a percentage of 50 - 74%, severe with >= 75%. This level of disorder depends on what percentage the user will get later. To determine the level of mental state disorder, each item has a different weight according to its level of importance in the diagnosis. The respondent's answer score for each item is multiplied by its weight, then added up to obtain a total score. Each item is assessed on a 4-point Likert scale, namely: 1 = Not at all, 2 = Rarely, 3 = Often, and 4 = Always.

In one example, a pregnant woman with the initials MD had several symptoms and the answers were as follows: G01 = 3, G02 = 3, G03 = 2, G04 = 3, G05 = 2, G06 = 2, G07 = 3, G08 = 1, G09 = 2, G10 = 2, G11 = 3, G12 = 3, G13 = 2, G14 = 2, G15 = 3, G16 = 3, G17 = 2, G18 = 2, G19 = 3, G20 = 3, G21 = 4, G22 = 3, G23 = 2, G24 = 1, G25 = 3, G26 = 2, G27 = 2. G28 = 2, G29 = 1, G30 = 2

To calculate the total score, multiply each Likert scale item by the weight of each symptom. Calculation of the level of disturbance to calculate the total score using formula 1. The calculation for the total score is as follows:

Total Score = (3 × 1) + (3 × 0.9) + (2 × 1) + (3 × 0.8) + (2 × 0.7) + (2 × 0.6) + (3 × 0.7) + (1 × 0.8) + (2 × 0.9) + (2 × 1) + (3 × 1) + (3 × 0.9) + (2 × 0.9) + (2 × 0.8) + (3 × 1) + (3 × 0.7) + (2 × 0.9) + (2 × 1) + (3 × 1.0) + (3 × 0.9) + (4 × 1) + (3 × 1) + (2 × 0.9) + (1 × 0.8) + (3 × 0.9) + (2 × 1) + (2 × 0.9) + (2 × 1) + (1 × 1) + (2 × 0.8)
= 66.90

Maximum score calculation, namely the highest score with a maximum value (4) multiplied by each symptom weight. In the process of calculating the maximum score using formula 2. The calculation for the maximum score is as follows:

Max Score = (1 × 4) + (4 × 0.9) + (4 × 1) + (4 × 0.8) + (4×0.7) + (4 × 0.6) + (4 × 0.7) + (4 × 0.8) + (4 × 0.9) + (4 × 1) + (4×1) + (4 × 0.9) + (4 × 0.9) + (4 × 0.8) + (4×1) + (4 × 0.7) + (4 × 0.9) + (4×1) + (4 ×1) + (4 × 0.9) + (4×1) + (4×1) + (4 × 0.9) + (4 × 0.8) + (4 × (0.9) + (4×1) + (4 × 0.9) + (4×1) + (4×1) + (4 × 0.8)
= 110.0

Next, the percentage score is calculated by dividing the total score by the maximum score. The percentage score calculation process uses formula 3. The percentage score calculation is as follows:

After that, the percentage score is calculated:

$$\text{Percentage Score} = \left(\frac{66.90}{110.0}\right) \times 100 = 60.82\%$$

Based on the 30 symptoms assessed from the respondents' answers, this figure indicates that the level of mental disorder, namely depression, is moderate.

### 3.2 Application of the Forward Chaining Method

To determine the type of mental disorder experienced by respondents or users, the system uses a conditional probability calculation method based on the selected symptoms. There are 30 symptoms that have been classified into three categories of mental disorders, namely depression (G01-G10), stress (G11-G20), and anxiety (G21-G30). If the user selects 12 symptoms from 30 symptoms, then the conditional probability calculation process to calculate the possible diagnosis that occurs uses formula 4, as follows:

G01, G02, G03, G04, G05, G06, G08, G10, G12, G15, G22, G24
G01, G02, G03, G04, G05, G06, G08 = 8 symptoms from G01-G10 (Depression)
G12, G15 = 2 symptoms from G11-G20 (Stress)
G22, G24 = 2 symptoms from G21-G30 (Anxiety)

$$P\,(\text{Depresi} \cap F) = \frac{8}{30} = 0.2667$$

$$P\,(\text{Stres} \cap F) = \frac{2}{30} = 0.066$$

$$P(\text{Kecemasan} \cap F) = \frac{2}{30} = 0.066$$

$$P(F) = \frac{12}{30} = 0.4$$

$$P(\text{Depresi} \mid F) = \frac{P(\text{Depresi} \cap F)}{P(F)} = \frac{0.2667}{0.4} = 0.6667 \text{ or } 66.67\%$$

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$$P(\text{Stres} \mid F) = \frac{P(\text{Stres} \cap F)}{P(F)} = \frac{0.066}{0.4} = 0.165 \text{ or } 16.5\%$$

$$P(\text{Kecemasan} \mid F) = \frac{P(\text{Kecemasan} \cap F)}{P(F)} = \frac{0.066}{0.4} = 0.165 \text{ or } 16.5\%$$

Based on the selected symptom proportions, the conclusion is that the symptoms experienced by users across three disease categories are most likely depression, with a probability value of 66.67%.

