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Expert System to Diagnose Mental Health Disorders Using the Dempster Shafer Algorithm

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Abstract

This study aims to address the challenge of diagnosing mental disorders by using an expert system to provide accurate and efficient diagnosis. Mental health is crucial for achieving harmony in life, and the ability to face problems, feel happiness, and maintain positivity are all essential aspects of this. However, diagnosing mental disorders can be difficult and time-consuming, as symptoms may vary depending on the patient's condition and lifestyle. The study utilizes symptom data from 30 patients with 6 types of mental disorders, with each symptom assigned a weighted value of belief for the corresponding disorder. The Dempster Shafer algorithm is then used to process this data and obtain a total confidence value for each disorder. The results show a 97% confidence value for the patient's mental disorder, which can help psychologists make informed decisions and provide appropriate treatment.

Keywords: Expert System, Mental Disorder, Dempster Shafer, Belief

1. INTRODUCTION

Disease is an abnormal condition of the body and mind that results in dysfunction in the body's performance. This dysfunction may take the form of a disease in the body or a disorder in the mind, which is commonly referred to as a mental disorder. Mental disorders are psychological patterns that are related to stress or mental disorders that differ from typical human psychological development [1]. Mental disorders may involve affective, behavioral, cognitive, or perceptual components that are related to specific functions in areas of the brain or nervous system that carry out certain functions, including human social functions, job functions, and individual physical functions. Failure to handle mental disorders properly will exacerbate the condition, eventually becoming a burden for families, communities, and governments [2]. As such, it is necessary to consult a psychologist to help overcome mental disorders.

The study of mental health is an applied science that is widely practiced in everyday human life to address mental disorders [3]. Diagnosing mental disorders can be difficult because the symptoms can vary depending on the patient's condition and lifestyle. Expertise is required to provide the correct diagnosis and treatment for

mental disorders, which is typically the responsibility of psychologists. However, age and time constraints limit the efficiency and effectiveness of psychologists in diagnosing and treating patients [4]. Consequently, technology in the form of an expert system that can assist psychologists in diagnosing mental disorders in patients is needed.

An expert system is a system that utilizes the expertise of professionals in a particular field by implementing their knowledge into computer programs, enabling general users to make decisions like experts [5]. Expert systems operate within two primary environments: the development environment, which incorporates expert knowledge into computer programs, and the consulting environment, which obtains information or knowledge from experts through computer programs [6]. To function optimally, expert systems commonly employ techniques or algorithms in data processing, one of which is the Dempster Shafer algorithm. The Dempster-Shafer algorithm is a mathematical theory used to find evidence based on belief functions and plausible reasoning, combining information to calculate an event's probability [7]. While many techniques or algorithm models are complete and consistent in determining uncertainty, they require assistance to address the problem entirely and consistently. The addition of new facts stated nonmonotonically often causes inconsistency, making the Dempster Shafer algorithm particularly advantageous in addressing these issues [4].

In prior research, the Certainty Factor algorithm was utilized for the diagnosis of mental illness, specifically Psychosis. This current study focused on five types of mental disorders and 24 associated symptoms. From this data, researchers derived five rules that linked each mental disorder to its corresponding symptoms. Application of the Certainty Factor algorithm resulted in a 95.8% prediction rate for a mental disorder. However, this algorithm can produce inconsistent values when new symptoms are added to the rule, leading to varying results [8]. In addition, previous studies have utilized the Dempster-Shafer algorithm for the diagnosis of human skin diseases. One such study conducted a skin disease diagnosis test using 10 types of diseases and 30 disease symptoms. The data was processed using the Dempster-Shafer algorithm, resulting in an accuracy rate of trust in a disease of 99.43%. The root system was then tested on 30 respondents, resulting in an accuracy rate of 92.3% when compared to direct diagnosis by experts [9].

Based on these prior studies, researchers have attempted to apply different cases to manage data in their research on the diagnosis of mental disorders. The aim is to demonstrate the superiority of the Dempster-Shafer algorithm in overcoming inconsistencies, and the results obtained using this algorithm have shown a high accuracy value that can be consistently applied across various cases.

