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A Knowledge-Based Stress Diagnosis System Using the Certainty Factor Approach and DASS-42 Psychological Indicators

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Abstract – **Stress is a natural physiological and psychological response to everyday demands, yet chronic stress can impair cognitive functioning, emotional regulation, sleep quality, social interaction, and academic or occupational performance. Access to mental health professionals remains limited and early detection is crucial. To address this issue, this study developed a Depression, Anxiety, and Stress Scale-42 (DASS-42)–based expert system for stress diagnosis using the Certainty Factor (CF) method. A key contribution of this work is the active involvement of licensed psychologists in knowledge elicitation, rule construction, symptom weighting, and iterative validation, ensuring clinical accuracy, reliability, and interpretability. The system underwent functional, usability, and diagnostic testing. Black Box Testing confirmed full feature performance (100%), indicating strong system stability. Usability evaluation using the System Usability Scale (SUS) produced a score of 78.375 (Grade B+, "Good"), with the highest acceptance among students and employees, and lower ratings from users with limited digital literacy. Diagnostic validation using 20 test cases assessed by two certified psychologists yielded an average accuracy of 87.5%, showing strong agreement between system results and expert judgment. These findings demonstrate that CF-based reasoning effectively models clinical evaluation *o*f 13 stress indicators from DASS-42, indicating the system's feasibility a reliable early stress-screening tool.**

Keywords— *Certainty Factor, DASS-42, Expert System, Mental Health Screening, Stress Diagnosis*

INTRODUCTION

Stress is a psychophysiological response to life pressures that is widely experienced by final-year university students due to academic burdens, thesis completion demands, and future career anxiety [1–3]. This condition is often exacerbated by students' reluctance to seek professional help due to cost and social stigma surrounding mental health, causing many stress cases to remain untreated and progress into anxiety, sleep disorders, academic performance decline [1,3–5]. Previous studies show that unmanaged academic stress can reduce psychological well-being, lower productivity, and potentially delay student graduation [6-7].

Expert system approaches using the Certainty Factor (CF) method have been widely adopted in mental health diagnostics, showing accuracy levels ranging from 85% to 91.11% in prior studies [2,5,8,9]. The CF method is capable of representing expert confidence in inference processes, making it suitable for modeling psychological conditions with inherent uncertainty. However, most existing research focuses on depression diagnosis, does not specifically address academic stress using standardized psychometric instruments such as DASS-42 [4], and has not developed an expert system that provides accessible early intervention recommendations.

Based on these gaps, there is a strong need for an expert system that diagnoses stress using DASS-42 indicators and integrates the CF method to improve diagnostic confidence and accuracy as a preliminary self-screening tool prior to professional consultation. Thus, this research problem includes: (1) what stress symptoms in DASS-42 are relevant for diagnosis, (2) how to design an expert system based on these symptoms, and (3) how the CF method can enhance diagnostic accuracy. The aims of this study are to: (1) identify stress symptoms within DASS-42, (2) develop an expert system for stress diagnosis based on these symptoms, and (3) implement the CF method to strengthen diagnostic confidence, providing an accurate, affordable, and easily accessible mental health screening alternative.

This study was further strengthened through active involvement of three mental health experts recruited through a structured expert selection process, including two clinical psychologists working in public health centers and one academic psychologist. The inclusion of domain experts is a well-established approach for eliciting tacit and experiential knowledge, particularly in diagnostic systems where outcomes are influenced by subjectivity and uncertainty. Expert-based knowledge acquisition not only improves the reliability of the knowledge base but also ensures contextual relevance of decision rules and inference mechanisms, as emphasized in prior studies on expert system development.

METHOD

This study applies the Expert System Development Life Cycle (ESDLC) as the main methodological framework for developing a stress diagnosis expert system. ESDLC refers to a structured methodology applied in the development of expert systems, encompassing stages of assessment, knowledge acquisition, system design, testing, and documentation [10 - 11].

This approach serves as a systematic guideline to ensure each development phase is executed in an organized and well-directed manner. By adopting ESDLC, both the knowledge base and the overall workflow of the expert system can be consistently monitored and refined. The following section outlines each phase of the ESDLC methodology.

Assessment – This phase involves conducting preliminary analysis and feasibility evaluation for system development. Relevant references, such as related scientific articles and textbooks, are reviewed to support problem identification and system requirements gathering.

Knowledge Acquisition – In this stage, essential domain knowledge is collected through direct expert engagement, including interviews and observations. The accuracy and credibility of information depend significantly on the expertise of the selected subject matter expert.

System Design – This phase focuses on transforming the acquired knowledge and requirements into system blueprints. It includes designing the user interface, structuring system workflows, and modeling the architecture of the expert system.

