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Comparison of Certainty Factor and Dempster-Shafer Methods in ENT Disease Diagnosis Expert System

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Abstract−Diagnosis of Ear, Nose, and Throat (ENT) diseases often faces obstacles in determining the level of certainty of a disease based on the symptoms experienced by the patient. The main problem in this research is how to compare the level of accuracy between the Certainty Factor and Dempster-Shafer methods in an expert system for diagnosing ENT diseases. As a solution, this research applies both methods and analyzes the results of their calculations on various symptoms entered by the patient. The purpose of this research is to determine which method is more effective in providing certainty of diagnosis. The results show that the Certainty Factor method produces a higher level of certainty than Dempster-Shafer, for example in Tonsillitis disease which reaches 94.68% compared to 0.02% in Dempster-Shafer. Thus, the Certainty Factor method is more recommended for ENT disease diagnosis expert systems. The contribution of this research is to provide insight into the use of artificial intelligence methods in the medical field, especially in improving the accuracy of expert systems to assist health workers in making diagnostic decisions.

Keywords: Expert System; Certainty Factor; Dempster-Shafer; Diagnosis of ENT Diseases

1. INTRODUCTION

Ear, Nose, and Throat (ENT) diseases are one of the health disorders that are often found in society. These disorders include ear infections, sinusitis, pharyngitis, and tonsillitis which can cause serious complications if not treated properly. Ear infections, for example, can cause hearing loss if not treated properly. Likewise, sinusitis can develop into a chronic condition, and pharyngitis and tonsillitis have the potential to cause systemic complications if the infection spreads to other organs[1].

The lack of specialist medical personnel in several areas is one of the factors that causes delays in the diagnosis and treatment of ENT diseases. This often occurs in areas with limited health facilities and adequate human resources. Therefore, an expert system based on artificial intelligence can be an alternative solution to help doctors or medical personnel in providing a more accurate initial diagnosis. This system can provide recommendations based on data and rules that have been set by experts, so as to reduce uncertainty in the diagnosis process and provide faster and more efficient results[2].

In the development of expert systems, there are various methods used to handle uncertainty in disease diagnosis. One method that is often used is Certainty Factor (CF). Certainty Factor was developed by Shortliffe and Buchanan to handle uncertainty in rule-based systems. This method allows expert systems to determine the level of confidence in a diagnosis based on facts provided by experts. By using CF, expert systems can combine certainty factors from various symptoms and calculate the final probability of a diagnosis[3][4].

Meanwhile, the Dempster-Shafer (DS) method is an approach based on belief theory that is able to combine several sources of information to determine the likelihood of a disease. This method was introduced by Arthur P. Dempster and further developed by Glenn Shafer. DS can handle uncertainty by combining various evidence from different sources, making it more flexible in providing estimates of the likelihood of a disease. By using this theory, expert systems can integrate various information from different data and produce decisions based on a combination of the levels of confidence obtained[5][6][7].

Several studies have been conducted in the development of expert systems for diagnosing diseases using various methods. Lanang Dian Ajisari and Putri Taqwa Prasetyaningrum (2024) developed an expert system to diagnose cardiovascular disease using the Certainty Factor method. This system involves six disease data, 29 symptom data, and 20 case data, and is tested based on expert validation with an accuracy level of 100%. These results indicate that the Certainty Factor method has a high level of accuracy in detecting cardiovascular disease based on the data used in the study[8]. Mustopa Husein Lubis et al. (2025) applied the Certainty Factor method in an expert system to detect diseases in watermelon plants. From the test results, the disease detected was Leaf Blight with an expertise level of 0.8 or 80%, indicating a fairly good accuracy value. Although this expert system is applied in an agricultural context, the use of the Certainty Factor method remains relevant in dealing with the uncertainty of disease diagnosis, both in the medical and non-medical fields[9]. Another study by R. Putri Angela Parapak et al. (2024) developed an expert system for diagnosing kidney disease at Pirngadi Medan Hospital using the Dempster-Shafer method. This system was tested with 31 cases and successfully diagnosed 29 cases correctly, resulting in an accuracy level of 93.54%. These results indicate that the Dempster-Shafer method can be used with a high level of accuracy in detecting

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kidney disease based on symptoms inputted by the user[10]. In addition, Muhammad Fakhri Al-Zikri et al. (2024) designed an expert system for diagnosing COVID-19 disease using the Dempster-Shafer method, where the diagnosis results showed the highest density value of 0.63 or 63%. These results indicate that the DS method can be used to provide the probability of a diagnosis based on existing evidence, although the level of accuracy may be lower than other methods depending on the data used[11]. Meanwhile, Bernica Azzahra and Putri Taqwa Prasetyaningrum (2024) conducted a comparative analysis of the Certainty Factor and Dempster-Shafer methods in an expert system to detect Parechovirus disease in toddlers. The results showed that the Dempster-Shafer method had a confidence level of 99.77%, higher than the Certainty Factor which only reached 54.22%. This shows that the Dempster-Shafer method can provide a higher level of confidence in some cases, especially when there are many sources of evidence that can be combined to strengthen the diagnosis[12].