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2. METHODS

The research framework explained and carried out in this study can be described. Step by step can explain the research framework in Figure 1.

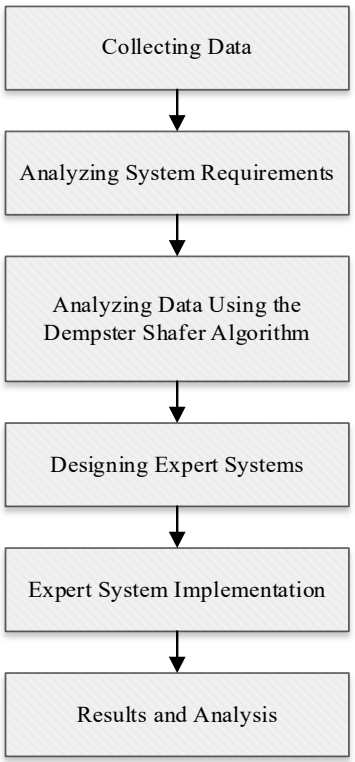

Figure 1. Research Framework

Figure 1 describes the research process for building an expert system for diagnosing mental health disorders. Based on the picture above, it can be explained as follows:

2.1. Collecting Data

Data collection for this study was conducted by interviewing mental health experts, namely psychologists from the Cirebon city mental health and mental clinic. Based on interview results, mental health obtained 6 types of mental health disorders with 30 symptoms of mental health disorders. The types of mental disorders that can occur in humans can be seen in Table 1.

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Table 1. Types of Mental Health Disorders

No	Mental Disorders Code	Name of Mental Disorder
1	P01	Anxiety Disorder
2	P02	Bipolar Disorder
3	P03	Psychotic Disorders
4	P04	Obsessive Compulsive Disorder
5	P05	Post Traumatic Stress Disorder (PTSD)
6	P06	Depression

While the symptoms that cause mental disorders can be seen in Table 2.

Table 2. Data on Symptoms of Mental Health Disorders

No	Symptom Code	Name of Symptoms of Mental Disorders
1	G01	Delusions/delusions
2	G02	Behavioural disorders
3	G03	Mood swings
4	G04	Often suspicious, challenging to focus and concentrate
5	G05	Feeling afraid and worried about the circumstances around
6	G06	Often feel less or don't even feel clean when washing hands.
7	G07	Often has a focus on arranging things sequentially, neatly, and symmetrically.
8	G08	Constantly checking something repeatedly
9	G09	Like or desire to collect used goods that you find
10	G10	Unwanted, disturbing memories that come repeatedly.
11	G11	Trying to avoid thinking or talking about the traumatic event.
12	G12	Negative thoughts about others, yourself, the environment, and the world.
13	G13	Often feels overwhelming guilt or shame.
14	G14	Difficulty maintaining close relationships.
15	G15	Unstable Emotions and Behavior
16	G16	It is tough to control anger
17	G17	Feeling useless, guilty, and hopeless
18	G18	Not caring about the safety of yourself and others
19	G19	Feeling inferior and limiting yourself
20	G20	Delusions/delusions
21	G21	Behavioral disorders
22	G22	Mood swings
23	G23	Often suspicious, challenging to focus and concentrate
24	G24	Feeling afraid and worried about the circumstances around
25	G25	Often feel less or don't even feel clean when washing hands.
26	G26	Often has a focus on arranging things sequentially, neatly, and symmetrically.
27	G27	Constantly checking something repeatedly
28	G28	Like or desire to collect used goods that you find
29	G29	Unwanted, disturbing memories that come repeatedly.
30	G30	Trying to avoid thinking or talking about the traumatic event.

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From the data in Table 2, a knowledge base is created to create rules or rules that explain the relationship between data on types of disorders and symptoms of mental health disorders. Apart from that, knowledge from experts is also needed to determine the Belief value of each symptom for the type of mental health disorder. The knowledge base or rules created can be seen in Table 3.

