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Digital innovation in islamic guidance: Fuzzy mamdani-based stress level detection for muslim adolescents

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Abstract

Purpose - The purpose of this study is to address the urgent need for a reliable and accessible preliminary assessment tool for mental health issues among Indonesian adolescents, a demographic significantly impacted by recent societal changes and showing high rates of psychological distress (e.g., 34.9% experiencing mental problems per I-NAMHS 2022)

Method - The methodology employed is the design and development of a web-based expert system utilizing Fuzzy Logic to diagnose stress symptoms. The system is structured with four core components (User Interface, Knowledge Base, Inference Mechanism, Working Memory) and incorporates Fuzzy Tsukamoto/Mamdani/Sugeno principles for mapping firm numerical symptom inputs to linguistic variables through Fuzzification and Defuzzification processes.

Result - The result (anticipated/achieved) is a functional, dual-role web system (Admin/User) capable of providing objective, preliminary stress categorization, thereby serving as a first step toward early intervention.

Implication – The implication of this work is twofold: clinically, it provides an immediate, non-expert-dependent tool for initial screening; ethically and religiously, it supports the collective obligation (fard kifayah) to safeguard youth mental well-being and maintain their fitrah.

Originality/Value - The originality of this research lies in the specific integration of Fuzzy Logic reasoning within a web-based expert system tailored explicitly to the Indonesian adolescent context for stress awareness and preliminary diagnosis.

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Kata kunci:
Nilai-nilai Islam, pendekatan spiritual, konseling berbasis keyakinan.

Abstrak

Tujuan - Tujuan studi ini adalah untuk memenuhi kebutuhan mendesak akan alat penilaian awal yang andal dan mudah diakses untuk masalah kesehatan mental di kalangan remaja Indonesia, kelompok demografis yang sangat terdampak oleh perubahan sosial terkini dan menunjukkan tingkat gangguan psikologis yang tinggi (misalnya, 34,9% mengalami masalah mental menurut I-NAMHS 2022)

Metode - Metode yang digunakan adalah desain dan pengembangan sistem pakar berbasis web yang memanfaatkan Logika Fuzzy untuk mendiagnosis gejala stres. Sistem ini terdiri dari empat komponen inti (Antarmuka Pengguna, Basis Pengetahuan, Mekanisme Inferensi, Memori Kerja) dan mengintegrasikan prinsip-prinsip Fuzzy Tsukamoto/Mamdani/Sugeno untuk memetakan masukan numerik gejala yang pasti ke variabel linguistik melalui proses Fuzzifikasi dan Defuzzifikasi.

Hasil - Hasil (diperkirakan/tercapai) adalah sistem web fungsional dengan dua peran (Admin/Pengguna) yang mampu memberikan kategorisasi stres awal yang objektif, sehingga berfungsi sebagai langkah awal menuju intervensi dini.

Implikasi – Implikasi dari penelitian ini dua arah: secara klinis, menyediakan alat skrining awal yang segera dan tidak bergantung pada ahli; secara etis dan agama, mendukung kewajiban kolektif (fard kifayah) untuk melindungi kesejahteraan mental remaja dan menjaga fitrah mereka.

Orisinalitas/Nilai - Keaslian penelitian ini terletak pada integrasi spesifik logika fuzzy dalam sistem pakar berbasis web yang dirancang khusus untuk konteks remaja Indonesia dalam kesadaran stres dan diagnosis awal.

Introduction

Humans have several phases in life, one of which is the adolescent phase (Lewis, 2022). The adolescent phase is a transitional stage between childhood and adulthood. Zikry mentioned that in 2015, population projections in Indonesia showed that the number of adolescents aged 10-24 years reached more than 25% or around 66 million of the total population (Zikry et al., 2020). Based on this research data, we assume that in 2024 the number of Indonesian teenagers has increased significantly. This can be seen from the population census data in 2023. According to the Indonesian Central Bureau of Statistics, in the last 10 years, the percentage of adolescents in Indonesia reached 23.18% or around 64.16 million people.

The COVID-19 pandemic has had a significant impact on the pattern of life of the Indonesian people, especially in terms of mental health (Wahyuhadi et al, 2022; Karuniawati et al, 2022; Desdiani, 2022). This is because there are significant changes, which make it difficult for people to adapt to the new patterns of life that must be lived after the COVID-19 pandemic. With this change in lifestyle and information about COVID-19, the level of community stress has increased (Setyaningrum & Yanuarita, 2020). In addition, if we look at the data on suicides during January - November 2023, which reached 37 complaints received by KPAI, it indicates that there are problems regarding mental health experienced by adolescents.

Seeing the important role of adolescents in the development of the nation and world civilization makes the topic of adolescent mental health a very important topic to pay attention to. According to the Indonesian Ministry of Health in 2018, the number of adolescents in Indonesia aged 10-14 years was 22.878, and for adolescents aged 15-19 years 22.242 people suffering from emotional disorders in the form of stress, depression, and anxiety in adolescents (Khasanah et al., 2021).In addition, based on the results of research conducted by the Indonesia-National Adolescent Mental Health Survey 2022 (I-NAMHS) in 2022, it was stated that this survey was conducted on 10.000 adolescents aged 10-17 years in 34 provinces in Indonesia. The survey results showed that 34.9% of adolescents experience mental problems and 5.5% experienced mental disorders. The most common mental disorder experienced by adolescents was anxiety disorder (3.7%), followed by major depressive disorder (1.0%), conduct disorder (0.9%), and post-traumatic stress disorder (PTSD) (0.5%). (I-NAMHS: Indonesia-National Adolescent Mental Health Survey, 2023).From these data, it can be seen that people with mental disorders reach a fairly high number, which if not immediately taken early treatment steps are feared to affect the future of adolescents and the Indonesian nation. In the context of Dakwah, promoting mental well-being is considered fard kifayah (a collective obligation) within the community, as psychological distress hinders an individual's ability to fulfill their spiritual, moral, and social duties. Therefore, early, accurate diagnosis of stress is not merely a clinical necessity but an ethical imperative to help the youth maintain their fitrah (innate goodness).

