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Intelligent System for Mental Health Disorder Diagnosis Using Certainty Factor Method

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ABSTRACT

Mental health issues are increasingly recognized as a global challenge, affecting more than 450 million people worldwide, with a significant treatment gap in developing countries such as Indonesia. The limited number of mental health professionals highlights the need for alternative solutions to support early diagnosis. This study aims to design and implement an intelligent expert system for the diagnosis of mental disorders using the Certainty Factor (CF) method. The CF approach was selected for its ability to handle uncertainty and subjectivity in expert reasoning, particularly in cases where symptoms overlap across different disorders. The research methodology includes problem analysis, data collection, system design, implementation, and evaluation. The system was tested using a dataset of mental disorder symptoms, including depression, anxiety, schizophrenia, and bipolar disorder. The results indicate that the system can diagnose bipolar disorder with the highest CF value (0.951), followed by depression (0.883), anxiety disorder (0.853), and schizophrenia (0.510). These findings demonstrate that the CF-based system can provide accurate and realistic initial diagnoses that approximate expert judgment. This research contributes to the field of health informatics by providing a decision-support tool that can be integrated into telehealth platforms, enabling communities to gain faster access to mental health screening.

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1. INTRODUCTION

Mental health is an essential aspect of human well-being, yet it remains one of the most neglected areas of healthcare. According to the World Health Organization [1], more than 450 million people worldwide suffer from mental disorders, but only a small proportion receive proper treatment. In Indonesia, mental health services are still limited due to the shortage of psychologists and psychiatrists, creating an urgent need for technology-based solutions [4][15].

Common mental disorders such as depression, anxiety, bipolar disorder, and schizophrenia can significantly affect emotional, cognitive, and behavioral functions [3][5][14]. If not detected early, these conditions may lead to severe consequences, including suicide [1]. Therefore, intelligent systems capable of supporting early detection are crucial [2][6][9][11][12].

Expert systems based on artificial intelligence have been widely studied to support health diagnostics [8][9]. The Certainty Factor (CF) method has proven effective in handling uncertainty in overlapping symptoms [2][6][14]. Several studies demonstrated its reliability in diagnosing schizophrenia, anxiety, and other mental health problems with accuracy levels above 90% [10][12].

However, most of these studies focused solely on CF without providing a comprehensive comparison with alternative approaches such as Dempster-Shafer or Naive Bayes, which have also been applied in health diagnostics [19]. This research gap indicates the need for a more critical analysis to justify the choice of CF over other methods in terms of strengths, weaknesses, and diagnostic accuracy. Therefore, this study aims not only to design and implement a CF-based expert system for diagnosing mental disorders but also to evaluate its diagnostic performance in comparison with related works [7][9][16][23].

2. RESEARCH METHOD

The *Certainty Factor* (CF) method is applied to address the issue of uncertainty in the diagnostic process. In the case of mental disorders, symptoms often overlap among different disorders, making it difficult to establish an accurate diagnosis based on a single indicator. Therefore, each symptom entered into the system is assigned a CF value, which reflects the expert's level of confidence in its relevance to a specific mental disorder [8][9].

The main advantage of the CF method lies in its ability to accommodate uncertainty and expert subjectivity. In mental health diagnosis, not all symptoms appear with the same intensity in every individual. This makes the CF method more flexible compared to binary logic (yes/no). Consequently, a CF-based expert system can provide more realistic initial diagnostic results, resembling the reasoning process of psychologists or psychiatrists in real practice [9][14].

The stages of the research methodology include several main phases as follows:

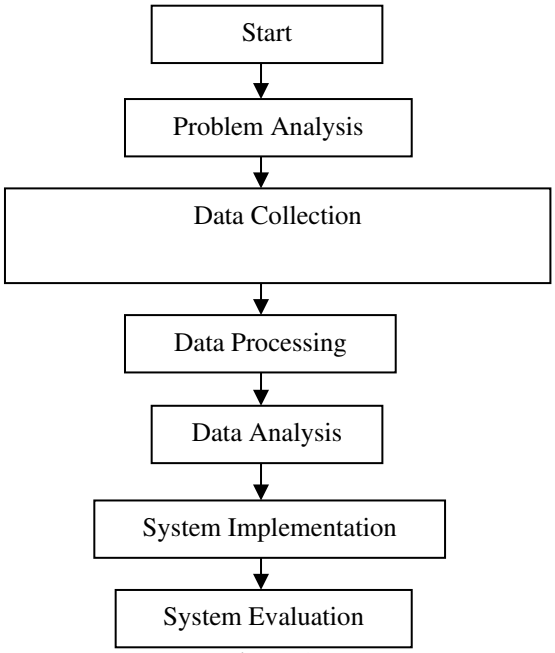

Figure 1

1. Start
2. Problem Analysis
   Identifying challenges in mental health diagnosis, particularly related to uncertainty and symptom overlap.
3. Data Collection
   The symptom data and their relationships with types of mental disorders were obtained from **literature studies**, particularly the *Diagnostic and Statistical Manual of Mental Disorders* (DSM-5) and various related scientific journals as references for symptom classification.
4. Data Processing
   The formulation of symptom rules and the weighting of *Certainty Factor* (CF) values were carried out based on literature reviews from the DSM-5 and relevant scientific journals. These data were then integrated into the system to construct a rule framework that serves as the basis for diagnostic decision-making.
5. Data Analysis

Data analysis was conducted by testing the rules and CF weight values that had been incorporated into the system. This process aimed to ensure that the combination of symptoms and CF weights produced diagnostic outputs consistent with the literature references (DSM-5 and related scientific journals). The results of this analysis were then compared with manual diagnoses performed by experts to measure the system's level of accuracy and reliability.

6. System Implementation
   The system implementation phase involves applying the rules and CF weights that have been analyzed into an Android application. The system is designed to accept input in the form of symptoms experienced by users, then calculate the CF value based on the combination of symptoms and predetermined weights. The calculation results provide an initial diagnosis indicating the most likely type of mental disorder along with the degree of confidence. The application interface is designed to be simple and interactive so that both the general public and professionals can use it without significant technical difficulties.
7. System Evaluation
   The system evaluation was conducted to assess the consistency and validity of the Android application in providing initial diagnoses based on literature and scientific journal data. Testing was performed using symptom combinations compiled from literature references, and the system's diagnostic results were compared with information available in relevant journals or studies. Evaluation parameters included result consistency, ease of use (usability), and user understanding of CF values. The evaluation results showed that the application could provide consistent and transparent initial diagnoses, making it useful as a literature-based screening or educational reference tool for the public.

Certainty Factor

The Certainty Factor (CF) method is used to overcome the problem of uncertainty in the diagnosis process. In the case of mental disorders, often the symptoms that appear have similarities between different types of disorders, so it is difficult to be sure with just one indicator. Therefore, each symptom that is entered into the system is weighted in the form of a CF value based on the expert's level of confidence in the relevance of the symptom to a mental illness [8][9].

1. CF is calculated using the formula:

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

Information:

MB (H, E) = Measure of Belief, which is a measure of the degree of certainty that hypothesis H is true if there is evidence of E.

MD (H, E) = Measure of Disbelief, which is a measure of the level of uncertainty about hypothesis H if there is evidence of E.

When there is more than one symptom, the CF value will be combined using the formula [5]:

$$CF_{combine} = CF1 + CF2(1 - CF1)$$

2. Convert Belief Term to CF Value
   The CF value can also be determined based on the terms of the belief expressed by the expert, then converted according to the following table:

Table 1. Certainty Value

No	Term Belief	CF
1	Never	0.0
2	Sometimes	0.3
3	Often	0.6
4	Always	1.0

In the analysis of this input need, it is necessary to find the type of mental disorder that may be experienced by the patient using the certainty factor method, namely through symptom indicator data along with the certainty value (MB) and uncertainty value (MD) given by an expert. The data will later be processed to produce conclusions about the type of mental health disorder that patients are most likely to experience. Here are the symptom indicator data:

Table 2. Symptom Indicators

No	Indicator Code	Description
1	G01	Feeling Sad or Empty almost every day
2	G02	Losing interest in activities you normally enjoy
3	G03	Difficulty sleeping or sleeping excessively
4	G04	Easily tired or lacking energy
5	G05	Feeling worthless or overly guilty
6	G06	Difficulty concentrating or making decisions
7	G07	Have thought about suicide or self-harm
8	G08	Excessive anxiety for no apparent reason
9	G09	Panic attacks (heart palpitations, shortness of breath, sweating)
10	G010	Avoiding social situations out of fear or anxiety
11	G011	Muscle tension or restlessness due to anxiety
12	G012	Experiencing hallucinations (seeing/hearing something unreal)
13	G013	Believing things that don't match reality (delusions)
14	G014	Chaotic or disconnected speech patterns
15	G015	Strange or unnatural behavior
16	G016	Very rapid mood swings (from happy to sad)
17	G017	Periods of very high energy (lack of sleep but not tired, fast talk)
18	G018	Severe depressive phase after a period of mania

