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Expert System for Early Diagnosis of Epilepsy Using the Web-Based Dempster Shafer Method

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Abstract

The development of information and communication technology is currently very extensive in its use, especially technology in the field of computers. Expert Systems are one of the sciences in the field of computers that can help in diagnosing various diseases, one of which is epilepsy. There are 50 million people with epilepsy in the world and of these, 125,000 die each year, and over 80% of these deaths occur in low- and middle-income countries. The expert system method used to diagnose epilepsy early is the Dempster Shafer method. The theory called Dempster Shafer provides a new method of weighting according to the facts collected. This study used 7 types of epilepsy, including in the Focal Epilepsy category consisting of Simple Partial and Complex Partial, while in the General Epilepsy category consisting of Absence, Atonic, Myoclonic, Tonic-Clonic, and Clonic. This study produces a website-based application for early diagnosis of epilepsy using the Dempster Shafer method with the PHP programming language and MySQL database. By using this application, it can provide convenience to the medical community and patients in early diagnosis of epilepsy experienced by sufferers. From the results of this study, it was found that the highest level of accuracy was found in Tonic-Clonic seizures which are included in the General Epilepsy category, namely 92.78%.

Keywords: Expert System, Early Diagnosis, Epilepsy, Epileptic, Dempster Shafer Method

1. Introduction

The development of information and communication technology is currently very extensive in its use, especially technology in the field of computers. Expert Systems are one of the sciences in the field of computers that can help in diagnosing various diseases, one of which is epilepsy. Epileptic seizures are abnormal jerky or trembling movements in the body due to abnormal neuronal activity and can result in damage to the brain or other parts of the body (Anwar et al., 2020). There are 50 million people with epilepsy in the world and of these, 125,000 die each year, and over 80% of these deaths occur in low- and middle-income countries. Overall, a global decline in the number of epilepsy-related deaths has been seen between 1990 and 2016 (Singh and Sander, 2020).

The expert system method used in this study is the Dempster Shafer method for early diagnosis of epilepsy. The theory called Dempster-Shafer provides a new method of weighting according to the facts collected. The latest theory can distinguish between uncertainty and ignorance. Dempster-Shafer Theory is a combination, propagation of uncertainty and representation, in which this theory has several instutitive characteristics according to the way of thinking of an expert, but has a strong mathematical knowledge base (Wang et al., 2016).

Various studies on expert systems using the Dempster Shafer method have been developed to detect or diagnose various diseases. (Anggi Mahesa, 2021) used the Dempster Shafer method to diagnose epilepsy, providing the highest level of accuracy in common epilepsy of 99%. Meanwhile, (Susilawati and Simanullang, 2023) applied the Dempster Shafer method to identify ITP (Idiopathic Thrombocytopenic Purpura), providing a high level of accuracy in concluding a diagnosis of 97%. (Fadhilah and Triayudi, 2024) compared the Dempster Shafer and Certainty Factor methods to detect coronary heart disease, and showed that the Dempster Shafer method tends to provide a higher level of certainty of 99.8% compared to the Certainty Factor method of 92%. (Fadhilah and Triayudi, 2024) also applied the Dempster Shafer method to diagnose Pneumonia, and provided a maximum value for each combination of symptoms used of 98.11%. Meanwhile, (Mustaqim et al., 2024) compared the Dempster Shafer method and Bayes' Theorem to detect encephalitis, providing an accuracy level of 99.8%. Dempster Shafer stands out as a more reliable and accurate method. In contrast, Bayes' Theorem provides a much lower diagnosis rate of 3.5%.

Several studies on expert systems in diagnosing epilepsy using other methods have been conducted previously. (Johan, 2021) developed a computer-based expert system to diagnose epilepsy using the K-Means Clustering method, with a clustering accuracy rate of 67% of patients with Idiopathic Epilepsy. (Mandasari et al., 2022) used the Certainty Factor method to diagnose epilepsy, and the final result of the highest combined value of the five sample data was 99% with definite information.

Based on previous studies described above, the Dempster Shafer method provides a higher level of accuracy compared to other methods. So this study will use an expert system to diagnose epilepsy early using the Dempster Shafer method. By using an expert system, it is hoped that it can accelerate the early diagnosis of epilepsy, so that the type of epilepsy being experienced can be easily identified.