Table 3. Rule of Symptoms of Mental Disorders for Types of Mental Health Disorders

Symptom Code (G)	Disease Code (P)						Belief
	1	2	3	4	5	6	
G01	*						0,4
G02	*			*			0,5
G03	*					*	0,6
G04	*						0,5
G05	*						0,8
G06		*			*		0,5
G07		*					0,3
G08		*					0,6
G09		*		*			0,8
G10		*					0,6
G11			*				0,6
G12			*		*		0,7
G13			*				0,5
G14			*				0,5
G15			*				0,4
G16				*			0,8
G17				*			0,8
G18	*			*			0,5
G19				*			0,4
G20				*			0,3
G21					*		0,6
G22					*		0,8
G23			*		*		0,5
G24					*		0,4
G25					*		0,3
G26						*	0,8
G27	*					*	0,6
G28						*	0,4
G29				*		*	0,5
G30						*	0,3

The belief value is obtained from the expert's statement, which is measured by how much the value of the expert's belief in a symptom of a mental disorder depends on the type of mental health disorder. The magnitude of the belief value can be measured from a range of values from 0 to 1. The more the belief value of a symptom reaches 1, the greater the belief value. The greater the belief value of a

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symptom for one type of disorder, the greater the symptom can affect the type of disorder [4].

2.2. Analyzing System Requirements

System requirements analysis outlines the requirements to build an expert system for diagnosing mental health disorders. The system requirements can include expert knowledge, devices, programming languages, system design requirements, system development and system implementation.

2.3. Analyzing Data Using the Dempster Shafer Algorithm

The next step is to analyze the data collected using the Dempster-Shafer algorithm. Dempster Shafer's theory is generally written in an interval of Belief and Plausibility. Belief (Bel) measures the strength of evidence in supporting a set of propositions. If it has a value of 0, it indicates that there is no evidence, and if it has a value of 1, it indicates certainty. In comparison, Plausibility (Pls) will reduce the level of certainty from the evidence [10]. According to Giarranto and Rilley, the Belief function can be formulated as follows:

$$Bel\ (X) = \sum_{Y \subseteq X} m(Y) \tag{1}$$

Information:
Bel(X) : Belief(X)
m(Y) : m(Y) = mass function from (Y)

While Plausibility (Pls) is formulated as follows:

$$\text{Pls}\ (X) = 1 - Bel(X') = 1 - \sum_{Y \subseteq X} m(X') \tag{2}$$

Information:
Bel(X') : Belief (X)
Pls(X) : Plausibility (X)
m(X') : mass function from (X)
m(Y) : mass function from (Y)

Plausibility has a value of 0 to 1. If we believe in X', then it can be said that Belief (X') = 1 so that from the above formula the value of Pls (X) = 0. Several possible ranges between Belief and Plausibility are shown in Table 4.

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Table 4. Range Belief and Plausibility

Possibility	Information
[1,1]	Everything is correct.
[0,0]	All Wrong
[0,1]	Uncertainty
[Bel,1] where 0 < Bel < 1	Tend to Support
[0,Pls] where 0 < Pls < 1	Tend to Refuse
[Bel,Pls] where 0 < Bel ≤ Pls < 1	Tend to Support and Reject

In Dempster Shafer, there is a Frame of Discernment that is denoted by the symbol (Θ), which is the universe of speakers from a set of hypotheses so that it is often called the environment, which can be shown in equation [3]:

$$\Theta = \{\theta 1, \theta 2, ...\theta n\} \quad (3)$$

Where

Θ : FOD or environment

θ1,.....θn : Elements in the environment

The environment has elements that describe possibilities as an answer where only one answer matches what is needed. This possibility is called the power set, denoted by P(Θ),; each element in the power set has an interval value between 0 to 1. $m : P(\Theta) \rightarrow [0,1]$, then it can be formulated as:

$$\sum_{XeP(\ )} m(X) = 1 \quad (4)$$

The mass function (m) is the confidence level of evidence, often called an evidence measure. The goal is to relate the measure of the trustworthiness of the elements θ. Not all evidence directly supports each element, so it is necessary to have a probability density function (m). The value of m defines not only the elements θ, but also all of its subsets so that it is intended that all (m) in the subset θ equal to 1. If there is hypothesis information, then m{θ}= 1 - (m), and if there is no information whatever to choose the hypothesis, then the value of m{θ} = 1,0 [10]. In expert system applications, the lot will use several pieces of evidence on the uncertainty factor in the diagnosis results. To overcome the amount of evidence, Dempster's Rule of Combination is used, which generally uses the formula [6]:

$$m1 \oplus m2(Z) = \frac{\sum_{X \cap Y = Z} m1(X).m2(Y)}{1 - \sum_{X \cap Y = \phi} m1(X).m2(Y)} \quad (5)$$

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Where

m1⊕ m2(Z)	: mass function from evidence (Z)
m1	: mass function from evidence (X)
m2	: mass function from evidence (Y)

2.4. Designing Expert Systems

System design describes the description of the system to be built. System design is carried out using the Unified Modeling Language (UML). The form of the system design to be built can be seen in Figure 2, Figure 3, and Figure 4.

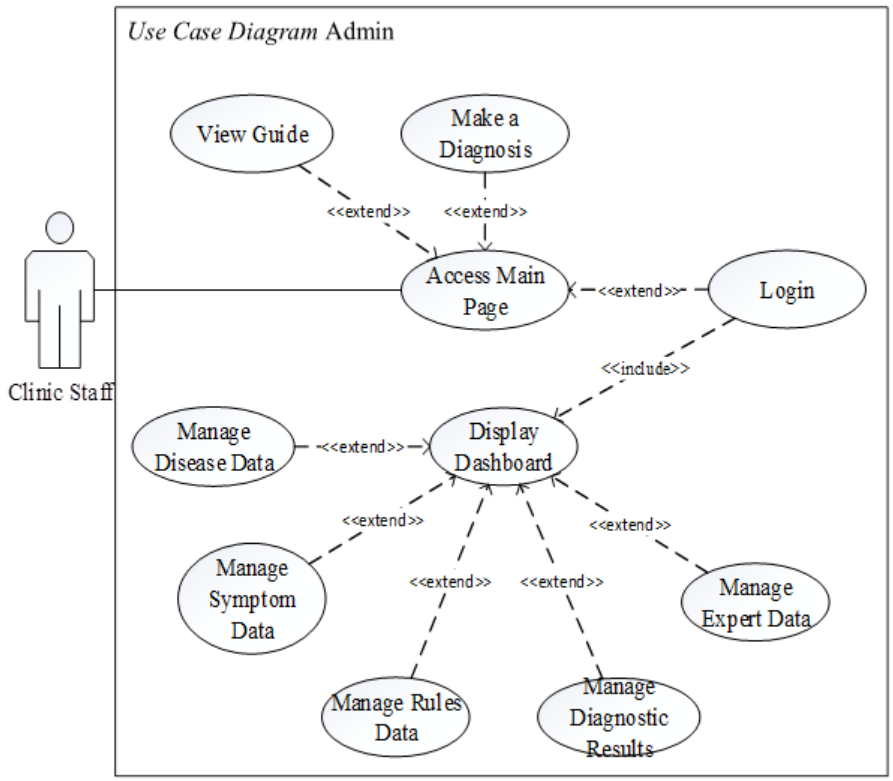

Figure 2. Use Case Diagram Users (Clinical Staff) Manage Data

Figure 2 clinic staff in interacting with the system, where all data management in the system is managed by clinical staff, starting from login, disease data, symptom data, roles, diagnostics, and advanced data.