Based on previous studies, there is still a gap in the comparative study of the Certainty Factor and Dempster-Shafer methods, especially in the diagnosis of ENT diseases. Most of the studies that have been conducted have focused more on cardiovascular, kidney, and infectious diseases such as COVID-19. Therefore, this study aims to evaluate the advantages and disadvantages of each method in the context of ENT disease diagnosis.

2. RESEARCH METHODOLOGY

2.1 Expert System

An expert system is a computer-based system designed to imitate the decision-making process of an expert in a particular field. This system uses a knowledge base and inference mechanism to provide advice or decisions that are close to the results of an expert's analysis[13][14][15]. In this study, an expert system was applied to assist the diagnosis process of ENT diseases using the Certainty Factor and Dempster-Shafer methods as an approach to dealing with uncertainty.

2.2 Certainty Factor Method

The Certainty Factor (CF) method is an approach in an expert system used to deal with uncertainty in diagnosis. CF was introduced to measure the level of confidence in a fact based on a combination of the certainty value of the expert and the level of confidence given by the user[16][17][18]. The basic formula used in the CF method is[19]:

a. Premise

$$CF(H,E) = CF_{expert} * CF_{user} \tag{1}$$

b. Combination Premise

$$CF_{combination}\ CF(expert, user)_1 = CF(expert, user_1) + CF(expert, user_2) * (1 - CF(expert, user_1) \tag{2}$$

Where:
$CF(H,E)$ = Certainty value of a hypothesis based on existing evidence.
CF_{expert} = Certainty value given by the expert regarding the relationship between symptoms and disease.
CF_{user} = User's level of confidence in the symptoms they are experiencing.

This method allows the expert system to provide diagnostic results with a certain level of confidence based on data entered by the user.

2.3 Dempster Shafer Method

The Dempster-Shafer (DS) method is a belief theory-based approach that allows the combination of several sources of information to produce a probability level of an event. This method works by combining evidence from various sources to produce a more accurate probability distribution in dealing with uncertainty[20]. The two main concepts in this method are[21][22]:

a. Basic Belief Assignment (BBA)
   Determining the degree of confidence in a set of hypotheses based on the information provided.
b. Evidence Combination (Dempster's Rule of Combination)
   Combining various sources of information to obtain a stronger belief value for a hypothesis.

In the Dempster-Shafer theory, the level of confidence in a hypothesis is expressed through Belief (Bel) and Plausibility (Pls). The Belief value for a hypothesis X is calculated by summing the mass functions of all subsets Y included in X, which is formulated as follows:

$$Bel(X) = \sum_{Y \subseteq X} M(Y) \tag{3}$$

Where:
$Bel(X)$ = Level of confidence in X.
$M(Y)$ = *The mass function of Y, which reflects how much confidence one has in the body of evidence.*

Meanwhile, Plausibility measures the extent to which a hypothesis is still likely to be true considering uncertainty. Its value is calculated using the formula:

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$$Pls(X) = 1 - Bel(X) = 1 - \sum_{Y \subseteq X} M(X') \quad (4)$$

Where:
$Pls(X)$ = Plausibility value for hypothesis X.
$Bel(X)$ = Level of confidence in X.
$M(X')$ = Mass function of the complement of X.

In Dempster-Shafer theory, the environment is defined as a set of possible worlds formed from various assumptions. From a set of elements representing possible responses, only one element will correspond to the correct response.

The concept of mass function (M) da in this theory functions as a measure of the level of confidence in evidence. If there are two mass functions, $M1$ and $M2$, each related to subsets X and Y, then both can be combined to form a new mass function, $M3$. The equation for the combination of these two mass functions is stated as:

$$M3(Z) = \frac{\sum_{X \cap Y = M1(X).M2(Y)}}{1 - \sum_{X \cap Y = \theta M1(X).M2(Y)}} \quad (5)$$

Where:
$M3(Z)$ = Combined mass function for evidence Z.
$M1(X)$ = Mass function for evidence X.
$M2(Y)$ = Mass function for evidence Y.