2. Literature Review

2.1. Definition of Expert

An expert is commonly defined as someone with comprehensive and authoritative knowledge in a particular area not possessed by most people. Expert knowledge, however, is unlikely ever to be completely accurate or certain, especially where experts are engaged because of the novelty of a situation and where empirical information is limited (Caley et al., 2014).

2.2. Expert System

In general, an expert system is a programmed tool capable of answering questions, making a reasoning based on known facts and rules. This expert system is one of the common applications used to solve complicated problems in different fields (Tkatek et al., 2020).

2.3. Diagnosis

Diagnosis is an abstract model of concrete morbid processes manifesting themselves as symptoms in living beings. The model is useful, if it facilitates the deduction of a patient's prognosis from abstract, general medical knowledge concerning disease processes (Karl Poikolainen, 1979).

2.4. Epilepsy

Epilepsy is a disorder of the central nervous system in which brain activity becomes abnormal. This causes seizures or unusual behavioral states to loss of consciousness or fainting. Epilepsy can affect anyone, both men and women, and can affect all age groups, from infants, adults, to the elderly. As a chronic disease, it has adverse effects on the quality of life of patients, including cognitive impairment, decreased ability of daily activities, and the possible social stigmatization (Kaur et al., 2021). In general, epilepsy is divided into two types, including (Dr. Ricky C. Kohar, SpN, FINA, 2024):

1. Focal Epilepsy

   Focal epilepsy is a type of epilepsy that occurs due to abnormal nerve cell activity that initially occurs in one part of the brain, then spreads to other areas. Focal epilepsy usually occurs only on one half of the body, for example only on the left side and the seizure movements are not similar. Focal epilepsy is grouped into several types, namely:

   a. Simple Partial Seizures
      Simple partial seizures are seizures that occur in one part of the brain, but can also spread to other parts of the brain. This type does not affect consciousness or memory.
   b. Complex Partial Seizures
      Complex partial seizures are a type of seizure that can occur shortly after a simple partial seizure. This type affects behavior, awareness, or memory before, during, and shortly after the seizure.

2. Generalized Epilepsy

   Generalized epilepsy is a type of epilepsy that occurs due to abnormal nerve cell activity on both sides of the brain simultaneously. Usually the symptoms include, the same seizure movements, the presence of abnormalities such as genetic factors. Generalized epilepsy is grouped into several types, namely:

   a. Absence seizures
      Absence seizures are seizures characterized by symptoms such as staring blankly for a few seconds when the seizure occurs. Although they only last a short time, absence seizures can occur repeatedly in a day.
   b. Atonic seizures
      Atonic seizures are seizures characterized by a limp or loss of muscle control. Atonic seizures cause the sufferer to become limp, as if all the muscles in his body have stopped working.
   c. Myoclonic Seizures
      Myoclonic seizures are a type of seizure caused by sudden muscle contractions. This type of seizure can affect the entire body.
   d. Tonic-Clonic Seizures

Tonic-clonic seizures are a type of seizure characterized by leg movements and jerking. Typically, this is a dysfunction on both sides of the brain.

e. Clonic Seizures
Clonic seizures are a type of seizure characterized by stiffness and tension in the muscles. And sufferers often experience falls due to loss of balance.

2.5. Dempster Shafer Method

Dempster Shafer is a mathematical theory of evidence. The theory can provide a way to combine evidence from several sources and derive or provide a level of confidence (represented through a confidence function) by taking all available evidence. This theory can show a way to distinguish the weight of confidence that is adjusted to the existing facts. This theory can also distinguish uncertainty and ignorance. Dempster Shafer is one of the reasoning that can solve the problem of inconsistency. Dempster Shafer's theory has several characteristics that are in accordance with the way an expert thinks, but is based on strong mathematics. The following is the flow of the calculation process using the Dempster Shafer method, which can be seen in Figure 1.

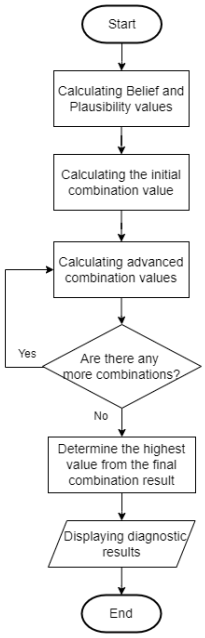

Figure 1: Dempster Shafer Method Flow

2.6. PHP

PHP (PHP: Hypertext Preprocessor) is an open source server side scripting programming language. As a scripting language, PHP executes programming instructions at runtime. The results of the instructions will of course be different depending on the data processed. PHP is a server-side programming language, so scripts from PHP will be processed on the server. Server types that are often used in conjunction with PHP include Apache, Nginx, and LiteSpeed Muqorobin and Rais, 2022).