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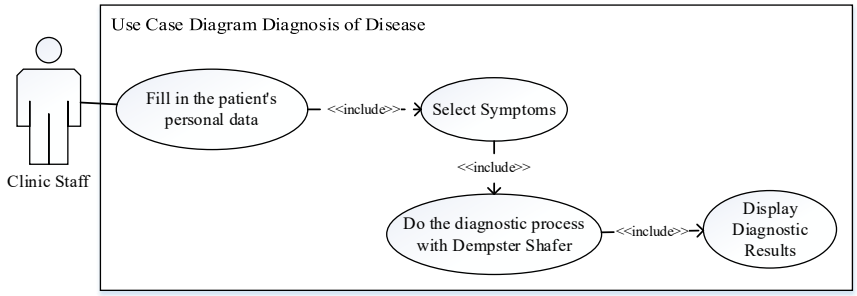

Figure 3. Use Case Diagram Users (Experts) make a Diagnosis.

Figure 3 explains making further diagnoses by entering patient data with the symptoms that appear. The system diagnoses health problems with the Dempster Shafer algorithm so that the diagnosis results occur for patient recommendations.

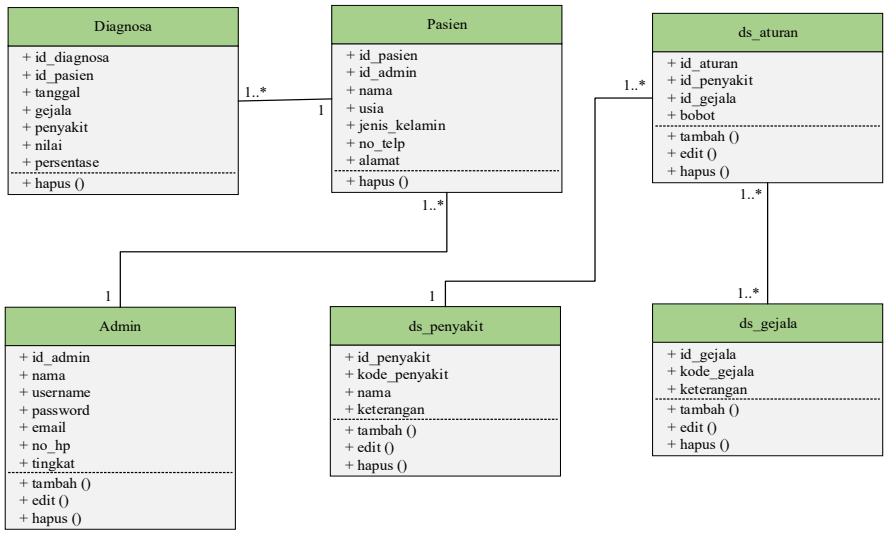

Figure 4. Class Diagram as Database Table Design

Figure 4 explains the relationship for database relations that can build for the health disorder diagnosis system with the Dempster Shafer algorithm, where there are six tables consisting of the diagnosa table, pasien table, ds_aturan table, admin table, ds_penyakit table, and ds_gejala.

2.5. Expert System Implementation

Implementation will implement implementation of expert systems in this study in web programming. So that clinic staff or experts can access the system anywhere and anytime using a laptop or smartphone device.

3. RESULTS AND DISCUSSION

3.1 Testing the Dempster Shafer Algorithm

The discussion in this study is to test the Dempster Shafer algorithm to diagnose mental health disorders with symptoms experienced by patients so that they can be implemented into an expert system. The patient symptom data to be tested can be seen in Table 5 below:

Table 5. Symptoms Experienced by Patients

Symptom Code	Symptom Name	Belief
G07	Excited spirit	0,3
G08	Reduced interest in an activity	0,6
G09	Trouble sleeping or insomnia	0,8
G10	Excessive feelings of guilt	0,5
G27	It is tough to control anger	0,6

Furthermore, these symptoms determine the value of belief and plausibility to obtain the final result. Then the calculation process is carried out as follows:
1) Determine the belief values of M_ 1 and M_ 2 to produce M_ 3
Fact 1: G07 Is a symptom of bipolar disorder (P02), so the value of belief and plausibility can be determined as follows:

$$Value\ belief\ M_1\ \{G07\}=0,3$$
$$Value\ Plausibility\ M_1\ \{\theta\}=1-0,3=0,7$$

Fact 2: G08 Is a symptom of bipolar disorder (P02), so the value of belief and plausibility can be determined as follows:

$$Value\ belief\ M_2\ \{G08\}=0,6$$
$$Value\ Plausibility\ M_2\ \{\theta\}=1-0,6=0,4$$

Recalculating new density values for each subset of functions with the M_3 density function. Following are the combination rules for M_3 in Table 6.