Testing – The developed system undergoes validation to ensure correct functionality and to prevent errors such as inaccurate inference or misdiagnosis. Testing results are often compared with expert evaluations to verify system reliability and alignment with domain knowledge. The testing and evaluation phase consisted three key testing methods: Black Box Testing, System Usability Scale (SUS) evaluation, and Expert Diagnosis Comparison.

According to prior studies, SUS is a standardized questionnaire used to measure system usability based on users' subjective perception. Developed by John Brooke in 1986, SUS remains widely adopted due to several advantages: it is easy to administer, generates a simple score from 0–100, does not require complex calculations, is freely available without cost, and has been proven valid and reliable even with small sample sizes [12-13].

Documentation – The final stage involves preparing comprehensive documentation that explains the system's deployment, operational procedures, and user guidelines to ensure ease of adoption and long-term usability by end users.

ESDLC methodology integrates expert-based knowledge with an uncertainty reasoning model using Certainty Factor (CF) to quantify confidence levels in psychological symptom diagnosis.

RESULTS AND DISCUSSION

The expert selection process involved three qualified mental health practitioners, consisting of two clinical psychologists from community health centers and one academic psychologist.: (1) Siti Rahmawati, M. Psi., (2) Ardias Nugraheni, S. Psi., M. Psi., Psikolog, and (3) Ratu Rantilia, M. Psi., Psikolog. Input from domain experts is a validated approach to capturing tacit knowledge, especially in diagnostic systems where subjectivity and uncertainty are inherent.

The Assessment phase focuses on problem identification and system goal formulation. The identified problem is the lack of accessible early stress screening tools for students reluctant to seek professional psychological support. Therefore, the system is designed as a web-based early stress screening instrument built to provide initial diagnostic insights using DASS-42 stress indicators and CF reasoning to model diagnostic uncertainty [5].

The primary objective of the system is to perform preliminary stress screening, assist users in understanding symptom severity, and generate early self-awareness toward mental health conditions without stigma or financial barriers. Expert system objectives are designed to deliver interpretable reasoning and actionable suggestions for users, fulfilling usability and clinical decision-support principles.

The Knowledge Acquisition phase involves formalizing psychological knowledge into a machine-readable knowledge base. Symptoms are extracted from expert interviews and aligned with stress components of the DASS-42 framework. Each symptom is assigned a CF value by experts, then aggregated using averaged CF scoring to generate a consolidated knowledge weight representing confidence agreement among experts.

The resulting knowledge base contains 13 validated stress symptoms as shown in Table 1, such as irritability, panic responses, emotional instability, and restlessness, each quantified by expert confidence values. These structured rules will later be used in the inferencing engine to compute stress likelihood based on user responses. The combination of ESDLC methodology and CF reasoning ensures the system is scientifically grounded, traceable, transparent, and diagnostically reliable for early stress screening.

Table 1. Symptoms of DASS-42

No.	Code	Symtoms
1.	G1	Easily irritated by small things
2.	G2	Tends to overreact to situations
3.	G3	Mouth feels dry
4.	G4	Easily feel upset about many things that happen around you
5.	G5	Feeling like you spend a lot of energy because of anxiety
6.	G6	Impatient
7.	G7	Gets angry easily at things
8.	G8	Easily offended
9.	G9	Panic easily
10.	G10	Fear of being overwhelmed by tasks tasks usually performed
11.	G11	Difficulty calming down after something upsetting
12.	G12	Unable to tolerate anything that prevents you from completing what you are doing
13.	G13	Being easily agitated

The Design phase consists of several modeling representations, including the Use Case Diagram, Activity Diagram, and Entity Relationship Diagram (ERD). Each of these models provides a different perspective of the system's structure and behavior, enabling a more holistic understanding of how users interact with the system and how the system processes data internally.

Use Case Diagram illustrates the functional interactions between the user (actor) and the system. It provides an overview of how users engage with the system to achieve specific goals, typically through scenarios that reflect real-world behavior. In this research, as depicted in Fig 1, the primary actor is the end user, which may include students or members of the general public seeking to assess their stress level through self-screening. The secondary actor is the domain expert or system administrator, responsible for managing the knowledge base, defining and validating diagnostic rules, and ensuring the clinical accuracy of the system's reasoning model.

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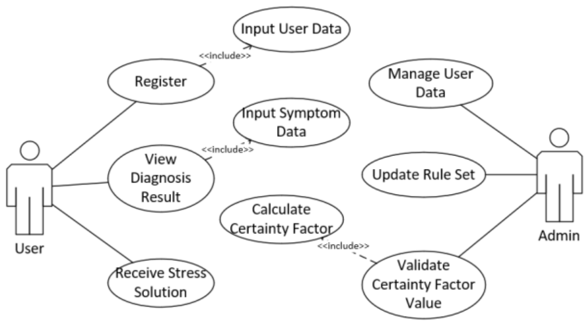

Figure 1. Stress Diagnosis Expert System Use Case Diagram

In the proposed system, the user interacts by inputting symptom data derived from the DASS-42 questionnaire. The system then processes this input to generate a diagnosis and corresponding stress-level category. After that, user can view the diagnosis Each function the user performs—such as "Input Symptom Data," "View Diagnosis Result," and "Receive Stress Management Suggestions"—is represented as a use case.