This method is very suitable for use in expert systems because it is able to handle uncertainty more flexibly than classical probabilistic methods.

2.4 ENT Diseases

Ear, Nose, and Throat (ENT) diseases include various disorders that occur in these organs, including[23][24]:

a. Ear infections – Caused by bacteria or viruses that interfere with hearing function.
b. Sinusitis – Inflammation of the sinuses that causes facial pain and difficulty breathing.
c. Tonsillitis – Infection or inflammation of the tonsils that often causes a sore throat.
d. Nasal allergies – Allergic reactions to dust, pollen, or other substances that cause nasal congestion and sneezing.

Early diagnosis of these diseases is essential to prevent further complications. Expert systems can assist in the diagnosis process by analyzing the symptoms experienced by patients and providing recommendations for diseases and their level of certainty based on the Certainty Factor and Dempster-Shafer methods.

2.5 Research Stages

This research was conducted through several stages as follows:

a. Problem Analysis
This research began with the identification of problems in the diagnosis of ENT diseases that are still carried out manually by medical personnel, which has the potential to cause inaccuracy in determining the disease. To overcome this, an expert system was developed with the aim of helping the diagnosis process more accurately.

b. Literature Study
Next, a literature study was conducted that included a review of previous research related to expert systems, especially those using the Certainty Factor and Dempster-Shafer methods in disease diagnosis. From the results of this study, the advantages and disadvantages of each method that has been used previously were analyzed to understand its effectiveness in dealing with uncertainty in medical diagnosis.

c. Data Collection
The data collection stage is carried out by collecting information about ENT diseases, accompanying symptoms, and diagnostic rules obtained from medical experts. In addition, to improve the accuracy of the expert system, the certainty value of each symptom is determined based on direct consultation with medical experts, so that the system can provide more valid and reliable diagnosis results.

d. Analysis of the Implementation
At this stage, the Certainty Factor method is implemented in the expert system to calculate the level of certainty of the diagnosis based on a combination of values given by experts and users. In addition, the Dempster-Shafer method is applied to combine various available evidence, so that it can produce the probability of a disease based on the symptoms detected. Both of these methods are used to handle uncertainty in the diagnosis process and improve the accuracy of the results obtained.

e. Comparative Method Analysis
At the comparative analysis stage, an evaluation of the diagnosis results obtained from the Certainty Factor and Dempster-Shafer methods is carried out. This comparison aims to assess the differences in the approach of each method in handling uncertainty in expert systems. In addition, measurements of accuracy, reliability, and effectiveness of both methods are carried out to determine the more optimal method in providing an accurate and reliable diagnosis.

f. Preparation of Research Report

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In the final stage, the entire research process, analysis results, and conclusions obtained are systematically documented. This documentation covers every stage of the research, from problem identification to system evaluation. In addition, the final research report is prepared as a reference for further research, so that it can provide insight and contribution to the development of expert systems in the field of ENT disease diagnosis.

The research stage chart is designed to provide a clear picture of the steps taken in the process of completing this research. The chart explains the systematic flow of each stage, from problem identification to the preparation of the final report. These stages include problem analysis, literature study, data collection, method implementation, comparative analysis, system testing, and evaluation of results. The research chart can be seen in Figure 1, which illustrates the relationship between each stage in this research.

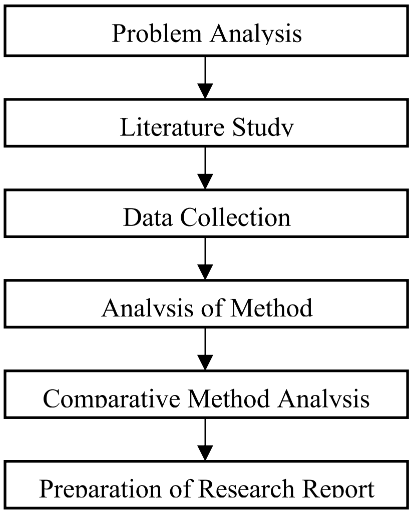

Figure 1. Research Stages

3. RESULTS AND DISCUSSION

In this phase, the information sought and collected by the experts is used for analysis to provide information about ENT diseases. These diseases include various disorders of the ear, nose, and throat that can significantly affect health if not treated immediately. These diseases can spread through the air, direct contact, or bacterial and viral infections.

3.1 Determination of Disease Data

Data on the types of diseases that are the focus of this study include several major disorders of ENT, namely ear infections, sinusitis, tonsillitis, and nasal allergies. Each disease is given a code to facilitate identification in the analysis, as shown in Table 1.

