

Implementation Expert System for Diagnosing Tuberculosis Using Dempster-Shafer Method

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Abstract: Tuberculosis (pulmonary TB) is still a frightening disease for the world community, especially in Indonesia. This expert system application for the diagnosis of Tuberculosis is a computerized system to assist doctors and the public in diagnosing Tuberculosis. Efforts that can be made are to provide the best information to patients or the public about Tuberculosis disease through consultation with experts or using expert system applications. So for this reason, an application is designed that can provide expert information about Tuberculosis as a substitute for an expert or doctor. The purpose of this research is to build a web-based expert system for the diagnosis of tuberculosis. The stages carried out in this research are preliminary studies, identification of problems in which problems are found in expertise or designing an expert system, then literature study, the process of diagnosing symptoms and diseases by collecting data, if fulfilled then proceed with making a rule base and designing system. After completion, proceed to the testing and implementation phase to find out the system is feasible to use and in accordance with the design, then evaluate the results and report and finish. Based on the results of research and testing of the implementation of an expert system for diagnosing tuberculosis using the web-based Dempster-Shafer method that has been carried out by the author, several conclusions can be drawn, namely; This expert system created successfully performs data processing and provides disease results from the selected symptoms using the Dempster-Shafer method, the application is built using the PHP programming language and is supported by visualization languages such as HTML, CSS, JQuery and MySQL as databases, as well as system applications. Experts who are built can make it easier for people with tuberculosis and health parties to diagnose using the Dempster-Shafer method.

Index Terms: Implementation; Expert System; Tuberculosis Disease; Dempster-Shafer; Web.

1. Introduction

The use of technology in today's life is very helpful for humans in completing their work [1][2]. Everything feels so easy and fast with the use of various tools that are designed and programmed as well as possible so as to make it comfortable and safe [3][4]. As technology advances, nowadays humans are increasingly dependent on technology, because the use of computers that present a good system helps humans a lot in solving problems or difficulties [5][6]. Submission of information is now so easy to access because it has been connected to the network and almost reaches all corners of the world [7][8]. Not only that, various systems have been designed by experts to replace human work [8]. One of them is an expert system that can display information presented in a method that can replace the human brain [9][10][11]. Utilization of this expert system is designed as well as possible so that it can be applied without the presence of an expert [9][12]. Tuberculosis (pulmonary TB) is still a frightening disease for the world community [13], especially in Indonesia. This expert system application for the diagnosis of Tuberculosis is a computerized system to assist doctors and the public in diagnosing Tuberculosis [14][15]. Efforts that can be made are to provide the best information to patients or the public about Tuberculosis disease through consultation with experts or using expert system applications [16][17]. So for that, an application is designed that can provide expert information about Tuberculosis as a substitute for an expert or doctor.

Previous research by Hardianti *et al* (2017) with the title Mobile-Based Expert System Application for Early Diagnosis of Meningitis. The steps of making an expert system using this method are assessment, knowledge acquisition, design, and testing. Testing this application using the black box testing method and direct testing by experts. Based on the test results obtained qualitative test results that the system has no errors in carrying out its functions [18]. Furthermore, by

Kurniawati (2018) entitled Implementation of the Dempster Shafer Method in the Expert System for Diagnosing Types of Diabetes Mellitus. This study aims to implement the dempster-shafer method in the system for diagnosing diabetes mellitus. This method provides space for the expert in providing the value of trust in the knowledge he expresses. In this study, the test used was expert system accuracy testing with test data of 30 cases. The test results showed an accuracy test of 96.67% from 30 cases using the dempster-shafer method [19]. Tuberculosis (Tuberculosis, abbreviated as Tbc), is a common infectious disease, and in many cases deadly. This disease is caused by various strains of mycobacteria, generally *Mycobacterium tuberculosis* which is abbreviated as "MTb" or "MTbc" [20][21]. TB infection is generally asymptomatic and latent. However, only one in ten cases of latent infection develop into active disease. If tuberculosis is not treated, more than 50% of infected people can die. The classic symptoms of active TB infection are chronic cough with blood in the sputum or sputum, fever, night sweats, and weight loss. Tuberculosis usually attacks the lungs, but can also affect other parts of the body. Tuberculosis is spread through the air when a person with an active TB infection coughs, sneezes, or spreads their saliva through the air. Experts believe that a third of the world's population has been infected by *M. tuberculosis* and new infections occur at a rate of one person per second. Tuberculosis is not spread evenly around the world. Of the populations in various countries in Asia and Africa who have tuberculin tests, 80% are positive, while in the United States, only 5-10% are positive. People in the developing world are increasingly suffering from tuberculosis because of their weak immune system. Usually, they develop Tuberculosis as a result of being infected with the HIV virus and progress to AIDS [22].