The administrator's use cases include "Manage User Data", "Update Rule Set," and "Validate Certainty Factor Values." By structuring these interactions, the use case diagram ensures that all user needs and system responsibilities are captured systematically. The diagram also aids in identifying potential system extensions, such as adding consultation features or integrating machine learning modules in the future. Overall, the use case model ensures that the system design remains user-centered and logically coherent.

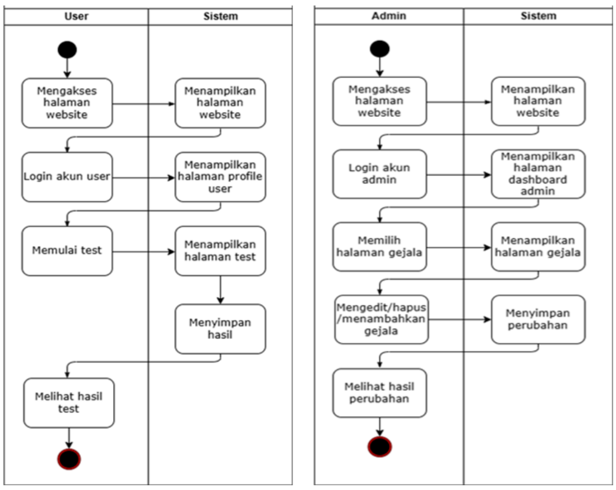

Figure 2. Activity diagram of user and administrator

The Activity Diagram illustrates the sequential flow of operations that occur within the system, from the moment a user initiates input until the final diagnosis result is displayed. This diagram maps out the procedural logic of how the system processes user data. Figure 2 depicte part of activity flow of user and admin.

The Entity Relationship Diagram (ERD) defines the structure of the database that supports the expert system. The ERD in this research as depicted in Fig. 3 identifies the main entities—such as User, Symptom, Diagnosis, Rule, and Certainty Factor—and describes how these entities are related. For example, one user can have multiple symptom entries, and each symptom may be associated with one or more diagnostic rules. The relationship between the Rule and Certainty Factor entities ensures that each rule has a confidence level stored and referenced during inference.

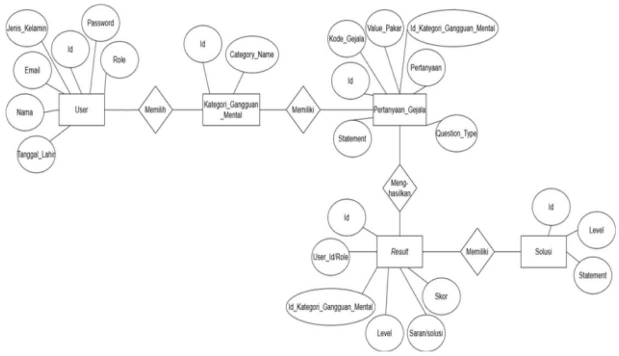

Figure 3. ERD of stress diagnosis expert system

Figure 4. Login Page, Test Page, Diagnosis Result Page

The selected interface designs for both user and administrator roles illustrated in Figure 4. The **login page** serves as the entry point for all users. It allows users to either register for the first time or log in using existing credentials. The authentication process ensures that user data is secure and personalized, enabling users to track their previous test results. Once authenticated, the user gains access to the main features of the system, including the stress diagnosis module.

This implementation emphasizes security through input validation and encrypted password storage. Additionally, the login page includes simple visual design elements that prioritize accessibility and clarity, helping first-time users navigate the interface easily.

The test page is the central component of the system, where users provide responses to a set of symptom-related statements derived from the DASS-42 questionnaire. Each symptom corresponds to a variable in the system's knowledge base, which is processed using the CF method.

Upon submission, the system calculates the CF value for each symptom and aggregates the confidence levels to infer the degree of stress experienced by the user. This mechanism allows the expert system to emulate expert reasoning by combining multiple sources of evidence with varying levels of certainty.

The interface on this page was designed to be intuitive, using form controls such as checkboxes and Likert-scale options, allowing users to respond quickly and consistently. The diagnosis results page displays the computed outcomes after the user completes the test. The results are presented in an informative and visually clear manner, showing the stress level category (e.g., mild, moderate, or severe) along with recommendations for managing stress.

