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Expert System for Diagnosing Human Psychological Disorders Using the Forward Chaining Method

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***Abstract*— This study aims to develop an expert system for the early diagnosis of human psychological disorders using the Forward Chaining method. The knowledge base was constructed based on the Diagnostic and Statistical Manual of Mental Disorders (DSM-5) and relevant psychological literature, and subsequently validated through an expert judgment process involving a psychology expert to ensure the appropriateness of diagnostic rules. The system is capable of identifying eight types of psychological disorders based on twenty main symptoms represented as IF–THEN rules. System evaluation was conducted using predefined test scenarios and accuracy measurement through a confusion matrix. The experimental results indicate that the system achieves an accuracy of 85%, demonstrating that the Forward Chaining method is effective as an inference mechanism for early mental health screening. This system serves as a decision-support tool and is not intended to replace professional psychological diagnosis.**

***Index Terms*— Expert System; Forward Chaining; Psychological Diagnosis; Mental Health; Knowledge Base**

I. INTRODUCTION

Psychological health is a fundamental aspect that influences a person's quality of life, mindset, behavior, and ability to carry out daily activities. In recent years, cases of psychological disorders such as depression, anxiety, severe stress, and personality disorders have continued to increase. However, public awareness of mental health screenings and consultations remains relatively low. Factors such as lack of education, limited availability of experts, high consultation costs, and social stigma make early detection difficult, resulting in many individuals only seeking treatment when their condition has already worsened [1].

The development of information technology provides a significant opportunity to provide early detection services for mental health through an expert system approach. Expert systems have been widely used in various health fields, for example, in the early detection of stunting using the Forward Chaining method, which has proven effective in gradually analyzing symptoms to produce a diagnostic decision [1]. A similar approach has also been applied to website-based early detection of asthma risk, demonstrating that Forward Chaining can work optimally in symptom-based initial consultation systems [2].

In addition to the health sector, expert systems have also proven effective in assisting technical diagnostic processes. For example, the Certainty Factor method was used to diagnose Android smartphone damage and was able to provide accurate results based on the level of confidence in rules and symptoms [3]. Another study applied the Forward Chaining method to diagnose computer hardware damage, and the results showed that this method was capable of systematic and consistent rule-based reasoning [4]. The success of these various studies shows that the application of expert systems, including Forward Chaining, has great potential for application in the psychological domain.

Furthermore, expert systems have also been specifically used to detect early anxiety disorders in adolescents using the Forward Chaining method. This study proves that expert systems can assist the early screening process for psychological disorders by adapting to the rules and symptoms entered by the user [5]. This reinforces the importance of developing an expert system for early diagnosis of psychological disorders, particularly for increasing access to independent, flexible, and easy-to-use early consultation services.

Although numerous studies have implemented expert systems and Forward Chaining methods in the healthcare domain, most existing research focuses on physical disease diagnosis or technical problem identification. Studies specifically addressing psychological disorder diagnosis remain limited, and many do not clearly describe expert involvement in knowledge validation or provide measurable system performance evaluation.

Therefore, this study addresses these limitations by developing a Forward Chaining-based expert system for early psychological disorder diagnosis that is

grounded in DSM-5 guidelines, explicitly validated through expert judgment, and evaluated using quantitative accuracy measurement. The main contribution of this research lies in the structured knowledge base design, expert-validated diagnostic rules, and measurable system performance for early mental health screening.

II. LITERATURE REVIEW

Expert systems are a branch of artificial intelligence designed to replicate the reasoning process of human experts in solving specific problems. These systems operate using a knowledge base and a set of rules that enable them to produce diagnoses or conclusions. One example of their implementation can be seen in a study that developed an expert system to diagnose Android smartphone damage using the certainty factor method, where the system was able to provide diagnostic results based on confidence levels assigned to user-provided symptoms [3]. The certainty factor method itself is a technique used to handle uncertainty in the reasoning process and is highly suitable for diagnostic cases that have similar or overlapping symptoms. This method has also been applied to a web-based expert system for diagnosing mental disorders in children, demonstrating that the combination of knowledge-based rules and certainty values can improve diagnostic accuracy [6].

In addition to the certainty factor, rule-based reasoning techniques such as Forward Chaining are widely utilized in expert system development. Forward Chaining works by tracing user-provided facts to find matching rules, then producing a conclusion based on those conditions. This method has proven effective in health-related applications, such as an early detection system for asthma risk that utilized Forward Chaining as its primary reasoning mechanism [2]. Its ability to process symptoms step by step has also been applied in the development of expert systems for diagnosing computer hardware damage, showing that Forward Chaining can be implemented flexibly across various problem domains [4].