2.7. MySQL

MySQL is a popular open-source relational database management system (RDBMS) that is distributed, developed, and supported by Oracle Corporation. The relational systems like, MySQL stores data in tabular form and uses structured query language (SQL) for accessing of data. In MySQL, we should pre-define the schema based on requirements and set up rules to control the relationships between fields in the record. In MySQL, related informations may be stored in different tables, but they are associated by the use of joins. Thus, data duplication can be minimized (Damodaran B et al., 2016).

2.8. XAMPP

XAMPP is a free and open source cross-platform web server solution stack package developed by Apache friends, consisting mainly of the Apache HTTP server, Maria DB database, and interpreters for scripts written in the PHP and Perl programming languages. XAMPP stands for cross-platform(X), Apache (A), Maria DB (M), PHP (P), and Perl (P). It is a simple, lightweight Apache distribution that makes it extremely easy for developers to create a local web server for testing and deployment process (Patel et al., 2017).

2.9. Website

Web or website is a collection of site pages and documents spread across several different server computers around the world and connected into one network through a network called the internet. By using the web, someone can easily do various things without having to leave home. For example, registering at an educational institution, accessing various learning resources, discussing with others, and publishing the results of their thoughts (Batubara, 2018).

3. Materials and Methods

3.1. Materials

The data collection methods used in this study are primary data and secondary data. The technique used in collecting primary data is through direct observation to obtain accurate data from experts, and conducting interviews with direct questions and answers with an expert or neurologist, namely Dr. Ricky C. Kohar, SpN, FINA., located at Siloam Hospital Bogor. While secondary data in this study comes from discussion forums on the Alomedika and Alodokter websites regarding patients with epilepsy.

3.1.1. Disease Type Data

The following is a list of the types of epilepsy shown in Table 1.

Table 1: Types of Epilepsy Disease

Disease Code	Name of Disease	Category
P1	Simple Partial	Focal Epilepsy
P2	Complex Partial	Focal Epilepsy
P3	Absence	Generalized Epilepsy
P4	Atonic	Generalized Epilepsy
P5	Myoclonic	Generalized Epilepsy
P6	Tonic-Clonic	Generalized Epilepsy
P7	Clonic	Generalized Epilepsy

3.1.2. Disease Symptom Data

The following is a list of the symptoms of epilepsy experienced by sufferers as shown in Table 2.

Table 2: Symptoms of Epilepsy

Symptom Code	Symptom Name	Symptom Code	Symptom Name
G1	Foaming or drooling from the mouth	G16	Both hands are stiff
G2	Mouth drooping	G17	Urinating
G3	Mouth smacking	G18	Mental retardation
G4	Tongue biting	G19	Sudden muscle contractions
G5	Eyes rolling upwards	G20	Snoring
G6	Blank stare or daydreaming	G21	Trembling of the body
G7	Impaired memory	G22	Difficulty breathing
G8	Drowsiness	G23	Seizures in one part of the body
G9	Loss of consciousness or confusion	G24	Seizures in the whole body
G10	Tingling or cramps	G25	Frequent falls due to loss of balance
G11	Hallucinations	G26	Sudden jerks in the legs, arms, or face
G12	Feeling weak	G27	Feelings of fear or anxiety
G13	Migraines	G28	Inability to speak even temporarily
G14	Repeated same seizure movements	G29	Suddenly stopping talking in the middle of a sentence
G15	Repeated unequal seizure movements	G30	Genetic or hereditary factors

3.1.3. Relationship between Symptoms and Disease

The relationship between symptoms and types of epilepsy can be seen in Table 3.

