

# Expert System for Screening of Borderline Personality Disorder

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**Abstract**—Individuals who have symptoms of borderline personality disorder (BPD) usually experience intense feelings of hatred, anger, depression, or anxiety. These feelings are often frightening, overwhelming and difficult to control. In the midst of intense emotions, individuals with BPD may act impulsively to reduce emotional pain, calm themselves, or communicate emotional distress. This results in 10% of people with BPD dying by suicide. The system is made to anticipate and minimize these problems. The expert system built in this study can measure a person's level of borderline personality disorder, so that it can increase knowledge in the general public to help someone who is detected as having mental health problems or BPD. The certainty factor method is used to assume the degree of confidence in the value used, and Forward chaining as forward tracking which starts from gathering facts and events that support the assumption/hypothesis, until a conclusion is obtained. Based on tests using 50 test data using accuracy testing, it shows that the CF method has a presentation of 100% accuracy in the test results that have been carried out in this study.

**Keywords:** *Borderline Personality Disorder, Certainty Factor, Forward Chaining.*

## I. INTRODUCTION

Mental health is an important aspect of a person in achieving overall health for himself. Mental health is very important to pay attention to, and is no less important than physical health. A person cannot be said to be healthy without mental health insurance, as the definition of health conveyed by the World Health Organization (WHO) states that health is a state of complete physical, mental and social well-being of a person, and not merely the absence of disease or infirmity. Mental health is a fundamental or initial component of health definitions and indicators. People

who have good mental health enable them to realize their potential, can cope with the normal pressures of life, work productively, and contribute to their community. Therefore, we cannot ignore the existence of mental health problems, because the number of cases currently is quite alarming. There are approximately 450 million people suffering from mental and behavioral disorders worldwide. It is estimated that one in four people with a mental disorder will suffer from it in their lifetime. According to WHO Asia Pacific Region (WHO SEARO) the highest number of cases of depressive disorders is in India (56,675,969 cases or 4.5% of the total population), the lowest is in the Maldives (12,739 cases or 3.7% of the population). This problem cannot be generalized, then there is a false stigma about mental disorders which hinders access to health services resulting in mishandling. As reported by Human Rights Watch Indonesia, which highlighted the poor handling of citizens with mental disorders in Indonesia. It is known that more than 57,000 people with psychosocial disabilities (mental health conditions), at least once in their lives have been shackled [1-5].

Individuals with BPD experience intense feelings of fear, hatred, anger, depression, or anxiety. These feelings are often explosive, frightening, overwhelming, and difficult to control. In the midst of intense emotions, individuals with BPD may act impulsively, lash out and hurt themselves to reduce emotional pain, self-soothe, or communicate emotional stress. There are more than 10% of people with BPD die by suicide. 80% of people with BPD who are hospitalized have had surgery because they injured themselves, hit themselves, burned their skin, bit themselves, banged their heads, scratched, carved their skin, and inserted needles. The emotional pain they experience is so unbearable that self-harm is a way of coping with the psychic pain they are feeling.

Sometimes people with BPD accidentally cause more harm to themselves than they take in. They need attention and want to be treated with compassion, like any other serious medical disorder. Friends, family, doctors, and community members can help validate their experiences of emotional distress, provide a safe environment, and help them access the appropriate level of care and support needed for recovery [1-5].

Based on research that childhood trauma is a major determinant of Personality threshold, depression, and suicidal behavior. It was also stated that apart from other personality disorders, childhood trauma was mostly related to borderline personality and also involved romantic love, intimacy, and commitment [1-7].

## II. LITERATURE REVIEW

### A. Depression

Depression is a common serious health problem, frequently recurring and associated with reduced function, quality of life, medical morbidity and mortality. Depression is one of the most common mental health disorders. 350 million people are affected by depression worldwide and it is thought to be a cause the second most common cause of the global disease burden in 2020 [7-8].

### B. Borderline Personality Disorder

People with BPD can experience drastic mood swings towards themselves, their environment, or the people around them for no apparent reason. Mood changes can occur from positive feelings to negative or vice versa. The term borderline personality was first coined by a therapist who is a psychoanalyst, named Adolf Strem, when experiencing a negative mood, people with BPD can feel angry, empty, sad, worthless, ashamed, panic or afraid, and very lonely. In fact, BPD can cause sufferers to think that they are bad, guilty, or insignificant [1-8].

### C. Expert System

An expert system is a system that is designed and implemented with the help of a particular programming language to be able to solve problems as done by experts. The basic concept of an expert system contains several elements, namely: expertise or expert, experts or experts, transfer of expertise or expert, inference, rules and ability to explain. The purpose of an expert system is to transfer the expertise of an expert to a computer [9-14].

