

## Identifying Severe Malnutrition in Children with an Expert System

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### Abstract

Expert system is a computer program which is designed for modelling the ability of problem solving as it is an expert (human expert). The expert system method used is the forward chaining method which is the inference method that is doing logical reasoning from the problem to its solution. The aim of this research is to design and develop an expert system that is able to identify the severe malnutrition on children from the age of 0 - 5 years old. The knowledge is derived from the question asked to a nutrition expert. The data are taken from the questions asked to the user and when all of the questions has been answered, then the goal will be appeared which shows the nutrition status. This system application will enable the user to diagnose the nutrition/disease that affects children and get the solution. This system can be used by any kind of user due to the easy access. This system is also put the important information about the severe malnutrition and the recent news of children's health so it will add more knowledge for the parents about the importance of severe malnutrition's prevention.

Keywords: Expert system; Severe malnutrition; Children; Forward chaining

### 1. Introduction

Recently, there are number of malnutrition cases happen in Indonesia which is actually a prosperous country. The nutrition disorder in early age will effect to the next stage of life [1]. The malnutrition on children / toddler will not only causing a physical growth disorder, but it also impacts to the intelligence and the productivity in the future. Severe malnutrition is the worst form of the process of chronic less nutrition [2]. Severe malnutrition is not only caused by social condition, economy, family culture, parenting pattern, purchasing ability, and mother's knowledge, but it also because of the lack of consumption in energy, protein, and another nutrition and also due to the disease infection [3]. Therefore, a proper knowledge of nutrition and the effort of nutrition's improvement are very important to prevent the chance of severe malnutrition [4].

However, it seems difficult for people with less knowledge in nutrition. This difficulty can be solved by the presence of nutritional expert. By the rapid growth of technology, the result of research and training of well-developed people, there is a type of technology which adopts the process of human's way of thinking which is called as Artificial Intelligence (AI) [5,6,7]. Artificial Intelligence (AI) has many types of application, and one of them is expert system. It is a system which adopts the human knowledge into a computer so that the computer will be able to solve problems as if it is an expert [8,9]. The expert system has been applied in many fields including the health field [10,11]. By this experts system, people will be easier to make consultation

since the knowledge of nutritional expert has been adopted to this system.

This research uses the forward chaining method as an expert system for identifying children severe malnutrition. It is used to adjust the fact or statement of malnutrition. The expert system is developed which can identify the severe malnutrition on children from the age of 0 – 5 years old. where it is a web-based and use PHP and MySQL that can be accessed everytime and everywhere as the alternative of more economical consultation and information giving. The rest of this paper is organized as follow. Section 2 describes related works on malnutrition. Section 3 describes proposed method. Section 4 describes results and following by discussion. Finally, the conclusion of this work is described in Section 5.

### 2. Research Method

Expert system is a computer program which is designed for modelling the ability of problem solving as it is an expert (human expert). The human expert then can be adopted to a system in which everybody can have an access. There are many benefits by using the expert system and it has been used by many previous researchers, for example in [12]. In this case, the researcher detects the fault or damage on a car and the research needs the skill of an expert. In his paper, the expert system uses a model named knowledge-based system (KBS). In [13], the authors discussed the development of web based expert system for diagnosing children diseases using PHP and MySQL in acknowledging the disease on children. By the rapid growth of technology, the

expert of a pediatrician can be put into a system named expert system. A web-based expert system can be used every time and everywhere [13]. In [14], Erdani discussed developing recursive forward chaining method in ternary grid expert systems. This paper [14] discussed the ternary grid and uses forward chaining method. This method is used since the previous method is less efficient in solving the case [14].

The nutrition problem is basically a society health problem, but the solution cannot be done only by media approach and health service. The cause of nutrition problems is multi-factors, so the approach of the solution should involve the related sectors. Although the nutrition problem is often related with food shortage, the solution is not always with the production improvement and food availability. In a book published by World Health Organization (WHO), it is stated that the growth of a child can be determined by several factors, and one of them is the nutritional problem.

Some of the factors can be known when the baby does the immunization [15]. There are some ways to determine the nutritional status of someone, one of them is by anthropometry. Anthropometry is the study of geometry and application skill which defines physical geometry, the nature of mass, and the skill strength of human body [16,17]. The anthropometry measurement has 2 types that are growth and body composition size which is derived into body mass measurement and free of fat body mass. This involves a systematical measurement of physical nature of human body, especially the dimension descriptor of body and fat sizes [18].