Table 3: Relationship between Symptoms and Types of Epilepsy

Symptom Code	Symptom Name	Disease Code							Expert Value
		P1	P2	P3	P4	P5	P6	P7	
G1	Foaming or drooling from the mouth		✓				✓		0.3
G2	Mouth drooping		✓						0.1
G3	Mouth smacking			✓					0.5
G4	Tongue biting						✓		0.5
G5	Eyes rolling upwards						✓		0.5
G6	Blank stare or daydreaming			✓					0.5
G7	Impaired memory		✓						0.1
G8	Drowsiness						✓		0.5
G9	Loss of consciousness or confusion		✓	✓			✓		0.5
G10	Tingling or cramps	✓	✓					✓	0.1
G11	Hallucinations	✓	✓						0.1
G12	Feeling weak		✓		✓		✓		0.3
G13	Migraines	✓	✓				✓		0.1
G14	Repeated same seizure movements			✓	✓		✓		0.3
G15	Repeated unequal seizure movements	✓	✓					✓	0.1
G16	Both hands are stiff						✓		0.5
G17	Urinating						✓		0.3
G18	Mental retardation		✓						0.1
G19	Sudden muscle contractions		✓			✓	✓	✓	0.5
G20	Snoring		✓				✓		0.1
G21	Trembling of the body					✓			0.5
G22	Difficulty breathing						✓		0.1
G23	Seizures in one part of the body	✓	✓						0.5
G24	Seizures in the whole body						✓		0.5
G25	Frequent falls due to loss of balance				✓				0.5
G26	Sudden jerks in the legs, arms, or face						✓	✓	0.5
G27	Feelings of fear or anxiety	✓	✓						0.1
G28	Inability to speak even temporarily		✓	✓	✓		✓		0.5
G29	Suddenly stopping talking in the middle of a sentence		✓	✓	✓				0.5
G30	Genetic or hereditary factors	✓	✓	✓		✓		✓	0.1

The weight value or belief value of the symptoms is determined by an expert or neurologist, with the weight value range limit being 0.1 – 0.9. The belief value table can be seen in Table 4 below.

Table 4: Belief Values

Information	Value
Not Sure	0.1
Less Sure	0.3
Quite Sure	0.5
Sure	0.7
Very Sure	0.9

Table 5 is the Dempster Shafer percentage value of the probability of an event. This scale measures a person's level of belief in the truth of the symptoms of the disease they are experiencing.

Table 5: Dempster Shafer Percentage Value

Information	Percentage Value
Not Sure	0 – 19
Less Sure	20 – 39
Quite Sure	40 – 69
Sure	70 – 89
Very Sure	90 – 100

Source: Faisal Anggi Mahesa and Sulindawaty, 2021

3.2. Methods

3.2.1. Dempster Shafer Method

In general, Dempster Shafer theory is able to provide the right combination, clear representation and is able to provide the exact value of uncertainty (Buono et al., 2020). The Dempster Shafer theory is written in an interval, namely [Belief, Plausibility]. Belief (Bel) is a measure of certainty or confidence in evidence in calculating a set of propositions. If it is worth 0, it indicates that there is no evidence, and if it is worth 1, it indicates certainty. Plausibility (Pls) is a measure of disbelief or uncertainty about evidence. Plausibility (Pls) will reduce the level of certainty of the evidence. Plausibility has a value of 0 to 1. If you are sure of X, then it can be said that Bel(X) = 1, so the value of Pls(X) = 0. The Belief function is formulated as in Equation 1 and the Plausibility function is formulated as in Equation 2 (Kusuma and Nas, 2023).

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

$$Pls(X) = 1 - Bel(X')$$

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

Where:

$Bel(X')$ = Belief (X)
$Pls(X)$ = Plausibility (X)
$m(X')$ = Mass function from (X)
$m(Y)$ = Mass function from (Y)

In Dempster Shafer's theory, it is also known as the existence of a frame of discernment (FOD). Which is denoted by Θ. The frame of discernment (FOD) is the universe of discussion of a set of hypotheses so it is often called the environment, the frame of discernment (FOD) is formulated in the form of the equation Θ = {θ1,θ2,……θn}, where Θ is the frame of discernment (FOD) or environment and θ1, ……θn are elements or elements in the environment.

