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Adult Attention Deficit Hyperactivity Disorder Risk Detection Using Forward Chaining Method

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Abstract
Adult Attention Deficit Hyperactivity Disorder (ADHD) remains underrecognized due to subtle symptoms, persistent misconceptions, and limited access to self-screening tools. This study developed a robust expert system to support the early detection of ADHD risk using the Forward Chaining method. Knowledge acquisition was conducted through literature review and consultation with a psychologist specializing in ADHD to construct a rule-based knowledge base of symptoms and risk classifications. The system provided three possible outcomes including high, moderate, or no risk. Evaluation was carried out through black-box testing with ten respondents and accuracy testing against expert diagnoses. The results showed that the system achieved 100% functionality and 100% accuracy in identifying ADHD risk levels. This research contributes to addressing the gap in digital screening platforms for adult ADHD in Indonesia by providing an accessible and user-friendly tool for self-assessment. The system can be a substitute for an early detection aid to consultation and reduce delays in intervention.

Keywords:
Detection, ADHD, Forward Chaining, Early Detection

1. Introduction

Attention Deficit Hyperactivity Disorder (ADHD) is a neurodevelopmental disorder characterized by symptoms of inattention, hyperactivity, and impulsivity [1]. ADHD has long been perceived as a condition that only affects children. However, numerous studies have shown that its symptoms can persist into adulthood, and even into old age [2]. Longitudinal research spanning over 40 years indicates that approximately 40–50% of children diagnosed with ADHD continue to exhibit symptoms into adulthood [3]. A meta-analysis study reported that the prevalence of adult ADHD reaches 6.76%, including individuals with or without a formal childhood diagnosis [4].

ADHD symptoms tend to evolve with age. In children, symptoms typically manifest externally as hyperactivity, impulsivity, and difficulty maintaining attention. In adults, however, symptoms are often more internal and less visible. For instance, attention difficulties may arise when completing monotonous tasks, but can shift into hyperfocus when engaging in tasks of personal interest. Hyperactivity may appear as inner restlessness or difficulty relaxing, while impulsivity may manifest as reckless spending or interrupting conversations. Adults with ADHD also tend to experience difficulties in emotional regulation, time management, and daily responsibilities, which can negatively impact work performance and social relationships [5]. Due to their subtle nature, these

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symptoms are often mistaken for personal flaws, such as laziness, carelessness, or irresponsibility. This misperception is exacerbated by social stigma and a lack of adequate information, preventing many individuals from recognizing that their struggles may be linked to ADHD. Some adults may have developed coping strategies from an early age, such as strict scheduling, reminders, or supportive environments, but begin to face difficulties when encountering more complex demands in higher education or the workforce [6].

In Indonesia, public awareness of adult ADHD remains low. The lack of local academic literature, limited access to mental health services, and the absence of self-screening tools pose significant barriers to early identification. In recent years, awareness has begun to grow through social media, where psychologists, psychiatrists, and individuals with ADHD have increasingly shared educational content about adult ADHD. While many individuals relate to the symptoms described, they often remain unsure of how or where to seek a formal evaluation. This highlights the need for a formal support system that enables early detection through self-assessment before proceeding to professional consultation. Early detection plays a vital role in ensuring that individuals with ADHD symptoms receive timely intervention and can avoid more serious consequences in the future.

A web-based expert system offers a promising approach to address these challenges. An expert system is designed to emulate the decision-making ability of a human expert by encoding domain-specific knowledge into a computerized rule-based system [7]. In this study, the expert system is developed using the Forward Chaining method, which works by tracing user-input symptoms and applying predefined rules to conclude [8]. Forward Chaining is an inference technique that begins with known facts and matches them against the IF parts of IF–THEN rules. If a match is found, the corresponding rule is executed to produce new facts, continuing the process until no more rules can be applied [9]. The system is not intended to provide a clinical diagnosis, but rather to serve as an early risk detection tool. The final output consists of three risk levels, including high, moderate, and no risk, based on the quantity and pattern of symptoms reported by the user.