One of the efforts that can be made to regrow teenagers' awareness of stress is by providing education and understanding to teenagers about the importance of recognizing stress and maintaining mental health. The utilization of technology such as web-based expert systems can be an alternative solution. Expert systems can help teenagers (even adults) recognize self-symptoms related to mental health.

An expert system is a computerized system that uses knowledge of a particular field to solve a problem from that field where the solution provided is by the knowledge of an expert or someone who is an expert in that field. In designing an expert system, several components are needed, including (Janjanam et al, 2021; Sabzaliyev, 2024):

1. User interface

The User Interface is a crucial component that bridges the gap between novice or specialist users and the core intelligence of an expert system. Its function is to enable easy and intuitive interaction. Users input data, questions, or symptoms through this interface, and in return, the system clearly presents conclusions, diagnoses, or recommendations. Its design must minimize the user's need for knowledge about the system's internal structure. An effective interface ensures that the input provided is accurate and the resulting output is easily understood, thereby enhancing the overall adoption and usability of the expert system.

2. Knowledge base

The Knowledge Base is the heart of an expert system, where all domain knowledge is gathered, organized, and stored. This knowledge is typically represented in the form of production rules (such as *IF-THEN*), frames, or semantic networks, which reflect an expert's understanding. This component separates the specific knowledge from the reasoning mechanism. The knowledge base must be comprehensive, consistent, and well-structured. The quality and depth of the information here directly determine the limits of capability and the accuracy of the solutions that the expert system can provide.

3. Inference mechanism

The Inference Mechanism functions as the "brain" of the expert system. Its primary task is to reason based on the knowledge stored in the Knowledge Base and the temporary facts present in the Working Memory. This mechanism applies search strategies, such as forward chaining (reasoning from data to a conclusion) or backward chaining (reasoning from a goal back to the needed data), to process user input. It determines the order in which rules should be evaluated and how to draw logical conclusions from the existing evidence, simulating an expert's thought process.

4. Working memory

The Working Memory is a dynamic temporary storage area within the expert system, similar to human short-term memory. This component holds the specific facts relevant to the current problem-solving session. When the user enters initial data, or when the Inference Mechanism generates a new partial conclusion from the Knowledge Base, that information is placed in the Working Memory. This component is constantly updated throughout the session, and the Inference Mechanism will continuously refer to it to continue the reasoning process until a final solution or a valid conclusion is reached.

Of the four components to consider, the user interface is crucial because the expert system must provide a user-friendly communication medium. This is essential since the system is intended for general users, not experts. The knowledge base is another component, consisting of a set of expert-level knowledge in a specific field, stored in a particular format. The knowledge comes from various sources. The inference engine in an expert system can be said to be the brain of an expert system. This brain is in the form of software that performs inference reasoning about the input received by the system. The last component is working memory. Working memory is a part of place of the system to store knowledge or facts owned by the system(Fauzan Masykur, 2012). In the field of expert systems, there is a logic of thinking called Fuzzy logic. Fuzzy logic was first introduced by Professor Lotfi A. Zadeh who came from the University of California in June 1965. Fuzzy logic is a generalization of classical logic which only has two membership values consisting of 0 and 1. In Fuzzy logic, the truth value ranges from completely true to completely false, so that an object can be a member of many sets with different degrees of membership (Fauzan Masykur, 2012; Karim, 2025).

Fuzzy logic has several types, such as Fuzzy Tsukamoto, Fuzzy Mamdani, Fuzzy Sugeno, and others (Olmedo-García et al, 2025; Murnawan & Lestari, 2021; Yogachi et al, 2021). In general, Fuzzy logic is the right way to map an input into an output which has 4 stages, namely:

1. Entering a rule base that contains rules or knowledge sourced by an expert.
2. Decision-making mechanism based on expert knowledge that has been owned by the system.
3. Fuzzification process, where inputs in the form of firm numbers are then converted into fuzzy variables or linguistic variables.
4. Defuzzification process, this process is the opposite of the fuzzification process, where this process converts the result of the inference engine into firm numbers (Budiman & Arifin Toni, 2022).

Using Fuzzy logic and website technology, in designing this expert system users will be categorized into two types, namely admin and user, where the admin can manage all users (admin and users) and stress symptoms. While the user can only diagnose and see the diagnosis results.

The significance of conducting this study thus lies in the urgent need to establish a reliable, accessible, and objective tool capable of performing preliminary stress assessment for this high-risk demographic, thereby facilitating timely intervention and supporting the community's religious and moral obligation to safeguard its youth.

Research Methods

The research method used to build this Expert System for Diagnosing Levels of Stress in Adolescents Using Web-Based System is a quantitative method by applying Fuzzy Mamdani to conclude or make decisions objectively. Meanwhile, the system development process includes requirement analysis, design, and system development in stages and sequentially using SDLC Waterfall.