The environment contains elements that describe the possibility as an answer and there is only one that will match the answer needed. This possibility in Dempster Shafer's theory is called the power set and is denoted by P (Θ), each element in this power set has an interval value between 0 and 1, so it can be formulated in Equation 3.

$$m = P(\Theta) \longrightarrow [0,1] \quad (3)$$

Meanwhile, Mass function (m) in Dempster Shafer theory is the level of confidence of an evidence. Mass function (m) is formulated in Equation 4 (Purwanti et al., 2021).

$$m_3(Z) = \frac{\sum_{X \cap Y = Z} m_1(X).m_2(Y)}{1 - \sum_{X \cap Y = \emptyset} m_1(X).m_2(Y)} \quad (4)$$

Where:

$m_3(Z)$ = Mass function of evidence (Z), where Z is the new density value of the intersection of m_1(X) and m_2(Y) divided by 1 minus the empty intersection (∅) of m_1(X) and m_2(Y)
$m_1(X)$ = Mass function or confidence level of evidence (X), where X is a disease that experiences symptom 1
$m_2(Y)$ = Mass function or confidence level of evidence (Y), where Y is a disease that experiences symptom 2

The main concept in this method is the theory of evidence, allowing the integration of information from various sources and considering uncertainty in decision making. The method is widely used, including in expert systems, pattern recognition, image processing, and complex decision making. With this principle, Dempster Shafer helps users overcome challenges in data analysis and decision making (Susilawati and Simanullang, 2023).

3.2.2. Dempster Shafer Calculation

Manual calculation using the Dempster Shafer method serves to provide an overview of the system to be built. The following is a manual calculation using the Dempster Shafer method.

Table 6: Case study

Symptom Code	Symptom Name	Disease Code							Expert Value
		P1	P2	P3	P4	P5	P6	P7	
G1	Foaming or drooling from the mouth		✓				✓		0.3
G8	Drowsiness						✓		0.5
G5	Eyes rolling upwards						✓		0.5
G16	Stiff hands						✓		0.5
G9	Loss of consciousness or confusion		✓	✓			✓		0.5
G14	Repeated seizure movements			✓	✓		✓		0.3
G26	Sudden jerking of the legs, arms, or face						✓	✓	0.5

1. **G1: Foaming or drooling from the mouth**
   Belief : $m_1\{P2, P6\}$ = 0.3
   Plausibility : $m_1\{\theta\}$ = 1 – 0.3 = 0.7
2. **G8: Drowsiness**
   Belief : $m_2\{P6\}$ = 0.5
   Plausibility : $m_2\{\theta\}$ = 1 – 0.5 = 0.5

Recalculate the new density values for each subset of the function with the density function m_3. The combination rule for m_3 is as follows.

Table 7: Density Value m_3

	$m_2\{P6\}$ 0.5	**$m_2(\theta)$ 0.5**
$m_1\{P2, P6\}$ 0.3	{P6} 0.15	{P2, P6} 0.15
$m_1(\theta)$ 0.7	{P6} 0.35	θ 0.35

From the results of the combination of the tables above, the m_3 value is obtained, namely:

$m_3\{P6\} = \frac{0.15+0.35}{1-0} = 0.50$

$m_3\{P2, P6\} = \frac{0.15}{1-0} = 0.15$

$m_3\{\theta\} = \frac{0.35}{1-0} = 0.35$

3. **G5: Eyes rolling upwards**
   Belief : $m_4\{P3\}$ = 0.5
   Plausibility : $m_4\{\theta\}$ = 1 – 0.5 = 0.5

Recalculate the new density values for each subset of the function with the density function m_5. The combination rule for m_5 is as follows.

Table 8: Density Value m_5

	m_4{P6} **0.5**	**m_4{θ}** **0.5**
m_3{P6} **0.5**	{P6} 0.25	{P6} 0.25
m_3{P2, P6} **0.15**	{P6} 0.075	{P2, P6} 0.075
m_3{θ} **0.35**	{P6} 0.175	θ 0.175

From the results of the combination of the tables above, the value of m_5 is obtained, namely:

$m_5\{P6\} = \frac{0.25+0.075+0.175+0.25}{1-0} = 0.75$

$m_5\{P2, P6\} = \frac{0.075}{1-0} = 0.075$

$m_5\{\theta\} = \frac{0.175}{1-0} = 0.175$

4. G16: Stiff hands

Belief : $m_6\{P6, P7\} = 0.5$

Plausibility : $m_6\{\theta\} = 1 - 0.5 = 0.5$

Recalculate the new density values for each subset of the function with the density function m_6. The combination rule for m_6 is as follows.