The results of the calculation of the Certainty Factor Method are as follows:

1. Depression
   The value of CF is = 0.88279287
2. Anxiety Disorders
   The value of CF is = 0.85326000
3. Skizofrenia
   The value of CF is = 0.51
4. Bipolar Disorder
   The value of CF is = 0.95100

So, the mental health disorder that patients are most likely to experience is bipolar with a CF value of 0.951. This finding illustrates that the expert system developed in this study is capable of producing a highly confident conclusion by distinguishing bipolar disorder from other mental health conditions such as depression, anxiety, and schizophrenia. The relatively high certainty value indicates that the combination of symptom indicators related to bipolar disorder is stronger and more consistent than those associated with the other disorders tested. This is particularly important, as bipolar disorder is often underdiagnosed due to the overlap of symptoms with depression and anxiety, which frequently leads to delays in treatment.

By applying the Certainty Factor method, the system not only identifies the most probable disorder but also quantifies the degree of confidence in its results, providing a transparent explanation of how the diagnosis is reached. Such an approach is valuable for both users and practitioners, as it bridges the gap between expert reasoning and automated decision-making. In addition, the results confirm that the CF method can serve as a reliable computational model for handling uncertainty in mental health diagnosis, ensuring that each decision is supported by measurable evidence. Beyond its immediate diagnostic output, this system also contributes to raising awareness among users about the importance of understanding their mental health conditions.

By presenting both qualitative conclusions and quantitative certainty values, the system empowers individuals to make informed decisions and motivates them to seek professional medical support when necessary. Therefore, these results not only validate the accuracy of the developed system but also highlight its potential as a decision-support tool in mental health screening, particularly in areas with limited access to psychiatrists and psychologists.

System Design

System design is a crucial stage in the development of an expert system, as it provides a comprehensive framework that illustrates how the system will function and interact with its users before actual implementation. In this study, the intelligent system for diagnosing mental health disorders based on the Certainty Factor method is designed using a use case diagram as one of the primary modeling tools. The use case diagram serves not only as a visual representation of the relationship between the system and its users (actors) but also as a roadmap that explains the logical sequence of activities, beginning from when the user accesses the application until the diagnostic results are generated. By presenting the use case diagram, the interaction flow becomes clearer and more structured, ensuring that the system development process aligns with user needs while also fulfilling the objectives of this research.

In the context of this study, the main actors involved in the system are the patients or general users and the expert system itself. Users play an active role by entering symptom data that reflects their current mental health conditions, while the system processes this data through a knowledge base defined in collaboration with experts. The output is then generated in the form of a diagnosis of mental health disorders—such as depression, anxiety, schizophrenia, or bipolar disorder—along with a certainty value that quantifies the system's level of confidence. The use case diagram clearly illustrates each stage of this process, including logging into the system, completing the symptom questionnaire, selecting the frequency or intensity of symptoms, and receiving diagnostic results supported by Certainty Factor calculations.

Furthermore, the use case diagram reflects the principles of usability and simplicity in system design. This aspect is particularly important given that the target users are not only healthcare professionals but also members of the general public who may have limited technological literacy. Therefore, the flow illustrated in the diagram must be straightforward, structured, and free from unnecessary complexity, ensuring that the system can be used widely without requiring specialized training.

The diagram also emphasizes the integration of the Certainty Factor method as the core mechanism for decision-making within the system. Each symptom selected by the user is assigned a certainty weight based on expert belief, which is then combined mathematically to produce a more accurate overall confidence value. By embedding this mechanism into the system workflow as shown in the use case diagram, the diagnostic process becomes transparent, measurable, and reliable.

By presenting the use case diagram, this research highlights that the system is not only built on a strong theoretical foundation but also designed for practical implementation, with clear consideration of how real users will interact with it. The diagram serves as a bridge between conceptual planning and technical implementation, ensuring that the developed system truly meets the research objective of supporting early diagnosis of mental health disorders. Therefore, the use case diagram is not merely a design document but also an effective communication tool that aligns the understanding of researchers, developers, and end-users regarding how this Certainty Factor–based intelligent system operates.