Table 1. Types of ENT Diseases

Code	Name of Disease
JP01	Ear Infection
JP02	Sinusitis
JP03	Tonsillitis
JP04	Nasal Allergies

Table 1 contains a list of types of Ear, Nose, and Throat (ENT) diseases along with their identification codes. Each disease has a unique code to facilitate reference in data analysis or health information systems.

3.2 Determination of Symptoms

In this study, there are 30 symptoms used to diagnose ENT diseases. Each symptom is given a code to facilitate data processing, as shown in Table 2.

Table 2. List of ENT Disease Symptoms

Symptom Code	Symptoms Description	Expert Value
GJL001	Earache	0.8
GJL002	Ringing in the ears	0.6
GJL003	Feeling of fullness in the ears	0.6
GJL004	Ear discharge	1.0
GJL005	Hearing problems	0.8
GJL006	Fever	0.6

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Symptom Code	Symptoms Description	Expert Value
GJL007	Nose congestion	0.8
GJL008	Runny nose	0.8
GJL009	Headache	0.6
GJL010	Facial pain	0.6
GJL011	Sneezing	0.8
GJL012	Itchy nose	0.6
GJL013	Sore throat	0.8
GJL014	Difficulty swallowing	0.8
GJL015	Hoarseness	0.6
GJL016	Dry cough	0.6
GJL017	Coughing up phlegm	0.6
GJL018	Nausea and vomiting	0.4
GJL019	Swollen tonsils	1.0
GJL020	White spots on tonsils	1.0
GJL021	Watery eyes	0.6
GJL022	Pain around the eyes	0.6
GJL023	Burning sensation in the throat	0.6
GJL024	Itchy nose	0.6
GJL025	Yellow or green mucus	0.8
GJL026	Upper jaw and teeth pain	0.6
GJL027	Unbalanced sensation (vertigo)	0.6
GJL028	Smell problems	0.6
GJL029	Difficulty breathing through the nose	0.8
GJL030	Easily tired	0.4

Table 2 presents a list of symptoms related to Ear, Nose, and Throat (ENT) diseases. Each symptom has a unique code, a brief description, and an expert value indicating the level of relevance of the symptom in diagnosing ENT diseases. Expert values range from 0.4 to 1.0, where the higher the value, the more significant the symptom is in determining a disease.

3.3 Determination of Rules

The knowledge obtained from the expert will be represented in the form of rules (rule base) used to find conclusions about the type of ENT disease. The Certainty Factor (CF) value is obtained from the interpretation of the "term" from the expert, which is converted into a certain CF value according to Table 3.

Table 3. Certainty Value

Information	CF Value
Very Sure	1.0
Sure	0.8
Quite Sure	0.6
Less Sure	0.4
Don't Know	0.2
No	0

Table 3 contains the certainty value (CF - Certainty Factor) which is used to measure the level of confidence in a symptom or diagnosis in the expert system. CF values range from 0 to 1, with 1.0 indicating complete confidence and 0 indicating no confidence.

Table 4. Rule Base for ENT Diseases

Disease Code	Types of Diseases	Symptom
JP01	Ear Infection	GJL001, GJL002, GJL003, GJL004, GJL005, GJL006
JP02	Sinusitis	GJL007, GJL008, GJL009, GJL10, GJL022, GJL025
JP03	Tonsillitis	GJL013, GJL014, GJL015, GJL016, GJL019, GJL020
JP04	Nasal Allergies	GJL007, GJL011, GJL012, GJL021, GJL024, GJL029

Table 4 presents the rule base for diagnosing ENT diseases based on the symptoms that appear. Each disease has a unique code and is associated with several specific symptoms that are used as the basis for the expert system-based diagnosis process.

3.4 Calculations Using the Certainty Factor Method

After collecting data related to symptoms, diseases, and rules obtained from experts, the application of the Certainty Factor algorithm is based on a value that reflects the level of expert confidence [19]. Certainty Factor allows each rule

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to have its own level of certainty, so it does not only depend on the certainty of its premises [20]. If a user is confirmed to have a symptom, then the value used will be adjusted to the related disease. The following is how to summarize the CF value of symptoms based on user conditions which can be seen in Table 5.