The research methodology is needed as the framework and the guidance in doing the research process, so that the research will be more directed, organized, and systematic. The research methodology is the branch study of science which defines the way of doing research which is started from searching, taking notes, composing, analyzing, until composing the report based on the facts or symptoms scientifically. The motivation and the aim of research are basically the same that is the research is the reflection of human's will that are curious of something.

The will of getting and developing knowledge are basic needs of human that becomes motivation for doing the research. The research methodology is done systematically that can be used as the guidance for the research in doing the research so that the result achieved won't be out of line and the aim will be achieved according to the designed aim. This working framework is the steps done by the researcher to solve the problem. It is designed in the Figure 1.

Based on the Figure 1 working framework, then each step is being explained in detail as follows:

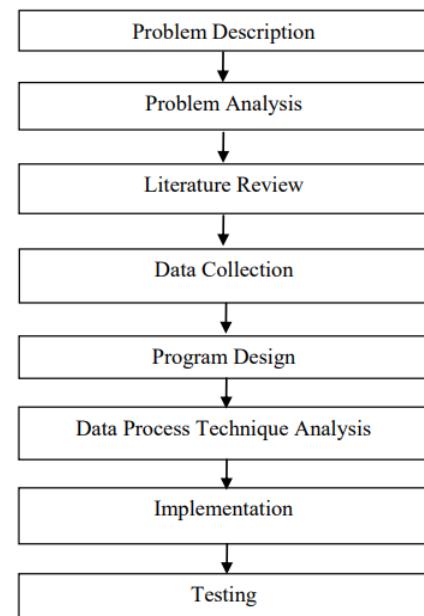


Figure.1 Proposed Framework

First step is deciding the problem description by deciding and defining the problem limitation, so that it will help in getting the best solution.

#### a. Problem Analysis

This step is the process of understanding the problems that have been decided and limited. By analyzing the problem, it will help to understand the problem better.

#### b. Literature Review

To achieve the aim, there is the process of literature review then deciding which literature can be used to support the research.

#### c. Data Collection

In collecting the data, the observation is done by doing direct observation so the problems can be known clearly. Then, the next process is interview which is aimed to get information or data needed. besides, there is also a process of literature study by reading books that support to do the data analysis.

#### d. Data Process Technique Analysis

The data collected from the research location then be analyzed and processed by using forward chaining method.

#### e. Program Design

The data analysis which uses forward chaining method then be given the layout planning of user interface program. In this chapter, there will be a

model of the upcoming program layout once it has finished.

f. Implementation

This step will allow the researcher to discuss the programming language that will be used. The researcher will use PHP and MySQL which are appropriate for the making of a knowledge based system.

g. Testing

The next process is testing. The program that has been made will be tested to see whether the program has run smoothly according to the planning.

### 3. Result and Discussion

#### 3.1 System Analysis

The system analysis is aimed to identify the problem occurs in the developed expert system of severe malnutrition symptoms diagnosis on toddler, as the basis of the system development of the data

gathered from the expert. System analysis is done so that the development and the new system design can be done well according to the user request. In doing the analysis to the running system of severe malnutrition, the authors analyze what are the symptoms behind the severe malnutrition nowadays. The number of problems in toddler's health that may occur is probably due to several factors depending on the condition of the user itself.

#### 3.2 Data Analysis

Data analysis is aimed to limit the findings in order to make the data be more organized and meaningful. In this research, the analysis is done non-statistically that is by reading the tables or graphics then doing the explanation and interpretation Table.1 below presents the data about the types of severe malnutrition symptoms and the types of disease occur.

Table 1: Data disease

Symptoms code	Name diseases
R01	<i>Kwarsiorhor</i>
R02	<i>Marasmus</i>
R03	<i>Marasmic Kwarshiorhor</i>

Table 2 presents statements for collecting data.