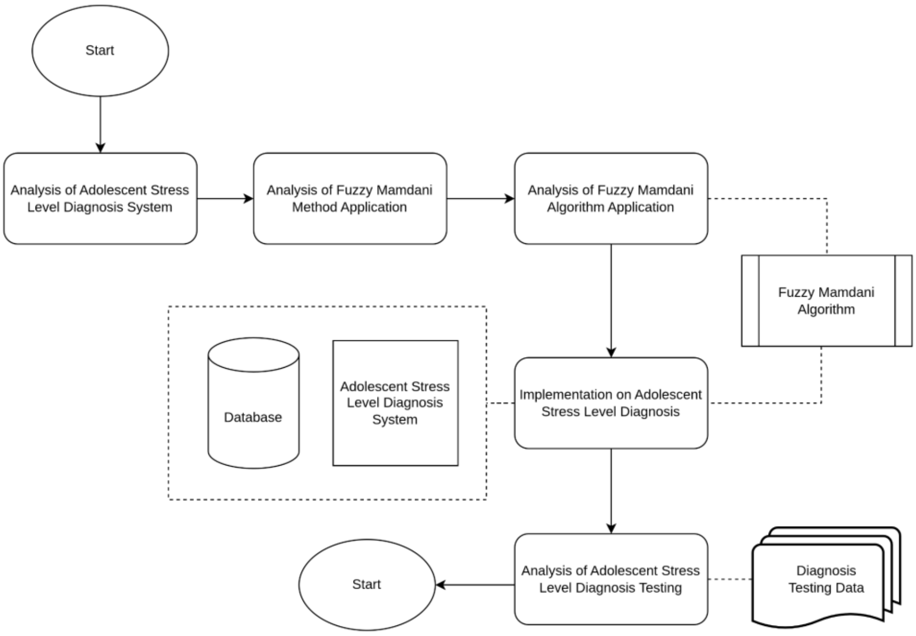

Figure 1. Research Method Flowchart Diagram

Figure 1 shows the workflow for a stress level diagnosis system for adolescents utilizing the Fuzzy Mamdani method. The process commences at the Start point, proceeding to the Analysis of the Adolescent Stress Level Diagnosis System. This is followed by the Analysis of the Fuzzy Mamdani Method Application, which leads to the Analysis of the Fuzzy Mamdani Algorithm Application, with the algorithm itself also referenced in a separate block. Subsequently, the analysis results are realized through the Implementation in Adolescent Stress Level Diagnosis, which is also linked to the database (DB) storing the Adolescent Stress Level Diagnosis System. The final stage before End is the Analysis of the Adolescent Stress Level Diagnosis Testing, which generates the Diagnosis Testing Data, concluding the entire process flow.

Data Collection Method

In this study, researchers collected data and information to support the truth and success of this research using literature studies and field studies, literature studies carried out are by multiplying reference sources from articles, journals, and printed books related to research, and filed studies conducted in this data collection are as follows:

During the interview phase, researchers consulted with two individuals from psychology backgrounds—Agil Wahyu Wicaksono and student Zumrotin Ummi Fadhilah—to gain specific insights into the classification and symptoms of adolescent stress. The results indicated that stress is influenced by social pressures and parenting styles, categorized into mild, moderate, and severe levels based on behavioral indicators like overthinking or feelings of inferiority. While stress can drive positive coping mechanisms, it can also lead to negative behaviors such as substance abuse if not managed well. The interviewees concluded that while an expert system would be beneficial for helping adolescents recognize their mental health condition through initial diagnosis, it is crucial that this system serves only as a preliminary tool. Professional follow-up remains essential to prevent misunderstanding and the risks associated with self-diagnosis.

System Development Method

After collecting data, researchers developed this web-based expert system using the SDLC Waterfall method which is often used in software design starting from the concept planning stage (Requirement Analyst), system modeling (System Design), implementation, testing, and maintenance (Maintenance). In SDLC Waterfall, the next stage cannot be done if the previous stage has not been completed(Alif Ramadhan et al., 2023)

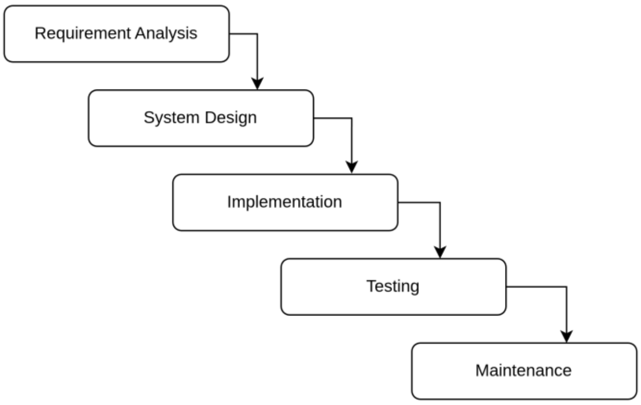

Figure 2. SDLC Waterfall Diagram

The steps in developing this system, as shown in Figure 2, are:

1. Requirement Analysis
   At this stage, the researcher analyzes to understand what needs to be included in the system.
2. System Modeling
   This system modeling stage includes designing a system database and designing a system model using a Data Flow Diagram (DFD).
3. Implementation (Coding)
   In this implementation stage, researchers designed an expert system using the PHP programming language with the Laravel framework. To manage the database, researchers use the MySql programming language and MySql Workbench 8.0 CE tools.
4. Testing
   The testing stage is carried out to avoid any bugs or errors contained in the system. At this stage, researchers use the Black Box Testing method.
5. Maintenance
   This maintenance stage aims to maintain system performance so that it can continue to run well and as an evaluation for developers when problems occur in the future with this expert system.

Results and Discussion

By using the Fuzzy Mamdani method as the inference process, 4 steps must be taken starting from entering rules based on the knowledge that has been obtained from an expert, the fuzzification process, the fuzzy inference process, and the last step is the defuzzification process.