Given these problems and their urgency, this study aims to design and develop a web-based expert system to support the early detection of ADHD risk in adults. Its focus on adult ADHD and the application of an expert system approach contribute a novel perspective, especially in the context of the limited digital screening platforms available for adult ADHD in Indonesia.

2. Related Works

Adult Attention-Deficit/Hyperactivity Disorder (ADHD) has become a growing topic in recent years [16][17][18][19][20]. Hidayat and Mirza (2023) developed a web-based expert system for early screening of Social Anxiety Disorder using the Forward Chaining method. This system was motivated by the fact that many people often perceive social anxiety as a normal condition and fail to recognize its impact on daily functioning. The lack of mental health education and the absence of self-screening tools served as the primary background for this development. Forward Chaining was chosen because it allows the system to trace user-input symptoms and generate conclusions based on predefined rules. Built using the waterfall model, the system successfully helped users, particularly late adolescents and young adults, gain awareness and determine whether they were likely to exhibit social anxiety. This study is relevant to the current research as it demonstrates how a forward chaining-based expert system can support early detection of mental health issues via web platforms [10].

Zaldi and Hansun (2024) created an expert system for early diagnosis of Post-Traumatic Stress Disorder (PTSD) using the Forward Chaining method. Their work was driven by low

public awareness of PTSD symptoms and the reluctance or inability of individuals to consult professionals due to cost or stigma. The system was designed as a web-based alternative screening tool and developed using the Expert System Development Life Cycle. Evaluation results showed high system accuracy and a usability score of 86.67%, indicating that users found the system effective and beneficial. This study reinforces the potential of web-based expert systems as practical solutions for addressing mental health screening barriers [11].

Bilad et al. (2022) designed a responsive web-based expert system for detecting ADHD in children using Forward Chaining. The system aimed to assist teachers and parents in identifying early signs of ADHD by observing children's behavior at school and home. It utilized decision trees and rule tables to represent expert knowledge. Users responded to symptom-related questions with "Yes" or "No" answers, and the system would then conclude the likely type of ADHD along with recommended treatments. Although this study focused on children, it is relevant to the current research due to its use of Forward Chaining in early ADHD detection [12].

Yuliana and Noviyanti (2021) developed a web-based expert system to diagnose various mental disorders, accommodating 22 symptoms and 9 different diagnoses. The system was intended for individuals in remote areas with limited access to psychiatric services. It employed the Forward Chaining method and was implemented using PHP and MySQL. Evaluation showed that the system achieved 98.99% in user-friendliness and 100% success in black-box testing, confirming its usability and reliability. The study demonstrates how expert systems as accessible digital consultation tools for mental health support [13].

Aldisa (2022) developed an Android-based expert system for detecting mental health conditions using the Forward Chaining method. The system provided diagnostic support for three mental health disorders (bipolar, dissociative disorder, and major depression) based on 15 symptoms and offered additional information such as causes, mental health tips, and final suggestions. The study used black-box testing and alpha testing with 17 respondents, achieving a 51% "Correct" response rate and high user acceptance. This study supports the current research by demonstrating the adaptability of Forward Chaining for mobile mental health screening[14].

3. Proposed Method

This study adopts the Expert System Development Life Cycle (ESDLC) as the primary methodology for expert system development. ESDLC provides a structured framework consisting of sequential stages, ranging from problem identification to system maintenance. Fig. 1 depicts ESDLC in this study.

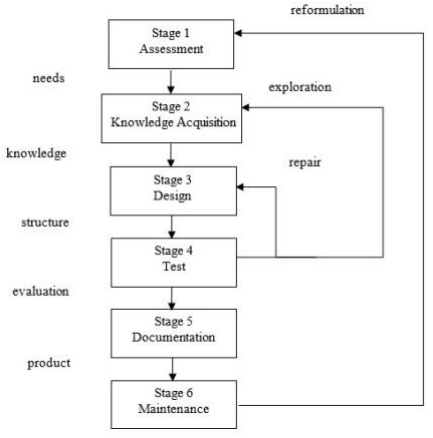

Fig. 1. Expert System Development Life Cycle

The development process of the expert system for early detection of ADHD risk in adults begins with the assessment stage, which identifies the core problem, defines system requirements, and determines the involvement of domain experts. This phase emphasizes analyzing user needs and conceptualizing an effective solution to support the diagnostic process through computational reasoning. In the knowledge acquisition phase, essential information is collected through structured interviews with psychologists specializing in ADHD and a comprehensive literature review. The data obtained include ADHD symptom patterns in adults, diagnostic rule classifications, and risk-level categorizations, which are systematically organized into a knowledge base to enable accurate inference and decision-making by the system.

