Expert System of Initial Anamnesis Process of Menstrual Disorders using Certainty Factor Method

Gina Giftia Azmiana Delilah[1], Cepy Slamet[2], Diena Rauda Ramdania[3], Ulfiah Ulfiah[4], Amalia Mahmudah[5]

[1]Faculty of Sains and Technology UIN Sunan Gunung Djati Bandung, Indonesia, ginagiftia@uinsgd.ac.id
[1]Doctoral Program of Religious Phyloshopy UIN Sunan Gunung Djati Bandung, Indonesia
[2]Department of Informatics UIN Sunan Gunung Djati Bandung, Indonesia, cepy.lucky@uinsgd.ac.id
[2]Department of ICT Asia E University, Malaysia
[3]Department of Informatics UIN Sunan Gunung Djati Bandung, Indonesia, diena.rauda@uinsgd.ac.id
[4]Department of Psychology UIN Sunan Gunung Djati Bandung, Indonesia, ulfiah@uinsgd.ac.id
[5]Department of Informatics UIN Sunan Gunung Djati Bandung, Indonesia, amalia@gmail.com

ABSTRACT

Anamnesis is a preliminary examination to obtain information about the patient's disease. This process is carried out by the doctor as part of the initial diagnosis of the patient's condition. The purpose of this research is to assist the history process in eliminating the diagnosis of possible diseases from experts by adopting their knowledge into the expert system. The method used in this study is the Certainty Factor method. Fifty test data collected to test this approach. The test results showed 44 data following expert opinion and obtained an accuracy rate of 88%. These results indicate that the expert system is suitable for the early history of menstrual disorders.

Key words: Anamnesis, certainty factor, expert system, menstrual disorder.

1. INTRODUCTION

Menstruation is characterized by the thickening of the uterine wall (endometrium), which contains blood vessels. If pregnancy does not occur, then the endometrium will decay and come out with blood through the vagina [1–4]. Menstrual health aspects are an essential part of a woman's reproductive health, not only in the field of physical health but also in aspects of mental health, spiritual and social. A person needs to know the pattern, the distance of her menstruation so that he can judge if something unusual happens [3,4]. The average duration of menstruation is five days. In some ca[5,6]ses, menstruation occurs 2-7 days, even more than 15 days. If the blood is more than 15 days, it is considered as a disease outside the menstrual cycle [2,7]. In 2016, it was found out that in general menstrual disorders are experienced by 90% of women worldwide [8].

Consultation with a specialist is needed to detect menstrual disorders. This initial inspection activity is known as an anamnesis. Complaints raised by patients taken carefully will help a lot in determining the diagnosis of an illness. There are many types of claims raised by a sufferer of the reproductive system and not always complain about menstrual abnormalities so that patience is needed in conducting anamnesis on a patient [9]. The diagnosis of menstrual disorders in women is categorized from mild to severe, including vomiting and nausea, feeling tired/tired, aching under the waist, feeling anxious and tense, as well as headaches and confusion [10].

Several previous studies have realized the importance of ease of diagnosis regarding health care, including jaundice detection system [11], a determination of menstrual disorders using a forward chaining algorithm [12,13], an expert system for diagnosing dysmenorrhea with Naive Bayes [14], an expert system for diagnosing menstrual abnormalities [15], an expert system for diagnosing menstrual delays (Oligomenorrhea) with Bayes [16], an expert system for menstruation diagnostics based on Android [17], and so forth. In this study, an expert system builds to diagnose the anamnesis disturbance process using the Certainty Factor Method inference engine. The reason for using expert systems is because they have proven to be able to solve cases effectively [18,19]. The certainty factor is a method that can determine whether a fact is certain or not [20].

2. CERTAINTY FACTOR

Certainty Factor method is a method proposed in 1975 by Shortlife and Buchanan to accommodate the uncertainty of the thinking of an expert [6,21,22]. Certainty Factor is a certain measure of a rule or fact. The calculation of the Certainty Factor value is explained in Equation 1 [21,23].

$$CF(H, E) = MB(H, E) - MD(H, E) \quad (1)$$

where
CF: the certainty factor in the hypothesis H due to evidence E
MB: the measure of increased belief in H due to E
MD: the measure of increased disbelief in H due to E

$$MB[h,e1]+MB[h,e2].(1-MB[h,e1]) \quad (2)$$
$$MD[h,e1]+MD[h,e2].(1-MD[h,e1]) \quad (3)$$

CF value data is taken from the reduction between MB value and MD value. CF value data is used for the calculation process between MB and MD so that the results obtained from the consultation. From the results of interviews and discussions with experts or obstetricians, weight tables for MB and MD values, which can be seen in Table 1 [24].