Table. 2: Data questions

No	STATEMENT	YES	NO
<b>Severe Malnutrition Symptoms of Kwarsiorhor</b>			
1	Does your children's hair tend to be slight?		
2	Does your children's hair tend to be reddish?		
3	Does your children's hair tend to be easily falls off?		
4	Is there any abnormality on your children's complexion?		
5	Is there any swelling on your children's face?		
6	Does your children's sight seem to be glazed?		
7	Is there any enlargement on your children's liver?		
8	Does your children often be affected by ISPA/ TBC?		
9	Does your children tend to be apathetic?		
10	Does the muscle tend to be smaller?		
11	Does your children tend to be cranky?		
12	Does your children feel anemic?		
13	Does your children tend to get diarrhea?		
<b>Severe Malnutrition Symptoms of Marasmus</b>			
14	Does your children's body tend to be so thin?		
15	Does your children's face look like an elder?		
16	Does your children tend to be cranky?		
17	Does your children's skin tend to be wrinkle?		
18	Does the subcutaneous fatty tissue (on the hip and others) seem to be so few or even none?		
19	Does your children's stomach tend to be concave and the rib seems to be prominent?		
20	Does your children tend to get infected (chronically repeated)?		
21	Does your children get chronic diarrhea or constipation?		
<b>Severe Malnutrition Symptoms of Marasmic-Kwarsiorhor</b>			
22	Does your children's hair tend to be slight?		
23	Is there any swelling on your children's face?		
24	Does the muscle tend to be smaller?		
25	Does your children's stomach tend to be bloated into abnormal size?		
26	Does your children tend to get infected (chronically repeated)?		
27	Is there any enlargement on your children's liver?		
28	Are your children's weight and height categorized into bad category?		

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29 Is there any swelling on your children?  
Do the wrinkle and fatty tissue seem to be none?  
30  
31 Does your children's hair tend to be slight?  
Does your children's stomach tend to be concave and the rib seems to be  
32 prominent?  
33 Are there any disorder in skin such as reddish or purging?

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### 3.3 Process Analysis

In developing this expert system, knowledge and information are gathered from several sources that are from the nutritional expert and health book, and etc. Knowledge will be represented in the form of *rule* which is useful for finding the conclusion from complains and the solution. Basically, the *rule* consists of two main points i.e. *premise* or condition and *conclusion*. The *rule* structure logically connects one or more conditions (*premises*) on **IF** part (that will test the truth from a set of data) with

one or more *conclusions* on **THEN** part. Beside *rule*, the expert system needs a database which consists of facts about the cause of the problems or the symptoms of severe malnutrition. By the presence of *rule* and the database, they are still not enough to solve the severe malnutrition problem in this expert system since it need an inference method to track the problem. The inference method which is used to track the problem in this severe malnutrition diagnosis expert system is the forward chaining method. The Table 3 as follow presents the guidance or rule of severe malnutrition expert system.

Table.3 Guidance or rule of severe malnutrition expert system

No	Rule
1	<b>IF</b> your children's hair tend to be slight AND your children's hair tend to be reddish AND your children's hair tend to be easily fall off AND there is abnormality on your children's skin AND there is swelling on your children's face AND your children's sight seem to be glazed AND there is enlargement on your children's liver AND your children often be affected by ISPA/ TBC AND your children tends to be apathetic AND the muscles tend to be smaller AND your children tends to be cranky AND your children feels anemic AND your children get diarrhea <b>THEN</b> It is diagnosed as Severe Malnutrition of Kwashiorkor
2	<b>IF</b> your children's body tends to be so thin AND your children's face looks like an elder AND your children tends to be cranky AND your children's skin tends to be wrinkle AND the subcutaneous fatty tissue (on the hip and others) seem to be so few or even none AND your children's stomach tend to be concave and the rib seem to be prominent AND
3	your children tends to get infected (chronically repeated) AND your children get chronic diarrhea or constipation <b>THEN</b> It is diagnosed as Severe Malnutrition of Marasmus If your children's hair tend to be slight AND there is swelling on your children's face AND the muscles tend to be smaller AND your children's stomach tend to be bloated into abnormal size AND your children tends to get infected (chronically repeated) AND there is enlargement on your children's liver AND your children's weight and height categorized into bad category AND your children's body get swollen AND the wrinkle and fatty tissue seem to be none AND your children's stomach tend to be concave and the rib seem to be prominent AND there is disorder in skin such as reddish or purging <b>THEN</b> It is diagnosed as Severe Malnutrition of Marasmic-Kwashiorkor

### 3.4 System Design by using UML

As the tools for the design for this expert system, the UML diagram which is used has 7 types, such as:

- Use Case diagram.
- Class diagram.
- Sequence Diagram
- Statechart diagram.
- Activity diagram.
- Collaboration diagram
- Deployment diagram

#### 3.4.1 Designing by using Use Case Diagram

The *Use Case Diagram* is used to get the functional requirement of a system. It consists of what have been done by the system, not how the system does. It draws narrative by how the interaction between the user and the system.