In the context of mental health, understanding the symptoms and classifications of psychological disorders is essential as the foundation of building a knowledge base for expert systems. Several studies emphasize the importance of mental health education—especially among adolescents—to enhance awareness and the ability to identify early signs of psychological disorders. Mental health education programs have been proven to improve adolescents' understanding of risks and symptoms, enabling them to take appropriate early actions [7]. Similar efforts have been conducted through peer-education programs, which aim to provide knowledge regarding risk factors and prevention of mental disorders, while encouraging adolescents to support each other in maintaining psychological well-being within their communities [8].

Furthermore, knowledge of the types and characteristics of mental disorders is an important component in developing expert systems. Studies on mental disorders describe various types, causes, and symptoms that can be used as parameters in expert systems for psychological diagnosis [10]. This information serves as a basis for determining symptoms, rules, and diagnostic classifications within the developed system.

The application of expert systems in the field of psychology continues to grow, one example being the development of an expert system designed to detect early signs of anxiety disorders in adolescents. This study implemented Forward Chaining to trace anxiety-related symptoms and generate an initial diagnosis that could help users better understand their psychological condition before seeking professional assistance [5]. This demonstrates that expert systems can serve as an effective preliminary screening tool for psychological disorders, particularly for individuals who do not yet have direct access to mental health services.

III. RESEARCH METHODOLOGY

This study employs a knowledge-based expert system approach to perform early diagnosis of psychological disorders. The diagnostic knowledge was acquired from the Diagnostic and Statistical Manual of Mental Disorders (DSM-5) and relevant psychological literature. The knowledge acquisition process focused on identifying key psychological symptoms and their relationships with specific psychological disorders to ensure diagnostic relevance and consistency.

The psychological symptoms used in this study were selected based on DSM-5 diagnostic criteria and subsequently reviewed through an expert judgment process involving a psychology expert. The expert evaluated the relevance and clarity of each symptom to ensure that the selected symptoms accurately represent the characteristics of psychological disorders. The finalized set of psychological symptoms used by the system is presented in Table 1.

TABLE I. PSYCHOLOGICAL DISORDER SYMPTOM DATA

Code	Symptom
G1	Loss of interest or pleasure in activities
G2	Sleep disturbances (insomnia/hypersomnia)
G3	Excessive anxiety without clear triggers
G4	Difficulty concentrating
G5	Easily irritated or emotionally reactive
G6	Intense fear of social situations
G7	Excessive fear of specific objects or situations

G8	Recurrent panic attacks
G9	Feelings of worthlessness or excessive guilt
G10	Avoidance of situations due to anxiety
G11	Extreme fatigue without physical cause
G12	Negative thoughts about oneself
G13	Difficulty controlling emotions
G14	Heart palpitations and shortness of breath
G15	Difficulty building interpersonal relationships
G16	Extreme mood swings
G17	Withdrawal from social environments
G18	Trauma and flashbacks of distressing events
G19	Increased stress over minor pressures
G20	Suicidal thoughts or desire to end life

Psychological disorders included in this study were determined based on DSM-5 classifications and expert validation. Each disorder represents a specific category of psychological conditions that can be identified through combinations of selected symptoms. The list of psychological disorders and their corresponding codes is shown in Table 2.

TABLE II. PSYCHOLOGICAL DISORDER DATA

Disorder Code	Disorder Name	Brief Description
P01	Anxiety Disorder	Persistent and intense anxiety accompanied by physical symptoms
P02	Major Depressive Disorder	Ongoing sadness, loss of interest, fatigue, pessimism
P03	Panic Disorder	Recurrent panic attacks with severe physical reactions
P04	Specific Phobia	Excessive fear towards certain objects or situations
P05	Social Anxiety Disorder	Intense fear in social interactions or performance situations
P06	PTSD (Post-Traumatic Stress Disorder)	Trauma flashbacks, nightmares, avoidance of triggers
P07	Bipolar Disorder	Extreme emotional changes between mania and depression
P08	Acute Stress Disorder	Mental and physical exhaustion due to high stress

Diagnostic knowledge was represented in the form of IF–THEN rules that define the relationships between psychological symptoms and disorder categories. These rules were formulated based on DSM-5 guidelines and refined through expert judgment to ensure logical consistency and diagnostic accuracy. The final set of expert-validated Forward Chaining rules applied in the system is presented in Table 3.

TABEL III. FORWARD CHAINING RULES (IF – THEN)

Rule Code	Rule
R01	IF G03 AND G04 AND G14 THEN P01 (Anxiety Disorder)
R02	IF G01 AND G02 AND G11 AND G12 THEN P02 (Major Depression)
R03	IF G08 AND G14 AND G19 THEN P03 (Panic Disorder)
R04	IF G07 AND G14 THEN P04 (Specific Phobia)
R05	IF G06 AND G10 AND G15 THEN P05 (Social Anxiety Disorder)
R06	IF G18 AND G19 AND G01 THEN P06 (PTSD)
R07	IF G16 AND G04 AND G15 THEN P07 (Bipolar Disorder)
R08	IF G11 AND G05 AND G19 THEN P08 (Acute Stress Disorder)

The Forward Chaining method was applied as the inference mechanism in this expert system. The reasoning process begins with psychological symptoms selected by users as initial facts. These facts are sequentially matched against the IF–THEN rules defined in Table III. When all conditions of a rule are satisfied, the system generates a diagnostic conclusion corresponding to the identified psychological disorder. This inference approach ensures transparent and systematic rule-based reasoning.