Table 1: MB and MD Value Range

Trust	MB/MD
Unknown	0-0.29
Maybe	0.3-0.49
Most Likely	0.5-0.69
Almost certainly	0.7-0.89
Certainly	0.9-1.0

Certainty Factor values are in the range -1 to 1. Following the confidence level of CF can be seen in Table 2 [24].

Table 2: Level of Confidence CF

| Uncertain Term	CF
Definitely not	-1.0
Almost certainly not	-0.8
Probably not	-0.6
Maybe not	-0.4
Unknown	-0.2 to 0.2
Maybe	0.4
Probably	0.6
Almost Certainly	0.8
Definitely	1.0

3. METHODOLOGY

3.1 Business Modeling

In constructing an early history of menstrual disorders, an analysis of the current system was carried out by distributing questionnaires to women with 111 respondents, the results of the respondents noted that 68.5% had menstruation at the age of 12-16 years, and more than 80% of women had understood the meaning of menstruation scientifically and menstrual disorders themselves, but of 111 women 55.9% did not know how to manage menstrual disorders and 19.8% said they did not know at all.

Types of menstrual disorders that women often experience are pain during menstruation or (dysmenorrhea) with a percentage of 30.6%, and the second disorder is irregular menstruation (Oligomenorrhea with a percentage of 13.5%, with the existence of this survey 93.7% of 111 respondents want a system that can help them know the types of menstrual disorders they are experiencing and how to manage menstrual disorders.

In the system running in the field, the patient must go through a long process when consulting with a doctor, as in Figure 1.

This study simplifies the process of history, taking in a flowchart in Figure 2.
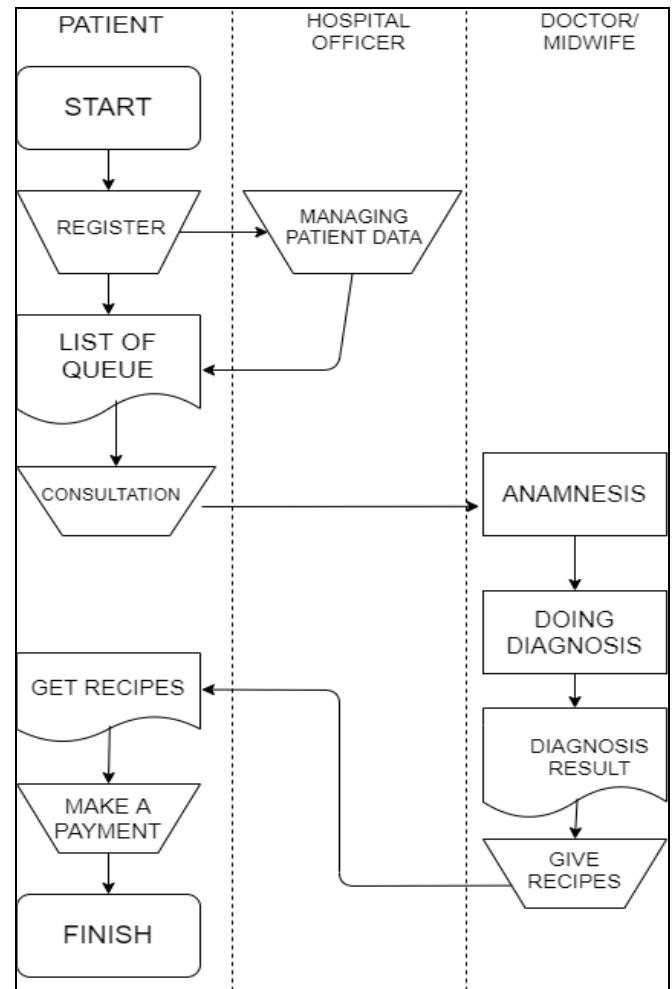
Figure 1: Flow map of the current system
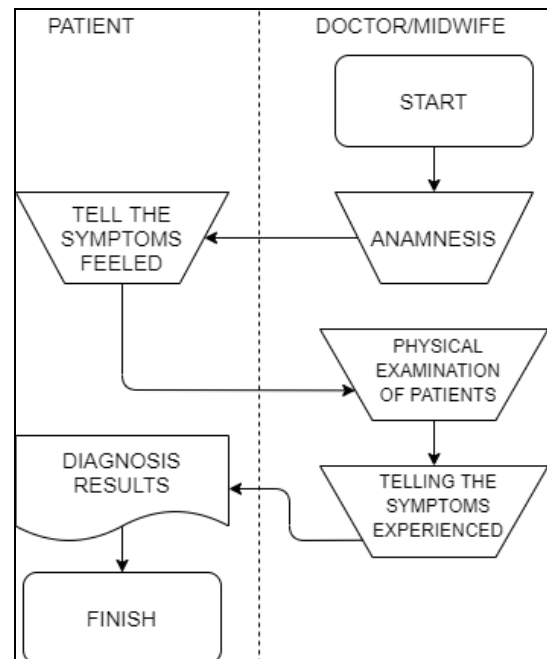
Figure 2: Flowchart of the expert system

