



Implementation of Certainty Factor Method in Mental Health Diagnosis Expert System in Adolescents Aged 18 – 24 Years

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Abstract

Mental health in adolescents aged 18-24 years is a real condition and a problem that has received less attention from parents or certain parties. Individual adolescents free from all forms of symptoms of mental disorders are one of the keys to maintaining a healthy body from mental health disorders. The group most vulnerable to mental health disorders is adolescents, where many adolescents do not receive the care they should from their parents. Expert systems can help solve problems in the field of mental health in adolescents aged 14-18 years as befits a psychiatrist by adopting expert knowledge into computers. This study aims to develop an expert system for diagnosing mental health disorders in adolescents aged 18-24 years using the Certainty Factor (CF) method by combining expert and user belief values in the diagnostic solutions provided later by the expert system. This study used five mental disorders in adolescents aged 18-24 years, namely depression, schizophrenia, bipolar, obsessive, anxiety disorders which were later given the weight of symptom beliefs and data on preventive solutions to the disease using the CF method. The results of the study are in the form of an expert system for diagnosing mental health in adolescents. using the CF method which displays the certainty value of expert knowledge diagnosis. Testing of the expert system application in this study uses the black-box method with valid test results used.

Keywords: CF Implementation; Disease Diagnosis; Adolescent Mental Health; Expert System; Black-box

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1.0 INTRODUCTION

Mental health is a condition in which a person is free from psychological, emotional, behavioral, and social disorders. Therefore, mental health needs to be an important concern for every teenager (Rosidin & Sumarni, 2024). Mental health of adolescents aged 18-24 years is a real condition of a mental disorder in humans. Where mental disorders in adolescents aged 18-24 such as depression, schizophrenia, bipolar, obsessive, anxiety disorders is a dangerous disease if it is not treated early as shown in research results (Hasbie et al., 2023) (Annisa, 2018) (Nopi et al., 2022) by developing an expert system for consultation media. Mental or mental disorders are disturbances within a person that result in a person being disturbed in the process of thinking, acting, social relationships and emotions. A significant portion of the global disease burden is also reflected in mental illness.

Limited information, time and cost are also reasons why someone needs help from an expert such as a psychologist or psychiatrist. The lack of mental health literacy in Indonesian society also requires people who seek treatment from a psychologist or psychiatrist to be people who are affected by mental health. Where mental health problems, one of which is anxiety and depression, still require further testing and exploration (Greene Barker et al., 2024). With recent technological developments, an expert can be transformed into a knowledge-based system. Where clinical evidence is convincing that psychological care or therapy equipped with digital technology can increase the efficiency and access to children's mental health services, from examples of successful digital implementation in health services (Creswell et al., 2024). With digital psychological therapy, it has the potential to increase the availability of effective assistance for mental health problems.

Knowledge-based systems offer added value that can diagnose personality disorders based on data obtained from psychologists (Kalengkongan et al., 2020). Knowledge-based systems that are widely used in expert

systems can identify the emotions of Javanese women using several facts from experts or psychology experts by users filling in questions given by the expert system using the Certainty Factor (CF) method. (Rosiani et al., 2018) . Other studies have also created a system to detect or diagnose mental disorders or syndromes where the facts are processed using the CF method. (Putra & Yuhandri, 2021) .

Research on the application of the CF method that can estimate the measure of certainty of solutions derived from facts translated by a rule base on human mental disorder problems, namely children, adolescents and adults has been carried out by (Sukiakhy et al., 2022) (Pinem et al., 2023) . Where the expert system is used to make it easier for patients or sufferers of mental disorders, especially depression, to detect diseases early online (Hernawan et al., 2022) . The implementation of the CF method in this expert system can also help psychologists/psychiatrists in making initial diagnoses on patients. Where the diagnosis and solution generated from the CF method will be displayed by the expert system based on the belief value to measure the level of trust and distrust of an expert in a symptom or disease experienced by the patient (Adi Suwarno, Ishak Husin, 2019) (Sancaka, 2022) . The expert system is designed to diagnose personality disorders that occur in adolescents by knowing the results of calculating the values of symptoms that have been defined in the knowledge base of the expert system whose application has been tested using the Black Box System method. (Suwarno et al., 2019) . The application of the CF method to the diagnosis of mental disorders can also display a presentation of the certainty of the answer to the solution to each disease from searching the knowledge base or facts used (Wildan & Sari, 2022) .

