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Abstract. The purpose of this research was to early diagnose pulmonary infectious tuberculosis, commonly known as tuberculosis (TBC). This disease is caused by Mycobacterium tuberculosis through active TB sufferers who cough and excrete small droplets of saliva. Then an expert system is created that can assist in diagnosing and providing solutions to patients based on the symptoms of TB disease experienced by patients so that patients can detect it early and do not have to consult directly with a doctor. In this research, the method of Certainty Factor (CF) was used to calculate the certainty value in order to make the final decision clearer. There are several steps used to diagnose someone with TB disease: (1) Collecting disease and symptom data, (2) Creating rules from existing symptoms based on expert references and literature, (3) Calculating the certainty value with the CF method used. From the results of the system testing conducted on 20 people, the results of these trials and compared with the doctor's opinion, the accuracy of this system is 85% accurate, indicating that the results of the pulmonary tuberculosis diagnosis expert system can help doctors in diagnosing types of TB disease. based on the symptoms experienced by the patient and can provide first aid or early diagnosis by providing solutions to users.

Keywords: Tuberculosis, Active Tuberculosis, World Health Organization, Tuberculosis,expert system

1. INTRODUCTION

Tuberculosis is an infectious disease that has long been known in the world. This disease is a big enough problem for public health, especially in developing countries like Indonesia. According to a 2009 report

from the Word Health Organization (WHO), Indonesia was ranked fifth after India, China, South Africa and Nigeria [1]. Tuberculosis is a huge global health problem, causing morbidity and mortality worldwide. One third of the world's population is thought to be latently infected with Mycobacterium tuberculosis. The deadly synergy of HIV (Human Immunodedeficiency Syndrome) and HIV tuberculosis, and the emergence of multidrug resistant Mycobacterium tuberculosis (MDRTB), has more complicated TB control [2].
Expert System is a computer program that simulates the thoughts of experts in order to solve problems and assist in making decisions on certain problems. Expert System is a computer program that simulates the thoughts of experts in order to solve problems and assist in making decisions on certain problems. [3]. With this Expert System, awampun people can solve quite complex problems that actually can only be solved with the help of experts. For experts, this Expert System will also assist in their activities as highly experienced assistants. The three main components that appear virtually in any Expert System are the knowledge base, the inference engine and the user interface. Expert system must be able to work in uncertainty [4].

The Certainty Factor method is used when facing a problem whose answer is uncertain. This uncertainty can be a probability. This method was introduced by Shortlife Buchanan in the 1970's. He uses this method when diagnosing and treating meningitis and blood infections [6].

From research journals with the journal Expert System to diagnose brain tumors using the Certainty Factor (CF) method, the conclusion is that brain tumor diagnosis has a confidence level of 98.43564% [7]. An expert system is a computer program that mimics the ability of several experts in a certain field to solve problems such as these experts solving problems in their field [11].

The very rapid development of technology in line with human needs which are increasingly numerous and complex allows it to be widely used in various fields such as in the world of business, health, education, and so on. With this software, it is expected to be able to help ordinary people find out whether someone is experiencing symptoms of Tuberculosis or not. It is hoped that the ease of accessing a website via the internet can quickly detect whether a person has Tuberculosis. The problems above can be overcome by building a computer-based system that can accommodate knowledge about the symptoms and types of tuberculosis that is stored in a computer program.

2. METHODS

Research is a systematic way to answer a problem to be studied. and from the word systematic itself there is something to do with the scientific method, which means that there is a procedural linkage which is marked by completeness and order. The method is very necessary in making writing so that it can be well directed. The method must be able to analyze which requires the method to show the existence of an appropriate and correct process in defining the problem and determining the method in solving the problem.