3.2 Requirement Modeling of the System

System Requirement Modeling consists of functional requirements and a proposed system to be built, namely an expert system for diagnosing menstrual disorders. Table 3 lists the functional requirements for an expert system for diagnosing menstrual disorders.

Table 3: Functional requirements

ID	Requirement	Explanation
AK-F-03	Manage data relations between diseases and symptoms	The software provides facilities to manage data relations between conditions and symptoms, including adding, deleting, and changing data.
AK-F-04	Display the consultation page	The system displays a consultation page that will be used by the user or patient by selecting symptoms that are felt by showing a checkbox.
AK-F-05	Perform an initial history process	The system can process the initial history by processing the data needed using the Certainty Factor method.
AK-F-06	Showing anamnesis results	The system can display the results of anamnesis in the form of the name of the disturbance and its handling and also the most significant percentage of CF obtained.
AK-F-07	Change the admin password	The system can change the old admin password into a new one

The history process starts after the user inputs the symptoms he feels into the system. After that, the system will first calculate the MB, and MD values of the first symptom input, the MB and MD values in this first symptom are the MB and MD values that have been given by experts or previous experts. Then, in the second symptom and so on, the MB and MD values in the first symptom become a benchmark for calculating the next MB and MD values.

To calculate the MB and MD values in the following symptoms the following formulas 4 and 5 are used

*Temporary MB = Old MB + (New MB * (1 - Old MB))* (4)
*Temporary MD = Old MD + (New MD * (1 - Old MD))* (5)

The Old MB and MD values are obtained from the MB and MD values from the first symptom, and the Old MB and MD values are derived from the MB and MD values for the signs that have been given by the first expert. After calculating all the symptoms entered, then the next is to calculate the CF value to get the amount of confidence. The assessment is carried out at this stage to determine the most considerable CF

value that will be used as a conclusion. Then, the system will output the type of menstrual disorders along with the percentage of CF and also recommendations for treatment and treatment that must be met by the user or patient.
Several scenarios were also made to support the development of an expert system of the history of menstrual disorders. Table 4 explains the analysis of various menstrual disorders.

Table 4: Data of Menstrual Disorders

Code	Disease Name
P1	Pain during menstruation (Dysmenorrhea)
P2	Extremely long periods of time (Menorrhagia) or (Heavy Menstrual Bleeding)
P3	Irregular Menstruation (Oligomenorrhea
P4	Not having menstruation (Amenorrhea)
P5	More frequent menstruation (Polimenorea)

Table 5 describes the analysis of the symptoms of menstrual disorders.

Table 5: Data Symptoms of Menstrual Disorders

Code	Name of Symptoms
G1	Cramping the uterus
G2	Pain that makes you unable to move
G3	Pain takes place early or during menstruation
G4	Pain in the lower back of the foot
G5	Pain in the hip bones, and nausea
G6	Menstruation exceeds the usual days or> 7 days
G7	Changing pads almost every hour
G8	Excessive menstrual bleeding at night which makes changing pads more often
G9	excessive blood loss causes anemia, weakness, fatigue, and shortness of breath
G10	There are blood clots that are not normal
G11	Irregular periods so unpredictable
G12	Within a year only 4-9 menstrual periods, for menstruation to the next period of more than 35 days
G13	Not menstruating at age> = 16
G14	Experiencing mental and emotional stress
G15	Has menstruated but stopped for three months or more in a row
G16	For menstruation to the next period is only 2-8 days apart
G17	Menstrual cycles shorter than 21 days in a regular pattern
G18	Almost the same amount of bleeding during menstruation

After the data and symptoms are obtained, an analysis of disease data is then made as a decision table. The results of the study are presented in Table 6.