### D. Certainty Factor

Certainty factor uses a value to assume the degree of confidence of an expert in a data. The certainty factor method is used to deal with a problem whose answer is uncertain. This uncertainty can be a probability. The Certainty factor uses a value to assume the degree of confidence of an expert in a data [9-14].

Several terms are used in the CF method. Evidence, are facts or symptoms that support the hypothesis. The hypothesis, the result sought or the result obtained from the symptoms. CF[H,E], the

certainty factor of the hypothesis H which is influenced by evidence E. The magnitude of CF ranges from -1 to 1. A value of -1 indicates absolute distrust while a value of 1 indicates absolute trust. MB, measure of increased belief,  $0 \leq MB \leq 1$ . MD, measure of increased disbelief,  $0 \leq MD \leq 1$ .

The following is the basic formula for the certainty factor of a rule IF E THEN H is shown as the following equation:

$$CF(H, e) = CF(E, e) \times CF(H, E) \quad (1)$$

Where:

$CF(H, e)$  : Hypothesis influenced by evidence

$CF(E, e)$  : Evidence that is influenced by evidence

$CF(H, E)$  : Hypothesis with the assumption that the evidence is known with certainty, namely when (1) Determining the combinations is the end of a candidate conclusion.

If the known data is 1 hypothesis, it has 1 CF rule, lots of evidence and lots of CF evidence. As well as using conjunction rules such as if E1 and E2 and 3n, then H. Then the results sought are CF combinations first, CF combinations initially look for 2 CFs first. Then the results of the CF are calculated again with the next CF until all CFs have been calculated. The CF combination formula depends on CF, namely.

If both  $CF > 0$ , then the formula used:

$$CF[H, E] = CF_1 + CF_2(1 - CF_1) \quad (2)$$

If both  $CF < 0$  then the formula used:

$$CF[H, E] = CF_1 + CF_2(1 + CF_1) \quad (3)$$

If both one  $CF < 0$  then the formula used:

Joins are needed if a conclusion is obtained from several rules at once. the end of one rule with other rules combined to get the final score for the candidate conclusion. The combined calculation formula is as follows

$$CF[H, E] = CF_1 + CF_2 / 1 - \min(CF_1 | CF_2) \quad (4)$$

Where:

$CF_1$ : Value from evidence 1 (first).

$CF_2$ : Value from evidence 2 (second).

$CF(CF_1, CF_2)$ : Result of the combined value of the existing evidence

## III. RESEARCH METHODS

### A. Stages of Research Implementation

The flow of the stages of an expert system for screening for borderline personality disorder. As the general public or experts, initially the expert will fill in the username and password then the expert can manage symptom data and user data [15-20]. Furthermore, as the general public will fill in the symptoms and then will be included in the forward chaining match then it will be calculated in the certainty factor calculation and the general public will

receive the results of the screening. psychiatric doctors or clinical psychologists with the stigma of people who are still unfamiliar with mental health. So it is hoped that this system can help the community in screening the level of Borderline Personality Disorder Stages of Research Implementation.

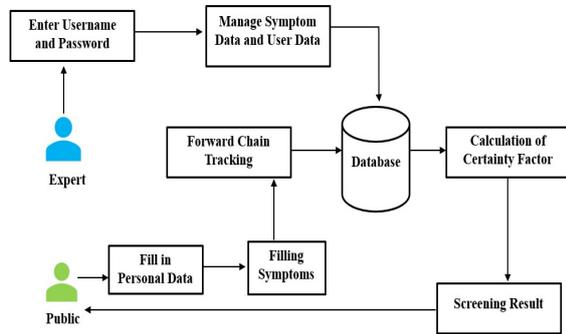


Fig. 1. Stages of Research Implementation

### B. Data Collection

Symptoms of Borderline Personality Disorder obtained from patients at the Atma Husada Mahakam Samarinda Mental Hospital, concepts and related theories that can support this research. This study conducted interviews and observations regarding the symptoms of BPD and assigned a weight value to each symptom in Borderline Personality Disorder based on data from the informant, Mr. Gerda Akbar., S.Psi., M.Psi.

### C. Data Processing

Following the stages in data design, there are borderline personality disorder classification tables, symptom tables, weight tables, interpretation tables of user belief weight values, suitability tables, rule tables and decision trees. The disease level table is given for description of the disease level code used as data which can be seen in Table I Classification of Borderline Personality Disorder Levels.