### 3.3 Application of the Backward Chaining Method

To determine the type of mental disorder experienced by respondents or users, the system uses a probability calculation method based on the selected symptoms. There are 30 symptoms classified into three categories of mental disorders: depression (G01-G10), stress (G11-G20), and anxiety (G21-G30). If the user selects depression, the conditional probability calculation process uses formula 4 to calculate the hypothesis of the likelihood of occurrence, as follows:

$$P(F) = \frac{12}{30} = 0.4$$

$$P(H) = P(\text{Depresi}) = \frac{10}{30} = 0.333$$

$$P(\text{Depresi} \cap F) = \frac{8}{30} = 0.2667$$

$$P(\text{Depresi} \mid F) = \frac{P(\text{Depresi} \cap F)}{P(F)} = \frac{0.2667}{0.4} = 0.6667 \text{ or } 66.67\ \%$$

If the user selects depression by selecting 12 symptoms from the 30 symptoms experienced, the results indicate that the underlying conditions are G01-G10, with a probability value of 66.67%.

a. Forward Chaining Search Tree

The process of identifying types of mental health disorders in this expert system is carried out using a search tree structure. This method allows the system to explore possible diagnoses based on the combination of symptoms provided by the user. Each node in the tree represents a specific symptom, and the branches indicate the possible diagnostic paths depending on the presence or absence of that symptom. Based on the previously described case example, suppose the user inputs the following symptoms:

1. Feeling sad or gloomy almost all the time (G01)
2. Often feeling sad or unmotivated (G02)
3. Not being able to enjoy things as usual (G03)
4. Feeling tired or having no energy (G04)
5. Feeling guilty for no apparent reason (G05)
6. Feeling like without crying wanting to be controlled (G06)
7. Everything feels like a heavy burden (G08)
8. Feeling like life has no hope (G10)
9. Feeling stressed in the past month (G12)
10. Being pressured by many responsibilities (G15)
11. Not being able to control worry (G22)
12. So restless that it is difficult to sit still (G24)

The system will then begin the search from the root node, which is the initial symptom used as the starting point for identification (for example, G01). If the symptom matches, the search will continue to the next branch, examining symptom G02, and so on, following a logical sequence based on the rule base defined by experts.

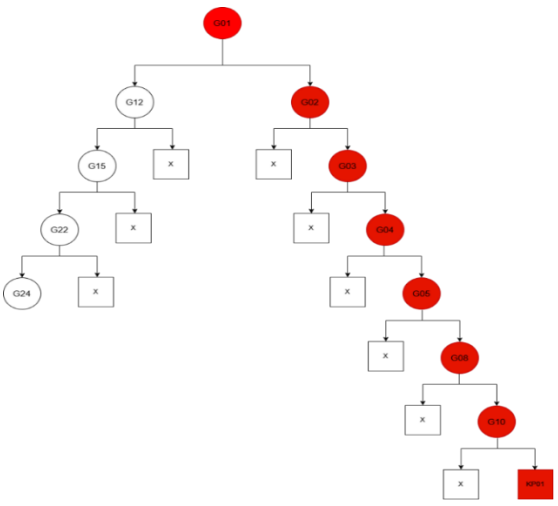


**Figure 5**. Forward Chaining Search Tree

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Figure 5 shows a visualization of a case example of a forward chaining method search used to diagnose a disease based on the symptoms experienced by the user, in the case above the user selects 12 symptoms out of 30 symptoms, and the search for symptoms that are fulfilled according to the symptom rule (G01-G10), and the score threshold ≥ 3, then based on the search above it is known that if the symptom data that is fulfilled is G01, G02, G03, G04, G05, G06, G08, G10, then the disease detected is KP01, namely Depression.