Table 6: Decision Table

Disease	P1	P2	P3	P4	P5
G1	√				
G2	√				
G3	√				
G4	√				
G5	√				
G6		√			
G7		√			
G8		√			
G9		√			
G10		√			
G11			√		
G12			√		
G13				√	
G14				√	
G15				√	
G16					√
G17					√
G18					√

MB and MD values in the Certainty Factor in this system were obtained from 3 experts in the field of menstrual disorders. The weight values obtained for MB and MD presented in Table 7.

Table 7: Value of MB and MD

No	Code of Disease	Code of Symptom	MB	MD
1	P1	G1	0.8	0.03
		G2	0.9	0.01
		G3	0.9	0.01
		G4	0.5	0.03
		G5	0.7	0.02
2	P2	G6	0.9	0.01
		G7	0.8	0.01
		G8	0.6	0.03
		G9	0.7	0.01
		G10	0.7	0.02
3	P3	G11	0.9	0.01
		G12	0.9	0.01
4	P4	G13	0.8	0.02
		G14	0.5	0.03
		G15	0.9	0.01
5	P5	G16	0.9	0.01
		G17	0.8	0.01
		G18	0.8	0.01

When the patient feels one symptom, the formula is CF = MB-MD. For example, when a patient experiences symptoms with the G1 code, then the MB and MD values of the symptoms can be seen in table 3.5, namely 0.8 and 0.03. And the relationship between disease and symptoms is only in those who have these symptoms only P1. So, the results of the calculation the user is likely to experience the criteria for signs of interference with the code P1 with a value of CF = 0.8-0.03 = 0.77. Another example is when a patient experiences one symptom in each menstrual disorder criteria. The first CF value of each sign must be sought after, then determining the CF value that is the greatest of each symptom in the disease.If the patient chooses more than one symptom, the method of calculation is combined with other symptoms. For example, users choose four symptoms, namely G1, G2, G3, and G4. MB and MD values of the symptoms are 0.8 and 0.03, 0.9 and 0.01, 0.9 and 0.01, 0.5 and 0.03. Here are the calculations.

1st calculation:
Disease 1: P1; Symptom 1: G1; MB = 0.8 MD = 0.03.
Old MB = Empty = 0
Old MD = Empty = 0
New MB = MB = 0.8
New MD = MD 0.03
Temporary MB = New MB = 0.8
Temporary MD = New MD = 0.03

2nd Calculation:
Old MB = Temporary MB = 0.8
Old MD = Temporary MD = 0.03
New MB = MB = 0.9
New MD = MD = 0.01
Temporary MB = Old MB + (New MB * (1 - Old MB)) = 0.98
Temporary MD = Old MD + (New MD * (1 - Old MD)) = 0.0397
Disease 1: P1; Symptom 2: G2; MB = 0.9 MD = 0.01.

3rd calculation:
Disease 1: P1; Symptom 3: G3; MB = 0.9 MD = 0.01.
Old MB = Temporary MB = 0.98
Old MD = Temporary MD = 0.0397
New MB = MB = 0.9
New MD = MD = 0.01
Temporary MB = Old MB + (New MB * (1 - Old MB)) = 0.998
Temporary MD = Old MD + (New MD * (1 - Old MD)) = 0.0493

4th calculation:
Old MB = Temporary MB 0.998
Old MD = Temporary MD 0.0493
New MB = MB 0.5
New MD = MD 0.03
Temporary MB = Old MB + (New MB * (1 - Old MB)) = 0.999
Temporary MD = Old MD + (New MD * (1 - Old MD)) = 0.0778
Disease 1: P1; Symptom 4: G4; MB = 0.5 MD = 0.03.
CF Results = Temporary MD-MD Provisional = 0.999-0.0778 = 0.9212
0.9212 * 100% = 92.12%

4. TESTING

In the expert system, we diagnose the functions of the systems using black-box testing. This test observes how the results of system execution through test data and functional checking of the expert system.