2. Research Method

The stages carried out in this research are preliminary studies, identification of problems in which problems are found in expertise or designing an expert system, then literature study, the process of diagnosing symptoms and diseases by collecting data, if fulfilled then proceed with making a rule base and designing system. After completion, proceed to the testing and implementation phase to find out the system is feasible to use and in accordance with the design, then evaluate the results and report and finish. The knowledge base contains knowledge for understanding in solving problems used in artificial intelligence systems. The knowledge base is used for drawing conclusions that are the result of the tracking process. In this design, the production rules are written in the form of an IF [premise] THEN [conclusion] statement. In designing the knowledge base of this expert system, the premise is a symptom and the conclusion is a type of kidney disease, so the form of the statement is IF [symptom] THEN [type of tuberculosis]. In this expert system in one rule can have more than one symptom. And the symptoms are connected by using the logical AND operator. The form of the statement is:

IF [symptom 1] AND [symptom 2] AND [symptom 3]
THEN [disease]

From the form of the production rule above, it can be applied as an example of the rule below:

IF Cough
AND Fever
AND chest pain
THEN Tuberculosis

At the application development stage, the prototype method is carried out which triggers the developer to only make a resolution sample to officially show the functional essence of the product to the user [23][24]. The developer will make various necessary changes according to user requests. Once the above sample is agreed upon, the new developer will create the original product as the final output of the project. The prototype method has a tendency to be able to solve various problems that occur in the waterfall method.

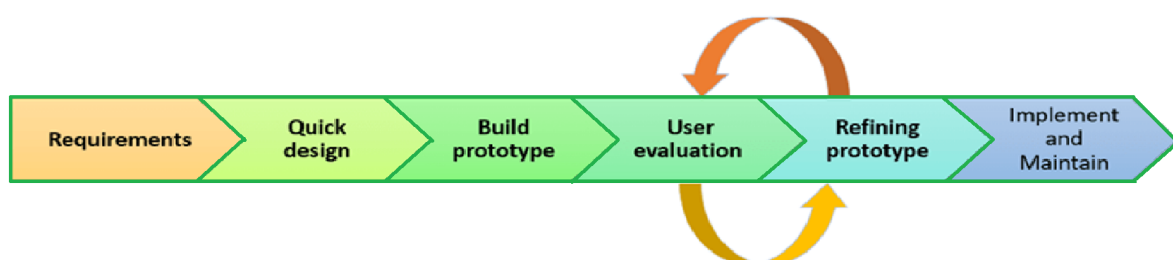


Fig 1. Stages in the Prototyping Model

The Dempster-Shafer theory was first introduced by Arthur P. Dempster and Glenn Shafer, who conducted an uncertainty experiment with a range of probabilities rather than as a single probability. Then in 1976 Shafer published Dempster's theory in a book entitled *Mathematical Theory of Evident*. In general, the Dempster-Shafer theory written in an interval is as follows:

1) Belief (Bel)

Is a measure of the strength of evidence in supporting a set of propositions. If it is 0 then it indicates that there is no evidence, and if it is 1, it indicates certainty.

2) Plausibility (Pl)

Denoted as: $Pl(s) = 1 - Bel(\neg s)$, Plausibility is also worth 0 to 1. If you are sure about s , then it can be said that $Bel(\neg s)=1$, and $Pl(\neg s)=0$. In the Dempster-Shafer theory, it is known that there is a frame of discernment denoted by. This frame is the universe of talks from a set of hypotheses. The goal is to relate the confidence measure of the elements of. Not all evidence directly supports each element. For this reason, it is necessary to have a probability density function (m). The value of m defines not only the elements of, but also all of its subsets. So if contains n elements, then the subset is n^2 . The sum of all m in the subset is equal to 1. If there is no information to choose the hypothesis, then the value: $m\{\emptyset\} = 1.0$. If it is known that X is a subset of, with m_1 as a function of its density, and Y is also a subset of with m_2 as a function of its density, then a combination function of m_1 and m_2 can be formed as m_3 , namely:

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

3. Result and Discussion

3.1 Results

The implementation of an expert system for diagnosing tuberculosis using the web-based Dempster-Shafer method that the author designed consists of several stages, namely input design, output design, process design, control design, labor design, and cost design. This input design consists of several program files, namely; Officer/Admin Data Entry Program, Symptom Data Entry Program, Disease Data Entry Program, Knowledge Data Entry Program (rule), and Consultation Data Entry Program. The output design of the implementation of an expert system for diagnosing tuberculosis using the web-based Dempster-Shafer method consists of several program outputs, namely; Analysis of Consultation Results, Symptom Reports, Disease Reports, Knowledge Reports, and User Lists.

Controlling user registration begins with collecting data into tables in the database. This process is done to prevent duplication or redundancy of data that will be input into the database. In addition, this process also ensures that the data entered is the correct data. In carrying out the implementation design of an expert system for diagnosing tuberculosis using the web-based Dempster-Shafer method, it requires workers who can operate computers so that it is easy to process consultation record data in determining disease. The current workforce is sufficient to run this application, only 1 person is needed to run this application, and it is necessary to provide training and skills on the use of the application. In the form below is the main menu form which contains the master display of symptoms, diseases, knowledge, consultations, reports, and users. Computer users just click the desired menu icon to see what is in the file.

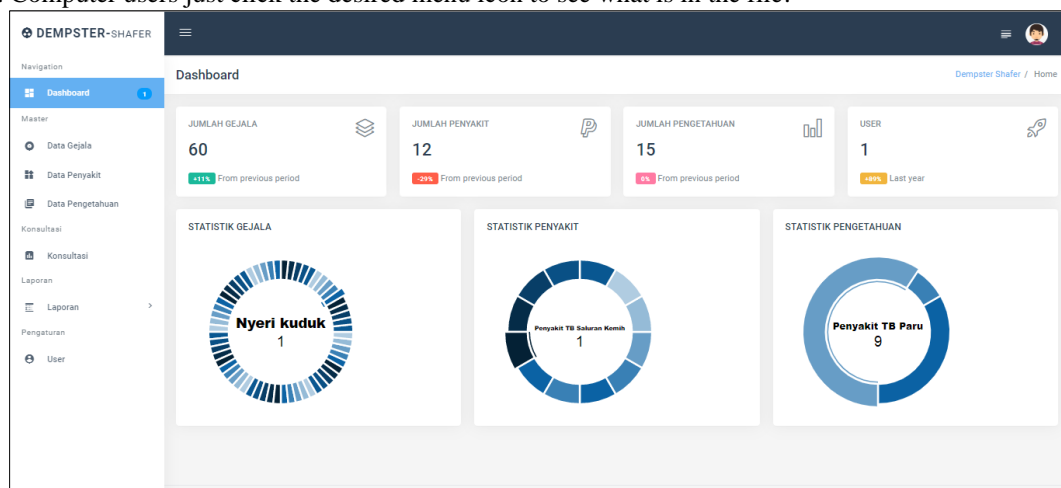


Fig 2. Application Menu Page

The consultation form menu is dynamic data where the data is filling from the consultation with the use of this system. The form contains information on questions about the rules that have been regulated with various symptoms which will later produce information that contains the disease later.