The purpose of this study is to diagnose adolescent mental health using data from five mental disorders in adolescents aged 18-24 years, namely depression, schizophrenia, bipolar, obsessive, anxiety disorders with disease beliefs and disease prevention solutions using the CF method. The results of this study are in the form of an expert system using the CF method that can help people in need such as patients, doctors, nurses, psychiatrists or psychologists. The next section of this article discusses literature review, methodology, results and discussion and conclusions.

2.0 LITERATURE REVIEW

Expert System

The development and expansion of information technology have brought new and important functions to computer-based decision making. Expert Systems (ES), as part of artificial intelligence, have a central role in this system (Dashti & Dashti, 2020) . ES emphasizes the importance of knowledge and experience. Where ES can be a computer program that imitates human expertise that offers advantages in providing solutions or decisions. Rule-based expert systems have played an important role in strategic goal setting, planning, development, scheduling, error control, diagnosis, and so on in modern intelligent systems and their implementation. Expert systems can be classified into rule-based systems and knowledge-based systems (Mohammed et al., 2019) . Where the main components of a rule-based expert system consist of a knowledge base, inference engine, explanation facility and User Interface/UI, where UI is used to facilitate user interaction with the expert system (Cao et al., 2021) .

The use of a knowledge base in an expert system can provide the information needed to perform a specific task, therefore the knowledge base is developed from a team of experts in a specific domain (Almulla, 2021) . The use of expert systems in the medical field has been practiced continuously for the past few decades. Where the expert system in this study can diagnose bipolar disorder and major depressive disorder early with the potential of a rule-based framework and can evaluate the impact of disorders on adolescent mental health using the *Certainty Factor* (CF) method, by proposing a semantic rule-based expert system developed based on expert recommendations (Zolfagharnasab et al., 2025) . With the results of the expert system, CF can be used as the highest category to be selected as the final prediction. The use of digital technology can be used in developing a rule-based mental health expert system in order to provide information from the results of data analysis for the knowledge of those in need (Strackiewicz et al., 2021) . So that the ES model can be developed as a provider of various medical services to patients ranging from diagnosing diseases and prescribing drugs to patient monitoring (Chen et al., 2022).

Certainty Factor (CF)

In this study, the Certainty Factor (CF) method was chosen because CF offers a more intuitive and interpretable framework for dealing with uncertainty. The choice of a CF rule-based system in this study can help with better handling of uncertainty, better alignment with clinical reasoning, better transparency, and greater computational efficiency. The advantages of a CF rule-based system make it a more appropriate choice for developing reliable and interpretable diagnostic tools in the medical domain. Research using the CF method can provide early diagnosis results for bipolar disorder has been carried out by (Muhammad et al., 2019) . Where the CF method

can provide a measure of confidence in a symptom and a level of accuracy to predict the diagnosis of the disease (Marlinda et al., 2020). The two subjective parameters used in the definition of CF are the probability of an event occurring and the probability of the event occurring when an event is observed, which are denoted as $MD(H|E)$ and $MB(H|E)$, then $CF(H|E)$ can be defined as follows (Tzafestas et al., 1994):

$$CF(H|E) = MB(H|E) - MD(H|E)$$

from hypothesis H with evidence E . Since $0 \leq MB(H|E) < 1$ and $0 \leq MD(H|E) \leq 1$ The certainty factor CF varies from -1 (full confidence that H is invalid) to +1 (full confidence that H is true). A value of $CF=0$ indicates complete disregard for H .

To calculate the CF of the 'Conjunction' and 'Disjunction' of the two hypotheses H_1 and H_2 , you can use several combinations of Certainty Factors (CF), namely:

1. CF for single premise rule:

$$\begin{aligned} CF(H,E) &= CF(E) \times CF(\text{Rule}) \\ &= CF(\text{user}) \times CF(\text{expert}) \end{aligned}$$

2. CF for some premise rules:

$$CF(A \text{ AND } B) = \text{Min} (MB-MD) \times CF(\text{rule})$$

3. CF for rules that are concluded from similar or more than 2 premises (Rules), namely combining CF from several symptoms:

$$CF_{\text{combine}} = CF_1 + (CF_2 \times (1 - |CF_1|))$$

Where:

- CF_1 and CF_2 are the CF values of two independent pieces of evidence supporting the same hypothesis.
- CF_{combine} is the combined CF value after integrating both evidences.