System accuracy testing is done to test the level of accuracy of the system created. Calculation results from the system will be compared with the results of manual calculations. Table 8 is the result of testing the accuracy of an expert system diagnosing menstrual disorders.

Table 8: System Accuracy Testing Results

No.	Code of Symptom	Manual Calculation	Calculation by system	Expert	Result
1.	G1, G5, G11, G8	Dysmenorrhea 89.06%, Ooligomenorrhea 89%, Menorrhagia 57%	Dysmenorrhea 89.06%	Dysmenorrhea 89.06%	√
2.	G15	Amenorrhea 89 %		Amenorrhea 89 %	√
3.	G7, G6	Menorrhagia 96.01%	Menorrhagia 96.01%	Menorrhagia 96.01	√
4.	G16 G17	Polimenorea 96.01%	Polimenorea 96.01%	Polimenorea 96.01%	√
5.	G8, G9	Menorrhagia 89%	Menorrhagia 89%	Menorrhagia 89%	√
6.	G2, G3	Dysmenorrhea 89.06%	Dysmenorrhea 89.06%	Dysmenorrhea 89.06%	√
7.	G11, G12	Oligomenorrhea 97.01%	Oligomenorrhea 97.01%	Oligomenorrhea 97.01%	√
8.	G11, G2	Oligomenorrhea 89% Dysmenorrhea 89 %	Dysmenorrhea 89 %	Dysmenorrhea 89 %	x
9.	G1	Dysmenorrhea 77%	Dysmenorrhea 77%	Dysmenorrhea 77%	√
10.	G14, G2	Amenorrhea 47 % Dysmenorrhea 89 %	Dysmenorrhea 89 %	Dysmenorrhea 89 %	√
11.	G1, G2	Dysmenorrhea 94.03%	Dysmenorrhea 94.03%	Dysmenorrhea 94.03%	√
12.	G7, G9	Menorrhagia 92.01%	Menorrhagia 92.01%	Menorrhagia 92.01%	√
13.	G13, G14	Amenorrhea 85.06%	Amenorrhea 85.06%	Amenorrhea 85.06%	√
14.	G5, G10	Dysmenorrhea 68%	Dysmenorrhea 68%	Dysmenorrhea 68%	√
15.	G16, G17	Polimenorea 96.01%	Polimenorea 96.01%	Polimenorea 96.01%	√
16.	G13	Amenorrhea 78%	Amenorrhea 78%	Amenorrhea 78%	√
17.	G1, G2, G11, G12	Oligomenorrhea 97.01% Dysmenorrhea 97.01%	Oligomenorrhea 97.01%	Oligomenorrhea 97.01%	x
18.	G8, G9, G16	Polimenorea 89% Dysmenorrhea 89 %	Polimenorea 89%	Polimenorea 89%	x
19.	G4, G9	Menorrhagia 69% Dysmenorrhea 47 %	Menorrhagia 69%	Menorrhagia 69%	√
20.	G17	Polimenorea 79%	Polimenorea 79%	Polimenorea 79%	√
21.	G15, G16, G1	Amenorrhea 91.03% Dysmenorrhea 89 %	Amenorrhea 91.03%	Amenorrhea 91.03%	√
22.	G2, G5	Dysmenorrhea 94.02%	Dysmenorrhea 94.02%	Dysmenorrhea 94.02%	√
23.	G7, G8, G9	Menorrhagia 92.67%	Menorrhagia 92.67%	Menorrhagia 92.67%	√
24.	G4, G9	Menorrhagia 69% Dysmenorrhea 47%	Menorrhagia 69%	Menorrhagia 69%	√
25.	G11, G12	Oligomenorrhea 97.01%	Oligomenorrhea 97.01%	Oligomenorrhea 97.01%	√
26.	G1, G2, G3, G4, G5	Dysmenorrhea 90.34%	Dysmenorrhea 90.34%	Dysmenorrhea 90.34%	√
27.	G6, G15	Menorrhagia 89% Amenorrhea 89%	Menorrhagia 89%	Menorrhagia 89%	x
28.	G13, G14	Amenorrhea 85.06%	Amenorrhea 85.06%	Amenorrhea 85.06%	x
29.	G12	Oligomenorrhea 89%	Oligomenorrhea 89%	Oligomenorrhea 89%	√
30.	G11, G12	Oligomenorrhea 97,01%	Oligomenorrhea 97,01%	Oligomenorrhea 97,01%	√
31.	G8, G9, G16	Polimenorea89% Dysmenorrhea 89%	Polimenorea89%	Polimenorea89%	x
32.	G10, G3	Dysmenorrhea 89%	Dysmenorrhea 89%	Dysmenorrhea 89%	√

