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Malaria Diagnostic System using Analythical Hierarcy Process (AHP)

Elok Fauziyah Istiqlaliah[1] and Subiyanto[2]
[1,2]Teknik Elektro, Universitas Negeri Semarang, Semarang, Indonesia
elistiqlaliah@gmail.com[1], subiyanto@mail.unnes.ac.id[2]

***Abstract*—The purpose of this study is to apply the analytical method hierarchyprocess (AHP) in developing a malaria diagnosis system. Medical development in terms of efficiency and accuracy of diagnosis is very important. The impacts in decision-making with a diagnosis of a disease is very influential. Medical diagnosis process involves a complex mental training and experience sufficient medical knowledge. It is required to diagnose a disease that is complicated, especially when a lot of variables involved and the patient shows symptoms uncertain. This study was developed using AHP method that can solve the problems that are complex. There are 13 malaria predicted patient data that has been tested with this system. The result is known that malaria diagnosis system with AHP method has the accuracy of the predicted by a doctor.**

Keywords—Malaria, Decision Support Systems (DSS), AHP

I. INTRODUCTION

Efficiency in the development of medical and diagnostic accuracy is crucial. Medical diagnosis process involves a complex mental training and experience sufficient medical knowledge. This is required to diagnose complex diseases especially when a lot of variables involved and the patient shows symptoms of non-specific (Akinyokun & Adeniji , 1991).

The symptoms of malaria are many and complex so a bit difficult to predict (Infodatin kemenkes, 2013). technology and Information systems has now started to be applied and developed for health affairs which are known as clinical decision support systems (CDSS). According to Wyatt and Spiedelhalter this system is a knowledge which uses two or more items of patient data to provide advice on a particular case. Analytical Hierarchy Process (AHP) is a decision-making tool that is powerful and flexible, so it can help to set priorities and make decisions with aspects of qualitative and quantitative involved then both should be considered (Turban, 2005).

II. CONTEXT

Research conducted by scott morton (1970) he developed a system called the decision management system (MDS). The study utilizes data and certain models with computer-based systems. The study utilizes data and certain models with computer-based systems. Another study conducted by Keen and Scott (1980) who developed the research and revealed that a decision-making system requires the incorporation of intelligence sources with the individual components. Faith-Michael E. Uzoka et al (2010) developed a comparative research on malaria value prediction accuracy by comparing two methods of AHP and Fuzzy with a doctor. and his research found that the two methods are approaching the doctor's diagnosis. Symptoms are caused when a person experiences malaria are fever, anemia (dizziness) and spenomegali (Cristin Weekley, BA et al , 2013). Decision support system (DSS) is a computer-based system that produces a variety of alternative decisions to assist management in addressing various issues in a structured or unstructured using data and models (McLeod, 2004). In the development of information technology and healthcare, DSS have started to be applied to health problems is called the Clinical Decision Support System (CDSS). CDSS major components is : medical knowledge, patient data and advice for specific cases (Bemmel et al, 1997: 262). DSS method that can be used is the Analytical Hierarchy Process (AHP) is because this method is flexible and able to break down complex problems into structured (Turban, 2005).

AHP method is not only used in medical research but used in other studies. Doraid dalalah et al (2010) developed a draft research on decision support systems are used to optimize the selection of cranes or crane to be used. Farzad Tahriris (2008) conducted a study on the evaluation of the best suppliers in the steel manufacturing company. Sanjay Kumar et al (2009) study on the selection of the vendor issues in small-scale industries, medium, and large with AHP.

At this paper, we present the results of malaria diagnosis system with a comparison between the AHP method with the prediction doctor.

III. METHODOLOGI

A. Manually malaria diagnosis

Medical diagnosis process to manually as below (Faith-Michael E. Uzoka, 2010) :

- Collect subjective patient information includes medical history, history of mosquito bites, family history, and other subjective information.
- The list of possible diagnoses other.
- Confirm the diagnosis aimed at collecting evidence such as measuring vital signs of patients.

B. AHP Method

AHP method principle that must be understood in solving the problem is:

- Create a hierarchy (Decomposition) Making the decision to assess the consistency of the decision-making process with consistency ratio (Hsin-Hung Wu, Ya-Ning Tsai, 2010). to create a hierarchy must have three levels, namely level 1, level 2 and level 5 (Hastarini Dwi Atmantir, 2008).
- Determine criteria and alternatives (Comparative Judgement) Pairwise comparisons can be used to determine the criteria and alternatives (Saaty, 1998). 1-9 scale can be used to determine the criteria and alternatives (saaty, 2004)
- Synthesis of priority Criteria and alternatives need to be pairwise comparisons (Kusrini,2007). values are pairwise comparisons should be checked for consistency such as when doing a comparison we judge A> B and B> C, then it should logically A> C.
- Logical Consistency logical consistency of all the elements are grouped logically and consistently calculated in accordance with a logical criteria (Suryadi & Ramdhani, 1998). Calculation steps logical consistency : Multiplying matrices with corresponding priority, Summing up the results of multiplication of each row. The sum of each row divided with the relevant priorities and the results summed, will be obtained λmaks. λmaks = largest eigen value of a matrix of order n. The eigen value obtained by summing the results of multiplying the number of columns with eigen vector. Limit inconsistencies measured using consistency ratio (CR), which is the ratio consistency index (CI) value ratio index (RI). Consistency Index (CI) = (λmaks-n) / (n-1) consistency ratio = CI / RI, when the RI is a random index consistency. If the consistency ratio ≤ 0.1, the calculation results can be justified (Saaty, 1981).
- The flow of AHP Method