3. RESULTS AND DISCUSSION

The results of this study indicate that the application of the Certainty Factor (CF) method in an expert system can provide an initial diagnosis of mental health disorders with a relatively high degree of accuracy. The developed system does not only implement the CF formula mathematically but is also equipped with a user-friendly interface that is simple, intuitive, and easily accessible. This emphasizes that this research contributes not only to the theoretical aspect but also to the practical aspect by presenting an application that can be used as a screening tool by both the general public and healthcare professionals.

In the implementation process, the system is designed to process input in the form of symptoms commonly found in mental disorders such as depression, anxiety, schizophrenia, and bipolar disorder. Each symptom selected by the user is

evaluated through rules determined by experts, after which a certainty value (CF) is calculated to represent the level of confidence in the diagnosis. The final result does not only present the most probable type of disorder but also the associated confidence level. This transparency is important to increase user trust in the diagnostic results provided.

When compared with previous studies, this system demonstrates results that are consistent while also offering several improvements. For instance,

Table 3. Comparison Result CF

Researcher & Year	Method	Research Object	Accuracy / Highest CF Value	Strengths	Limitations	Comparison with This Study
Haerani et al. (2019)	Certainty Factor	Schizophrenia	Highest CF 0.937	Able to handle uncertainty in symptoms	Interface still limited, not user-friendly	This study adds a simple interface that is easier for general users to operate.
Julianti et al. (2020)	Certainty Factor	Stress & Depression	Accuracy ±92%	Utilizes a comprehensive expert rule base	Focuses only on one type of disorder	This study covers more disorders (depression, anxiety, schizophrenia, bipolar).
Saputra et al. (2021)	Dempster-Shafer vs CF	General Mental Disorders	CF superior in flexibility	Compares two methods for validation	Result interpretation less clear for non-technical users	This study strengthens the advantages of CF by adding a transparency feature for CF scores that is easier to understand.
This study (2025)	Certainty Factor	Depression, Anxiety, Schizophrenia, Bipolar	Highest CF 0.951 (Bipolar)	High accuracy + user-friendly interface	Challenge in user understanding of CF scores	Provides practical contribution in the form of a ready-to-use application as an early screening tool.

This supports the findings of this study, in which CF proved to be more realistic than binary logic methods in the context of mental health.

From the perspective of real-world implementation challenges, one important aspect is how users interpret CF scores. Not all lay users understand the meaning of probabilistic numbers, so additional explanatory mechanisms are needed to help them interpret the results without causing misunderstandings. Moreover, ethical considerations must also be taken into account, as this system functions only as a preliminary screening tool and not as a substitute for professional diagnosis.

Therefore, the discussion of the system implementation results not only describes the interface displays, the symptom questionnaire process, and the final diagnostic outputs but also emphasizes the role of the system as an educational and early awareness tool. The system can encourage individuals to better understand their mental health conditions and, if necessary, to immediately seek consultation with professionals.

System Interface Display

The overall system interface has been designed with a focus on simplicity and user experience. The purpose of this design is to ensure that users, whether they are experts or members of the general public, can easily navigate the application without encountering unnecessary technical difficulties. The interface serves as a medium that connects users with the expert system, allowing them to input symptoms, view progress, and receive diagnostic results. Displays the main system interface that integrates all of these components into a structured layout, highlighting the importance of usability and accessibility in supporting early mental health screening.

Main Page View

The main page serves as the first interaction point between the user and the expert system. It is designed to provide clear instructions and intuitive navigation, allowing users to begin the diagnostic process with minimal effort. The design incorporates a balance between simplicity and completeness, ensuring that users can immediately understand the purpose of the system. Figure 2 presents the main page view, which acts as the foundation for accessing all subsequent features of the system

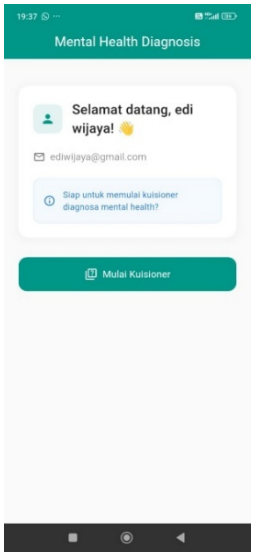

Figure 2 Main Page View

In Figure 2, the main page interface is displayed with a focus on readability and straightforward interaction. Prominent buttons guide the user toward the symptom questionnaire, while other options provide access to additional information and instructions. The structured design allows users to begin their diagnostic journey in just a few clicks, reflecting a human-centered approach to system development. This kind of design is important in health-related applications, where clarity and ease of use can significantly affect user compliance and accuracy of the input data.