Table 6. Combination For M_3

			M2			
			{P02}	(0,6)	θ	0,4
M1	{P02}	(0,3)	{P02}	(0,18)	{P02}	(0,12)
	θ	(0,6)	{P02}	(0,42)	θ	(0,28)

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So, it can be calculated:

$$M_3\{P02\}=\frac{0,18+0,42+0,12}{1-0}=0,72 \quad (6)$$

$$M_3\{\theta\}=\frac{0,28}{1-0}=0,28 \quad (7)$$

Then the belief value of bipolar disorder (P02) from symptoms G07 and G08 is 72%.

2) Determine the value of confidence M_3 and M_4 to earn M_5

Fact 3: G09 is a symptom of bipolar disorder (P02), so the value of belief and plausibility can be determined as follows:

Value belief M_4 $\{G09\}=0,8$
Value Plausibility M_4 $\{\theta\}=1-0,8=0,2$

Recalculate new density values for each subset of functions with density functions M_5. Here are the combination rules for M_5 in Table 7.

Table 7. Combination For M_5

			M_4			
			{P02}	(0,8)	θ	0,2
M_3	{P02,P02}	(0,72)	{P02,P02}	(0,576)	{P02,P02}	(0,144)
	θ	(0,28)	{P02}	(0,224)	θ	(0,056)

So, it can be calculated:

$$M_5\{P02,P02\}=\frac{0,576+0,224+0144}{1-0}=0,944 \quad (8)$$

$$M_5\{\theta\}=\frac{0,056}{1-0}=0,056 \quad (9)$$

Then the belief value of bipolar disorder (P02) from symptoms G07, G08 and G09 is 94.4%.

3) Determine the value of confidence M_5 and M_6 to earn M_7

Fact 4: G10 is a symptom of bipolar disorder (P02), so the value of belief and plausibility can be determined as follows:

Value belief M_6 $\{G10\}=0,5$
Value Plausibility M_6 $\{\theta\}=1-0,5=0,5$

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Recalculating new density values for each subset of functions with the density function M_7. Following are the combination rules for M_7 in Table 8.

Table 8. Combination For M_7

			M_6			
			{P02}	(0,5)	θ	0,5
M_5	{P02,P02, P02}	(0,944)	{P02,P02, P02}	(0,472)	{P02,P02, P02}	(0,472)
	θ	(0,056)	{P02}	(0,028)	θ	(0,028)

So, it can be calculated:

$$M_7\{P02,P02,P02\}=\frac{0,472+0,028+0,472}{1-0}=0,972 \quad (10)$$

$$M_7\{\theta\}=\frac{0,028}{1-0}=0,028 \quad (11)$$

Then the belief value of bipolar disorder (P02) from symptoms G07, G08, G09 and G10 is 97.2%.

4) Determine the value of confidence M_7 and M_8 to earn M_9

Fact 5: G27 is a symptom of depression (P06), so the value of belief and plausibility can be determined as follows:

Value belief M_8 {G27}=0,6
Value Plausibility M_8 {θ}=1-0,6=0,4

Recalculating new density values for each subset of functions with the M_9 density function. Following are the combination rules for M_9 in Table 9.

Table 9. Combination For M_9

			M_8			
			{P06}	(0,6)	θ	0,4
M_7	{P02,P02, P02,P02}	(0,972)	{P02,P02, P02,P02}	0,5832	{P02,P02, P02,P02}	0,3888
	θ	(0,028)	{P06}	0,0168	θ	0,0112

So, it can be calculated:

$$M_9\{P02,P02,P02,P02\}=\frac{0,5832+0,3888}{1-0}=0,972 \quad (12)$$

$$M_9\{P06\}=\frac{0,0168}{1-0}=0,0168 \quad (13)$$

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$$M_9\{\theta\}=\frac{0{,}0112}{1\text{-}0}=0{,}0112 \quad (14)$$

Then the belief value of bipolar disorder (P02) from symptoms G07, G08, G09 and G10 is 97%. Then the belief in the occurrence of depression (P06) simultaneously is 2%.