Table 5. Symptoms Experienced by Users/Patients

Symptom Code	Description	CF Value
GJL001	Earache	0.8
GJL002	Ringing in the ears	0.6
GJL007	Nose congestion	0.8
GJL009	Headache	0.4
GJL013	Sore throat	0.8
GJL014	Difficulty swallowing	0.2
GJL016	Dry cough	0.2
GJL019	Swollen tonsils	0.8
GJL024	Itchy nose	0.4
GJL029	Difficulty breathing through the nose	0.6

Table 5 lists the symptoms felt by the user or patient in the process of diagnosing ENT diseases. Each symptom has a unique code, description, and certainty value (CF) indicating the patient's level of confidence in the symptoms they are experiencing. The CF value ranges from 0.2 to 0.8, indicating variations in the level of certainty in the statement of symptoms. This method allows to identify the disease experienced by the patient. Based on the CF table, the diagnosis will be determined according to the symptoms that have been entered by the user.

a. Ear Infection Disease

The matching results for ENT disease type Ear Infection have 2 similar symptoms.

1. GJL001 = Earache

$$CF(H,E)_1 = CF(expert)_1 * CF(user)_1$$
$$= 0.8 * 0.8 = 0.64$$

2. GJL002 = Ringing in the ears

$$CF(H,E)_2 = CF(expert)_2 * CF(user)_2$$
$$= 0.6 * 0.6 = 0.36$$
$$CF_{combine1} = CF(expert, user)_1 + CF(expert, user)_2 * (1 - CF(expert, user)_1)$$
$$= 0.64 + 0.36 * (1 - 0.64)$$
$$= 0.7696$$

Based on the calculation results above, the level of certainty for sufferers of ear infection type disease is 0.7696 or 76.96%.

b. Sinusitis Disease

The matching results for the ENT disease type Sinusitis have 2 similar symptoms.

1. GJL007 = Nose congestion

$$CF(H,E)_1 = CF(expert)_1 * CF(user)_1$$
$$= 0.8 * 0.8 = 0.64$$

2. GJL009 = Headache

$$CF(H,E)_2 = CF(expert)_2 * CF(user)_2$$
$$= 0.6 * 0.4 = 0.24$$
$$CF_{combine1} = CF(expert, user)_1 + CF(expert, user)_2 * (1 - CF(expert, user)_1)$$
$$= 0.64 + 0.24 * (1 - 0.64)$$
$$= 0.7264$$

Based on the calculation results above, the level of certainty for sufferers of Sinusitis is 0.7264 or 72.64%.

c. Tonsillitis Disease

The matching results for ENT disease type Tonsillitis have 4 similar symptoms.

1. GJL013 = Sore throat

$$CF(H,E)_1 = CF(expert)_1 * CF(user)_1$$
$$= 0.8 * 0.8 = 0.64$$

2. GJL014 = Difficulty swallowing

$$CF(H,E)_2 = CF(expert)_2 * CF(user)_2$$
$$= 0.8 * 0.2 = 0.16$$

3. GJL016 = Dry cough

$$CF(H,E)_3 = CF(expert)_3 * CF(user)_3$$
$$= 0.6 * 0.2 = 0.12$$

4. GJL019 = Swollen tonsils

$$CF(H,E)_4 = CF(expert)_4 * CF(user)_4$$
$$= 1.0 * 0.8 = 0.8$$

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$$CF_{combine1} = CF(expert, user)_1 + CF(expert, user)_2 * (1 - CF(expert, user)_1)$$
$$= 0.64 + 0.16 * (1 - 0.64)$$
$$= 0.6976$$
$$CF_{combine2} = CF_{combine1} + CF(expert, user)_3 * (1 - CF_{combine1})$$
$$= 0.6976 + 0.12 * (1 - 0.6976)$$
$$= 0.7339$$
$$CF_{combine3} = CF_{combine2} + CF(expert, user)_4 * (1 - CF_{combine2})$$
$$= 0.7339 + 0.8 * (1 - 0.7339)$$
$$= 0.9468$$

Based on the calculation results above, the level of certainty for sufferers of Tonsillitis is 0.9468 or 94.68%.

d. Nasal Allergy Disease
The matching results for the ENT disease type Nasal Allergy have 3 similar symptoms.
1. GJL007 = Nose congestion
$$CF(H, E)_1 = CF(expert)_1 * CF(user)_1$$
$$= 0.8 * 1.0 = 0.8$$
2. GJL024 = Itchy nose
$$CF(H, E)_2 = CF(expert)_2 * CF(user)_2$$
$$= 0.6 * 0.4 = 0.24$$
3. GJL029 = Difficulty breathing through the nose
$$CF(H, E)_3 = CF(expert)_3 * CF(user)_3$$
$$= 0.8 * 0.6 = 0.48$$
$$CF_{combine1} = CF(expert, user)_1 + CF(expert, user)_2 * (1 - CF(expert, user)_1)$$
$$= 0.8 + 0.24 * (1 - 0.8)$$
$$= 0.848$$
$$CF_{combine2} = CF_{combine1} + CF(expert, user)_3 * (1 - CF_{combine1})$$
$$= 0.848 + 0.48 * (1 - 0.848)$$
$$= 0.921$$

Based on the calculation results above, the level of certainty for sufferers of Nasal Allergy type disease is 0.921 or 92.1%.