Now, suppose CF is the Certainty Factor of the hypothesis, calculated based on all previously available information, and CF_c is the Certainty Factor of the same hypothesis derived from the current evidence. Then the Certainty Factor CF' combining the information from CF and CF_c is found as

$$CF' = \begin{cases} \frac{CF + CF_c (1 - |CF|)}{CF + CF_c} & CF \cdot CF_c \geq 0 \\ \frac{CF + CF_c}{1 - \min\{|CF|, |CF_c|\}} - 1 & -1 < CF \cdot CF_c < 0 \\ \text{undefined} & CF \cdot CF_c = 1 \end{cases}$$

The CF form for the rule base can be illustrated in Figure 1 (Desnelita et al., 2018).

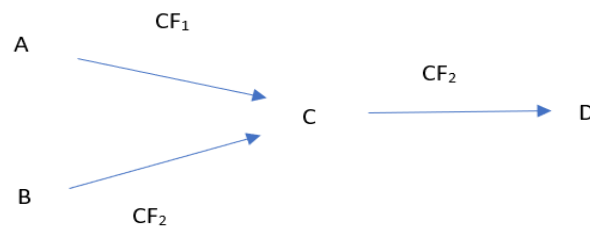


Figure 1. Rule Base Inference Network on CF

With a rule base involving a combination of CF :

Rule-1 : If A Then C, CF_1

Rule-1 : If B Then C, CF_2

Rule-1 : If C Then D, CF_3

CF is used to handle uncertainty in diagnosis by combining expert confidence values towards the observed symptoms. Where CF starts from selecting symptoms and the level of confidence in the selected symptoms. CF also acts as an inference engine and makes assumptions so that CF can produce a level of certainty over identification based on facts (Anggrawan et al. 2023).

3.0 METHODOLOGY

This research use Research and Development (R&D) method with an approach experiment to test accuracy system expert in diagnose disturbance mental health-based Certainty Factor (CF) method. With the research stages as following:

a. Literature Study and Data Collection

1. Do review library related adolescent mental health, common mental disorders: Depression, Schizophrenia, Bipolar, OCD, and anxiety disorders, as well as Certainty Factor method in system expert.
2. Gathering knowledge base from source trusted, such as journal psychology, mental health reports, and consultation with a psychologist or psychiatrist to determine rule diagnostics and MB-MD values for each disease.

b. Identification Symptoms and Rule Base Creation

1. Identifying symptom from each mental disorder based on source academic and professional mental health.
2. Determine IF-THEN based diagnostic rules that will used in system expert.
3. Set MB (Measure of Belief) and MD (Measure of Disbelief) values for each symptom based on interviews with experts and studies previously.

c. Design and Development Expert system

1. Designing architecture system experts covering knowledge base, engines inference, and interface user.
2. Develop system use Language appropriate programming and database to store the knowledge base.
3. Apply Certainty Factor (CF) method in the diagnosis process
4. Integrate system with interface user (UI/UX) for easy used by patients or healthcare professionals medical

d. Testing System

1. Testing Functionality use Black Box Testing method to ensure system works as expected.
2. Testing Accuracy by comparing system diagnosis results expert with diagnosis from psychologist or psychiatrist to measure accuracy Certainty Factor method.

e. Data Analysis and Conclusions

1. Analyze results Certainty Factor calculation and comparing with expert diagnosis to assess accuracy and reliability system.
2. Develop recommendations based on test results to improve system performance.

4.0 RESULTS AND DISCUSSION

This research explores the use of the Certainty Factor method in an expert system for early detection of mental illness in adolescents. This study highlights the effectiveness of the CF method in dealing with uncertainty in the diagnostic process and providing appropriate intervention recommendations. This study used data on adolescent mental illnesses, namely Depression (P1), Schizophrenia (P2), Bipolar (P3), Obsessive-Compulsive Disorder (OCD) (P4) and Anxiety Disorder (P5). Using 13 main symptoms described in Table 1.