The research framework in this research methodology is made so that the steps taken by the author in this design do not deviate from the subject matter and are easier to understand, then the sequence of steps will be systematically made so that it can be used as clear and easy guidelines to solve existing problems. . We can see the sequence of steps to be made in this study in Figure 1. on the following page:

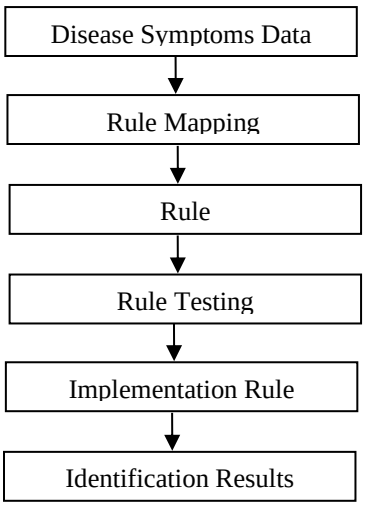

Figure 1. Research Framework

From the framework above, it is further explained to form an analytical framework. That's why the first thing that must be done is the analysis and design stage in the picture framework presented, which is the development of the analysis and design stage and the system testing application that has been shown in Figure 2. To see more details, you can see the following picture.

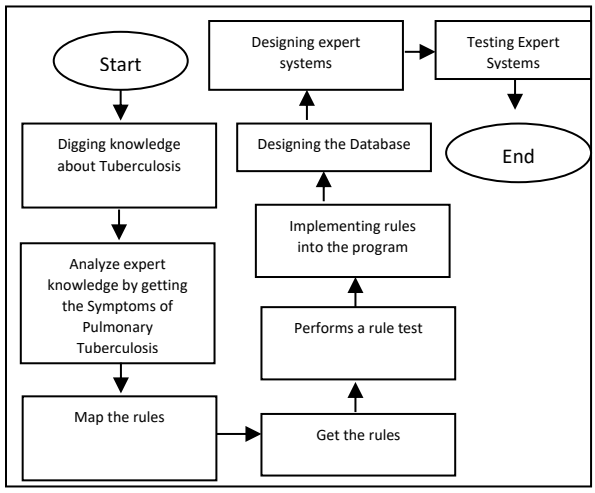

Figure 2. Analytical Framework

The inference engine used is the certainity factor method, where this method uses answers based on the value of the confidence level as shown in Table 1:

Table 1 Value CF (Certainty Factor)

Kondisitidakpasti (uncertain term)	CF
Pastitidak (Definetely Not)	0.2
HampirPastiTidak (almost Certainty Not)	0.3
KemungkinanBesartidak (Probably Not)	0.4
Kemungkinantidak (Maybe Not)	0.5
TidakTahu (Unknown)	0.6

Kemungkinan (Maybe)	0.7
KemungkinanBesar (Probably)	0.8
HampirPasti (Almost Certainty)	0.9
Pasti (Definitely)	1

3. RESULTS AND DISCUSSIONS

Expert system for early diagnosis of pulmonary tuberculosis is designed using the Certainity Factor method. The choice of this method is based on the fact that this method is suitable to be applied to find out the symptoms of pulmonary tuberculosis which is then used to determine the level of pulmonary tuberculosis suffered by the patient / user. From this pulmonary tuberculosis disease, it can be explained as follows.

3.1 Knowledge Base Design (Knowledge Base)

In this research, there are several symptoms that will be included in the rule, these symptoms are facts that produce conclusions in the form of the disease to be diagnosed. A list of symptoms is shown in Table 2:

Table 2. Symptoms of Pulmonary Tuberculosis

KodeGejala	Gejala
G01	PenurunanNafsuMakan
G02	Berat Badan Menurun
G03	Cepat Lelah Dan Lemah
G04	Demam Pada Malam Hari Dan Keringat Malam
G05	BatukDisertaiDarah
G06	SesakNafas
G07	BatukTidakSembuhDalamJangka Waktu 6 Bulan
G08	GangguanPendengaran
G09	Nyeri Sendi
G10	GangguanTidur
G11	Mual
G12	Muntah

After knowing the symptoms, the diseases to be diagnosed in this study will be displayed as shown in Table 3.

Table 3. Name of Disease

KodePenyakit	Nama Penyakit
KP 01	TuberkulosisParuBaru
KP 02	TB Paruputusobat
KP 03	MDR TB

In designing this knowledge base, it consists of two basic parts, namely facts and rules. The knowledge base contains knowledge in solving problems in certain domains. The knowledge base approach taken is knowledge-based reasoning (Rules-Based Reasoning) where knowledge is represented using the rules of the form: IF –THEN. In knowledge-based reasoning, problem solving can be solved sequentially where the technique used is the Certainity Factor, namely by searching from the first rule to the last rule.