Table 6. Disease Calculation Values Based on the Certainty Factor Method

Disease Code	Types of Diseases	Percentage
JP01	Ear Infection	76.96%
JP02	Sinusitis	72.64%
JP03	Tonsillitis	94.68%
JP04	Nasal Allergies	92.10%

Table 6 shows the results of the calculation of diseases based on the Certainty Factor (CF) method. Ear Infection (JP01) has a certainty of 76.96%, Sinusitis (JP02) 72.64%, Nasal Allergy (JP04) 92.10%, and Tonsillitis (JP03) reaches 94.68%, which means that the symptoms completely match the disease. With this method, the probability level of each disease can be identified based on the symptoms entered by the patient, thus helping to determine a more accurate diagnosis.

3.5 Calculations Using the Dempster Shafer Method

The following is the solution based on table 5 using the Dempster Shafer method:

a. GJL001 = Earache is a symptom of ear infection with a belief value of 0.8.
$M_1(JP01) = 0,8$
$M_1(\theta) = 1 - 0,8 = 0.2$

b. GJL002 = Ringing in the ears is a symptom of ear infection with a belief value of 0.6.
$M_2(JP01) = 0,6$
$M_2(\theta) = 1 - 0,6 = 0.4$
Next, perform a combination of calculations which can be seen in Table 7.

Table 7. M_3 Combination Rules

	M_2 (JP01)	M_2 (θ)
	0.6	0.4
M_1 (JP01)	JP01	JP01
0.8	0.48	0.32
M_1 (θ)	JP01	θ
0.2	0.12	0.08

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$M_3(JP01) = 0.48 + 0.32 + 0.12 = 0.92$
$M_3(\theta) = 0.08$
The strongest possible value is the disease code JP01 with a value of 0.92 or 92%.

c. GJL007 = A blocked nose is a symptom of Sinusitis and Nasal Allergies with a belief value of 0.8.
$M_4(JP02, JP0) = 0.8$
$M_4(\theta) = 1 - 0.8 = 0.2$

Tabel 8. M_5 Combination Rules

	M_4 (JP02, JP04)	M_4 (θ)
	0.8	0.2
M_3 (JP01)	0	JP01
0.92		0.184
M3 (θ)	JP02, JP04	θ
0.08	0.064	0.016

$M_5(JP02, JP04) = 0.064$
$M_5(JP01) = 0.184$
$M_5(\theta) = 0.016$
The strongest possible values are disease codes JP02 and JP04 with a value of 0.184 or 18.40%.

d. GJL009 = Headache is a symptom of Sinusitis with a belief value of 0.4.
$M_6(JP02) = 0.4$
$M_6(\theta) = 1 - 0.4 = 0.6$

Tabel 9. M_7 Combination Rules

	M_6 (JP02)	M_6 (θ)
	0.4	0.6
M_5 (JP02, JP04)	JP02	JP02, JP04
0.064	0.0256	0.0384
M_5 (JP01)	0	JP01
0.184		0.1104
M_5 (θ)	JP02	θ
0.016	0.0064	0.0096

$M_7(JP02, JP04) = 0.0384$
$M_7(JP02) = 0.0256 + 0.0064 = 0.032$
$M_7(JP01) = 0.1104$
$M_7(\theta) = 0.0096$
The strongest possible value is the disease code JP01 with a value of 0.1104 or 11.04%.

e. GJL013 = Sore throat is a symptom of Tonsillitis with a belief value of 0.8.
$M_8(JP03) = 0.8$
$M_8(\theta) = 1 - 0.8 = 0.2$

Tabel 10. M_9 Combination Rules

	M_8 (JP03)	M_8 (θ)
	0.8	0.2
M_7 (JP02, JP04)	0	JP02, JP04
0.0384		0.0077
M_7 (JP02)	0	JP02
0.032		0.0064
M_7 (JP01)	0	JP01
0.1104		0.0221
M_7 (θ)	JP03	θ
0.0096	0.0077	0.0019