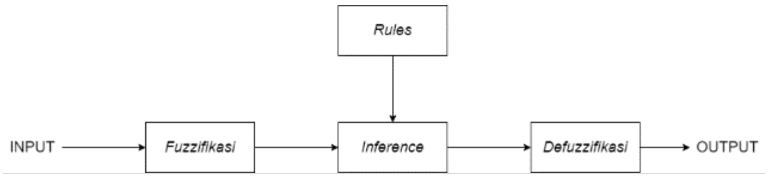

Figure 3. Inference Process Using Fuzzy Mamdani

Figure 3 illustrates the core structure of a Fuzzy Inference System, typically a Mamdani-type system, commencing with the crisp INPUT which undergoes Fuzzifikasi (Fuzzification) to convert it into linguistic variables. These fuzzy inputs are then processed in the Inference stage, where they are evaluated against a set of established Rules (the rule base) to determine the resulting fuzzy output set. Finally, the fuzzy output from the inference engine is converted back into a single, crisp value through the Defuzzifikasi (Defuzzification) process, yielding the final OUTPUT of the system.

Fuzzy Mamdani Implementation

The Mamdani model is often also known as the max-min method, where implementing this model requires 4 stages, namely:

a) Fuzzy Set Formation (Fuzzification)

Entering an input in the form of a firm number (crisp) which will be processed into a fuzzy variable (linguistic variable). In this stage, the incoming input will be converted into linguistic variables (for example: light, medium, high level). The linguistic variables will enter the inference engine and the results will go through the defuzzification stage before the output is given to the user.

In this system, there is one linguistic set of symptoms. In this set of linguistic symptoms, there are three levels of diagnosis, namely mild stress, moderate stress, and acute stress. The following is a table of interval linguistic values for each diagnosis:

Table 1. Linguistic Values Table

No	Linguistic value	Linguistic value interval
1	Normal symptom	0 ≤ 1.0
2	Moderate symptom	1.1 ≤ 3.0
3	Dominant symptom	3.1 ≤ 5.0

Based on Table 1. Linguistic Values, clinical symptoms are classified into three main categories based on their value range. The first category is Normal Symptom (0 ≤ 1.0) which covers a value range from 0 to 1.0. The next category is Moderate Symptom (1.1 ≤ 3.0), with a slightly higher value range, namely from 1.1 to 3.0. Finally, the most serious and prominent symptoms are grouped as Dominant Symptom (3.1 ≤ 5.0), which includes values from 3.1 to 5.0. This classification provides a clear framework for interpreting the severity of clinical symptoms based on the established numerical scale.

b) Determine the Rule

Then based on the data that has been obtained from literature studies and the results of interviews with experts who mention that 3 levels of stress can be experienced by a teenager, namely mild stress, moderate stress, and acute stress and there are 49 symptoms that researchers have given point weights between 1, 3, and 5 per the data obtained where the data will be used to determine the membership results when the fuzzification process is carried out.

Symptoms that indicate the occurrence of stress have been summarized by researchers in a table with a total of 49 symptoms, and each symptom is given a weight value of 1, 3, or 5 based on the seriousness of the symptoms experienced by the patient. The following is a table of stress symptoms with a weight value for each characteristic, the value of each characteristic will be processed using the Fuzzy Mamdani method to determine the level of stress experienced by a patient:

Table 2. Symptom Data and Weights

Symptom Code	Level Code	Symptom (Gejala)	Weight
G1	T1	Stomach ache	1
G2	T2	Hives/Rashes	1
G3	T3	Muscle weakness	1
G4	T4	Changes in appetite (more/less)	1
G5	T5	Changes in body weight	1
G6	T6	Changes in menstrual patterns (in adolescent girls)	1
G7	T7	Irritability	1
G8	T8	Difficulty sleeping	3
G9	T9	Feeling tired	1
G10	T10	Feeling worthless	1
G11	T11	Feeling helpless	3
G12	T12	Feeling meaningless	3
G13	T13	Absenteeism from school	1
G14	T14	Increased social media use	1
G15	T15	Becoming more easily influenced by others	1
G16	T16	Becoming more impulsive	5
G17	T17	Digestive problems (nausea, vomiting, constipation, diarrhea)	1
G18	T18	Muscle pain	1
G19	T19	Headache	1
G20	T20	Dizziness	1
G21	T21	Heart palpitations	3
G22	T22	Weakness	3
G23	T23	Exhaustion/Fatigue	3
G24	T24	Changes in sleep patterns (excessive/insufficient sleep)	5
G25	T25	Anxiety	5
G26	T26	Depression	5
G27	T27	Anger	3
G28	T28	Sadness	3
G29	T29	Worry	3

G30	T30	Confusion	3
G31	T31	Loss of motivation	3
G32	T32	Loss of interest in preferred activities	3
G33	T33	Difficulty concentrating	3
G34	T34	Withdrawal from social environments	3
G35	T35	Solitude/Isolation	3
G36	T36	Experiencing personality changes	3
G37	T37	Becoming more aggressive	5
G38	T38	Becoming more passive	1
G39	T39	Procrastinating tasks	1
G40	T40	Insomnia	5
G41	T41	Eating disorder (anorexia, bulimia)	1
G42	T42	Suicidal thoughts and behavior	5
G43	T43	Substance abuse (alcohol, narcotics)	5
G44	T44	Panic	3
G45	T45	Depersonalization	3
G46	T46	Derealization	3
G47	T47	Violent behavior	5
G48	T48	Risky sexual behavior	1
G49	T49	Legal problems	1