TABLE I. CLASSIFICATION OF BPD LEVELS

No	Code	Borderline Personality Disorder Level
1	T01	High Borderline Personality Disorder
2	T02	Low Borderline Personality Disorder

With scoring interpretation

If > 50.0 = High Borderline Personality Disorder

If < 50.0 = Low Borderline Personality Disorder

The symptom table provides a description of the code for each symptom and the weight value which can be seen in Table II. Code, symptom and weight value.

TABLE II. CODE, SYMPTOM AND WEIGHT VALUE

Symptoms Code	Symptoms	Expert Weight Value
G01	Trying to avoid being dumped or feeling afraid of losing and being abandoned so that you distance yourself from someone or the environment.	0.4

Symptoms Code	Symptoms	Expert Weight Value
G02	Experiencing unstable patterns of interpersonal relationships. Or a relationship that was fine at first can suddenly turn bad.	0.4
G03	Experiencing identity disturbances such as self-image that is always changing, and self-image that is unstable continuously. (change of self-description)	0.4
G04	Doing one of the impulsive behaviors such as wasteful, careless eating, free sex, to addiction to substances such as narcotics, etc.	0.4
G05	Attempting to engage in behavior or Movement, suicidal threats, or self-harm behavior. Repeatedly done.	0.4
G06	Experiencing marked mood swings (for example, feelings of joy that quickly turn to intense sadness, lasting for hours or days).	0.4
G07	Constantly feeling a very strong feeling of emptiness.	0.3
G08	Difficulty controlling emotions such as inappropriate anger, or you often display anger, and are always irritated to the point of getting into regular physical fights.	0.4
G09	Feeling prejudiced and easily suspicious of others.	0.2

Table III is the certainty factor of the rule made by the expert with the weight determined by the expert, this certainty value is given when the user inputs data in the screening rule.

TABLE III. INTERPRETATION OF USER CONFIDENCE WEIGHT VALUES

no	Description	CF User
1	No	0.0
2	Don't Know	0.2
3	Little Confident	0.4
4	Pretty sure	0.6

Table IV is a table for matching symptoms and levels of borderline personality disorder.

TABLE IV. CONFORMITY TABLE

Symptom Code	Symptoms	BPD Level	
		T01	T02
G01	Trying to avoid being dumped or feeling afraid of losing and being abandoned so that you distance yourself from someone or the environment.	√	
G02	Experiencing unstable patterns of interpersonal relationships. Or a relationship that was fine at first can suddenly turn bad.	√	
G03	Experiencing identity disturbances such as self-image that is always changing, and self-image		√

Symptom Code	Symptoms	BPD Level	
		T01	T02
	that is unstable continuously. (change of self-description)		
G04	Doing one of the impulsive behaviors such as wasteful, careless eating, free sex, to addiction to substances such as narcotics, etc.	√	
G05	Attempting to engage in behavior or Movement, suicidal threats, or self-harm behavior. Repeatedly done.		√
G06	Experiencing marked mood swings (for example, feelings of joy that quickly turn to intense sadness, lasting for hours or days).	√	
G07	Constantly feeling a very strong feeling of emptiness.		√
G08	Difficulty controlling emotions such as inappropriate anger, or you often display anger, and are always irritated to the point of getting into regular physical fights.	√	
G09	Feeling prejudiced and easily suspicious of others.		√

Table V is a knowledge representation table that is used in the process of compiling rules which is an inference of the forward chaining method to find a goal or conclusion based on collected data that will lead to the final conclusion.

TABLE V. TABLE OF RULES

Rule	If	Then
1	G01, G02, G04, G06, G08	T01
2	G03, G05, G07, G09	T02

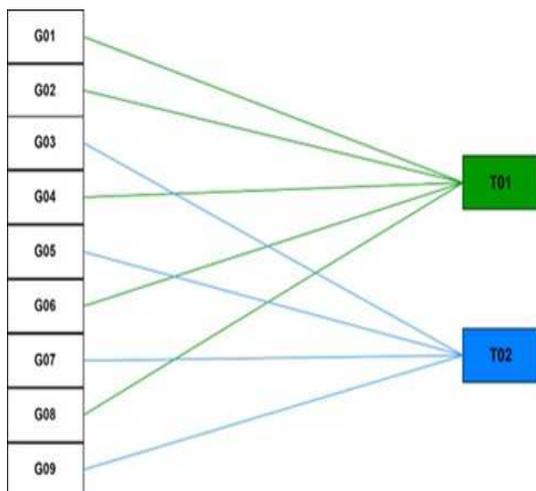


Fig. 2. Determination of BPD Symptoms

Based on the representation of the symptoms chosen and felt by the user, rules were drawn up which were formed based on the case study Medical Records at the Atma Husada Regional Mental

Hospital, Samarinda City, East Kalimantan Province, including the following:

- IF G01 AND G02 AND G04 AND G06 AND G08 THEN T01
- IF G03 AND G05 AND G07 AND G09 THEN T02

Use of AND as a production rule requirement to be used in determining the level of borderline personality disorder experienced by users. The symptoms selected by the user will be searched and then counted 28 using the certainty factor method so as to produce a borderline personality disorder screening level. Tracing with the forward chaining method.