$M_9(JP02, JP04) = 0.0077$
$M_9(JP03) = 0.0077$
$M_9(JP02) = 0.0064$
$M_9(JP01) = 0.0221$
$M_9(\theta) = 0.0019$
The strongest possible value is the disease code JP01 with a value of 0.0221 or 2.21%.

f. GJL014 = Difficulty swallowing is a symptom of Tonsillitis with a belief value of 0.2.
$M_{10}(JP03) = 0.2$
$M_{10}(\theta) = 1 - 0.2 = 0.8$

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Tabel 11. M_{11} Combination Rules

	M_{10} (JP03)	M_{10} (θ)
	0.2	0.8
M_9 (JP02, JP04)	0	JP02, JP04
0.0077		0.0062
M_9 (JP03)	JP03	JP03
0.0077	0.0015	0.0062
M_9 (JP02)	0	JP02
0.0064		0.0051
M_9 (JP01)	0	JP01
0.0221		0.0177
M_9 (θ)	JP03	θ
0.0019	0.0004	0.0015

$M_{11}(JP02, JP04) = 0.0062$
$M_{11}(JP03) = 0.0015 + 0.0062 + 0.0004 = 0.0081$
$M_{11}(JP02) = 0.0051$
$M_{11}(JP01) = 0.0177$
$M_{11}(\theta) = 0.0015$
The strongest possible value is the disease code JP01 with a value of 0.0177 or 1.77%.

g. GJL016 = Dry cough is a symptom of Tonsillitis with a belief value of 0.2.
$M_{12}(JP03) = 0.2$
$M_{12}(\theta) = 1 - 0.2 = 0.8$

Tabel 12. M_{13} Combination Rules

	M_{12} (JP03)	M_{12} (θ)
	0.2	0.8
M_{11} (JP02, JP04)	0	JP02, JP04
0.0062		0.005
M_{11} (JP03)	JP03	JP03
0.0081	0.0016	0.0065
M_{11} (JP02)	0	JP02
0.0051		0.0041
M_{11} (JP01)	0	JP01
0.0177		0.0142
M_{11} (θ)	JP03	θ
0.0015	0.0003	0.0012

$M_{13}(JP02, JP04) = 0.005$
$M_{13}(JP03) = 0.0016 + 0.0065 + 0.0003 = 0.0084$
$M_{13}(JP02) = 0.0041$
$M_{13}(JP01) = 0.0142$
$M_{13}(\theta) = 0.0012$
The strongest possible value is the disease code JP01 with a value of 0.0142 or 1.42%.

h. GJL019 = Swollen tonsils are a symptom of Tonsillitis with a belief value of 0.8.
$M_{14}(JP03) = 0.8$
$M_{14}(\theta) = 1 - 0.8 = 0.2$

Tabel 13. M_{15} Combination Rules

	M_{14} (JP03)	M_{14} (θ)
	0.8	0.2
M_{13} (JP02, JP04)	0	JP02, JP04
0.005		0.001
M_{13} (JP03)	JP03	JP03
0.0084	0.0067	0.0017
M_{13} (JP02)	0	JP02
0.0041		0.0008
M_{13} (JP01)	0	JP01
0.0142		0.0028
M_{13} (θ)	JP03	θ
0.0012	0.001	0.0002

$M_{15}(JP02, JP04) = 0.001$

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$M_{15}(JP03) = 0.0067 + 0.0017 + 0.001 = 0.0094$
$M_{15}(JP02) = 0.0008$
$M_{15}(JP01) = 0.0028$
$M_{15}(\theta) = 0.0002$
The strongest possible value is the disease code JP03 with a value of 0.0094 or 0.94%.

i. GJL024 = An itchy nose is a symptom of Nasal Allergy disease with a belief value of 0.4.
$M_{16}(JP04) = 0.4$
$M_{16}(\theta) = 1 - 0.4 = 0.6$

Tabel 13. M_{17} Combination Rules

	M_{16} (JP04)	M_{16} (θ)
	0.4	0.6
M_{15} (JP02, JP04)	JP04	JP02, JP04
0.001	0.0004	0.0006
M_{15} (JP03)	0	JP03
0.0094		0.0056
M_{15} (JP02)	0	JP02
0.0008		0.0005
M_{15} (JP01)	0	JP01
0.0028		0.0017
M_{15} (θ)	JP04	θ
0.0002	0.00008	0.00001

$M_{17}(JP02, JP04) = 0.0006$
$M_{17}(JP04) = 0.0004 + 0.00008 = 0.0005$
$M_{17}(JP03) = 0.0056$
$M_{17}(JP02) = 0.0005$
$M_{17}(JP01) = 0.0017$
$M_{17}(\theta) = 0.00001$
The strongest possible value is the disease code JP03 with a value of 0.0056 or 0.56%.