Table 2 shows the Symptom Data and Weights table details the knowledge base utilized in the stress diagnosis system, comprising 49 distinct symptoms categorized by their severity or impact. Each symptom, identified by a unique Symptom Code (Kd Gejala) (e.g., G1 to G49), is associated with a Weight (Bobot) of 1, 3, or 5, reflecting its contribution to the overall stress level calculation. Symptoms assigned a weight of 5 represent the most critical indicators, such as Insomnia (G40), Anxiety (G25), and Suicidal thoughts and behavior (G42), indicating severe manifestations of distress. Conversely, symptoms like Stomach ache (G1) and Feeling tired (G9) are assigned the lowest weight of 1, suggesting a lower severity contribution. These weighted inputs are essential for the subsequent Fuzzy Mamdani inference process, as the system aggregates these values to map the experienced symptoms against the predetermined stress level codes (T1 through T49) to ultimately determine the final diagnosis.

c) Fuzzy Inference

After obtaining the rules, the researcher proceeds to the next stage, namely the Fuzzy inference stage. At this stage, there is an example as follows:

When conducting system trials, users input 5 symptoms they experience, namely G17 (Gangguan pencernaan (mual, muntah, sembelit, diare), 1), G6 (Perubahan pola menstruasi (pada remaja perempuan), 1), G3 (Lemah Otot, 1), G9 (Merasa Lelah, 1), G11 (Merasa tidak berdaya, 3).

From these inputs, the weights are then summed up and the domain value is sought which will later output the results of the max calculation.

Symptoms:

1. Digestive problems = 1
2. Changes in menstrual patterns = 1
3. Muscle weakness = 1
4. Feeling helpless = 1
5. Feeling tired = 1

After the user inputs the symptoms experienced, then the weight of each selected symptom is summed up, and the value of all symptoms in each diagnosis is also summed up. And the results of each summation of these values will be calculated as the total value of each diagnosis as follows:

Total value of T1 (Mild Stress)
= 6/26
=0,23

Total value of T2 (Moderate Stress)

= 1/65
=0,01

The sum of T3 (Acute Stress) values
= 0/32
=0

After calculating the symptoms of each diagnosis, continue by summing up all the calculation results of each diagnosis into a total score, as follows:

Total score
= T1+T2+T3 = 0.23 + 0.01 + 0
= 0,24

After getting a total value of 0.24, then each number of diagnosis values is divided by the total value and multiplied by 100 to get the result in the form of a percentage value, as follows:

T1 = 0.23/0.24 = 0.9583 × 100 = 95.83%
T2 = 0.01/0.24 = 0.0417 × 100 = 4.17%
T3 = 0/0.24 = 0 × 100 = 0%

d) Defuzzification

The defuzzification process is the process of returning from crisp numbers that have passed the inference stage into linguistic variables. Continuing in the previous process we have gotten the number that the highest percentage is in T1, then the result of diagnosing the stress level of the user is that the user is likely to **experience mild stress with a percentage of 95.83%.**

System Implementation

a) System Modeling

In this process, the researcher creates a usecase and DFD level 0. The usecase of this system involves 2 user roles, namely admin and user. The usecase of this system is as follows:

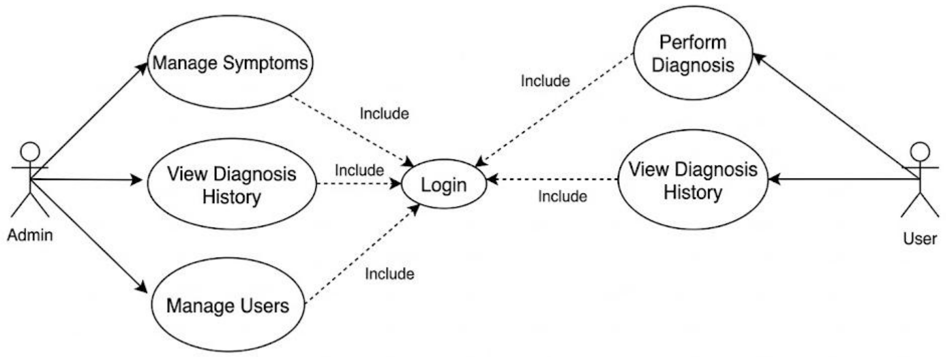

Figure 4. Usecase System

As shown in Figure 4, the Admin actor has the capabilities to Manage Symptoms, Manage Users, and View Diagnostic Result History. Conversely, the User actor is restricted to Performing Diagnosis and Viewing Diagnostic Result History, as both actions Include a prerequisite Login

From the usecase, it can be seen that the features owned by the admin can manage stress symptoms, see diagnostic results, and manage users or users. While users can diagnose, see the results of diagnoses that have been done, and provide criticism and suggestions.

Then for the design of the Data Flow Diagram (DFD) in this system design is as follows:

1) DFD Level 0

In DFD level 0 will explain as a whole about what processes will occur in the system as shown below:

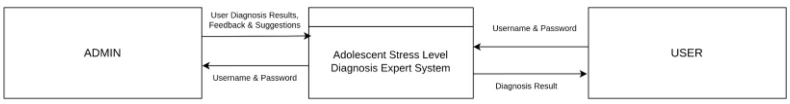

Figure 5. DFD Level 0

The provided Figure 5 illustrates the interaction between two primary external actors, Admin and User, and the central Expert System for Adolescent Stress Level Diagnosis. Both the Admin and User actors are required to submit their Username & Password to access the system. Once logged in, the User can perform a Diagnosis and receives the resulting diagnosis data. Conversely, the Admin interacts with the system to View User Diagnoses, Criticism, and Suggestions, enabling administrative oversight and system maintenance.