Table 1. List of Major Symptoms of Adolescent Mental Illness

Main Symptoms	Symptom Code	CF _{User}
Feeling sad prolonged	G1	0.9
Loss of interest in daily activities	G2	0.8
Sleep disorders (insomnia or hypersomnia)	G3	0.7
Difficulty concentrates	G4	0.6
Change significant weight gain	G5	0.4
Thoughts of self-harm or suicide	G6	0.5
Feeling worried excessive	G7	0.9
Increased heart rate for no apparent reason	G8	0.7
Thought unwanted obsessive	G9	0.9
Behavior compulsive repetitive	G10	0.8
Extreme mood swings	G11	0.8
Delusions or hallucinations	G12	0.7
Disorganized or catatonic behavior	G13	0.6

Symptoms of adolescent mental illness in Table 1 can be developed into a rule base to identify possible symptoms of mental disorders in adolescents. The rules in this study use IF-THEN with Certainty Factor (CF) values calculated from MB and MD. The rule base used in mental health problems in adolescents consists of 7 rules as samples in this study which can be seen in Table 2.

Tabel 2. Rule Base, MB-MD And CF

Rules	Rule Base (IF-THEN)		MB	MD	CF _{User}	CF _{Rules}	Confidence Percentage (%)
	IF (AND)	THEN					
1	G1 AND G2	P1	0.8	0.2	0.8	0.48	48%
2	G3 AND G4	P1	0.7	0.1	0.6	0.36	36%
3	G6	P1	0.9	0.1	0.5	0.40	40%
4	G12 AND G13	P2	0.85	0.15	0.6	0.42	42%
5	G11 AND G12	P3	0.8	0.2	0.7	0.42	42%
6	G9 AND G10	P4	0.9	0.1	0.8	0.64	64%
7	G7 AND G8	P5	0.75	0.25	0.7	0.35	35%

Where:

- MB (Measure of Belief) is level belief expert to connection between symptoms and diseases (from 0 to 1).
- MD (Measure of Disbelief) is level distrust expert to connection between symptoms and diseases (from 0 to 1).
- There are two or more required symptoms in a rule, then CF user determined by the formula $CF_{User} = \text{Min}(CF_{G1}, CF_{G2}, \dots, CF_{Gn})$ is mark belief user to each symptom in a rule
- $CF_{Rule1-n} = (MB_{R1-n} - MD_{R1-n}) \times CF_{user-R1-n}$
- Confidence Percentage = $CF_{R1-n} \times 100\%$
- If the rules need more from one symptom, we always use minimum value of user CF to symptoms in rule base.
- If the rules only own one symptom, then CF User direct equal to the CF symptom value.

Based on Table 2, it was carried out CF calculation for 7 Rules used in to diagnose adolescent mental health outlined to find mark CF_{user} every R1 to R6. As sample from CF calculation of adolescent mental illness diagnosis, used rules R1, R2, and R3.

Rule R1: IF G1 ($CF_{user}=0.9$) AND G2($CF_{user}=0.8$) THEN probability of Disease P1 (Depression), then mark belief user to rule This counted as:

$$CF_{User-R1} = \text{Min}(CF_{G1}, CF_{G2}) = \text{Min}(0.9, 0.8) = 0.8$$

Where is the smallest CF value used namely $CF_{G2} = 0.8$. Next search for CF_{R1} (CF Rule-1) using the formula:

$$CF_{R1} = (MB_{R1} - MD_{R1}) \times CF_{user-R1} = (0.8 - 0.2) \times 0.8 = 0.6 \times 0.8 = 0.48$$

R2 Rule: IF G3 ($CF_{user}=0.7$) AND G4 ($CF_{user}=0.6$) THEN Probability of Disease P1 (Depression)

$$CF_{user-R2} = \text{Min}(CF_{G3}, CF_{G4}) = \text{Min}(0.7, 0.6) = 0.6$$

The $CF_{user-R2}$ is obtained = 0.6, then looking for CF from The R2 rule is

$$CF_{R2} = (MB_{R2} - MD_{R2}) \times CF_{user-R2} = (0.7 - 0.1) \times 0.6 = 0.6 \times 0.6 = 0.36$$