The next stage, design, focuses on constructing the system's architecture and user interface, emphasizing usability and clarity. Unified Modeling Language (UML) diagrams, including use case and activity diagrams, are developed to illustrate the interaction between users and the system, followed by interface prototyping to validate user flow and functionality. During the testing phase, black-box testing is employed to verify that each functional component performs according to the design specifications, while an accuracy test evaluates the system's diagnostic performance against expert assessments. The documentation phase ensures all development artifacts—such as architectural blueprints, flow diagrams, and interface prototypes—are recorded to facilitate evaluation, reproducibility, and future enhancement. Finally, the maintenance phase involves periodic updates to fix software bugs, refine diagnostic rules, update symptom data, and incorporate user and expert feedback, ensuring the system remains reliable, up-to-date, and clinically relevant over time.

4. Experimental Setup

4.1 Assessment Stage

This stage includes two main parts:

a. Problem Analysis

Adult ADHD remains underrecognized in Indonesia despite growing awareness in recent years. Many adults with ADHD symptoms do not realize they may have the disorder due to the subtle and internal nature of adult symptoms, combined with persistent misconceptions that ADHD only affects children. This lack of awareness is worsened by limited access to mental health services, minimal local literature, and the absence of digital tools for self-screening. As a result, individuals may delay or avoid seeking proper diagnosis and support. Currently, there is no available system to help adults in Indonesia identify potential ADHD symptoms early through self-screening.

b. Needs Analysis

Needs analysis is required to support the development of the Expert System for Early Detection of ADHD Risk in Adults. This process consists of an information needs analysis (i.e., data on adult ADHD symptoms and risk levels) and a system requirements analysis covering the hardware and software used in this study. The tools used in this research are shown in Table 1.

4.2 Knowledge Acquisition Stage

a. Data Collection

Data were collected through two methods: literature review and expert interviews. The literature review focused on academic sources discussing ADHD in adults. Additionally, interviews were conducted with a psychologist specializing in adult ADHD to gather insight regarding symptoms, risk categorization, and rule-based

diagnostic considerations.

b. Knowledge Base

The knowledge base contains expert knowledge regarding ADHD risk levels, related symptoms, and inference rules. The ADHD Risk Level is shown in Table 2, the Symptoms of Adult ADHD in Table 3, and the Knowledge Base Rules in Table 4.

Table 1. ADHD Risk Level Table

Score Range	Risk Level
>= 24	High
17 - 23	Moderate
0 - 16	None

Table 2. Symptoms of Adult ADHD

Part	Symptom Code	Symptom Description
(A) Inattention	G001	Frequently makes careless mistakes when working on boring or difficult tasks
	G002	Difficulty maintaining attention on monotonous tasks
	G003	Trouble listening to others during direct interaction
	G004	Difficulty completing the final details of a task after finishing the hardest part
	G005	Struggles to organize or structure tasks that require order
	G006	Frequently avoids or delays tasks that require complex thinking
	G007	Often loses or misplaces items at home or work
	G008	Easily distracted by surrounding activities or noise
	G009	Often forgets appointments or obligations
(B) Hyperactive Impulsive	G010	Frequently fidgets or taps hands/feet when sitting for long periods
	G011	Often leaves the seat in situations where staying seated is expected
	G012	Restlessness or inability to stay still
	G013	Difficulty relaxing or unwinding during leisure
	G014	Feels driven to keep moving as if powered by a motor
	G015	Talks excessively in social situations
	G016	Interrupts others before they finish speaking
	G017	Difficulty waiting in line or taking turns
	G018	Frequently interrupts or intrudes on others' activities

