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Application of the Certainty Factor Method in Expert System for Diagnosing Toddler Diseases

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ABSTRACT

The toddler period is the period after birth up to the age of 59 months. During this period, the immune system in the toddler's body is not yet working optimally, so during this period the toddler is more vulnerable to attacks from various diseases. When a toddler is sick, it is not uncommon for parents to feel confused about what to do or misinterpret the symptoms experienced by the toddler. In conditions like this, the role of a doctor is very necessary. However, in reality, not all parents want to see a doctor, because of the high cost of treatment. Therefore, we need an expert system for diagnosing toddler diseases using the Certainty Factor method to support parents' ease in identifying symptoms and illnesses suffered by toddlers as early as possible. This study used 12 data on toddler illnesses with 51 symptoms. The results of this research show that from the 15 cases that were tested, the precession value was 86.66% and the recall value was 100%. Based on the results of this research, it can be concluded that this system can be used by users to diagnose illnesses in toddlers. With this system, it is hoped that parents can determine the type of disease experienced by toddlers quickly, precisely, and efficiently.

1. Introduction

Toddler growth is a period that starts when the baby is born until the age of 59 months. The growth period is divided into three phases, namely toddlers aged 0-28 days, toddlers aged 0-11 months and toddlers aged 12-59 months [1]. During this period, toddlers' physical and mental growth and development are very rapid, so it is important to continue to pay attention to and maintain the health of toddlers [2][3]. Efforts to maintain the health of toddlers include: fulfilling toddler nutrition, monitoring toddler growth and development, carrying out immunizations, providing treatment for chronic diseases, paying attention to parenting patterns, stimulating toddler development, and paying attention to healthy, safe and comfortable living conditions [4] [5].

At the age of 0-59 months, the immune system in toddlers' bodies is not working optimally, so at this time toddlers are more vulnerable to attacks from various diseases [6] [7]. When a toddler is sick, it is not uncommon for parents to feel confused about what to do or misinterpret the symptoms experienced by the child. So, in conditions like this the role of a doctor is really needed [8]. However, in reality, not all parents want to see a doctor, because of the high cost of treatment. Therefore, to anticipate disease attacks on toddlers, parents must routinely carry out immunizations or vaccines when toddlers are just born until they are 9 months old [9][10].

Diseases that attack toddlers are often difficult to recognize because toddlers are not yet able to communicate the pain they feel [11]. So, parents are required to be more careful in recognizing the symptoms experienced by toddlers [12]. Illness in toddlers is a problem that must be treated seriously, to prevent further complications that cause death in toddlers [13].

For this reason, with the rapid development of information technology today, a system is needed that can support parents' ease in identifying and understanding the symptoms and illnesses suffered by toddlers as early as possible [14].

One field of science that can represent human knowledge into computers is the field of artificial intelligence [15]. Artificial intelligence consists of several parts, one of which is the Expert System. An expert system is a technology application that aims to facilitate decision making and solve problems in more specific fields [16][17]. The expert system will explore factsrelated to the symptoms of certain diseases and can explain the results of the diagnosis or consultation carried out. When diagnosing a disease, it is not uncommon for a doctor or expert to find problems with

the information found, such as uncertain information[18]. To analyze uncertain information such as; statements are possible, most likely and almost certain, so an appropriate method is needed to overcome the problem of uncertainty, namely the Certainty Factor (CF) method [19]. The Certainty Factor (CF) method is a method that is very suitable for calculating certainty and uncertainty values in diagnosing a disease [14].

This research refers to several previous studies that have applied the Certainty Factor method to several diseases including; the first research with the title "Expert System for Diagnosing Diseases in Toddlers Using the Certainty Factor Method". The results of this research show that from the 22 data tested, the percentage of precision (speed) was 86.36% and recall (success) was 100% [8].

The second research with the title "Application of the Certainty Factor Method for a Website-Based Child Disease Diagnosis Expert System". This researchshows that the results of an expert system that stores 54data on symptoms and 10 diseases obtained an accuracy of 99.84%[14].

Furthermore, the third research with the title "Expert System for Diagnosis of Skin Diseases in Toddlers Using Certainty Factor and Forward Chaining Methods". The results of this research show that the accuracy level of the system developed in diagnosing skin diseases in toddlers is 83.33% from 30 medical record data [5].

The fourth research with the title "Certainty Factor in the Expert System for Diagnosis of Childhood Diseases". This research showed accuracy results of 87.68% fromthe 40 data samples used [20].