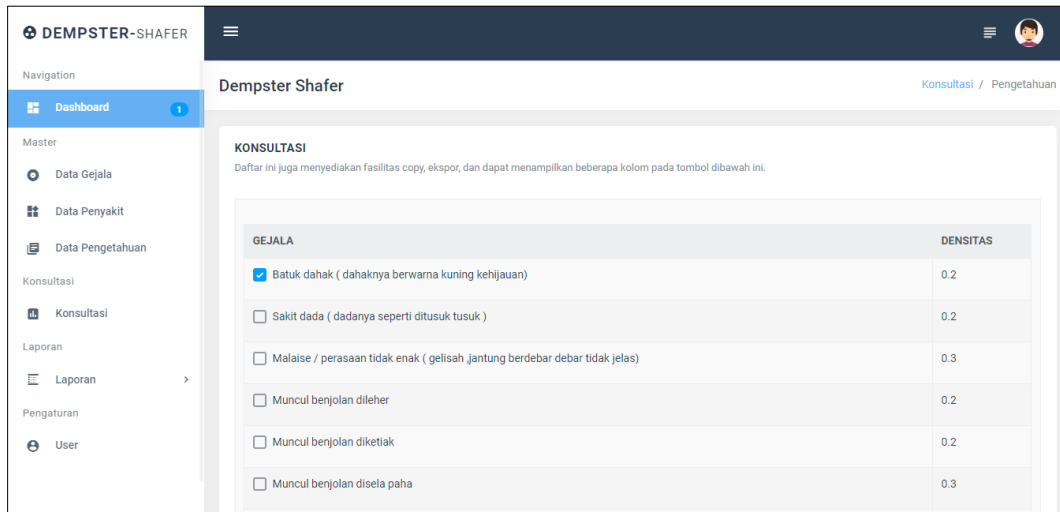


Fig 3. Consultation Form

3.2 Discussion

This result will contain information about the choice of symptom diagnosis. In this analysis using the Dempster-Shafer method so that the analysis in question is the result of filling out the consultation as shown in the following figure.

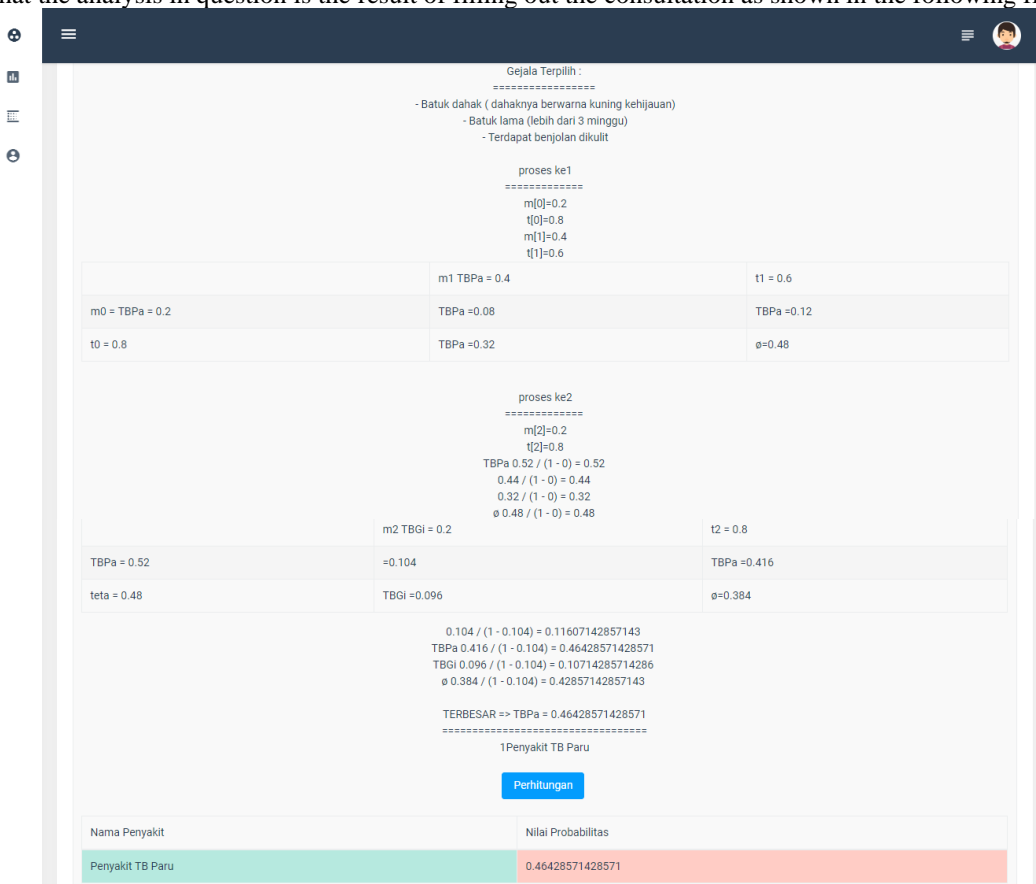


Fig 4. Consultation Results

The test is carried out by comparing the results of the diagnosis of the system built by diagnosing tuberculosis disease by calculating the accuracy of the system test. Testing is carried out by the user directly with the system that has been designed. The test is carried out in two stages, namely the first stage of testing according to the cases in the case base, while the second stage of testing is carried out using 60 test data. The results of the first stage of testing showed that the

system was able to correctly identify tuberculosis disease 100%. The recapitulation of the results of the second stage of testing with a similarity threshold of 70% is shown in Table 1.

