Expert System For Diagnosis Of Personality Disorders With Certainty Factor Approach

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***Abstract*— The research on mental disease entitled "The Global Burden of Disease" predicts that mental disease will rank second as the most common cause of death after cardiovascular diseases in 2020. Personality disorders belong to the type of mental disease if one's ways of thinking, understanding situations and interacting with others do not function. Many people feel embarrassed about visiting a psychiatrist. They are afraid if others will consider them crazy or having a crazy family member. Therefore, it is necessary to have a tool to assist early personality disorder diagnosis to deal with the problems. Certainty Factors are a method to manage uncertainty in a rule-based system. The input necessary to diagnose personality disorders are symptoms, a patient's certainty value and an expert's certainty value. Knowledge acquisition was carried out to collect data on an expert's knowledge. The obtained data were then presented in a decision table and rules of production to facilitate coding the knowledge into the program. The findings of this research can determine the type of personality disorder with the degree of accuracy by 80% and provide information about the proper treatment for the type of personality disorders.**

Keywords*— *personality disorders, expert system, certainty factor

I. INTRODUCTION

Research on mental disease entitled "The Global Burden of Disease" carried out by Murray [1] in conjuction with WHO and the World Bank predicts that mental disease will occupy the second position with a total of 78.7 million people suffering from it after cardiovascular diseases in the first rank by 82.3 million people suffering from it in 2020. Personality disorders belong to the group of mental disease. One is considered suffering from personality disorders if his/ her behavior, attitudes, and ways of thinking can disturb and endanger social functions and work, causing stress for the individual concerned, where the individual concerned commonly does not realize his/ her problematic behavior [2].

People feel ashamed visiting psychiatrists. They are afraid if others will consider them crazy or having a crazy family member. This is reasonable because there is an assumption that psychiatrists are for those who are mental disease and society also consider are mental disease people simply as crazy people (psychotic) [3]. Therefore, in this research an expert system will be built as a tool to assist personality disorder diagnoses to overcome the above-mentioned problems.

For psychiatrists, this expert system can assist them in experience sharing because it is built not only based on the existing theories but also based on the experience and knowledge of psychiatrists. Society can also use this system to perform an initial diagnosis to personality disorders they suffer from before treated by an expert for better treatment.

Razzouk et al. [3] have established a decision-supporting system to analyse schizophrenia, but the knowledge acquisition from three experts encounters difficulties because an agreement has not been reached among these three experts on the symptoms of schizophrenia. This causes uncertainties in the clasification which reaches 34% and the degree of accuracy range between 60 and 82%.

Asahar and Desty [4] establish an expert system for diagnosing personality disorders using Desktop-Based Frame and Forward Chaining. Frame is a set of slots used or attributes to describe knowledge. The value of the set of slots used is absolute in nature and thus it is difficult to apply in cases in which patients cannot provide fixed answers.

Research on an expert system for early diagnosis of neurosis, a mental disorder, has been conducted by Wita et al. [5] using the Certainty Factor method, but in practice the value of experts' Certainty Factor was not obtained directly from the experts but by dividing the number of selected symptoms by the total number of symptoms. Users were examined by distributing questionnaire which suggest satisfactory results on average. However, this research did not examine the system's performance.

There are many methods of expert systems commonly used in making a diagnosis of a disease. In fact, less certain answers are often provided. Certainty Factors are one of the methods that can be used to deal with uncertainty. The advantage of this method is that it can deal with uncertainty which is subjective in nature because its modeling is based on expert's idea.

II. LITERATURE REVIEW

Artificial Intelligence is one of the computer science disciplines that create computer-based system which behave intelligently like humans [6]. In other words, it makes a computer can think and reason like humans and make machines more useful for humans. On the other hand, an expert system is one of the branches of artificial intelligence that makes use special knowledge possessed by an expert to solve a particular problem [7]. Generally, an expert system refers to a system that tries to apply humans' knowledge to a computer in order the computer can solve a problem just like an expert.

In reality, solving a problem is often confronted with problems that cannot be modelled completely and contain with uncertainty. Certainty Factors are a method to manage uncertainty in a rule-based system. There are two values of Certainty Factors, namely:

1. The Certainty Factor value of a rule, whose value is attached to a particular rule and the magnitude of the value is given by experts.
2. The Certainty Factor value that is given by users to represent the degree of certainty or belief on the premise that is experienced by users.