The latest research with the title "Implementation of Certainty Factors for Diagnosis of Toddler Diseases Caused by Consumption of Products with Chemical Substances".The results of this research show that the level of diagnostic accuracy using the CF method for asthma is 64.2%, for diarrhea is 56.8%, and for dermatitis is 66% [1].

Based on the problems above, this research aims to build an expert system for diagnosing toddler diseases using the Certainty Factor method. With this system, it is hoped that parents can carry out temporary treatment quickly and efficiently if an illness is detected in a toddler. Apart from that, this system is also expected to help minimize the illnesses suffered by toddlers due to a lack of information from parents regarding their health.

2. Research Methodology

This research was carried out in several stages including: Literature Study, Problem Identification, Data Collection, Data Analysis, and Implementation Stage which are presented in Figure 1.

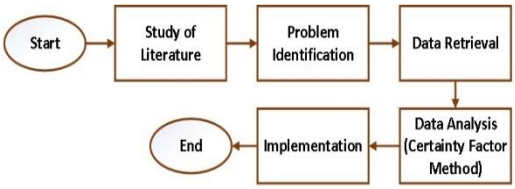

Figure 1 Research Stage

2.1 Study of Literature

The first stage in this research is the literature study stage. The literature study stage was carried out to find several previous studies that were relevant to this research to serve as a reference.

2.2 Problem Identification

The second stage in this research is problem formulation. This stage is carried out to determine the main problem in this research, so that objectives can be formulated that are appropriate to the problems at the research site.

2.3 Data Collection

Data collection techniques used in this research include; Literature study, namely studying somemanual data obtained from various references and direct observation techniques from experts in toddler diseases

2.4 Data Analysis with Certainty Factor Method

The next stage in this research is the Data Analysis stage using the Certainty Factor Method. The stages of data analysis carried out in this research are as follows:

1. Determine the types of toddler diseases
2. Determine the symptoms of toddler disease
3. Determine the weight of each symptom (expert weight)
4. Determine the user's weight
5. Perform calculations using the Certainty Factor method

Below are the calculation stages of the Certainty Factor method:

1. Calculate the CF value (one premise) with the following equation:

$$CF\ (h,e) = CF\ (user) * CF(Expert)$$

2. Calculate the CF value (if more than one premise) with the following equation:

$$CF(X \cap Y) = MIN\big(CF(X), CF(Y)\big) * CF(rule)$$

3. Calculate the CF value which produces a combined rule with the following equation:

$$CF\ combined(CF1 \cup CF2) = (CF1 + CF2) * (1 - CF1)$$

4. Calculate the combined CF value with the following equation:

$$CF\ combined\ (CF1, CF2) = CF[h,e]1 + CF\ [h,e]2 * (1 - CF[h,e]1)$$

Information:

CF combination [h1, e2] = Combination Value CF[h, e]1 and CF[h,e]2 = Calculating the certaintyvalue from the equation above, requires confidencevalues from related experts.

5. Calculate the confidence percentage value using the following equation:

$$Persentage\ CF = CF\ combined * 100\%)$$

2.6 Implementation Stage

The final stage in this research is the implementation stage. At this stage the author implements the process of diagnosing toddler diseases using the Certainty Factor method into a web-based system with a scheme that can be seen in Figure 2.

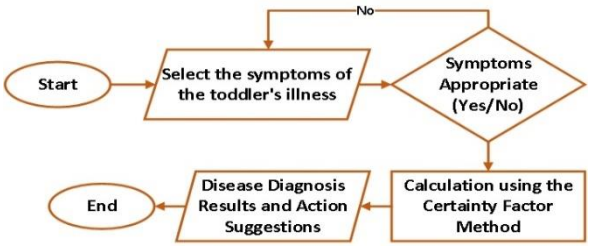

Figure 2. Expert System Scheme with Certainty Factor Method

Figure 2 is a schematic of an expert system for diagnosing toddler diseases using the Certainty Factor method. In this scheme, the user will select a symptom, if the symptom is not appropriate then the user will select the symptom again, but if the symptom is appropriate the system will carry out a calculation process using the Certainty Factor method based on the symptoms input by the user. After the calculation process is complete, the system will display the diagnosis results along with input actions or solutions that can be carried out by the user.

3. Results and Discussion

3.1 Description of Research Data

The data used in this research is disease data and symptom data for each toddler's disease. This study used 12 types of disease with 51 symptoms. The disease data and disease symptom data are presented in Table 1and Table 2.