Rule R3: IF G6($CF_{user-R6}=0.5$) THEN Probability of Disease P1 (Depression)

$$CF_{R3} = (MB_{R3} - MD_{R3}) \times CF_{user-R3} = (0.9 - 0.1) \times 0.5 = 0.8 \times 0.5 = 0.40$$

Because there are 3 Rules from disease Depression so need done merger from CF_{R1} , CF_{R2} and CF_{R3} by using the combined CF($CF_{Combine}$) namely:

$$CF_{Combine-1} = CF_{R1} + (CF_{R2} \times (1 - CF_{R1}))$$

$$CF_{Combine-1} = 0.48 + (0.36 \times (1 - 0.48)) = 0.48 + (0.36 \times 0.52) = 0.48 + 0.1872 = 0.6672$$

Next, look for the $CF_{Combine-Final}$ using the formula:

$$CF_{Combine-Final} = CF_{Combine-1} + (CF_{R3} \times (1 - CF_{Combine-1}))$$

$$CF_{Final-Combined} = 0.6672 + (0.4 \times (1 - 0.6672)) = 0.6672 + (0.4 \times 0.332) = 0.6672 + 0.13312 = 0.80032$$

The diagnostic conclusion from the CF calculation for P1 disease (Depression) is:

$$\begin{aligned} \text{Confidence Percentage} &= CF_{Final_Combined} \times 100\% \\ &= 0.80032 \times 100\% = 80.03\% \end{aligned}$$

Confidence Percentage shows that based on the symptoms experienced, the patient has an 80.03% chance of experiencing Depression. The CF_{R4} , CF_{R5} , CF_{R6} and CF_{R7} values from Rules R4 to R7 can use the formula

of 2 symptoms as samples, namely $CF_{User} = \min (CF_{G1}, CF_{G2}, \dots, CF_{Gn})$ and $CF_{R4-R7} = (MB_{R4-R7} - MD_{R4-R7}) \times CF_{User-R4-R7}$. The CF results for each disease experienced by the patient can be seen in Table 2.

Based on the CF calculation, the probability of a patient experiencing each disease can be calculated as explained in Table 3.

Table 3. Disease Diagnosis Results Based on CF

Mental Illness	Certainty Factor (CF)	Possibility (%)
Depression (P1)	0.80032	80.03%
Schizophrenia (P2)	0.42	42%
Bipolar (P3)	0.42	42%
Obsessive-Compulsive Disorder (OCD)	0.64	64%
Anxiety Disorder	0.35	35%

From Table 3, it is explained that the patient has a possibility of 80.03% experiencing depression which is the main diagnosis of the mental illness case discussed. While the possibility of experiencing OCD is quite high at 64%. Other disorders such as Schizophrenia, Bipolar and Anxiety Disorder have a lower possibility of experiencing symptoms of mental illness. This method ensures that the decision in providing diagnostic certainty remains conservative and not excessive.

In implementing the CF method, recommendations can also be provided to patients in the form of possible solutions, such as the following:

- If the CF value is > 70%, the patient may be advised to consult a psychologist or psychiatrist for further evaluation.
- If CF is at 40%- 70%, patients need to do further self-assessment and regular monitoring.
- If CF < 40%, patients can still manage stress independently with techniques such as meditation or cognitive therapy.

Adolescent Mental Health Diagnosis Expert System Application

Disease data is data that is used as alternative data to support the system in an expert system. seen in Figure 2.