Table 9: Density Value m_7

	m_6{P6} **0.5**	**m_6{θ}** **0.5**
m_5{P6} **0.75**	{P6} 0.375	{P6} 0.375
m_5{P2, P6} **0.075**	{P6} 0.0375	{P2, P6} 0.0375
m_5{θ} **0.003**	{P6} 0.0027	θ 0.0003

From the combination of the tables above, the value of m_7 is obtained, namely:

$m_7\{P6\} = \frac{0.375+0.00375+0.0875+0.375}{1-0} = 0.875$

$m_7\{P2, P6\} = \frac{0.0375}{1-0} = 0.0375$

$m_7\{\theta\} = \frac{0.0875}{1-0} = 0.0875$

5. G9: Loss of consciousness or confusion

Belief : $m_8\{P2, P4, P6\} = 0.5$

Plausibility : $m_8\{\theta\} = 1 - 0.5 = 0.5$

Recalculate the new density values for each subset of the function with the density function m_9. The combination rule for m_9 is as follows.

Table 10: Density Value m_9

	m_8{P2, P3, P6} **0.5**	**m_8{θ}** **0.5**
m_7{P6} **0.875**	{P6} 0.4375	{P6} 0.4375

m_7{P2, P6}	{P2, P6}	{P2, P6}
0.0375	0.01875	0.01875
m_7{θ}	{P2, P3, P6}	θ
0.0875	0.04375	0.04375

From the results of the combination of the tables above, the m_9 value is obtained, namely:

$m_9\{P6\} = \frac{0.4375+0.4375}{1-0} = 0.875$

$m_9\{P2, P6\} = \frac{0.01875+0.01875}{1-0} = 0.0375$

$m_9\{P2, P3, P6\} = \frac{0.04375}{1-0} = 0.04375$

$m_9\{\theta\} = \frac{0.04375}{1-0} = 0.04375$

6. G14: Repeated seizure movements

Belief : $m_{10}\{P3, P4, P5, P6, P7\} = 0.3$

Plausibility : $m_{10}\{\theta\} = 1 - 0.3 = 0.7$

Recalculate the new density values for each subset of the function with the density function m_{11}. The combination rule for m_{11} is as follows.

Table 11: Density Value m_{11}

	m_{10}{P3, P4, P6} **0.3**	**m_{10}{θ}** **0.7**
m_9{P6}	{P6}	{P6}
0.875	0.2625	0.6125
m_9{P2, P6}	{P6}	{P2, P6}
0.0375	0.0113	0.0263
m_9{P2, P3, P6}	{P3, P6}	{P2, P3, P6}
0.04375	0.013125	0.030625
m_9{θ}	{P3, P4, P6}	θ
0.04375	0.013125	0.030625

From the results of the combination of the tables above, the m_{11} value is obtained, namely:

$m_{11}\{P6\} = \frac{0.2625+0.0113+0.6125}{1-0} = 0.8863$

$m_{11}\{P3, P6\} = \frac{0.013125}{1-0} = 0.013125$

$m_{11}\{P3, P4, P6\} = \frac{0.013125}{1-0} = 0.013125$

$m_{11}\{P2, P6\} = \frac{0.0263}{1-0} = 0.0263$

$m_{11}\{P2, P3, P6\} = \frac{0.030625}{1-0} = 0.030625$

$m_{11}\{\theta\} = \frac{0.030625}{1-0} = 0.030625$

7. G26: Sudden jerking of the legs, arms, or face

Belief : $m_{12}\{P1, P5, P7\} = 0.5$

Plausibility : $m_{12}\{\theta\} = 1 - 0.5 = 0.5$

Recalculate the new density values for each subset of the function with the density function m_{13}. The combination rule for m_{13} is as follows.

Table 12: Density Value m_{13}

	m_{12}{P6, P7} **0.5**	**m_{12}{θ}** **0.5**
m_{11}{P6}	{P6}	{P6}
0.88625	0.44313	0.44313
m_{11}{P3, P6}	{P6}	{P3, P6}

0.013125	0.0065625	0.0065625
m_{11}{P3, P4, P6}	{P6}	{P3, P4, P6}
0.013125	0.0065625	0.0065625
m_{11}{P2, P6}	{P6}	{P2, P6}
0.02625	0.01313	0.01313
m_{11}{P2, P3, P6}	{P6}	{P2, P3, P6}
0.030625	0.0153125	0.0153125
m_{11}{θ}	{P6, P7}	θ
0.030625	0.0153125	0.0153125

From the results of the combination of the tables above, the m_{13} value is obtained, namely:

$m_{13}\{P6\} = \frac{0.44313+0.0065625+0.0065625+0.01313+0.0153125+0.44313}{1-0} = 0.9278 = 92.78\%$