2) DFD Level 1: Login Process

This DFD is an overview of the login process:

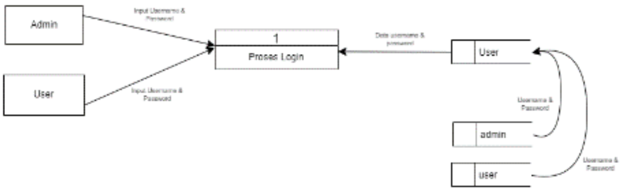

Figure 6. DFD Level 1 Login Process

Figure 6 indicates The Data Flow Diagram (DFD) excerpt models the authentication process for the system, where both the Admin and User actors initiate the system access by submitting their respective Input Username & Password credentials to the central process titled Login Process. Following successful authentication, the Login Process retrieves or validates the credentials from the data stores labeled admin and user using the Username & Password key. Upon successful validation, the process transmits the validated Data username & password back to the corresponding User entity, signifying authorized system entry.

3) DFD Level 1: Diagnosis Process

This DFD is an overview of the diagnosis process:

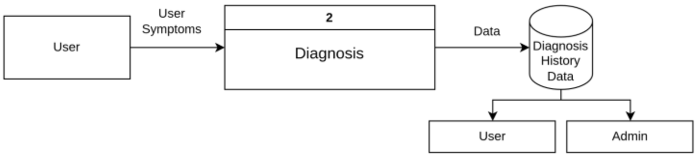

Figure 7. DFD Level 1 Diagnosis Process

This Data Flow Diagram (DFD) focuses on the diagnostic process initiated by the User actor (Figure 7). The User inputs the Symptoms being experienced into Process 2, labeled Diagnosis. Upon completion, the resulting Data is stored in the Diagnostic History Data (Data Riwayat Diagnosa) repository. This stored history is then accessible to both the User (presumably their own history) and the Admin actor, indicating that diagnostic records are maintained and viewable by administrative personnel.

4) DFD Level 1: User Management Process

This DFD is an overview of the user management process:

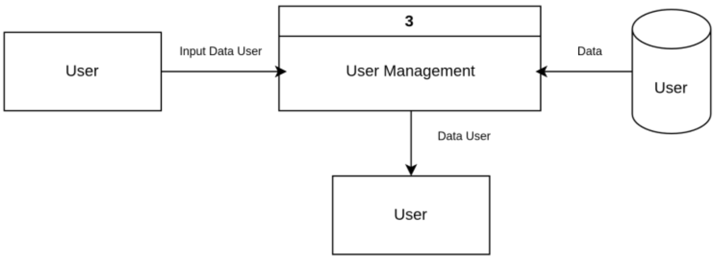

Figure 8. DFD Level 1 User Management Process

Figure 8 expresses Data Flow Diagram models the User Management process, designated as Process 3, which is primarily overseen by the Admin actor. The Admin initiates the process by sending User Data Input to the User Management process. Simultaneously, the User data entity supplies Data to the User Management process for reading or updates. Finally, the User

Management process outputs the resulting User Data, which is transmitted to the User entity, completing the flow for user account maintenance

5) DFD Level 1: Symptom Management Process

This DFD is an overview of the symptom management process:

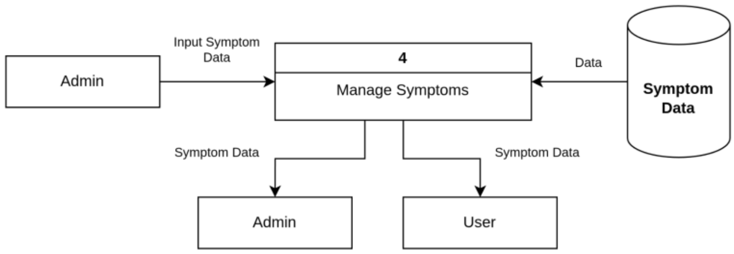

Figure 9. DFD Level 1 Symptom Management Process

This Data Flow Diagram outlines the Symptom Management process, labeled as Process 4 (Figure 9), which is centrally controlled by the Admin actor. The Admin initiates modifications or updates by sending Symptom Data Input to the Symptom Management process. Furthermore, the Symptom data store feeds its existing Data into this process for reading or reference. The output of the Symptom Management process, designated as Symptom Data, is then disseminated back to both the Admin (likely for verification or review) and the User actor (presumably to make symptoms available for the diagnosis module).

b) Database Design

To build this system, researchers designed a database with 5 tables consisting of login, user, admin, level_stress, and symptoms tables. The database design can be seen in the picture below:

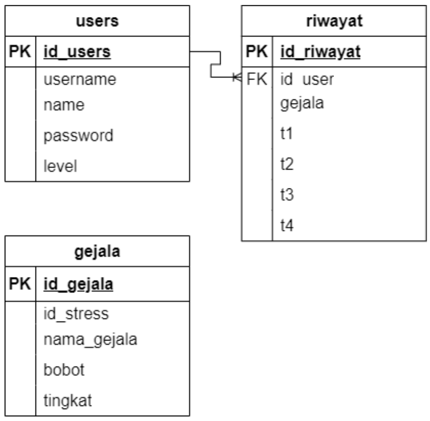

Figure 11. Database Design

Figure 11 reveals the database design for the system, as depicted, comprises three main tables: users, riwayat (history), and gejala (symptoms). The users table, with id_users as the Primary Key (PK), stores authentication and profile information, including username, name, password, and level. The riwayat table tracks diagnostic history, using id_riwayat as its PK and linking back to the users table via the id_user Foreign Key (FK), while recording gejala (symptoms) and possibly time/value indicators (t1 through t4). Finally, the gejala table, using id_gejala as the PK, manages symptom data essential for the diagnosis, including id_stress, nama_gejala (symptom name), bobot (weight), and tingkat (level).