The recommendations are generated based on pre-defined rules provided by psychological experts and stored within the knowledge base. Each result also includes the certainty value, which indicates the degree of confidence associated with the system's inference. This provides transparency, helping users understand how the system arrived at its conclusion.

After designing the use case, activity, database structure and the user interface, system ready to built. The system was developed using PHP and MySQL, supported by standard web technologies such as HTML, CSS, and JavaScript to create an interactive and user-friendly interface.

The completed system was deployed in a local web server environment for initial testing and validation. Integration testing was conducted to ensure seamless interaction among system modules—particularly between the rule-based reasoning engine and the user interface. Database connectivity was also verified to ensure that user inputs, symptom data, and CF values were stored and retrieved accurately.

The testing and evaluation phase consisted three key testing methods: Black Box Testing, System Usability Scale (SUS) evaluation, and Expert Diagnosis Comparison. Black Box Testing was conducted to verify that all system functions operated as expected without examining the internal code structure. The test ensured that core features such as registration, login, stress assessment, history tracking, psychologist service recommendations, and logout operated correctly according to predefined functional requirements. The results from 11 test cases demonstrated that 100% of tested cases were marked as valid, indicating that every system function performed successfully, produced the expected output, and displayed no critical errors. These results confirm that the system is functionally stable and ready for usability and diagnostic accuracy testing.

After validating system functionality, usability evaluation was carried out using SUS. The SUS survey was distributed to 20 respondents representing three user categories: 10 students, 5 employees, and 5 housewives, with an age range dominated by 19–27 years (65%). This category is made based on the level of computer literacy. SUS scores were calculated for each group: students achieved 82.75 (Grade A), employees 80 (Grade A-), and housewives 68 (Grade C). The lower score in the housewife group reflects challenges related to lower familiarity with digital platforms, highlighting a need for additional interface guidance or onboarding support. When all responses were aggregated, the system achieved an overall SUS score of 78.375 (Grade B+, adjective rating: "Good"), indicating that the system is generally acceptable, easy to use, and well-received, particularly by users under 45 years old with moderate to high digital literacy.

Qualitatively, the SUS evaluation revealed that users found the system interface intuitive, the stress diagnosis results easy to understand, and the solution recommendations relevant. Student and employee respondents highlighted that the percentage score and stress category helped them better interpret their mental condition. However, several respondents from the housewife group reported a need for clearer instructions, larger button visibility, and simpler navigation. These qualitative findings underscore that although the system meets general usability benchmarks, adaptive UI enhancements could further broaden accessibility for less digitally experienced users.

To measure diagnostic accuracy, the system's stress classification results were compared against assessments from two licensed psychologists using 20 real test cases. The results show that Expert 2 achieved 85% agreement with the system (17/20 matches), while Expert 3 achieved 90% agreement (18/20 matches). Using the average accuracy formula, the system obtained an overall diagnostic accuracy score of 87.5%. Misclassifications mostly occurred between "mild" and "moderate stress" categories. Three and two from 20 "moderate stress" system result are considered not valid for expert 2 and expert 3. It is largely due to overlapping symptom interpretations and differing expert judgment thresholds. These findings demonstrate that the system performs within an acceptable clinical alignment range when benchmarked against human experts.

Overall, the testing results indicate that the system is functionally valid (100% success rate), highly usable (SUS 78.375 - Good), and diagnostically reliable (87.5% accuracy). The combination of quantitative evidence and qualitative insights confirms that the developed expert system is technically robust, user-friendly for its main target demographic, and sufficiently accurate as a stress screening tool prior to professional consultation. Future improvements should prioritize UI simplification, guided user onboarding, and refinement of symptom weighting to further improve classification consistency, especially for mild stress differentiation.

CONCLUSION AND RECOMMENDATION

The testing phase confirmed that the expert system performs reliably from both a functional and diagnostic perspective. Black Box Testing verified that 100% of core features—including registration, login, testing, profile management, history, and psychologist service navigation—operated as expected, indicating high system stability. Usability evaluation using the System Usability Scale (SUS) produced an overall score of 78.375 (grade B+, "Good"), demonstrating that users generally found the system intuitive and acceptable for stress self-assessment. The highest acceptance was observed among students and employees (SUS 82.75 and 80), while lower usability was reported by housewives (SUS 68), highlighting differences in digital literacy.

Expert validation further strengthened the reliability of the system. Accuracy testing across 20 cases reviewed by two certified psychologists produced matching diagnoses in 17 cases (85%) and 18 cases (90%), yielding an average accuracy of 87.5%. These results confirm strong agreement between system decisions and clinical judgment, demonstrating that the Certainty Factor (CF) inference model effectively captures expert reasoning when diagnosing stress symptoms based on 13 stress items derived from the DASS-42 framework. The combination of high diagnostic accuracy and positive usability rating indicates that the system is feasible as an early stress detection tool for the general public.

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