Table 1. Toddler Disease Data

Code	The Type of Disease
P01	Malaria
P02	Diphtheria
P03	Eczema
P04	Pertussis
P05	ISPA
P06	Measles
P07	Smallpox
P08	Baby Head Crust
P09	Beri-Beri
P10	Kwashiorkor
P11	Diarrhea
P12	Diaper rash

Furthermore, symptom data on toddler illnesses ispresented in Table 2.

Table 2. Symptoms and Diseases of Corn Plants

Code	Symptom
G01	Body Partly Yellow
G02	CHAPTER Liquid
G03	Shivering and body shaking
G04	Nausea and Vomiting
G05	Pain in the body
G06	Fever
G07	Heart beat
G08	Swollen neck
G09	Inflammation of the throat or throat feels itchy
G10	Skin Rash
G11	Hard to breath
G12	Itchy rash
G13	Dry scaly skin
G14	Hard to sleep
G15	Cough
G16	Runny eye
G17	Red eye
G18	Dizziness and weakness
G19	Cold or Clocked nose
G20	No appetite or not wanting to drink breast milk for toddlers
G21	Crying often or being more-fussy
G22	Can't swallow food (painful to swallow)
G23	Bleeding cough
G24	The eyes look redder than usual
G25	There are spots all over the body
G26	Has white spots on the cheek area
G27	Blisters filled with fluid
G28	Headache
G29	The body feels itchy
G30	The skin appears swollen, warm and reddish
G31	Discharge from spots on the body
G32	There are white or yellow scales on the surface of the baby's head
G33	There are scales on the eyelids, ears, nose folds, back of the neck and armpits
G34	Diaper rash in the baby's groin folds
G35	The skin is crusty and produces yellow fluid
G36	The baby's skin may emit fluid and pus that smells bad
G37	Skin looks reddish
G38	Itchy and sore skin
G39	The skin of the thighs, groin and vital organs is red, sore and swollen
G40	There are pink spots and uneven skin
G41	The skin in the groin area is reddish
G42	Toddlers have difficulty walking
G43	Excessive sweating

G44	Toddlers have difficulty speaking
G45	Paralysis in toddler's legs
G46	The toddler's skin, lips and eyelids are very out cat
G47	Toddler's hair becomes easily pulled out, damaged and yellow
G48	The toddler's stomach is getting bigger
G49	Swelling of the feet
G50	Dry mouth
G51	Dry Eyes

The next stage is to determine the weight of the CF value on the symptoms of each disease. This weight is obtained from expert information. The weight of the expert CF values can be seen in Table 3.

Table 3. Expert CF Weight Value

Number	Trust Level	Weight
1	Very confident	1
2	Certain	0.8
3	Sure enough	0.6
4	A little sure	0.4
5	Don't know	0.2
6	There isn't any	0

Next, determine the users CF weight value which can be seen in Table 4.

Table 4. CF User Value

Number	Trust Level	Weight
1	Very confident	1
2	Certain	0.8
3	Sure enough	0.6
4	A little sure	0.4
5	Don't know	0.2
6	There isn't any	0

Next, Table 5 shows the relationship between types of disease and symptoms along with the weight of each symptom.

Table 5. User's Answer

Code	Symptom	Weight
P01	G01	0.6
	G02	0.6
	G03	0.8
	G04	0.8
	G05	0.8
P02	G06	0.6
	G07	0.7
	G08	0.9
	G09	0.8
	G10	0.6
	G11	0.8
P03	G12	0.8
	G13	0.9
	G14	0.8
P04	G15	0.8
	G06	0.7
	G16	0.8
	G17	0.9
	G11	0.6
P05	G06	0.6
	G18	0.6
	G19	0.5
	G15	0.6
	G20	0.9
	G21	0.8
	G22	0.6
	G11	0.7
	G23	0.8
P06	G10	0.6
	G24	0.7
	G25	0.8
	G26	0.8
	G06	0.7
	G15	0.6
	G09	0.7
	G19	0.7
P07	G27	0.9
	G29	0.6
	G31	0.8
	G30	0.7
	G06	0.6
	G15	0.6
	G09	0.5
	G19	0.5
P08	G32	0.9
	G33	0.8
	G34	0.6
	G35	0.8
	G36	0.4
P09	G42	0.8
	G43	0.7
	G44	0.9
	G45	0.9
P10	G56	0.8
	G47	0.9
	G48	0.9
	G49	0.8
P11	G02	0.9
	G04	0.7
	G50	0.6
	G51	0.6
	G18	0.8
P12	G37	0.9
	G38	0.6
	G39	0.8
	G40	0.8
	G41	0.8

3.2 Certainty Factor Value Calculation Process

The rule for giving weight to symptoms input by the user is to identify the level of confidence in the symptoms experienced by the user. If the user feels

Very Confident about the symptoms they are experiencing, they will be given a weight of = 1, Confident = 0.8, Quite Confident = 0.6, and Slightly Confident = 0.4. However, if the user does not know or is not sure about the symptoms they are experiencing, they will be given a weight of 0.2, whereas if the user does not experience certain symptoms, they will be given a weight of = 0. Table 6 is one of the cases of symptoms inputted by the user.