#### D. Process Design

Is an overview of the stages of the design process that will be developed into a complete expert system and in accordance with the needs of an expert system for borderline personality disorder screening.

This design is to determine the elements in the formation module that will be designed with flowcharts as well as use case diagrams and activity diagrams.

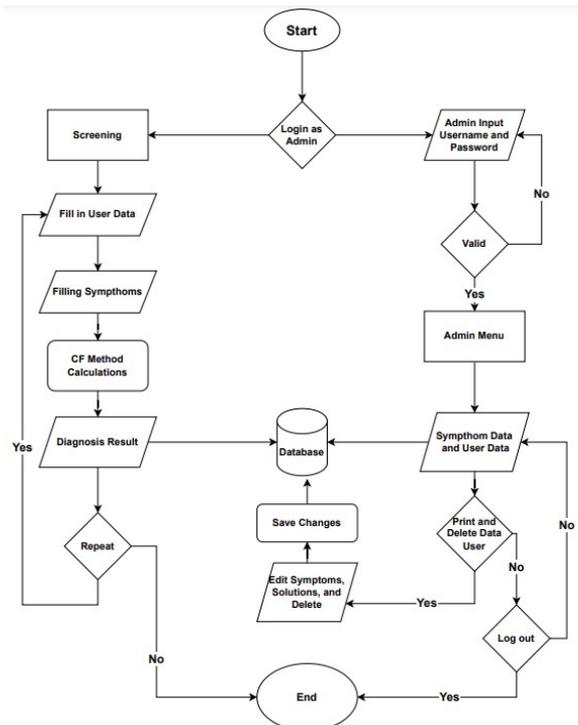


Fig. 3. Activity Diagrams

## IV. RESULTS AND DISCUSSION

The application of this expert system uses the certainty factor method where this calculation method is used to find the value of each predetermined symptom.

#### A. Certainty Factor Calculation Method

Calculations use the certainty factor method with the weights and MB and MD values obtained from experts, where the MD values are obtained from the

interpretation table chosen by the expert. The following is a sample calculation obtained from one of the user samples, then in the sample used the user experiences symptoms and has selected the appropriate symptoms. Calculation with sample 02 (symptoms met). The following calculations from one sample of users.

$$\begin{aligned} \text{CFcombine CF[H,E] 1,2} &= \text{CF[H,E]1} + \text{CF[H,E]2} * (1-[\text{H,E]1}) \\ &= 0,24+0,24*(1-0,24) \\ &= 0,4224 \end{aligned}$$

$$\begin{aligned} \text{CFcombine CF[H,E] 1,3} &= \text{CF[H,E]old1} + \text{CF[H,E]3} * (1-[\text{H,E]1}) \\ &= 0,4224+0,16*(1-0,4224) \\ &= 0,514816 \end{aligned}$$

$$\begin{aligned} \text{CFcombine CF[H,E] 3,4} &= \text{CF[H,E]3} + \text{CF[H,E]4} * (1-[\text{H,E]3}) \\ &= 0,514816+0*(1-0,514816) \\ &= 0,514816 \end{aligned}$$

$$\begin{aligned} \text{CFcombine CF[H,E] 4,5} &= \text{CF[H,E]4} + \text{CF[H,E]5} * (1-[\text{H,E]4}) \\ &= 0,514816+0,24*(1-0,514816) \\ &= 0,63126016 \end{aligned}$$

$$\begin{aligned} \text{CFcombine CF[H,E] 5,6} &= \text{CF[H,E]5} + \text{CF[H,E]6} * (1-[\text{H,E]5}) \\ &= 0,63126016+0,24*(1-0,63126016) \\ &= 0,7197577216 \end{aligned}$$

$$\begin{aligned} \text{CFcombine CF[H,E] 6,7} &= \text{CF[H,E]6} + \text{CF[H,E]7} * (1-[\text{H,E]6}) \\ &= 0,7197577216+0,18*(1-0,7197577216) \\ &= 0,770201331712 \end{aligned}$$