Table 3. Knowledge Base Rules

ADHD Risk Level	Rule
High	IF total score Part A ≥ 24 OR total score Part B ≥ 24 THEN High ADHD Risk
Moderate	IF 17 ≤ total score Part A < 24 or 17 ≤ total score Part B < 24THEN Moderate ADHD Risk
None	IF total score Part A < 17 OR total score Part B < 17 THEN No ADHD Risk

5. Result and Analysis

5.1 System Implementation

The homepage provides a brief introduction to the ADHD Check system and includes a button that allows users to start the screening process. The system offers an FAQ page that contains frequently asked questions related to the screening process. Fig. 2 displays a list of sample questions related to adult ADHD symptoms.

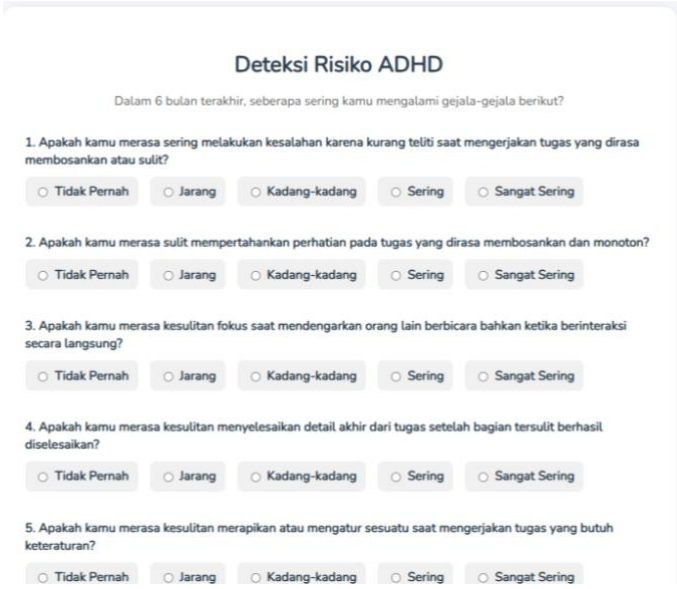

Fig. 2 Several questions related to adult ADHD symptoms.

5.2 Testing Stage

In this study, we evaluate the system using Blackbox Testing and Accuracy Testing.

a. Blackbox Testing

Blackbox Testing was conducted to examine the functionality of the system without considering its internal code or structure. The testing was conducted by distributing a questionnaire to 10 respondents, each consisting of 8 questions representing the main features of the system. Each question was answered with the option “Yes” if the system functioned as expected, or “No” if the system did not function properly. The results of the testing indicated that all features operated as expected by the users. Table 5 presents a summary of the testing results.

Table 4. Blackbox Testing

No	Feature Tested	Question	Respondent Responses		Percentage of Success
			Yes	No	
1	Homepage	Does the Homepage display system information and the “Take the Test” button?	10	0	100%
2	“Take the test” button	Does the “Take the Test” button function properly and redirect to the FAQ page after being clicked?	10	0	100%
3	FAQ Page	After clicking the “Next” button on the FAQ page, are you redirected to the Screening page?	10	0	100%
4	Screening Page	Can the Screening page be used to input symptoms based on the intensity experienced by the user?	10	0	100%
5	“Submit Answers” Button	After clicking the “Submit Answers” button, does the system display the test results page with the ADHD risk level?	10	0	100%
6	Results Page	Does the results page display recommendations according to the ADHD risk level?	10	0	100%
7	Download Results as PDF Feature	Does the download feature work and successfully download the test results in PDF format to the user’s device?	10	0	100%
8	Downloaded PDF file	Can the downloaded PDF test result file be opened and clearly read?	10	0	100%

Based on the Blackbox Testing conducted through questionnaires, a total of 10 respondents answered 8 questions that represented the system's core features, resulting in 80 possible responses. From these responses, 80 answers were "Yes" and 0 answers were "No," which indicates that every feature tested functioned properly as expected by the users. The accuracy of the testing can be calculated using the following formula:

$$\text{Accuracy (\%)} = \frac{Number\ of\ \text{"Yes" answers}}{Total\ Question \times Number\ of\ Respondents} \times 100\%$$

$$= \frac{80}{8 \times 10} \times 100\% = 100\%$$

This result shows that the system achieved an accuracy rate of 100%, which demonstrates that all implemented features operated successfully and met the intended functionality.