$m_{13}\{P6, P7\} = \frac{0.0153125}{1-0} = 0.0153125 = 1.53\%$

$m_{13}\{P3, P6\} = \frac{0.0065625}{1-0} = 0.0065625 = 0.66\%$

$m_{13}\{P3, P4, P6\} = \frac{0.0065625}{1-0} = 0.0065625 = 0.66\%$

$m_{13}\{P2, P6\} = \frac{0.01313}{1-0} = 0.01313 = 1.31\%$

$m_{13}\{P2, P3, P6\} = \frac{0.0153125}{1-0} = 0.0000081 = 1.53\%$

$m_{13}\{\theta\} = \frac{0.0153125}{1-0} = 0.0000009 = 1.53\%$

Based on the final calculation, there are 7 values, namely (92.78%, 1.53%, 0.66%, 0.66%, 1.31%, 1.53%, and 1.53%) of the seven values, the highest density value is in m13{P6} with a value of 92.78%, meaning that the highest value is in the disease "Tonic-Clonic Seizures" namely in the category of General Epilepsy type with a value of 92.78% "Very Sure".

4. Results and Discussion

4.1. Implementation

The following are the results of implementing the use of the Dempster Shafer method in early web-based diagnosis of epilepsy, along with an explanation of each page.

4.1.1. Home Page

The homepage or main page is the page that will first appear when the user runs the system. On this page there are several menus consisting of consultation, disease information, and a login menu for the admin. In addition, on this page there is also a start consultation button that can make it easier for users to consult directly. The homepage can be shown in Figure 2.

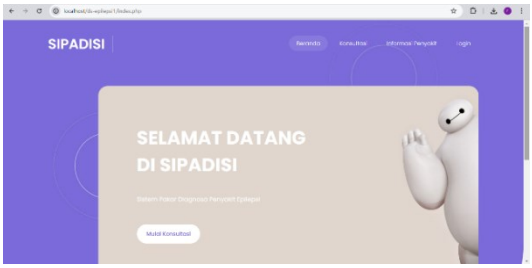

Figure 2: Home Page

4.1.2. Consultation Page

The consultation page is the page where the user starts the consultation. On this page there is a personal data form page, a consultation page, and a consultation results page.

a. Personal Data Form Page

On the personal data form page, the user must fill in their personal data first before consulting. The personal data form that must be input by the user includes name, gender, age, and address. The personal data form page can be shown in Figure 3.

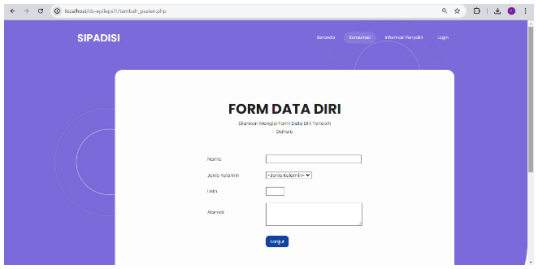

Figure 3: Personal Data Form Page

b. Consultation Page

After the user fills in the personal data form, then on the consultation page the user can choose what symptoms are experienced, the number of symptoms selected is at least two symptoms. If the user has selected the symptoms, the user can select the consultation button to get the consultation results. The consultation page can be shown in Figure 4.

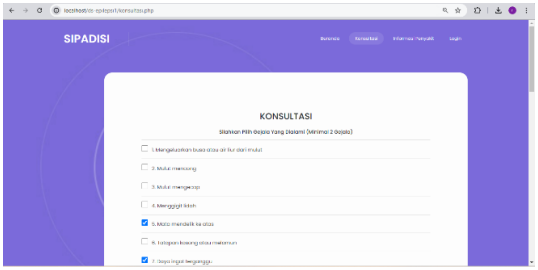

Figure 5: Consultation Page

c. Consultation Results Page

After selecting the consultation button, the consultation results page will be displayed containing information about the selected symptoms, the conclusion of the diagnosis results, and how to treat the disease. The consultation results page can be shown in Figure 6.