No.	Code of Symptom	Manual Calculation	Calculation by system	Expert	Result
		Menorrhagia 68%			
33.	G7, G9	Menorrhagia 92.01%	Menorrhagia 92.01%	Menorrhagia 92.01%	√
34.	G16, G18	Polimenorea 96.01%	Polimenorea 96.01%	Polimenorea 96.01%	√
35.	G14, G2	Dysmenorrhea 89 %	Dysmenorrhea 89 %	Dysmenorrhea 89 %	√
36.	G8, G9, G10	Menorrhagia 91.71%	Menorrhagia 91.71%	Menorrhagia 91.71%	√
37.	G2, G3	Dysmenorrhea 89.06%	Dysmenorrhea 89.06%	Dysmenorrhea 89.06%	√
38.	G3	Dysmenorrhea 89%	Dysmenorrhea 89%	Dysmenorrhea 89%	√
39.	G1, G8, G14	Dysmenorrhea 77% Menorrhagia 57 % Amenorrhea 47 %	Dysmenorrhea 77%	Dysmenorrhea 77%	√
40.	G11, G12	Oligomenorrhea 97.01%	Oligomenorrhea 97.01%	Oligomenorrhea 97.01%	√
41.	G17, G18	Polimenorea94.01%	Polimenorea94.01%	Polimenorea94.01%	√
42.	G7, G8	Menorrhagia 88.03%	Menorrhagia 88.03%	Menorrhagia 88.03%	√
43.	G4, G2	Dysmenorrhea 91.03%	Dysmenorrhea 91.03%	Dysmenorrhea 91.03%	√
44.	G14, G16, G17	Polimenorea 96.01%	Polimenorea 96.01%	Polimenorea96.01%	√
45.	G12, G13	Oligomenorrhea 89%	Oligomenorrhea 89	Oligomenorrhea 89%	√
46.	G1, G10	Dysmenorrhea 77%	Dysmenorrhea 77%	Dysmenorrhea 77%	√
47.	G11, G12	Oligomenorrhea 97.01%	Oligomenorrhea 97.01%	Oligomenorrhea 97.01%	√
48.	G1, G2, G3, G4, G5	Dysmenorrhea 90.34%	Dysmenorrhea 90.34%	Dysmenorrhea 90.34%	√
49.	G2, G3	Dysmenorrhea 89.06%	Dysmenorrhea 89.06%	Dysmenorrhea 89.06%	√
50.	G6, G15	Menorrhagia 89% Amenorrhea 89%	Menorrhagia 89%	Menorrhagia 89%	x

System accuracy testing is carried out according to the following formula 6.

Accuracy Value =
(appropriate amount/number of cases) x *100%*   (6)

Based on testing as many as 50 data, there are 6 cases that have had an incompatible execution between manual testing and system testing. This is because, in the manual calculation, there are two symptoms, while the results obtained from the system and experts mention one symptom. So the 6 cases are considered not suitable. The system accuracy values obtained are as follows:
Accuracy Value = (44/50) x 100% = 88%

5. CONCLUSION

An expert system has been built that applies certainty factors to analyze the history of menstrual symptoms. The study refers to 3 experts who are experts in the field of menstrual disorders. Based on 50 tests, 44 data were obtained according to manual and system calculations. The accuracy value obtained for this system is 88%. This shows that the expert system of anemnesa process early menstrual disorders can run well according to expert diagnosis. The system built is suitable for use in the initial process when consulting before meeting with experts or obstetricians. In the future, more disturbance data that can be felt can be added to produce a better system.