c) User Interface

Figure 12. Home Display

Figure 12 illustrates the Home display for the "Stress Checker" application introduces the Sistem Diagnosa Tingkat Stress Pada Remaja (Adolescent Stress Level Diagnosis System) to the user via a clean, modern interface featuring isometric graphic elements suggestive of data processing and validation. The main call to action is presented through the headline and a prominent button labeled "Get Started," which serves as the primary gateway for users, presumably leading to the initial steps of the stress assessment or login procedure described in the preceding system diagrams. The navigation bar also indicates access points for Home, Diagnosis, and Result Diagnosis, offering immediate pathways to the system's core functionalities.

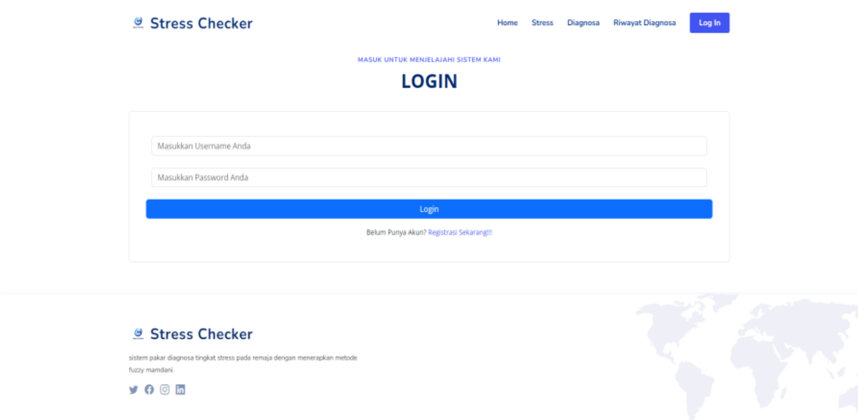

Figure 13. Authentication Display

The Authentication Display, branded as "Stress Checker," centers on a dedicated LOGIN interface designed to verify user identity before granting system access, consistent with the DFD in the preceding figure. This screen prompts both actors, Admin and User, to input their credentials using fields labeled "Masukkan Username Anda" (Enter Your Username) and "Masukkan Password Anda" (Enter Your Password). Upon entry, users activate the system through the primary blue "Login" button, while a supplementary link, "Belum Punya Akun? Silahkan Register" (Don't have an account? Please Register), provides an entry point for new users, ensuring controlled access to the stress diagnosis platform.

Figure 14. Stress Classification Display

This interface displays the Klasifikasi Stress Berdasarkan Tingkatannya (Stress Classification Based on Level), acting as the output presentation screen following a user's diagnosis. The system clearly categorizes the results into three distinct levels: STRES RINGAN (Mild Stress), STRES SEDANG (Moderate Stress), and STRES BERAT (Severe Stress). Each classification box contains a brief descriptive text explaining the characteristics associated with that specific stress level, thereby communicating the diagnostic outcome derived from the Fuzzy Inference Engine to the end-user, likely accessible after the login and diagnosis procedures.

Figure 15. Diagnosis Display

Figure 15 displays the Gejala (Symptoms) management or selection interface, which is a crucial component preceding the final diagnosis, directly corresponding to the Kelola Gejala (Manage Symptoms) function shown in the Use Case Diagram. The screen presents a list of potential stress-related symptoms for user interaction, although the input mechanism (like checkboxes or rating scales) is not fully visible. This list is where the raw input data is collected, which will subsequently be fed into the Fuzzy Inference System for processing, as outlined in the Fuzzy Inference Flow.

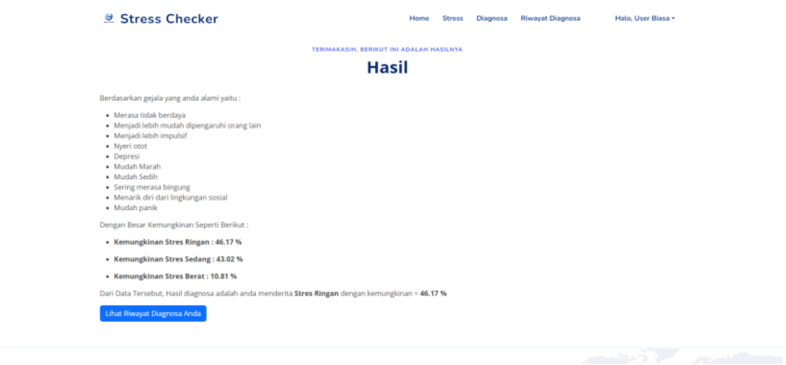

Figure 16. Diagnosis Result Display

This Figure 16 presents the final Hasil (Result) display of the Stress Checker application, representing the conclusion of the diagnosis process. The screen first lists the symptoms experienced by the client, such as feeling tired, easily angered, and difficulty concentrating, which served as the input data for the fuzzy system. Subsequently, it explicitly details the calculated certainty factors for each stress level: Ketidakpastian Stres Ringan (Mild Stress Certainty) at 49.77%, Ketidakpastian Stres Sedang (Moderate Stress Certainty) at 40.40%, and Ketidakpastian Stres Berat (Severe Stress Certainty) at 9.83%. The final output sentence clearly states the system's conclusion: the user's diagnosis is Stres Ringan with a certainty level of 49.77%, directly summarizing the outcome derived from the Fuzzy Mamdani process.