3.2 Results of Expert System Design

After testing the Dempster Shafer algorithm, build an expert system and implement the algorithm into the expert system. In using the system, clinic staff will be assisted in collecting patient data, including the complaints they feel. Then from the many types of complaints, the expert system process of diagnosing mental health disorders using the Dempster Shafer algorithm is carried out to get the value of the degree of trust following the symptoms the patient gives. So that the results obtained in using the Dempster-Shafer theory [11][12], are a result that will be accepted for decision-making with many uncertain situations to get recommendations by calculating the Dempster-Shafer algorithm, missing values can be replaced by a range of values whose lower and upper limits are determined by the confidence and plausibility functions. The results can be in the form of recommendations for diagnosing diseases, which competent doctors will explain further. The interface design that has been designed in this expert system can be seen as follows:

1) Main page

The Main Page view is the first display displayed and has several functions to connect to other views or pages. The display of the expert system's main page can be seen in Figure 5.

Figure 5. Display of the Expert System Main Page

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2) Symptom Input Page Display

Several input texts must be filled in on the Symptom Input page before making a diagnosis. The symptom input page can be seen in Figure 6.

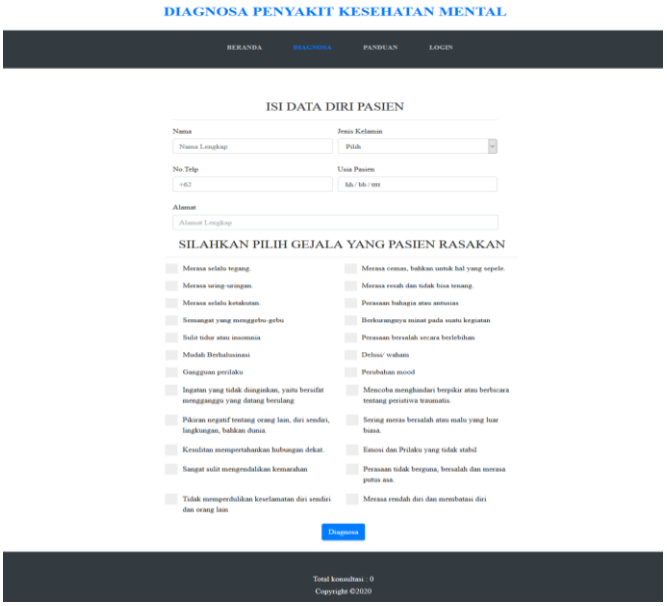

Figure 6. Symptom Input Page Display

3) Diagnostic Results page

The diagnosis results page is a page that displays the results of a diagnosis from a money consultation carried out by the patient. The diagnostic results page can be seen in Figure 7.

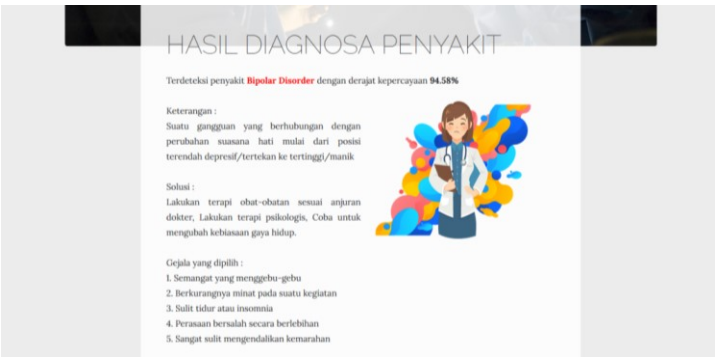

Figure 7. Diagnostic Results Page Display

4. CONCLUSION

Based on the discussion that has been done, the Dempster Shafer algorithm can analyze the data obtained so that it can diagnose mental health disorders experienced by patients. From the results of the tests, it was found that the type of mental health disorder, bipolar disorder is a disease experienced by patients with a confidence value of 97%. With this level of trust, the Dempster Shafer algorithm can be applied in expert systems to diagnose mental health disorders and assist psychologists in dealing with mental health disorders. Future research can use two methods of applying the Dempster Shafer algorithm and the Certainty Factor algorithm to provide better results accuracy.