REFERENCES

[1] Pediatric Clinic Advisor 2007 Menstrual Cycle: An Overview

[2] HealthEngine 2006 Menstruation (period or menstrual cycle)

[3] Maybin J A and Critchley H O D 2015 Menstrual physiology: Implications for endometrial pathology and beyond *Hum. Reprod. Update* 21 748–61 https://doi.org/10.1093/humupd/dmv038

[4] Sinaga E, Saribanon N, Sa'adah N, Salamah U, Murti Y A, Trisnamiati A and Lorita S 2017 *Manajemen Kesehatan Menstruasi* (Universitas Nasional)

[5] Krause P, Clark D, Krause P and Clark D 1993 The Certainty Factor Model *Representing Uncertain Knowledge*

[6] Heckerman D E and Shortliffe E H 1992 From certainty factors to belief networks *Artif. Intell. Med.*

[7] Anon Palmitoyl-CoA - an overview | ScienceDirect Topics

[8] Larasati T and Alatas F 2016 Dismenore Primer dan Faktor Risiko Dismenore Primer pada Remaja *Majority* 5 79–84

[9] Gleadle J 2007 Anamnesis dan Pemeriksaan fisik *Airlangga. Surabaya*

[10]   Negriff S, Dorn L D, Hillman J B and Huang B 2009 The measurement of menstrual symptoms: Factor structure of the menstrual symptom questionnaire in adolescent girls *J. Health Psychol.* 14 899–908

[11]   Raju R and Azzemi N N M 2019 Jaundice detection system *Int. J. Adv. Trends Comput. Sci. Eng.* 8 127–31
https://doi.org/10.30534/ijatcse/2019/2581.52019

[12]   Maulina D, Hadian N, Astuti Y and Hidayat T 2019 Penerapan Metode Forward Chaining Pada Sistem Pakar Menentukan Hukum Darah Wanita *SENSITIf: Seminar Nasional Sistem Informasi dan Teknologi Informasi* pp 629–42

[13]   Astuti T B and Utomo F S 2016 Sistem Pakar Diagnosis Gangguan Menstruasi Berbasis Web Service dengan Metode Forward Chaining *Isbn* 23–4

[14]   Nurfarianti Y, Tursina T and Sukamto A S Sistem Pakar untuk Diagnosis Dismenore Menggunakan Metode Naive Bayes *JUSTIN (Jurnal Sist. dan Teknol. Informasi)* 4 45–50

[15]   Yusuf C R M, Fatimah D D S and Damiri D J 2014 Perancangan Sistem Pakar untuk Diagnosis Penyakit Amenorea dengan Menggunakan Metode Expert System Development Life Cycle *J. Algoritm.* 11 220–9
https://doi.org/10.33364/algoritma/v.11-2.220

[16]   Arum V R 2015 Hubungan Status Gizi dengan Kejadian Oligomenore pada Sisiwi di SMK PERINTIS 29 UNGARAN *Semarang DIV Kebidanan STIKES Ngudi Waluyo Ung.*

[17]   Palupi R T 2013 Aplikasi Sistem Pakar Mendiagnosa Gangguan Pada Menstruasi Berbasis Android

[18]   Gan G W, Ong J P N and De Guzman M D M 2019 An expert system for a broadcasting network *Int. J. Adv. Trends Comput. Sci. Eng.* 8 683–8
https://doi.org/10.30534/ijatcse/2019/55832019

[19]   Guanzon J S, Caberte C N and Dela Rosa J G P 2019 An expert system optimization model for desktop computers *Int. J. Adv. Trends Comput. Sci. Eng.* 8 676–82
https://doi.org/10.30534/ijatcse/2019/54832019

[20]   Then S, Tursina T and Sastypratiwi H Implementasi Metode Certainty Factor Dalam Mendiagnosa Penyakit Kulit *J. Sist. dan Teknol. Inf.* 4 11–5

[21]   Roventa E and Spircu T 2009 Certainty factors theory *Stud. Fuzziness Soft Comput.* 227 153–60

[22]   Heckerman D 2016 *The Certainty-Factor Model ***

[23]   Munandar T A, Suherman and Sumiati 2012 The Use of Certainty Factor with Multiple Rules for Diagnosing Internal Disease *ijaiem* 1 58–64

[24]   Abidin R J, Kaffah F M, Khaerunisa P, Dauni P and Saputra M I N 2019 Sleep disorder diagnosis expert system using certainty factor method *J. Phys. Conf. Ser.* 1402
https://doi.org/10.1088/1742-6596/1402/6/066058