Table 1. Recapitulation of Tests

No	Disease Name	Amount of Test Data	Correct Identification
1	Kidney TB disease	5	5
2	Liver TB disease	1	1
3	Glandular TB disease		1
4	Skin TB disease	2	1
5	TB Laryngitis	2	2
6	Meningitis TB disease	1	1
7	Miliary TB disease	1	1
8	Otitis TB disease	1	1
9	Pulmonary TB disease	9	9
10	Urinary Tract TB	2	1
11	Bone TB disease	1	1
12	Intestinal TB disease	1	1
Amount		27	25

The test results need to be evaluated to determine whether the system built is feasible to be applied in identifying tuberculosis. Evaluation is done by calculating the sensitivity and accuracy using the equation.

$$\text{Sensitivity} = \frac{Tp}{Tp + Tn} \quad (1)$$

$$\text{Accuracy} = \frac{Tp + Tn}{Tp + Fp + Tn + Fn} \quad (2)$$

Information:

TP = Number of positive/true identification results for positive test data

FP = Number of negative/false identification results for positive test data

TN = Number of positive/true identification results for negative test data

FN = Number of negative/false identification results for negative test data.

The steps taken in system testing are to create a confusion matrix based on each value of the similarity of the system test results. Table 2 shows the confusion matrix from the test results Table 1.

Table 2. Confusion Matrix Test Results

Identification Type	Test Data	TP	TN	FP	FN
Tuberculosis Disease	27	25	0	2	0

$$\text{Sensitivity} = \frac{25}{25+2} = 93\%$$

$$\text{Accuracy} = \frac{27 + 0}{25 + 2 + 5 + 0} = \frac{27}{32} = 84\%$$

The results of the calculation of the sensitivity value of 100% with a system accuracy value of 84.38%. This shows that the expert system using Dempster-Shafer can identify tuberculosis well.

4. Related Work

Research conducted by Siregar (2020) produced an expert system to determine the initial diagnosis of pulmonary tuberculosis. In this research, the method used is the Nave Bayes method and the Dempster Shafer method. The system is built using the Java programming language using the Android Studio software. The result of the system is to determine the value of the results of the two methods where the accuracy rate is 75% - 92% [25]. Other studies have also resulted in testing the results using manual calculations and calculations on the system have reached above 80% of the probability calculation when determining the identity of the type of disease from calculations using the Dempster-Shafer method

[26]. Bani & Nugroho (2020) use different methods with the aim that expert systems are used to assist in disease diagnosis [27]. Accuracy in the treatment of determining and diagnosing diseases, especially tuberculosis, can use the Dempster Shafer, but even though all researchers agree with the use of the Dempster Shafer, data and collaboration with other methods are still needed to improve accuracy. This study also agrees that the implementation of an expert system for diagnosing tuberculosis with the Dempster-Shafer method provides a very precise disease result from the selected symptoms with a system accuracy of 84.38%.

5. Conclusion

Based on the results of research and testing of the implementation of an expert system for diagnosing tuberculosis using the web-based Dempster-Shafer method that has been carried out by the author, it can be concluded, namely; This expert system created successfully performs data processing and provides disease results from the selected symptoms using the Dempster-Shafer Method. HTML, CSS, JQuery and MySQL as databases, and expert system applications that are built can make it easier for tuberculosis sufferers and health professionals to diagnose using the Dempster-Shafer method. The suggestion that the author wants to convey after conducting research is that for further development, the system is expected to be able to combine several other methods as a comparison of disease outcomes from the selected symptoms and need further development in the reporting process, because this system is still very simple in displaying reports so that in the future use more detailed graphics.

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