REFERENCES

[1] Choresyo, B., Nulhaqim, S. A., & Wibowo, H., "Kesadaran Masyarakat Terhadap Penyakit Mental," *Pros. Penelit. dan Pengabdi. Kpd. Masy.*, vol. 2, no. 3, pp. 301–444, Nov. 2015, doi: 10.24198/jppm.v2i3.13587.

[2] Ayuningtyas, D., Misnaniarti, & Rayhani, M., "Analisis Situasi Kesehatan Mental Pada Masyarakat Di Indonesia Dan Strategi Penanggulangannya," *J. Ilmu Kesehat. Masy.*, vol. 9, no. 1, 2018, doi: 10.26553/jikm.2018.9.1.1-10.

[3] Fakhriyani, D., V., "Kesehatan Mental," in *Early Childhood Education Journal*, 1st ed., Pamekasan: Duta Media Publishing, 2019.

[4] Nas, C., "SISTEM PAKAR DIAGNOSA PENYAKT TIROID MENGGUNAKAN METODE DEMPSTER SHAFER," *J. Teknol. DAN OPEN SOURCE*, vol. 2, no. 1, 2019, doi: 10.36378/jtos.v2i1.114.

[5] Agusli, R., Iqbal, M., & Saputra, F., "Sistem Pakar Diagnosa Penyakit Pada Ibu Hamil Dengan Metode Certainty Faktor Berbasis Web," *Acad. J. Comput. Sci. Res.*, vol. 2, no. 1, 2020, doi: 10.38101/ajcsr.v2i1.264.

[6] Minardi, J., & Suyatno, S., "Sistem Pakar Untuk Diagnosa Penyakit Kehamilan Menggunakan Metode Dempster-Shafer Dan Decision Tree," *Simetris J. Tek. Mesin, Elektro dan Ilmu Komput.*, vol. 7, no. 1, 2016, doi: 10.24176/simet.v7i1.491.

[7] Nasyuha, A., H., Perangin Angin, M., I., & Marsono, "Implementasi Dempster Shafer Dalam Diagnosa Penyakit Impetigo Pada Balita," *J. MEDIA Inform. BUDIDARMA*, vol. 4, no. 3, 2020, doi: 10.30865/mib.v4i3.1901.

[8] Putri, G., V., G., "Sistem pakar diagnosa mental ilness sikosis dengan menggunakan metode certainty factor," *J. Inovtek Polbeng - Seri Inform.*, vol. 3, no. 2, 2018.

[9] Rosana MZ., A., Wijaya, I Gede., P., S., & Bimantoro, F., "Sistem Pakar Diagnosa Penyakit Kulit pada Manusia dengan Metode Dempster Shafer," *J. Comput. Sci. Informatics Eng.*, vol. 4, no. 2, 2020, doi: 10.29303/jcosine.v4i2.285.

[10] Sinaga, M., D., & Sembiring, N., Sari Br., "Penerapan Metode Dempster

Shafer Untuk Mendiagnosa Penyakit Dari Akibat Bakteri Salmonella," *CogITo Smart J.*, vol. 2, no. 2, 2016, doi: 10.31154/cogito.v2i2.18.94-107.

[11] N. Frittella, S., Manoorkar, K., Palmigiano, A., Tzimoulis, A., & Wijnberg, "Toward a Dempster-Shafer theory of concepts," *Int. J. Approx. Reason.*, vol. 125, 2020, doi: 10.1016/j.ijar.2020.05.004.

[12] Y. Xue, Y., & Deng, "Interval-valued belief entropies for Dempster–Shafer structures," *Soft Comput.*, vol. 25, no. 13, 2021, doi: 10.1007/s00500-021-05901-3.