Show Symptom Questionnaire

The symptom questionnaire interface is the core component of the expert system, as it collects crucial data from users that will later be processed by the Certainty Factor algorithm. This questionnaire includes multiple indicators that represent various symptoms of mental health disorders, such as depression, anxiety, bipolar disorder, and schizophrenia. The design of this interface emphasizes systematic data collection, encouraging users to carefully read and select the symptoms that best match their current conditions. Figure 3 demonstrates the questionnaire interface where these indicators are displayed.

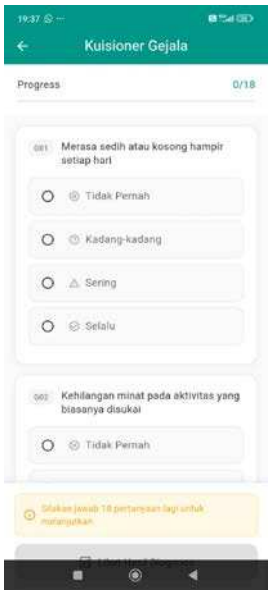

Figure 3 Symptom Questionnaire

As illustrated in Figure 3, each symptom is presented with a description and an option for the user to indicate its presence and intensity. This approach allows the system to capture not only binary responses (yes or no) but also the level of certainty associated with each symptom. By adopting this design, the questionnaire ensures that the data gathered reflects the

complexity and variability of mental health conditions. Furthermore, the structured and standardized format helps reduce ambiguity, thus improving the reliability of the diagnostic results generated by the system.

Result Form Display

Once users complete the symptom questionnaire, the system automatically processes the input using the Certainty Factor formula to generate diagnostic results. The result form acts as a summary of the analysis, providing users with insights into the most probable mental health disorder they may be experiencing. This form is an essential feature because it transforms raw input data into meaningful information that can support decision-making. Figure 4 shows the system's result form display.

Figure 4 Result Form Display

Based on the results of the *Certainty Factor* (CF) calculations, the confidence values obtained for several types of mental disorders are as follows: depression at **0.8827**, anxiety disorder at **0.8532**, schizophrenia at **0.51**, and bipolar disorder at **0.951**. From these results, it can be concluded that the disorder most likely experienced by the patient is **bipolar disorder**, with the highest CF value of **0.951**.

This finding indicates that the developed expert system is capable of producing conclusions with a high level of confidence and effectively distinguishing bipolar disorder from other conditions such as depression, anxiety, and schizophrenia. The relatively high certainty value suggests that the combination of symptom indicators associated with bipolar disorder is stronger and more consistent compared to those related to the other disorders tested. This is particularly important since bipolar disorder is often difficult to detect due to overlapping symptoms with depression and anxiety, frequently leading to delays in diagnosis and treatment.

As shown in **Figure 4**, the diagnostic result form is presented in a clear and structured manner. The system highlights the disorder most likely experienced by the user along with the CF value, which represents the level of confidence in the diagnosis. This quantitative representation enables users to better understand the degree of certainty behind the system's output, thereby making the results more transparent and trustworthy. Presenting the outcomes in this format also provides users with deeper knowledge about their mental health condition and encourages them to seek professional consultation when necessary. Thus, the result form not only functions as an output display but also as a bridge between automated diagnosis and human decision-making.

The application of the CF method in this study has proven to not only identify the disorder most likely experienced by the patient but also provide a quantitative measure of confidence in the diagnostic result. This transparency illustrates how expert reasoning can be transferred into an automated system, bridging the gap between expert knowledge and computer-based decision-making. Therefore, the CF method can be considered a reliable computational model for addressing uncertainty in mental health diagnosis.

In addition to generating diagnostic outcomes, this system also serves an educational role for users. By presenting the results in both qualitative conclusions and quantitative certainty values, users are encouraged to develop a better understanding of their mental health condition and are motivated to seek professional support when necessary. Consequently, the findings of this study not only validate the accuracy of the developed system but also highlight its potential as a decision-support tool for mental health screening, particularly in areas with limited access to psychiatrists and psychologists.

4. CONCLUSION

This study demonstrates that an expert system based on the Certainty Factor (CF) method can support early diagnosis of mental health disorders with relatively high accuracy, as evidenced by the highest CF value of 0.951 in detecting bipolar disorder. These findings confirm that the CF method is effective in handling uncertainty and overlapping symptoms, while also providing transparency through quantitative certainty scores. Although this system shows strong potential as a reliable screening tool, professional consultation remains necessary for treatment and clinical confirmation.

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