b. Backward Chaining Search Tree

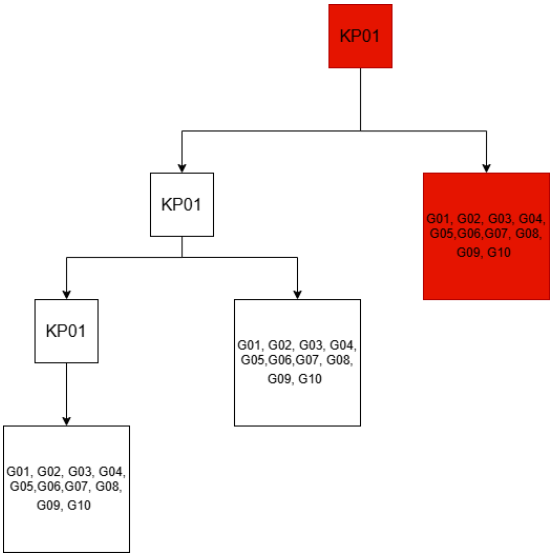


**Figure 6**. Backward Chaining Search Tree

Figure 3 shows a visualization of a case example of a backward chaining method search, which is still the same case if the user chooses depression (KP01). Based on the above analysis, it is known that if a user selects depression (KP01), the symptoms experienced, based on the rule, are: Feeling sad or gloomy almost all the time (G01), Frequently feeling sad or low on energy (G02), Inability to enjoy things as usual (G03), Feeling tired or lacking energy (G04), Feeling guilty for no apparent reason (G05), Feeling like crying uncontrollably (G06), Difficulty sleeping due to to anxiety (G07), Everything feels like a heavy burden (G08), Difficulty recovering from adversity (G09), Feeling hopeless in life (G10).

**Table 6**. Test Data

| Case | Symptom | Expert Diagnosis | Expert system | Status |
|---|---|---|---|---|
| Case 1 | G21, G22, G23, G24, G25, G26, G27, G28, G29, G30 | Worried | Worried | In accordance |
| Case 2 | G01, G02, G03, G04, G05, G06, G07, G08, G09, G10 | Depression | Depression | In accordance |
| Case 3 | G01, G02, G03, G04, G05, G06, G07, G08, G09, G10 | Depression | Depression | In accordance |
| Case 4 | G21, G22, G23, G24, G25, G26, G27, G28, G29, G30 | Worried | Worried | In accordance |
| Case 5 | G21, G22, G23, G24, G25, G26, G27, G28, G29, G30 | Worried | Worried | In accordance |
| Case 6 | G21, G22, G23, G24, G25, G26, G27, G28, G29, G30 | Worried | Worried | In accordance |
| Case 7 | G01, G02, G03, G04, G05, G06, G07, G08, G09, G10 | Depression | Depression | In accordance |
| Case 8 | G11, G12, G13, G14, G15, G16, G17, G18, G19, G20 | Stres | Stres | In accordance |
| Case 9 | G01, G02, G03, G04, G05, G06, G07, G08, G09, G10 | Depression | Depression | In accordance |
| Case 10 | G01, G02, G03, G04, G05, G06, G07, G08, G09, G10 | Depression | Depression | In accordance |
| Case 11 | G01, G02, G03, G04, G05, G06, G07, G08, G09, G10 | Depression | Depression | In accordance |
| Case 12 | G01, G02, G03, G04, G05, G06, G07, G08, G09, G10 | Depression | Worried | No |

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| Case | Symptom | Expert Diagnosis | Expert system | Status |
|---|---|---|---|---|
| | | | | In accordance |
| Case 13 | G01, G02, G03, G04, G05, G06, G07, G08, G09, G10 | Depression | Depression | In accordance |
| Case 14 | G01, G02, G03, G04, G05, G06, G07, G08, G09, G10 | Depression | Depression | In accordance |
| Case 15 | G21, G22, G23, G24, G25, G26, G27, G28, G29, G30 | Worried | Stres | No |
| | | | | In accordance |
| Case 16 | G01, G02, G03, G04, G05, G06, G07, G08, G09, G10 | Depression | Depression | In accordance |
| Case 17 | G11, G12, G13, G14, G15, G16, G17, G18, G19, G20 | Stres | Stres | In accordance |
| Case 18 | G21, G22, G23, G24, G25, G26, G27, G28, G29, G30 | Worried | Worried | In accordance |
| Case 19 | G11, G12, G13, G14, G15, G16, G17, G18, G19, G20 | Stres | Stres | In accordance |
| Case 20 | G01, G02, G03, G04, G05, G06, G07, G08, G09, G10 | Depression | Worried | No |
| | | | | In accordance |

Table 5 shows the test results using 20 case data tested using expert diagnoses with the expert system. Based on the test results above, to determine the system's accuracy level, the following calculations were performed:

$$\text{Accuracy value} = \frac{\text{Jumlah kasus yang sesuai}}{\text{total kasus}} \times 100\%$$

$$\text{Accuracy value} = \frac{17}{20} \times 100\%$$

$$= 85\%$$

The results above conclude that this application has an accuracy level of 85%.