Table 6. Symptoms of User Disease

Symptom	Information	Weight
G01	Body partly yellow	0.6
G02	CHAPTER Liquid	0.8
G03	Shivering and body shaking	0.6
G04	Nausea and Vomiting	0.8
G05	Pain in the body	0.4

Based on the user's answer above, an anlysis process will then be carried out using the Certainty Factor method, to validate the type of disease suffered by the toddler. The analysis process using the CF method can be seen in Table 7.

Table 7. Calculation of CF Values for Symptoms of Malaria

Disease |Symptom	CF Expert	CF User	Hasil (CF Expert * CF User)
CF [H1, e1]	0.6	0.6	0.36
CF [H1, e2]	0.6	0.8	0.48
CF [H1, e3]	0.8	0.6	0.48
CF [H1, e4]	0.8	0.8	0.64
CF [H1, e5]	0.8	0.4	0.32

Based on Table 7, the combination value of the Certainty Factor is then calculated as follows:

$CF_{Combine}\ CF\ [H1, e]_{1,2}$ $= CF[H_1\ e_1] + CF[H_1\ e_2] * (1 - CF[H_1\ e_1])$

= 0.36 + 0.48 * (1 – 0.36)

= **0.667 (old1)**

$CF_{Combine}\ CF\ [H3, e]_{old2}$ $= CF[H, e]_{old1} + CF[H_1\ e_3] * (1 - CF[H, e]_{old1})$

= 0.667 + 0.48 * (1- 0.667)

= **0.826 (old2)**

$CF_{Combine}\ CF\ [H4, e]_{old3}$ $= CF[H, e]_{old2} + + CF[H_1\ e_4] * (1 - CF[H, e]_{old2})$

= 0.826 + 0.64 * (1 – 0.826)

= **0.937 (old3)**

$CF_{Combine}\ CF\ [H5, e]_{old4}$ $= CF[H, e]_{old3} + CF[H_1\ e_5] * (1 - CF[H, e]_{old3})$

= 0.937 + 0.32 * (1 – 0.937)

= **0.957 (old4)**

Next, look for the Certainty Factor value based on the calculation results above as follows:

$CF_{Combine}\ CF\ [H5, e]_{old4}$ $= CF[H, e]_{old3} + CF[H_1\ e_5] * (1 - CF[H, e]_{old3})$

= 0.937 + 0.32 * (1 – 0.937)

= **0.957 (old4)**
= 0.957 * 100
= **95,7 %**

Based on the results of these calculations, it can be concluded that the user experiences malaria with a Certainty Factor value of 95.7%.

The next stage, the calculation process above is applied to 15 cases inputted by the user. From the results of calculations using the system, the overall confidence value for each type of disease is presented in Table 8

Table 8. Calculation Results of CF Values Against

No	Symptom	System Diagnostic Result	Expert Diagnosis Result	Result
1	G01, G02 G03, G04 G05	Malaria 95.7 %	Malaria	Same
2	G06, G07, G08, G09 G10, G11	Diphtheria 93.8%	Diphtheria	Same
3	G01, G02 G03, G04 G05, G14	Malaria 88.5%	Malaria	Same
4	G12, G13 G14	Eczema 86.0%	Eczema	Same
5	G15, G16 G17, G11 G06	Pertussis 85.7%	Pertussis	Same
6	G15, G16 G17, G11 G21, G18	Pertussis 80%	Pertussis	Same
7	G06, G07 G08, G09 G10, G11	Otitis Media 81%	Difteri	Not the same

	G12, G21 G14			
8	G06, G18 G19, G15 G20, G21 G22, G11 G23	ISPA 89.8%	ISPA	Same
9	G10, G24 G25, G26 G06, G15 G09, G19	Measle 87.4%	Measle	Same
10	G27, G29 G31, G30 G06, G15 G09, G19	89.2%	Smallpox	Same
11	G32, G33 G34, G35 G36	Baby Head Crust 78.8%	Baby Head Crust	Same
12	G42, G43 G44, G45	Beri-Beri 76%	Beri-Beri	Same
13	G46, G47 G48, G49	Kwashiokor 83.4%	Kwashiokor	Same
14	G02, G18 G04, G50 G51	Diarrhea 82.4%	Diarrhea	Same
15	G12, G13 G14, G37 G38, G39	Eksim 92.9%	Diaper Rash	Not the same