The general equation used to calculate the value of Certainty Factors is defined as follow [8]:

$$CF(H,E) = MB(H,E) - MD(H,E) \quad (1)$$

Description:

CF(H,E) : Hypothesis H of the Certainty Factor for the emergence of symptoms E,
MB(H,E) : The measure of increased belief towards hypothesis H that is influenced by symptoms E,
MD(H,E) : The measure of increased disbelief towards hypothesis H that is influenced by symptoms E.

Equation (2) is the basic form of the Certainty Factor formula in a rule in form of "IF E THEN H" [8]

$$CF(H,e) = CF(E,e) * CF(H,E). \quad (2)$$

Description:

CF(H,e) : The measure of increased disbelief towards hypothesis H that is influenced by symptoms e,
CF(E,e) : CF of symptoms E that is influenced by symptoms e,
CF(H,E) : CF of the hypothesis, with the assumption that the symptoms are known for sure when CF(E,e) = 1.

The followings are several descriptions of Certainty Factor combinations in various conditions, they are [8]:

- Certainty Factor for single premise rule:

$$CF(H,E) = CF(E) * CF(rule) = CF(User) * CF(expert). \quad (3)$$

- Certainty Factor for multiple premis rules:

$$CF(A \text{ AND } B) = Min(CF(A), CF(B)) * CF(rule) \quad (4)$$
$$CF(A \text{ OR } B) = Max(CF(A), CF(B)) * CF(rule) \quad (5)$$

- Certainty Factor for similarity concluded rules:

$$CFcom(CF1,CF2) = \begin{cases} CF1 + CF2 - (CF1*CF2), & CF1 \text{ and } CF2 > 0 \\ CF1 + CF2 * (1 + CF1), & CF1 \text{ and } CF2 < 0 \\ (CF1 + CF2) / 1\text{-min}(|CF1|, |CF2|), & CF1 \text{ or } CF2 < 0 \end{cases} \quad (6)$$

Description:

CFcom = CF combinations,
CF1 = CF rule 1,
CF2 = CF rule 2.

III. RESEARCH METHOD

An expert system is a system that tries to apply humans' knowledge (experts) to computer so that the computer can solve a problem just like an expert. To solve a problem just like an expert, rule-based reasoning is performed. Then, the experts' knowledge is represented using the IF-THEN rule.

Knowledge acquisition is one of the main components of an expert system. It is a process to collect data on experts' knowledge relating to a problem [10]. In this research, the knowledge was obtained from the book entitle "Guidance of Classification of Mental Disease Diagnostic" or translated into "Pedoman Penggolongan Diagnosis Gangguan Jiwa" [11] and experts in this area. The knowledge source was used as information to be studied, processed and organized in a structured manner into a knowledge base.

After the process of knowledge acquisition had been done completely, the next step was to represent the knowledge into a particular structure so as to assist knowledge coding into a program. In the knowledge representation stage, a decision table was made and converted into the rules of production.

This research used 10 (ten) patients whose mental disease was observed by 2 physciatrics. For their descriptions of personality disorders with the symptom codes used in this research, see Table I. Sample cases of the symptom codes are presented in Table II.

The decision table for the Certainty Factor values given by experts cannot be displayed entirely because there were too many data. For the example of the decision table of Certainty Factor values given by experts, see Table III.

TABLE I. Table Describing the Code, Name and Symptom Code of Personality Disorders

Disorder Code	Disorder Name	Symptom Code
GK1	Paranoid	G01,G02,G03,G04,G05, G06, G07
GK2	Anti-Social	G08,G09,G10,G11,G12, G13
GK3	Histrionics	G14,G15,G16,G17,G18, G19
GK4	Obsessive Compulsive	G20,G21,G22,G23,G24, G25, G26
GK5	Worried	G27,G28,G29,G30,G31, G32
GK6	Dependent	G33,G34,G35,G36,G37, G38