### 3.4 Results Graph

The results of the application of two forward chaining and backward chaining methods on this expert system, with 3 categories, namely depression, stress, and anxiety, there are 30 symptoms, with 3 categories of the level of disturbance scale, namely low, moderate, and severe. Resulting in the number of pregnant women diagnosed with depression as many as 179 people, with a mild scale of 107 people, a moderate scale of 33 cases, and a severe scale of 39 people. Pregnant women were diagnosed with anxiety as many as 150 people, with a mild scale of 24 people, a moderate scale of 91 people, and a severe scale of 35 people. Then pregnant women were diagnosed with stress as many as 171 people, with a mild scale of 82 people, a moderate scale of 50 people, and a severe scale of 39 people. The results graph can be seen in Figure 7, as follows.

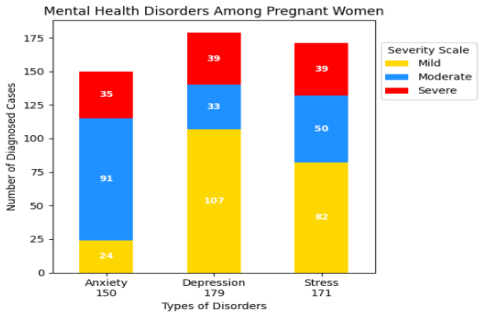


**Figure 7.** Results Graph

### 3.5 System Implementation

At this stage, the previously prepared system design is implemented. The program interface is designed to allow users to interact with the developed software.

a. Home Page

The home page is the user's main page when the system is first launched. It allows users to consult about their mental state by selecting a diagnostic method based on symptoms (forward) and disease (backward). The results can be seen in Figure 5 below.

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**Figure 8.** Home Page

b. Diagnosis Page
The diagnosis page displays the diagnosis results based on the user's selected diagnostic method, namely forward-backward chaining. The results can be seen in Figure 9 below.

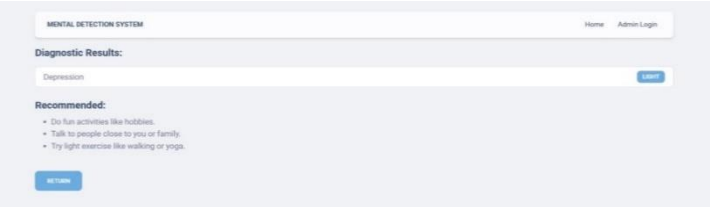


**Figure 9.** Diagnosis Page

c. Symptom-Based Consultation Page
This page uses the forward chaining diagnostic method, which contains questions about mental states based on symptoms. Before making a diagnosis, users must select the symptoms they experience (not at all, rarely, often, or always). The results can be seen in Figure 7 below.

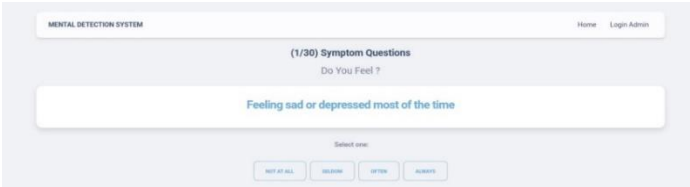


**Figure 10.** Symptom Consultation Page

d. Disease-Based Consultation Page
This page is a diagnostic method using backward chaining, but it starts from selecting the disease experienced, then the user will fill in questions based on symptoms, before making a diagnosis the user must select the symptoms experienced (none at all, rarely, often, always). The display results can be seen in Figure 8 below.


**Figure 11.** Disease Consultation Page

## 4. CONCLUSION

This research has successfully produced a web-based expert system capable of diagnosing three types of mental health disorders in pregnant women—depression, stress, and anxiety—based on 30 predetermined symptoms. The system implements two inference methods, namely Forward Chaining and Backward Chaining, to perform reasoning on symptom data inputted by the user. Forward Chaining is used to draw logical conclusions from available facts to obtain a diagnosis, while Backward Chaining is used to verify hypotheses of mental disorders based on supporting symptoms. Case study testing shows that the system is capable of providing diagnostic results with rational probabilities and treatment recommendations appropriate to the level of disorder. Based on testing of 20 case data, the system demonstrated 85% accuracy in matching diagnostic results with expert diagnoses. This indicates that the developed system is quite reliable and can be used as an aid in the early detection of mental health disorders in pregnant

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women. These findings are expected to support mental health services in a more efficient and structured initial screening process. This system contributes to public health services by providing accessible early screening tools for maternal mental health, which can help reduce undetected cases and improve timely interventions.For future development, the system can be enhanced through integration with electronic medical records and expanded into a mobile application platform to increase accessibility and usability in various healthcare settings.

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