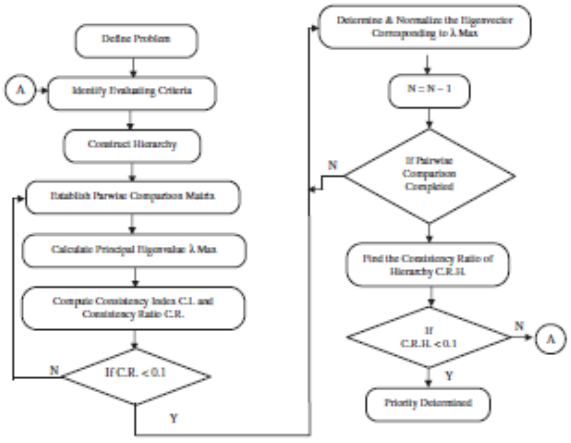

Figure 1. Flow of AHP method

(Faith-Michael E. Uzoka et al, 2010)

C. AHP Method for Malaria

AHP method is highly dependent on the input criteria and variables in managing information. Hierarchy process is a process in which priorities are derived from the eigenvalues vector of pairwise comparison matrices. The final results obtained in the calculation of AHP is a ratio scale.

TABLE I. SYMPTOMS OF MALARIA

Level 1	Level 2 Criteria	Level 3 Variables
Diagnosis Malaria	Fever (FVR)	Fever (FVR), sweating (SWT), Shivers (SVS)
	Aches (ACH)	Headache (HDC), muscle pain (MSP), backache (BKE), joint pain (JTP).
	Central Nervous System (CNS)	Chills (CHS), nausea (NSA), Delirium (DLM), Tiredness (TRS), excessive sleep (EXP), Dizziness (DZS)
	Gastro Intestinal Tract (GIT)	Vomiting (VMG), diarrhea (DRE), dehydration (DHN), Abdominal discomfort (ALD)
	Respiratory System (RSM)	Respiratory Not Normal (RNM), cough (CGH), Shortness of Breath (SNB)
	Depression General (DGR)	Loss of appetite (LOA), yellowish eyes (YWE), bad body condition (BBC)

After making the hierarchy then the next calculate the value of the weight criteria. at the initial stage, the calculations must determine the intensity of interest in the pairwise comparison value, then summed up each line.

TABLE II. PAIRWISE COMPARISON MATRIX

	FVR	ACH	CNS	GIT	RSM	DGR
FVR	1	5	7	7	8	6
ACH		1	7	6	7	3
CNS			1	1	3	0.2
GIT				1	6	0.5
RSM					1	0.2
DGR						1

TABLE III. PRIORITY VALUES (CRITERIA)

No.	Kriteria	Prioritas
1	Fever (FVR)	0,477
2	Aches (ACH)	0,241
3	Central Nervous System (CNS)	0,054
4	Gastro Intestinal Tract (GIT)	0,075
5	Respiratory System (RSM)	0,028
6	Depression General (DGR)	0,126

TABLE IV. PRIORITY OF VALUES (VARIABLE)

No.	Variable	Priority	High	Medium	Low
1.	Fever (FVR)	0.661	0.633	0.260	0.010
2.	Sweating (SWT)	0.249	0.581	0.3091	0.109
3.	Shivers (SVS)	0.089	0.647	0.2298	0.122
4.	Headache (HDC)	0.629	0.619	0.2842	0.096
5.	Muscle pain (MSP)	0.150	0.633	0.2604	0.106
6.	Backache (BKE)	0.129	0.607	0.3033	0.089
7.	Joint pain (JTP)	0.090	0.560	0.3117	0.127
8.	Chills (CHS)	0.265	0.702	0.1822	0.114
9.	Nausea (NSA)	0.229	0.650	0.2542	0.095
10.	Delirium(DLM)	0.035	0.680	0.2014	0.117
11.	Tiredness (TRS),	0.237	0.596	0.3191	0.084
12.	Excessive sleep (EXP)	0.049	0.619	0.2842	0.096
13.	Dizziness (DZS)	0.182	0.647	0.2683	0.084
14.	Vomiting (VMG)	0.150	0.593	0.2967	0.109
15.	Diarrhea (DRE),	0.370	0.722	0.1741	0.103
16.	Dehydration (DHN)	0.398	0.722	0.1741	0.103
17.	Abdominal discomfort (ALD)	0.079	0.588	0.2518	0.159
18.	Respiratory Not Normal (PTL)	0.228	0.603	0.2579	0.138
19.	Cough (CGH)	0.524	0.701	0.1972	0.100
20.	Shortness of Breath (SNF)	0.247	0.594	0.2766	0.128
21.	Loss of appetite (LOA)	0.659	0.588	0.2518	0.159
22.	Yellowish eyes (YWE)	0.148	0.647	0.2298	0.122
23.	Bad body condition (BBC)	0.191	0.596	0.3191	0.084