Malnutrition disease that often occur in Indonesia, especially in children aged 0 -5 years can cause interference and affect the physical growth and productivity of their intelligence in adulthood. Understanding and knowledge about nutrition and efforts to improve the nutritional improvement is needed to prevent premature worsening of possibilities that will happen. With the rapid technological advancement, the result of thinking and training of intelligent human beings, has developed a

technology that is able to adopt the human thought process and the way that artificial intelligence or Artificial Intelligence (AI). Artificial Intelligence (AI) has a wide range of applications, one of which is an expert system that is capable of resolving problems such as an expert. We successfully implemented an expert system with chaining forward method in the identification of diseases of malnutrition in children aged 0-5 years. Knowledge obtained through questions posed to a nutrition expert. Data taken based on questions posed to the user and when all the questions concerned has been completed it will show Goal regarding nutritional status. With the application of this system the user can

know the nutritional diagnosis or disease that strikes children and get a solution. This system can be used by ordinary users because of the ease of access given. In this system also included important information about malnutrition and the latest news about the health of children so they can add to the knowledge of parents about the child's health, especially the prevention of malnutrition. This application has a knowledge base by using forward chaining, so the future is expected to be developed with other methods are more specific, and the addition of new knowledge that will further enrich the knowledge base of expert system (See Figure 2).

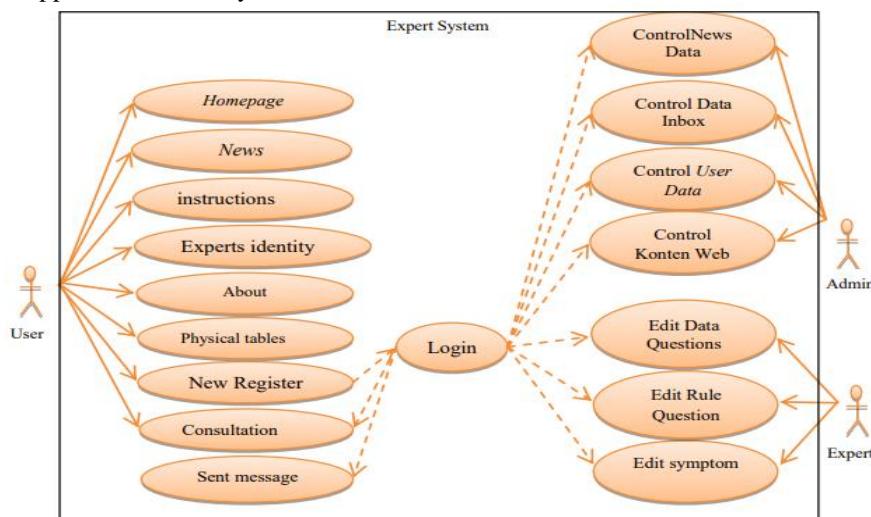


Figure. 2 Use Case Diagram for expert system in malnutrition disease

### 3.5 Implementation and Testing

#### 3.5.1 Homepage Expert System to Identify Malnutrition in Children

The front page home contains a glimpse of the submenu of the website, such as a glimpse of understanding of expert systems and anxiety disorders, as can be seen in Figure 3 below:



Figure. 3 The front page of the proposed system

#### 3.5.2 User Login

User must be logged in to be able to consult. The user login form as shown in Figure 4 below:

Figure. 4 User Login

#### 3.5.3 Question Form

In this form, users need to click "Start Consultation" to proceed to questions. Users who have registered, they can consult with the system as can be seen in Figure.5 below:



Figure. 5 The Form Question

#### 4. Conclusion

Malnutrition disease that often occur in Indonesia, especially in children aged 0 -5 years can cause interference and affect the physical growth and productivity of their intelligence in adulthood. Understanding and knowledge about nutrition and efforts to improve the nutritional improvement is needed to prevent premature worsening of possibilities that will happen. With the rapid technological advancement, the result of thinking and training of intelligent human beings, has developed a technology that is able to adopt the human thought process and the way that artificial intelligence or Artificial Intelligence (AI). Artificial Intelligence (AI) has a wide range of applications, one of which is an expert system that is capable of resolving problems such as an expert. We successfully implemented an expert system with chaining forward method in the identification of diseases of malnutrition in children aged 0- 5 years. Knowledge obtained through questions posed to a nutrition expert. Data taken based on questions posed to the user and when all the questions concerned has been completed it will show Goal regarding nutritional status. With the application of this system the user can know the nutritional diagnosis or disease that strikes children and get a solution. This system can be used by ordinary users because of the ease of access given. In this system also included important information about malnutrition and the latest news about the health of children so they can add to the knowledge of parents about the child's health, especially the prevention of malnutrition. This application has a knowledge base by using forward chaining, so the future is expected to be developed with other methods are more specific, and the addition of new knowledge that will further enrich the knowledge base of expert system.

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