Table *8* shows the results of system accuracy testing in 15 different cases. Based on the test results, of the 15 cases 2 cases were not the same, and 13 cases were the same. From the test results, accuracy is then calculated into percentages using the Precision and Recall formula as follows:

$$Precission = \frac{Same\ amount\ of\ data}{Same\ amount\ of\ data + Inappropriate\ amount\ of\ data}\ X\ 100\%$$

$$Precission = \frac{13}{13+2}\ x\ 100\%$$

$$Precission = 86{,}66\ \%$$

$$Recall = \frac{Same\ amount\ of\ data}{Same\ amount\ of\ data + Amount\ of\ data\ not\ found}\ X\ 100\%$$

$$Recall = \frac{13}{13+0}\ x\ 100\%$$

$$Recall = 100\ \%$$

3.3 Implementation

Implementation is the stage of developing an expert system for diagnosing toddler diseases. The system was created based on the results of detailed analysis and design based on the system currently running. The system design display can be seen in

Figure *3*, Figure 4, dan Figure 5.

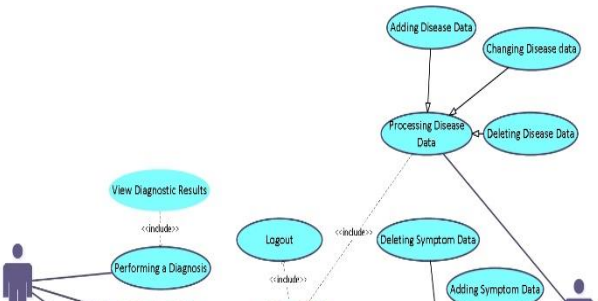

Figure 3. Use Case Diagram of an Expert System for Diagnosing Toddler Diseases

Figure 3 is a use case diagram of an expert system for diagnosing toddler diseases. In the system, there are two users, namely the User and admin. Users can carry out diagnoses, view diagnostic results, view disease information, and action suggestions. while users can process disease data, process disease symptom data, and process relationship data between symptoms and disease.

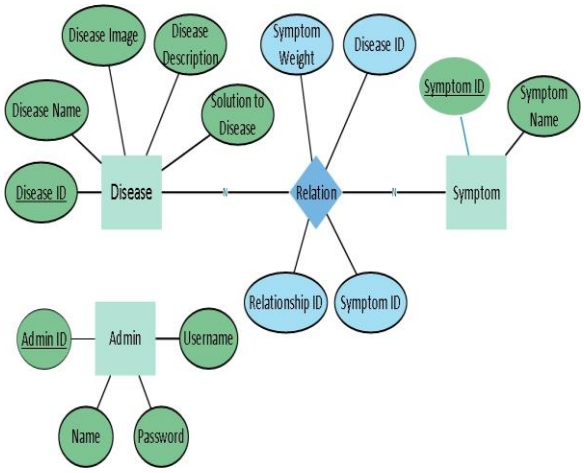

Figure 4. ERD Expert System for Diagnosis of Toddler Diseases

Figure 4 is the Entity Relationship Diagram of an expert system for diagnosing toddler diseases which has four entities, namely Admin, Disease Symptoms, Disease Relationships, and Disease Entities. Symptom entities have a relationship with disease entities, where many symptoms can be related to many diseases. Thus, a new entity is formed which is called a Relationship. The relationship entity will store the data ID_relation, ID_Symptom, ID_Disease and symptom weight. Meanwhile, the admin entity has no relationship with

any entity because the entity is only used to store username, password and admin name data so you can log in.

Figure 5. Display of the Expert System for Diagnosis of Toddler Diseases

4. Conclusion

Based on the results of the research and testing carried out, it can be concluded that by building an expert system for diagnosing toddler diseases, it will be possible to more quickly and precisely detect illnesses suffered by toddlers. With this system, users or parents can easily understand and identify the illnesses experienced by their children. From the 15case data that were tested, the perception value was 86.66% and the accuracy (recall) value was 100%. Even though the precession value is still far from 100%, this system can diagnose toddler illnesses based on existing symptom data. The input for further research is to increase the knowledge base of toddler symptoms and diseases as well as testing data to see the performance of the system.

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