$$\begin{aligned} \text{CFcombine CF[H,E] 7,8} &= \text{CF[H,E]7} + \text{CF[H,E]8} * (1-[\text{H,E]7}) \\ &= 0,770201331712+0*(1-0,770201331712) \\ &= 0,770201331712 \end{aligned}$$

$$\begin{aligned} \text{CFcombine CF[H,E] 8,9} &= \text{CF[H,E]8} + \text{CF[H,E]9} * (1-[\text{H,E]8}) \\ &= 0,770201331712+0,12*(1-0,770201331712) \\ &= 0,79777719065 \end{aligned}$$

$$\begin{aligned} \text{CFcombine CF[H,E] 5,6} &= \text{CF[H,E]5} + \text{CF[H,E]6} * (1-[\text{H,E]5}) \\ &= 0,63126016+0,24*(1-0,63126016) \\ &= 0,7197577216 \end{aligned}$$

$$\begin{aligned} \text{CFcombine CF[H,E] 6,7} &= \text{CF[H,E]6} + \text{CF[H,E]7} * (1-[\text{H,E]6}) \\ &= 0,7197577216+0,18*(1-0,7197577216) \\ &= 0,770201331712 \end{aligned}$$

$$\begin{aligned} \text{CFcombine CF[H,E] 7,8} &= \text{CF[H,E]7} + \text{CF[H,E]8} * (1-[\text{H,E]7}) \\ &= 0,770201331712+0*(1-0,770201331712) \\ &= 0,770201331712 \end{aligned}$$

$$\begin{aligned} \text{CFcombine CF[H,E] 8,9} &= \text{CF[H,E]8} + \text{CF[H,E]9} * (1-[\text{H,E]8}) \\ &= 0,770201331712+0,12*(1-0,770201331712) \\ &= 0,79777719065 \end{aligned}$$

The following is the result of manual calculation with CFcombine rounding  $[T01] = 0.79777719065 * 100\% = 79.777719065\%$ .

Based on the manual calculation above, the percentage of T01 confidence (after rounding off the two decimal places) is 79.77%, thus it is stated that the

user has a high level of borderline personality disorder.

### B. Implementation

The implementation stage is to prepare all the activities needed for the implementation of the system in accordance with a predetermined design. In this study using the visual studio code application and using the programming language HTML and PHP and building a display interface using CSS. As well as using MySQL as a database server and Apache web server.

### C. Test Results

Testing on this system uses data (testing) using the attached 50 system usage data. After that a sample is made using the test data to find out the results of the screening according to what was designed.

TABLE VI. TEST RESULTS

No	Disease Classification	Total Test Data	Screening Identification	
			Appropriate	Inappropriate
1	High BPD Level	41	41	0
2	Low BPD Level	9	9	0
	<b>Total</b>	<b>50</b>	<b>50</b>	<b>0</b>

In this stage, functional testing of the expert system to measure the level of borderline personality disorder using a certainty factor is carried out to ensure that the system runs according to what was planned beforehand. The testing method used is the Blackbox Testing method. The checks carried out include all the functions of the display which are easy for users to understand, both users and administrators. In Fig. 4 is a page containing user data who has consulted on the borderline personality disorder screening application, the results of the consultation can be printed to be taken for consultation materials to the doctor.

no.	name	cid	work	status	sex	op01	op02	symptoms	results	report
1	isaah satrianoq	00	out	married				0001(usa funu) 0002(usa funu) 0003(usa funu) 0004(usa funu) 0005(usa funu) 0006(usa funu) 0007(usa funu) 0008(usa funu) 0009(usa funu) 0010(usa funu)	74,24%	
2	tygg anggara	01	-	Not married				0001(usa funu) 0002(usa funu) 0003(usa funu) 0004(usa funu) 0005(usa funu) 0006(usa funu) 0007(usa funu) 0008(usa funu) 0009(usa funu) 0010(usa funu)	100%	

Fig. 4. Result of user consultation

## V. CONCLUSIONS AND SUGGESTIONS

Based on the results of the research from the design to the implementation of the expert system, several conclusions can be drawn as follows: To produce an expert system that can measure the level of borderline personality disorder using the certainty factor method, an expert system website for screening the level of borderline personality disorder can help

the general public to measure disorders. borderline level personality that might be experienced to get advice whether to consult a psychologist or not, an expert system website that uses the certainty factor method can also help experts in diagnosing patient symptoms, and the identification results of an expert system in this study using 50 test data obtained a percentage value 100% manual calculation accuracy produces the same level of output matching with the output of the developed software system. This expert system can be further developed by adding other diseases to assist experts in diagnosing patients with other mental disorders.

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