j. GJL029 = Difficulty breathing through the nose is a symptom of Nasal Allergy disease with a belief value of 0.6.
$M_{18}(JP04) = 0.6$
$M_{18}(\theta) = 1 - 0.6 = 0.4$

Tabel 14. M_{19} Combination Rules

	M_{18} (JP04)	M_{18} (θ)
	0.6	0.4
M_{17} (JP02, JP04)	JP04	JP02, JP04
0.0006	0.0004	0.0002
M_{17} (JP04)	JP04	JP04
0.0005	0.0003	0.0002
M_{17} (JP03)	0	JP03
0.0056		0.0022
M_{17} (JP02)	0	JP02
0.0005		0.0002
M_{17} (JP01)	0	JP01
0.0017		0.0007
M_{17} (θ)	JP04	θ
0.00001	0.000006	0,000004

$M_{19}(JP02, JP04) = 0.0002$
$M_{19}(JP04) = 0.0004 + 0.0003 + 0.000006 + 0.0002 = 0.0009$
$M_{19}(JP03) = 0.0022$
$M_{19}(JP02) = 0.0002$
$M_{19}(JP01) = 0.0007$
$M_{19}(\theta) = 0.000004$
The strongest possible value is the disease code JP03 with a value of 0.0022 or 0.22%.

Table 15. Disease Calculation Values Based on the Dempster Shafer Method

Disease Code	Types of Diseases	Percentage
JP01	Ear Infection	0.09%
JP02	Sinusitis	0.22%
JP03	Tonsillitis	0.02%

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Disease Code	Types of Diseases	Percentage
JP04	Nasal Allergies	0.07%

Table 15 shows the results of disease calculations using the Dempster-Shafer method. Ear Infection (JP01) has a confidence level of 0.09%, Sinusitis (JP02) 0.22%, Tonsillitis (JP03) 0.02%, and Nasal Allergy (JP04) 0.07%. These probability values indicate the level of confidence of the system in each disease based on evidence obtained from the symptoms experienced by the patient. This method helps in measuring diagnostic uncertainty to provide more objective results.

3.6 Comparative Analysis of Methods

In this study, the Certainty Factor (CF) and Dempster-Shafer (DS) methods were used to diagnose diseases based on the symptoms experienced by patients. The calculation results of both methods showed significant differences in determining the level of confidence in a disease. The following is a table of 16 percentage results of calculations using the Certainty Factor and Dempster Shafer methods for diagnosing ENT diseases.

Table 16. Percentage Results of Calculation

Disease Code	Types of Diseases	Methods Used	
		Certainty Factor	Dempster Shafer
JP01	Ear Infection	76.96%	0.09%
JP02	Sinusitis	72.64%	0.22%
JP03	Tonsillitis	94.68%	0.02%
JP04	Nasal Allergies	92.10%	0.07%

Table 16 shows the results of the calculation of the percentage of disease based on two methods, namely Certainty Factor (CF) and Dempster-Shafer (DS). From the table, it can be seen that the Certainty Factor method produces a higher level of certainty for each disease compared to the Dempster-Shafer method. For example, Ear Infection has a value of 76.96% in the CF method, while in the DS method it is only 0.09%. Likewise with Sinusitis, Tonsillitis, and Nasal Allergy, which show significant differences between the two methods. This indicates that the CF method provides results with higher certainty, while the DS method is more conservative in determining the level of confidence in a disease.

4. CONCLUSION

Based on the comparison results between the Certainty Factor (CF) and Dempster-Shafer (DS) methods, there are significant differences in the level of certainty produced by the two methods in diagnosing diseases. In the CF method, the highest level of certainty was obtained for Tonsillitis with a value of 94.68%, followed by Nasal Allergy at 92.10%, Ear Infection at 76.96%, and Sinusitis at 72.64%. Meanwhile, the DS method provides a much lower certainty value, with Sinusitis having the highest value of 0.22%, followed by Ear Infection at 0.09%, Nasal Allergy at 0.07%, and Tonsillitis only at 0.02%. This difference shows that the CF method is more sensitive in providing certainty of a diagnosis based on the input of symptoms given, while the DS method tends to be more conservative in combining evidence before determining the final result. Therefore, in the context of a medical decision support system, the CF method is more suitable for rapid diagnosis with a high level of confidence, while the DS method can be used for more complex evidence-based analysis.

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