TABLE II. Table of Symptom Selection by User

Symptom Code	Symptom	CF User
G14	Expressions of emotions that are made-up such as pretending and exaggerating.	Very Sure = 1
G16	Emotions which are shallow dan easily change.	Sure = 0,8
G17	High necessary to be the center of attention	Very Sure = 1
G18	Dressed or behaving in a way which provoke something improper	Very Sure = 1
G19	Using physical attraction to gain attention	Very Sure = 1

TABLE III. Decision Table

Rules No:	CF Value for a User's Symptoms						Personality Disorder	Expert's CF
	G 14	G 15	G 16	G 17	G 18	G 19		
16			0,8	1	1		GK3	0,8
17				1	1	1	GK3	0,8
18	1				1	1	GK3	0,8

This research uses the Certainty Factor method to deal with the uncertainty in the answers provided by patients. Then, those answers were converted as follows [12]:

- A bit unsure = 0,4,
- Sure enough = 0,6,
- Sure = 0,8,
- Very sure = 1.

The value of Certainty Factors was assigned by patients and experts. The value of Certainty Factors assigned by patients was given when the patients selected the symptoms of personality disorders they encountered. The value of Certainty Factors assigned by experts was given by the experts in response to a disorder in a rule. Table II provides examples of answers provided by one patient when consulting with an expert.

In accordance with the data on symptoms and the degree of certainty of the patients in Table II, then the data were inserted into a decision table as described in Table III.

Based on the decision table in Table III, then the table decision was converted into the following rules of productions:

Rule 16

IF G16 [Patient's CF = 0,8]

AND G17 [Patient's CF = 1]

AND G18 [Patient's CF = 1]

THEN GK3 [Expert's CF = 0,8]

Rule 17

IF G17 [Patient's CF = 1]

AND G18 [Patient's CF = 1]

AND G19 [Patient's CF = 1]

THEN GK3 [Expert's CF = 0,8]

Rule 18

IF G14 [Patient's CF = 1]

AND G18 [Patient's CF = 1]

AND G19 [Patient's CF = 1]

THEN GK3 [Expert's CF =0,8]

The manual calculations of the conclusion's CF of each rules, Equation (4) is used as follows:

For Rule 16,

CF(G16,G17,G18) = Min(CF(G16),CF(G17),CF(G18)) *CF(R16)
= Min (0,8 ; 1 ; 1) * 0,8
= 0,8 x 0,8
= 0,64.

For Rule 17,

CF(G17,G18,G19) = Min(CF(G17),CF(G18),CF(G19)) * CF(R17)
= Min (1 ; 1 ; 1) * 0,8
= 1 x 0,8
= 0,8.

For Rule 18,

CF(G14,G18,G19) = Min(CF(G14),CF(G18),CF(G19)) * CF(R18)
= Min (1 ; 1 ; 1) * 0,8
= 1 x 0,8
= 0,8.

Since there are more than one rules for Histrionics personality disorders i.e. rules 16, 17 and 18 having value higher than 0 (zero), then the calculation to determine the Certainty Factor of the conclusions was carried out using Equation (6) as follows:

CFcom(C16,C17) = C16 + C17 – (C16 x C17)
= 0,64 + 0,8 – (0,64 x 0,8)
= 1,44 – 0,512
= 0,928.

CFcom(a)(CFcom,C18) = CFcom+K18–(CFcom x C18)
= 0,928 + 0,8 – (0,928 x 0,8)
= 1,728 – 0,7424
= 0,9856.

TABLE IV. Testing Result of 10 Cases

No	Symptom	The Result of System Diagnosis	The Result of Expert Diagnosis
1	G14, G16, G17, G18, G19	Histrionics (98,56 %)	Histrionics
2	G01, G02, G03, G04, G05	Paranoid (99,22%)	Paranoid
3	G27, G29, G30, G31, G32	Avoidant (97,75%)	Avoidant
4	G33, G36, G37, G38	Dependent (93,28%)	Dependent
5	G20, G21, G22, G25, G26	Obsessive Compulsive (97,13%)	Obsessive Compulsive
6	G15, G16 G18, G19	-	Histrionics
7	G02, G03, G04, G05, G08, G10, G12, G13	Paranoid (78,84%) and Anti-Social (57,00%)	Paranoid and Anti-Social
8	G20, G21, G25, G26, G29, G32	Obsessive Compulsive (84,32%)	Obsessive Compulsive
9	G35, G36, G37, G38	Dependent (92,16%)	Dependent
10	G14, G15, G18, G19, G21, G23, G24	Histrionics (87,04%)	Histrionics and Obsessive Compulsive

Thus, the conclusions Certainty Factor of all patient was diagnosed as Histrionics personality disorders with the degree of certainty were 0.9856 or 98.56% for Rules 16, 17 and 18.