Table 4. Rule

No	Rule (Aturan)
1	IF KG01 AND KG02 AND KG03 AND KG04 THEN P01(CF=0.75)
2	IF KG03 AND KG04 AND KG05AND KG06 THEN P01(CF=0.45)
3	IF KG01 AND KG03 AND KG05 AND KG06 THEN P01(CF=0.35)

4	IF KG03AND KG05 AND KG06 AND KG07 THENP02(CF=0.60)
5	IF KG05 AND KG06 AND KG07 THEN P02(CF=0.55)
6	IF KG03 AND KG06 AND KG07 THENP02(CF=0.45)
7	IF KG01 AND KG06 AND KG08 AND KG09 THEN P03(CF=0.55)
8	IF KG08 AND KG09 AND KG10 AND KG11 AND KG12THEN P03(CF=0.85)
9	IF KG04 AND KG06 AND KG09 AND KG10 THEN P03(CF=0.45)
10	IF KG02 AND KG05 AND KG11 AND KG12 THEN P03(CF=0.35)

3.2 Implementing Rules and Processes

Based on the rules that have been obtained, the application of these rules will be carried out in cases of illness experienced by patients, where the symptoms experienced by the patient are as follows:

Table 5. Sample case

No	Gejala	Jawaban Pasien	Nilai CF
1	Penurunan Nafsu Makan	Kemungkinan Besar	0.8
2	Berat Badan Menurun	Kemungkinan Besar Tidak	0.4
3	Cepat Lelah dan Lemah	Hampir Pasti Tidak	0.3
4	Demam Pada Malam Hari dan Keringat Malam	Hampir Pasti Tidak	0.3
5	Batuk Disertai Darah	Kemungkinan Tidak	0.5
6	Sesak Nafas	Tidak Tahu	0.6
7	Apabila Batuk Tidak Sembuh Dalam Jangka Waktu 6 Bulan	Kemungkinan	0.7
8	Gangguan Pendengaran	Hampir Pasti Tidak	0.3
9	Nyeri Sendi	Kemungkinan	0.7
10	Gangguan Tidur	Kemungkinan Besar Tidak	0.4
11	Mual	Hampir Pasti Tidak	0.3
12	Muntah	Kemungkinan Besar Tidak	0.4

After the characteristic facts are obtained from the user, the next process is the system to check the characteristics in the rules in table 4. After the rules are known, the next step is to calculate the Hypothesis value search (new facts) using the Certainty Factor formula, namely CF (A AND B) = Min (CF (A), CF (B)) * CF (rule). The calculations can be seen as follows:

[RULE 1] IF KG01 AND KG02 AND KG03 AND KG04 THEN P01(CF=0.45)

[RULE 2] IF KG03 AND KG04 AND KG04 AND KG06 THEN P01(CF=0.75)

[RULE 3] IF KG01 AND KG03 AND KG05 AND KG06 THEN P01(CF=0.55)

[RULE 4] IF KG03 AND KG05 AND KG06 AND KG07 THEN P02(CF=0.70)

[RULE 5] IF KG05 AND KG06 AND KG07 THEN P02(CF=0.80)

[RULE 6] IF KG03 AND KG06 AND KG07 THEN P02(CF=0.75)

[RULE 7] IF KG01 AND KG06 AND KG08 AND KG09 THEN P03(CF=0.65)

[RULE 8] IF KG08 AND KG09 AND KG10 AND KG11 AND KG11 THEN P03(CF=0.85)

[RULE 9] IF KG04 AND KG06 AND KG09 AND KG10 THEN P03(CF=0.45)

[RULE 10] IF KG02 AND KG05 AND KG11 AND KG12 THEN P03(CF=0.35)

From the results of the search for the value of CF, it will be entered into a new fact table, such as table 6.