- Calculation Classification Diagnostic Faktor Index (DFI)

  The purpose of this calculation is to prove that the values of the priority that has been calculated to have a consistent value

TABLE V. DIAGNOSTIC FAKTOR INDEX (DFI)

No.	DFI	Priority value	Total
1.	DFI 1	0,47657FVR + 0,24329ACH + 0,05432CNS + 0,07042GIT + 0,02735RSM + 0,12805DGR	1
2.	DFI2 (FVR)	0,6612FVR + 0,2491SWT + 0,0895SVS	1
3.	DFI2 (ACH)	0,6295HDC + 0,1503MSP + 0,1299BKE + 0,0902JTP	1
4.	DFI2 (CNS)	0,0442CHS + 0,2295NSA + 0,0357DLM + 0,2377TRS + 0,0496EXP + 0,1820DZS	1
5.	DFI2 (GIT)	0,1508VMG + 0,3705DRE + 0,3989DHN + 0,0796ALD	1
6.	DFI2 (RSM)	0,2281RNM+ 0,5241CGH + 0,2477SNB	1
7.	DFI2 (DGR)	0,6592LOA + 0,1489YWE + 0,1918BBC	1

IV. RESULT AND DISCUTION

This study examined 13 patients suspected of malaria by using AHP and then the results were compared with results done by a doctor. This study aimed to determines the level of effectiveness of the calculation method of AHP.

TABLE VI. SUMMARY OF THE RESULTS OF THE COMPARISON

No.	Patient's name	Prediction of Doctor		AHP calculation			suitability Diagnosis	intensity of malaria
		Number Scale	Classes	Number Scale	Classes	ADFI		
1.	Nofitasari	2	moderate	2	moderate	2.716	AMD	moderate
2.	Adi. F	2	low	3	height	3.231	DNM	height
3.	Sutekno	3	height	3	height	3.299	AMD	height
4.	Galang Pratama	1	low	2	moderate	2.858	DNM	moderate
5.	Sarmijah	3	height	3	height	3.139	AMD	height
6.	Winda kartika	2	low	2	low	1.994	AMD	low
7.	Yeni Puspita	2	moderate	2	moderate	2.138	AMD	moderate
8.	Aji Santoso	3	height	3	height	3.112	AMD	height
9.	Andika	1	low	1	low	1.898	AMD	low
10.	Wahyu. M	3	height	3	height	3.822	AMD	height
11.	Indi Nisak	3	height	3	height	3.211	AMD	height
12.	A. Faizal. M	2	moderate	2	moderate	2.047	AMD	moderate
13.	Luluk . Z	1	low	1	low	1.153	AMD	low

Keyword : All matched diagnosis (AMD), Do not match (DNM), Agregate Diagnostic Faktor Index (ADFI)

In the table 6 there are two different diagnoses between doctors with the calculation AHP analysis but when compared with the scale of the total number of patients, it can be concluded that the suitability of AHP almost close to the prediction doctor.

V. CONCLUSION

The application of AHP (Saaty, 1980) in the health sector can be developed. AHP method can parse complicated case be arranged, but the AHP method also has the disadvantage of the source of the data input because it still relies on human expertise (Chou, Chou, & Tzeng, 2006). This research aims to develop and analyze the symptoms of malaria. In Table 6 shows that AHP has a match similar to the prediction of doctors.

TABLE VII. THE FINAL RESULTS OF PATIENTS DIAGNOSIS OF MALARIA

No.	Patient's name	ADFI	intensity of malaria
1.	Nofitasari	2.716	moderate
2.	Adi. F	3.231	height
3.	Sutekno	3.299	height
4.	Galang Pratama	2.858	moderate
5.	Sarmijah	3.139	height
6.	Winda kartika	1.994	low
7.	Yeni Puspita	2.138	moderate
8.	Aji Santoso	3.112	height
9.	Andika	1.898	low
10.	Wahyu. M	3.822	height
11.	Indi Nisak	3.211	height
12.	A. Faizal. M	2.047	moderate
13.	Luluk . Z	1.153	low

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