The accuracy testing was conducted to determine the performance of the expert system to provide identification results relating to the conclusions of diagnoses on the types of personality disorders. The formula used to calculate the accuracy value is [13]:

Accuration = (The number of accurate data / the number of the whole data) x 100%

IV. Results and Discussion

This diagnoses system for personality disorders conducted using rule-based reasoning had been tested using 10 (ten) cases. This test was conducted and examined directly by experts. The result testing was conducted by comparing the output of those 10 cases.

From the diagnosis result in Table IV, the test for the first case until the fifth case and the sixth case until the tenth case was conducted by different experts. Results of the first case until the fifth case reveal that the certainty factor value of the system in response to the possibility that patients suffer from personality disorders was above 90%. For the sixth case until the tenth case, the certainty factor value of the system in response to the possibility that patients suffer from personality disorders was above 50%. This is consistent with the nature of the Certainty Factor method that can deal with uncertainty which is subjective in nature because its model is based on experts' idea.

In this research, the values of certainty factors generated from the testing of the 10 cases were as follows: 50% - 80% for 1 case, 80% - 90% for 3 cases, and above 90% for 6 cases. These certainty factors were influenced by the certainty value of the symptoms experienced by the patients. The more the rules that are used to calculate the symptoms experienced by a patient, the higher the resulting percentage of the certainty factor value of the personality disorders is.

Based on the calculation of personality disorder diagnosis, there were several symptoms that cannot be included into the knowledge base. This also causes the value of certainty factors that is generated by the system is small because those symptoms are excluded from the existing rule.

The experts suggests that it would be better if this system did not only use symptoms in making diagnosis but also including the results of CT Scan, MRI, laboratory examination, and also matching the similarity to the previous cases to ensure more accurate results.

After those ten cases had been examined using the established expert system, and based on the results of the testing on those ten cases, the resulting accuracy was calculated as follow:

Accuration = 8/10 x 100% = 80%.

Value 8 in the numerator was obtained from the total correct of personality disorders by experts. Value 10 in the denominator referred to the total cases tested.

After conducting the research on the expert system of personality disorder diagnosis, there are a number of strengths and weaknesses. The following strengths of this research are:

1. This research generated a degree of accuracy by 80%.
2. The experts' certainty factor value was obtained directly from the experts, unlike the previous research in which certainty factor value was obtained from the number of symptoms selected divided by the total number of the existing symptoms.

As for the weaknesses of this research, they are explained as follows:

1. The rules of production formulated were less complete.
2. The research employed two experts to test the degree of accuracy.
3. The research only used symptom data to make diagnosis.
4. The number of cases used to compare the diagnosis results was remains lacking.

V. Conclusions

This research had successfully established a system that can solve problems relating to uncertainty in incomplete information by using the value of the symptoms experienced by patients and the rules used by experts.

In this research, the values of certainty factors generated from the testing of the 10 cases were as follows: 50% - 80% for 1 case, 80% - 90% for 3 cases, and above 90% for 6 cases.

Diagnoses of personality disorders were carried out using rule-based reasoning in conjunction with Certainty Factor method. The results testing of the 10 (ten) cases by experts and the system suggested that the diagnosis results by the experts and the system led to the same diagnosis results with the degree of accuracy by 80%.

VI. SUGGESTIONS

This research diagnoses personality disorders, it would be better if the research adds other psychiatric disorders to get a better system that will accommodate the needs of paramedics in making a diagnosis of psychiatric disorder.

More criteria should be added to make a diagnosis such as the results of CT Scan, MRI and laboratory examination to ensure more accurate results.

More cases should be used to compare the diagnosis results made by experts and those generated using a system to generate a more precise degree of accuracy.

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