No	Nama Penyakit	Detail Penyakit	Saran Penyakit	Aksi
1	Depresi	Gangguan Mental yang satu ini sudah tidak asing lagi didengar. Depresi dapat berpengaruh besar dalam menjalankan aktifitas harian.	Pada umumnya, orang yang sedang depresi akan selalu merasa cemas, sedih, dan tak bersemangat melakukan kegiatan apapun.	Ubah Hapus
2	Skizofrenia	Skizofrenia merupakan gangguan serius dan dapat membahayakan. Pasalnya, seorang yang mengidap penyakit ini, memiliki halusinasi yang tinggi dan jauh dari fakta realita yang sesungguhnya.	memiliki halusinasi yang tinggi dan jauh dari fakta realita yang sesungguhnya.	Ubah Hapus
3	Bipolar	Bipolar adalah gangguan mental yang menjadikan perasaan seseorang berubah secara drastis. Terkadang merasa sangat bahagia, terkadang juga merasa sedih yang mendalam.	Bipolar adalah gangguan mental yang menjadikan perasaan seseorang berubah secara drastis. Terkadang merasa sangat bahagia, terkadang juga merasa sedih yang mendalam.	Ubah Hapus
4	Obsessive-Compulsive Disorder (OCD)	Jenis gangguan yang satu ini berdampak pada keharusan penderita untuk melakukan sesuatu secara berulang-ulang. Apabila tidak dilakukan, maka dapat berpengaruh pada kecemasan yang mendalam.	Jenis gangguan yang satu ini berdampak pada keharusan penderita untuk melakukan sesuatu secara berulang-ulang. Apabila tidak dilakukan, maka dapat berpengaruh pada kecemasan yang mendalam.	Ubah Hapus
5	Anxiety Disorders	Anxiety Disorders adalah kondisi di mana seseorang menderita kecemasan ketika bereaksi terhadap suatu objek atau keadaan. Pasien biasanya mengalami ketakutan yang intens, yang diikuti dengan perubahan gejala tubuh seperti detak jantung yang semakin cepat dan keringat.	Gangguan kecemasan ini meliputi kecemasan di tempat umum atau kelompok, panik, dan takut akan apa pun. Jika kamu pernah terlalu ketakutan di depan umum, kemungkinan kamu mengidap penyakit ini.	Ubah Hapus
6	Psychotic Disorders	Penyakit psikotik ini menyebabkan individu mengalami distorsi kesadaran dan ide. Salah satu tanda paling menonjol dari kondisi ini adalah penderitaanya sering berhalusinasi terhadap gambar atau suara yang tidak nyata.	Terjadi ketika ada suara-suara yang muncul untuk menyalahkan namanya meskipun kenyataannya tidak ada suara. Namun, pasien percaya bahwa suara itu asli. Penyakit psikotik ini termasuk skizofrenia.	Ubah Hapus

Figure 2. Disease Data Display

Symptom data is data used for the expert system process as seen in Figure 3. Symptom data is a knowledge base obtained or collected from experts and the WHO website. Facts in the form of symptoms of adolescent mental illness are entered into the knowledge base database of this expert system application.

Figure 3. Display of Disease Symptom Data

Certainty Factor

- [Dashboard](#)
- [Data Penyakit](#)
- [Data Gejala](#)
- [Data Aturan](#)
- [Data Kerfeld](#)
- [Data Whagat](#)
- [Data User](#)
- [Ubah Password](#)

Data Aturan

+ Tambah Data KIRI dan kanan cari... Cari

No	Penyakit	Gejala	NB	MD	Aksi
1	Depresi	Morok, minum alkohol lebih dari biasanya, atau bahkan menggunakan narkoba	1.0	0.5	✕ Ubah + Hapus
2	Depresi	Tidak mampu memahami situasi dan orang-orang	0.5	0.2	✕ Ubah + Hapus
3	Depresi	Kehilangan kemampuan untuk berkonsentrasi	0.2	0.2	✕ Ubah + Hapus
4	Skitzofrenia	Kesulitan untuk berkonsentrasi dan kurang motivasi	1.0	0.2	✕ Ubah + Hapus
5	Skitzofrenia	Mendengar suara atau memperasai sesuatu yang tidak benar	0.5	0.2	✕ Ubah + Hapus
6	Skitzofrenia	Perubahan drastis dalam kebiasaan makan, seperti makan terlalu banyak atau terlalu sedikit	0.5	0.2	✕ Ubah + Hapus
7	Bipolar	Sangat sedih dan putus asa	1.0	0.5	✕ Ubah + Hapus
8	Bipolar	Gelisah	0.5	0.2	✕ Ubah + Hapus
9	Bipolar	Enggan beraktivitas	0.5	0.2	✕ Ubah + Hapus

Figure 4. Rule Base View

[illegible]

Figure 5. Display Performing Diagnosis

Figure 6 is a display of the diagnostic results used as recommendations for users who use this application.