b. Accuracy Testing

Accuracy testing was performed to evaluate the alignment between the system's output and the expert's diagnosis. The system's conclusions were derived from a predefined rule-based mechanism using manually calculated references during the knowledge base construction. The test involved six user-submitted cases, and the results were then compared against expert evaluations. Table 6 presents the comparison between the system-generated results and expert diagnoses.

Table 5. Accuracy Testing Results

No	Part A Score	Part B Score	System Diagnosis	Expert Diagnosis
1	20	17	Moderate	Moderate
2	16	9	None	None
3	10	10	None	None
4	8	3	None	None
5	10	2	None	None
6	29	23	High	High
7	4	5	None	None
8	3	2	None	None
9	20	14	Moderate	Moderate
10	18	18	Moderate	Moderate

As shown in Table 6, the expert system produced results that were fully consistent with those of the domain expert. Based on ten test cases, the system achieved a 100% accuracy rate, calculated as follows:

$$\text{Accuracy (\%)} = \frac{10}{10} \times 100\% = 100\%.$$

These results demonstrate that the system is capable of accurately detecting ADHD risk levels based on predefined rules and expert knowledge.

5.3 Documentation Stage

This documentation explains the user guide for both Admin and User. The Admin documentation describes how to manage symptom data, tendency data, and detection result reports. The User documentation explains the steps for conducting ADHD risk

detection, starting from entering symptom data to viewing detection results. The Documentation Table is shown in Table 7.

Table 6. Documentation Table

No	Activity	Steps	Role
1	Access Dashboard Page	a. Access homepage b. Login c. Done	Admin
2	Access Symptoms Page	a. Enter the Symptoms Page b. Manage symptom data with CRUD operations c. Done	Admin
3	Access Tendency Data Page	a. Enter the Tendency Data Page b. Manage tendency data with CRUD operations c. Done	Admin
4	Access Detection Result Report Page	a. Enter the Detection Result Page b. View detection results c. Done	Admin
5	Access ADHD Risk Detection Test Page	a. Enter the Homepage b. Click Take Test c. Read the guidelines before taking the test (FAQ) d. Select experienced symptoms according to perceived intensity e. Click Submit Answers f. Done	User
6	Access Detection Result Page	a. View ADHD risk level results b. View handling recommendations c. Download detection results in PDF format d. Done	User

5.4 Maintenance Stage

The maintenance stage is carried out after the expert system has been completed. This stage is the regular system maintenance process, where the system can be updated or further developed. The maintenance of the Expert System for Detecting ADHD Risk in Adults is conducted until the research is completed. The maintenance activities carried out are shown in Table 8.

Table 7. System Maintenance

No	Maintenance Date	Before Maintenance	After Maintenance
1	September 10, 2025	Knowledge Base: To obtain detection results, each rule requires a minimum of 5 symptoms for each tendency.	Knowledge Base: Detection results based on total score without minimum symptoms
2	September 12, 2025	Login Page: No registration feature for new admins	Login Page: Added a registration feature for a new admin

6. Conclusion

This study proposed a detection technique for adult ADHD identification issues using the Forward Chaining method. The system was designed to guide users in self-screening and provide risk levels, including high, moderate, or none. The evaluation results demonstrated that the system achieved 100% functionality in black-box testing and 100% accuracy when compared with expert assessments, confirming its reliability and alignment with domain knowledge. These findings support current models that emphasize the potential of rule-based expert systems in improving accessibility to early mental health screening. The contribution of this research lies in its focus on adult ADHD, an area that is often overlooked in both clinical practice and digital innovation, especially in Indonesia. By providing a reliable and easy-to-use platform, this system can help individuals recognize potential ADHD symptoms earlier and encourage them to seek professional consultation, thereby reducing stigma and delays in diagnosis.

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