Table 6. New Facts Table

No	Rule	Nilai CF
1	[RULE 1] IF KG01 AND KG02 AND KG03 AND KG04 THEN P01(CF=0.75)	0.225
2	[RULE 2] IF KG03 AND KG04 AND KG05 AND KG06 THEN P01(CF=0.45)	0.135
3	[RULE 3] IF KG01 AND KG03 AND KG05 AND KG06 THEN P01(CF=0.35)	0.105
4	[RULE 4] IF KG03AND KG05 AND KG06 AND KG07 THENP02(CF=0.60)	0.180
5	[RULE 5] IF KG05 AND KG06 AND KG07 THEN P02(CF=0.55)	0.225
6	[RULE 6] IF KG03 AND KG06 AND KG07 THENP02(CF=0.45)	0.135
7	[RULE 7] IF KG01 AND KG06 AND KG08 AND KG09 THEN P03(CF=0.55)	0.165
8	[RULE 8] IF KG08 AND KG09 AND KG10 AND KG11 AND KG12 THEN P03(CF=0.85)	0.255
9	[RULE 9] IF KG04 AND KG06 AND KG09 AND KG10 THEN P03(CF=0.45)	0.135
10	[RULE 10] IF KG02 AND KG05 AND KG11 AND KG12 THEN P03(CF=0.35)	0.105

From the table of new facts above, we can see that there is the same hypothesis. Then the next step is to calculate the combined CF (combination) using the formula CF1 + CF2 * (1 -CF1) or in other words, the sum of each new fact value per each type is then the total addition multiplied by one minus the maximum value of the new fact per each type. Where R1, R2, and R3 are the rules for KP01 so that merging can be done. R4, R5 and R6 are the rules for KP02 and the Merger of R7, R8, R9 and R10 is the rule for KP03.

1. Hipotesis KP01
   CFgab1 = CF1+CF2*(1-CF1)
   =0.135+0.225*(1-0.135)
   =0.135+0.225*0.865
   =0.3296
   CFgab2 = CFgab1+CF3*(1- CFgab1)
   =0.3296+0.165*(1-0.3296)
   =0.3296+0.165*0.6704
   =0.4402
2. Hipotesis KP02
   CFgab1 = CF4+CF5*(1-CF4)
   = 0.210+0.320*(1-0.210)
   = 0.210+0.320*0.790
   =0.4628
   CFgab2 = (CFgab1+CF6)*(1- CFgab1)
   =(0.4628+0.225)*(1-0.4628)
   =0.4628+0.225*0.5372
   =0.5836
3. Hipotesis KP03
   CFgab1 = CF7+CF8*(1-CF7)
   =0.260+0.340*(1-0.260)
   =0.260+0.340*0.740
   =0.5116
   CFgab2 = CFgab1+CF9*(1- CFgab1)
   =0.5116+0.180*(1-0.5116)
   =0.5116+0.180*0.4884
   =0.5995

   CFgab3 = CFgab2+CF10*(1- CFgab2)
   =0.5995+0.175*(1-0.5995)
   = 0.5995+0.175*0.4005
   =0.6695

From the combined results above, a comparison will be made of the results of each disease as follows:

Table 7. Conclusion Results

KP01	KP02	KP03	Diagnosis
0.3999	0.4502	0.4988	MDR TB

Conclusion The implementation of the certainty factor method for the diagnosis of pulmonary tuberculosis was successfully implemented with an accuracy percentage of 49.88% which resulted in the conclusion that there was Multi Drug Resistance (MDR) disease. It becomes clear evidence that the diagnosis of every symptom affects the level of accuracy. In this research, the trial was conducted on 20 users, from 20 test data obtained 17 valid data or the results were the same as expert data. Where from the results of these trials and compared with the doctor's opinion, the accuracy of this system is 85%.

4. CONCLUSION

The conclusion in this study is the implementation of the certainty factor method for the diagnosis of pulmonary tuberculosis has been successfully implemented with an accuracy of 66.95% which results in the conclusion that there is Multi Drug Resistant (MDR) disease. It is clear evidence that the diagnosis of every symptom affects the level of accuracy. And the results of testing with 20 users, the accuracy of this system is 85% and it can be concluded that the system is running according to its function.

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