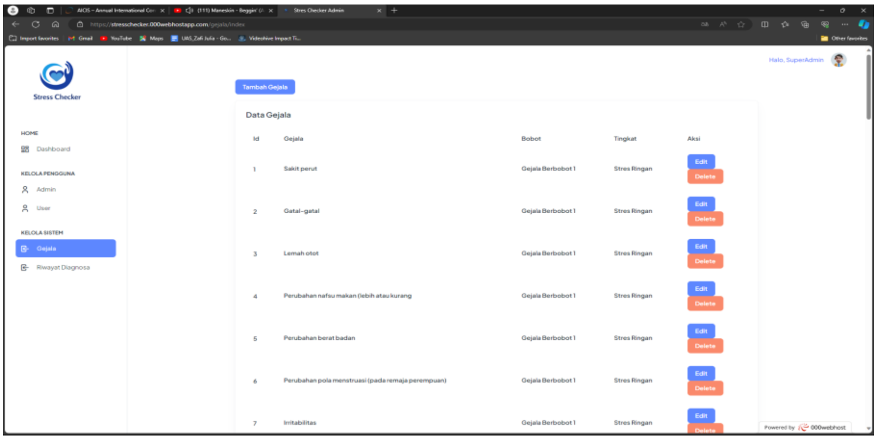

Figure 17. Symptom Management Dashboard

This screen capture displays the Symptom Management Dashboard, which corresponds to the administrative function of managing symptoms (Kelola Gejala) within the expert system. The dashboard presents symptoms in a tabular format, listing entries with sequential numbers, likely referencing the symptom's name (though text is partially obscured), the associated stress level (e.g., Stres Ringan), and the associated stress ID. Crucially, administrative control is evident through the presence of Edit and Delete buttons for each symptom record, indicating that this interface is where the Admin directly inputs and maintains the symptom data that feeds the initial fuzzification stage of the diagnosis process.

d) System Testing

The Blackbox Testing test method was chosen as the test method in this study because the test was carried out without knowing about the internal details of the system such as program code, database design, and system architecture. The testing verifies system functionality from the user's perspective without considering the internal code structure, encompassing the two primary roles: User and Admin. Regarding authentication, testing will ensure successful Login with valid credentials for both roles, while simultaneously testing error handling when incorrect credentials (username or password) are entered. Furthermore, the core diagnosis functionality will be tested by inputting various combinations of Symptoms to verify that the Diagnosis process yields a logical and correct Stress Classification output (e.g., Mild, Moderate, or Severe Stress) along with the correct certainty factor, and also testing input validation if the user selects no symptoms.

On the administrative side, Black Box testing will concentrate on the data management features accessed by the Admin. This includes verifying that the Admin can effectively Manage Symptoms (add, edit, or delete symptom data) and Manage Users (update user details or access levels) according to the related Data Flow Diagram pathways. Meanwhile, for the User role, testing will validate their ability to access and view their own Diagnostic Result History after a diagnosis session is complete, ensuring that all actor interactions and history data storage function as designed in the established database schema.

The implementation and testing of the Adolescent Stress Level Diagnosis System, underpinned by the Fuzzy Mamdani method for inference, confirm the viability of integrating expert knowledge into automated assessment. The system development lifecycle, spanning analysis of the Fuzzy Mamdani algorithm, system modeling via Use Cases and DFDs, and database design, culminates in the functional user interface. The Fuzzy Inference Process itself relies on the four core stages: Fuzzification converts crisp input (symptoms selected by the user) into linguistic variables based on predefined intervals for Mild, Moderate, and Acute stress indicators (Table 1). The subsequent rule evaluation, based on expert-derived weights for 49 distinct symptoms (Table 2), then determines the initial fuzzy output set.

The Fuzzy Inference and Defuzzification stages are crucial, as demonstrated by the detailed testing example where specific symptom weights aggregate to yield probability scores for T1 (Mild Stress), T2 (Moderate Stress), and T3 (Acute Stress). The highest score, 95.83% for Mild Stress in the example, dictates the final crisp output presented to the User via the Diagnosis Result Display. This quantitative output confirms that the system successfully maps complex, subjective symptomatic evidence to a concrete, quantifiable stress level classification, a key advantage of utilizing fuzzy logic over traditional binary methods.

System implementation, validated through DFDs (Level 0 and Level 1) and the relational database design (linking users, symptoms, and history), confirms data integrity and operational flow. The Admin maintains control through dedicated dashboards for Symptom Management and User Management, ensuring the system's knowledge base and user access remain current and secure. Overall, the integrated system successfully achieves its objective by providing a structured, rule-based diagnostic assessment, thereby offering a valuable, automated screening tool for adolescent stress levels.

Conclusion

Based on the research that has been conducted, the researcher concludes that the topic of stress management is something that needs to be considered to be able to reduce the number of sufferers of mental health disorders. Combining technology with the science of psychology can lead to an innovation in recognizing the level of stress experienced by adolescents. An expert system for diagnosing stress levels in adolescents can be a bridge for teenagers to be able to recognize stress and its levels. A friendly interface or display provides convenience for users. With this system, researchers hope to help teenagers recognize stress and its levels so that they can carry out appropriate stress management according to their level.

However, this stress level diagnosis expert system has limitations where the results of the diagnosis cannot be the main reference. This system is only a tool for making initial diagnoses and of course, it is still necessary to consult an expert or psychiatrist for more serious follow-up.

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