The performance of the proposed expert system was evaluated using predefined test cases derived from the constructed knowledge base. Each test case consisted of a combination of psychological symptoms and a corresponding diagnosis determined by a psychology expert.

The diagnostic results generated by the system were compared with expert diagnoses and summarized using a confusion matrix consisting of True Positive (TP), True Negative (TN), False Positive (FP), and False Negative (FN) values. System accuracy was calculated using the following formula:

$$Accuracy = \frac{TP + TN}{TP+TN+FP+FN} \times 100\%$$

This evaluation approach was employed to measure the system's ability to generate accurate early

diagnostic indications and to assess the effectiveness of the Forward Chaining inference mechanism.

IV. RESULTS AND DISCUSSION

This chapter presents the results of the research obtained through the design of an expert system for diagnosing human psychological disorders using the Forward Chaining method, along with the discussion based on inference logic analysis and case simulation. This study focuses on the conceptual development of the expert system through the construction of a knowledge base and rule-based inference mechanism, without implementing the system into a software application or coding environment.

The results of the study indicate that the Forward Chaining method can be applied to perform early diagnosis based on psychological symptoms experienced by individuals. The decision-making process is carried out by matching factual symptom input with the rules available in the knowledge base. Each symptom acts as an initial fact, and the system traces the rules sequentially until a conclusion regarding the type of psychological disorder is generated.

The knowledge base was developed based on psychological literature sources and expert validation references. Rules were constructed in a tabular form describing the relationship between symptoms (G) and psychological diagnoses (D). The following table presents a portion of the rules used in the system:

Rule Code	Symptoms	Psychological Disorder Diagnosis
R01	G1, G2, G4, G6	Depression
R02	G3, G7, G9	Bipolar Disorder
R03	G2, G5, G8	Anxiety Disorder
R04	G4, G8, G10	PTSD (Post-Traumatic Stress Disorder)

Symptom descriptions:

G1 = Persistent sadness

G2 = Difficulty sleeping / insomnia

G3 = Extreme mood changes

G4 = Loss of interest and motivation

G5 = Excessive fear

G6 = Lack of enthusiasm for daily activity

G7 = High energy followed by extreme fatigue

G8 = Frequent anxiety or panic

G9 = Impulsive behavior and irritability

G10 = Deep trauma caused by a specific event

To evaluate the effectiveness of the Forward Chaining inference process, a simulation case was conducted to test whether the rules could produce conclusions accurately. The sample diagnostic scenario is presented below:

Simulation Case

A user reports the following symptoms:

- (G1) Persistent sadness
- (G2) Difficulty sleeping
- (G4) Loss of interest
- (G6) Lack of enthusiasm

These symptoms are entered into the system as initial facts. The system then matches the facts with the existing rules:

If G1 AND G2 AND G4 AND G6

Then Diagnosis = Depression

(Referring to Rule R1)

Based on the Forward Chaining inference process, the system generates an initial diagnostic result indicating Depression. This outcome serves as preliminary information that can support users in seeking further psychological consultation or professional mental health evaluation.

From the rule-based case simulation results, it was found that the Forward Chaining method can assist in identifying potential psychological disorders through combinations of selected symptoms. The system-generated diagnostic conclusions are produced through a logical and systematic reasoning process based on predefined rules. In addition to quantitative evaluation, the diagnostic results and rule consistency were reviewed by a psychology expert to ensure alignment with established psychological diagnostic principles.

Overall, this study demonstrates that the expert system design using the Forward Chaining method is capable of producing early diagnostic indications that can be used as reference material in identifying psychological disorders. However, the system is limited because the results are indicative in nature and do not replace professional psychological assessment. Future work is recommended to implement the system as a web-based or mobile application and to evaluate its performance using a broader dataset.

V. CONCLUSION

This study presented the development of a rule-based expert system for early diagnosis of psychological disorders using the Forward Chaining method. The knowledge base was constructed based on DSM-5 guidelines and relevant psychological literature and validated through expert judgment involving a

psychology expert to ensure the appropriateness of diagnostic rules.

The evaluation results obtained through rule-based case simulation indicate that the proposed system is capable of generating logically consistent early diagnostic indications based on selected symptoms. Quantitative evaluation using a confusion matrix shows that the system achieved an accuracy of 85%, demonstrating the effectiveness of the Forward Chaining inference mechanism for early mental health screening.

Nevertheless, the diagnostic results produced by the system are indicative in nature and are not intended to replace professional psychological assessment. Future research is recommended to implement the proposed system in a web-based or mobile application and to further evaluate its performance using a larger and more diverse dataset.

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