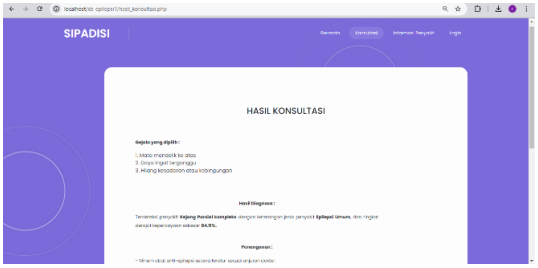

Figure 6: Consultation Results Page

4.1.3. Disease Information Page

The disease information page is a page that displays an explanation of information about epilepsy consisting of the definition of epilepsy, types of epilepsy, symptoms of epilepsy, and how to treat epilepsy. The disease information page can be shown in Figure 7.

Figure 7: Disease Information Page

4.2. Validity Testing

Validity testing is conducted to determine the accuracy of the data results that have been entered into the system. This test is conducted by comparing the results of experts and the results of the system after using the Dempster Shafer method to see whether the diagnostic results obtained will be appropriate or not. The results of the validity testing can be seen in Table 13.

Table 13: Validity Testing

No	Gender	Age	Symptom	Expert Results	Dempster Shafer System Results	Information
				Disease Type Category	Disease Type Category	
1	P	52	G1, G5, G8, G9, G14, G16, G26	Focal Epilepsy	Generalized Epilepsy	Not Appropriate
2	L	21	G1, G5, G9, G16	Generalized Epilepsy	Generalized Epilepsy	Appropriate
3	L	33	G6, G9	Focal Epilepsy	Generalized Epilepsy	Not Appropriate
4	P	22	G1, G10, G15, G23	Focal Epilepsy	Focal Epilepsy	Appropriate
5	P	51	G3, G9, G16	Focal Epilepsy	Generalized Epilepsy	Not Appropriate
6	P	16	G1, G2, G5, G30	Generalized Epilepsy	Generalized Epilepsy	Appropriate
7	L	53	G13, G15	Focal Epilepsy	Focal Epilepsy	Appropriate
8	P	12	G1, G14, G30	Generalized Epilepsy	Generalized Epilepsy	Appropriate
9	L	57	G7, G14, G17	Focal Epilepsy	Generalized Epilepsy	Appropriate
10	L	51	G5, G9, G14	Generalized Epilepsy	Generalized Epilepsy	Not Appropriate

Based on the validation trial conducted on 10 sample data from experts that have been classified into the categories of "General Epilepsy" and "Focal Epilepsy" by a neurologist, Dr. Ricky C. Kohar, SpN, FINA, to test the suitability between the results of the experts and the results obtained from the system after using the Dempster Shafer method. From the 10 sample data obtained from experts, it was found that 7 of them were in accordance with the results obtained from the system after using the Dempster Shafer method, so the percentage of suitability between the results of the experts and the results of the system after using the Dempster Shafer method was 70%.

4.3. Percentage of Epilepsy Disease

The following are the percentage results obtained from the system after using the Dempster Shafer method for various types of epilepsy based on trials on 100 patient data. From the results of these percentages, it can be seen that the epilepsy most often experienced by patients is Tonic-Clonic which is a common type of epilepsy, reaching 49%. The percentage of epilepsy can be seen in Figure 8.

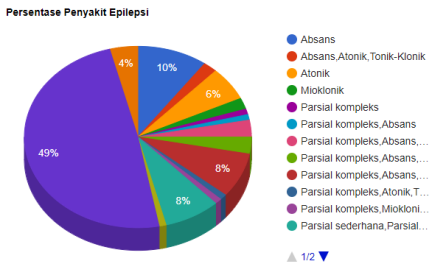

Figure 8: Percentage of Epilepsy Disease

5. Conclussion

This website-based expert system for early diagnosis of epilepsy using the Dempster Shafer method was created using code editor software, namely Visual Studio Code, PHP programming language and MySQL as database storage. This expert system can provide convenience to doctors in making the right decisions to find out what type of epilepsy is being experienced by patients with a computerized system. In addition, this expert system is easy to use by users because users do not need to log in first to consult or diagnose epilepsy.

Based on the calculation results using the Dempster Shafer method, the highest level of confidence accuracy is in Tonic-Clonic seizures which are included in the category of General Epilepsy, which is 92.78%. Based on this value, it

can be concluded that the patient is most likely to have Tonic-Clonic seizures, which are in the category of General Epilepsy.

The percentage of conformity of 10 sample data obtained from experts with the results of the system after using the Dempster Shafer method is 70%. Meanwhile, the percentage of epilepsy most commonly experienced by patients is Tonic-Clonic seizures which are included in the category of General Epilepsy, which is 49%.

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