Hasil Konsultasi [Cetak](#)

Nama

Usia

Jenis Kelamin

Alamat

No Telp

No	Kode	Gejala Yang Dialami	Kontrol
1	G001	Merosok, minum alkohol lebih dari biasanya, atau bahkan menggunakan narkoba	Kontrol
2	G002	Tidak mampu memahami situasi dan orang-orang	Kontrol
3	G003	Kehilangan kemampuan untuk berkonsentrasi	Kontrol

Diagnosis Penyakit

Depresi / 60 % (0.60)

Figure 6. Display of Diagnostic Results

Testing *Black Box*

By using the *Blackbox* testing method for testing application features, it is done with the aim of seeing whether the input and output functions of the application created are in accordance with the required specifications. Table 4 shows the results of application testing on the menu or tool functions created.

Table 4. Testing of the Expert System Application for Mental Illness Diagnosis

Menu/ Function	Test Case	Function System	Expected results	Test Results
Login	Testing the login menu	To ensure user access rights	Displays the Dashboard page menu for each user	Succeed
Adding disease data	Adding disease data	To add disease data	Disease data successfully added	Succeed
Deleting disease data	Deleting disease data	To delete disease data	Disease data successfully deleted	Succeed
Changing disease data	Changing disease data	To change disease data	Disease data successfully deleted	Succeed
Adding Symptom Data	Adding Symptom Data	To add symptom data	Symptom data successfully added	Succeed
Deleting symptom data	Deleting symptom data	To delete symptom data	Symptom data successfully deleted	Succeed
Changing symptom data	Changing symptom data	To change symptom data	Symptom data successfully deleted	Succeed
Adding rule data	Adding rule data	To add rule data	Rule data successfully added	Succeed
Delete rule data	Delete rule data	To delete rule data	Rule data successfully deleted	Succeed
Changing rule data	Changing rule data	To change rule data	Rule data successfully deleted	Succeed
Change mark	Change mark	To change mark	Value data successfully changed	Succeed
Performing a diagnosis	Do diagnosis	To do diagnosis	Diagnosis succeed done	Succeed
See results diagnosis	See results diagnosis	To display results diagnosis	Showing diagnostic result successful	Succeed

Blackbox Testing, it can be concluded that all functional/menu requirements of the expert system application for diagnosing mental health for adolescents aged 18-24 using the web-based *Certainty Factor method* that was built have been met and are valid.

Comparison with other methods in the field of mental health diagnosis, there are various methods used besides Certainty Factor, including 1) Naïve Bayes Classifier (NBC) which is used in several AI-based diagnostic systems with advantages in statistical probability, but is less flexible in handling rule-based data such as CF, 2) Artificial Neural Network (ANN) has high accuracy in medical data classification but requires large amounts of data and complex training, 3) Decision Tree (DT) makes it easier to interpret diagnosis results but is less effective in handling uncertainty than CF. Based on this comparison, the CF method is more suitable for use in mental health diagnosis expert systems because it allows the combination of expert opinions with a calculable degree of uncertainty.

Based on the results of the study, it can have an impact on academic and technological aspects and also has broad implications for mental health services as a whole. With proper implementation, a Certainty Factor (CF)-based expert system can be an effective tool in helping early detection, supporting medical personnel, and increasing public awareness of mental health.

5.0 CONCLUSION

The implementation of the Certainty Factor (CF) method in an expert system for mental health diagnosis in adolescents aged 18–24 years provides a systematic approach in evaluating psychological conditions based on observed symptoms and expert knowledge. By combining MB (Measure of Belief) and MD (Measure of Disbelief), this system is able to measure uncertainty in decision making, resulting in a more accurate and well-interpretable diagnosis.

Through case studies and computational analysis, this expert system successfully identified potential mental disorders such as Depression, Schizophrenia, Bipolar Disorder, Obsessive-Compulsive Disorder (OCD), and Anxiety Disorders. The CF method allows the system to combine evaluations of various symptoms and determine the probability of a disorder occurring. The results of the study showed that the CF method is effective in dealing with uncertainty in mental health diagnosis, thus providing probability-based results. The combination of various symptoms in the CF calculation increases the accuracy of the diagnosis given. This system is a reliable decision-making tool for psychologists and mental health professionals in the process of early screening and early intervention.

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