Diagnostic System of Children's Nutritional Status Using the Production Rule Method

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ABSTRACT

This research develops an expert system to identify the malnutrition problem on the children living in the underdeveloped regions. The purpose of this research is to identify the nutritional status of children in rural areas. The method is used to develop the production rule. The production rule method includes analyzing the needs as a base of the rule development. The stages performed to diagnose the children's nutritional status are the measurement of body weight, height, age, and gender. The results of the research show that the body weight and height do not match the standard deviation (SD) threshold, where the value between <-3SD to <-2SD is categorized as thin. If the value <-3SD it is classified as very thin, while -2 SD up to 2 SD means normal category, and the value > 2 SD is stated as fat. From the mapping of the underdeveloped regions in X village, there are still many malnutrition children with 5% percentage of thin category, and 1% is very thin and suffering from bronchopneumonia.

1. Introduction

The Health Research and Development Agency of the Ministry of Health states that nutrition is very important in the children's life cycle under five. Efforts to improve nutrition in society especially in remote areas will give a good contribution to the achievement of national development goals, especially in the prevalence of malnutrition at the age of five. This anthropometry book is used to explain the nutritional status of the children. After their weight and height are measured, the next step is to determine the standard deviation value where the results obtained show a child's nutritional level (Depkes RI, 2013).

Some previous studies have shown that children's growth, development, and intelligence are greatly influenced by nutrition. Often the parents consider the nutritional status of their children has been good without checking it to the health experts, which results in poor nutritional status and delays in handling it. They also do not understand the children's behavior that has different psychological types (Wildani, 2017).

Another related study has also been carried out by Amalia in Lhokseumawe City. The nutritional status data were presented spatially and could be drawn on a map using Quantum Geographic Information System Software (Quantum GIS). This study aimed to make a distribution map under five cases of nutritional status in Lhokseumawe City in 2015. This was a descriptive study. The population was all children whose ages were under five having nutritional issues and was registered in the Lhokseumawe Health Office as many as 43 cases in 2012, and all of them were selected as the research samples. The results showed that of 43 toddlers with nutritional status problems in Lhokseumawe, 15 cases (34.88%) were found in Banda Sakti sub-district and they lived near the coast, there were 15 clinical symptoms, 2 cases without any clinical symptoms (4.65%) and those who lived on the hill and on the side of the road, 8 children (18.60%) lived in a radius of less than 1 km from their homes to the health center, 12 cases or children (27.91%) were in a radius of less than 1 km to the hospital, and 1 child (2.33%) died who lived less than 1 km to the hospital. By using

Quantum GIS software, it would be easy for the Lhokseumawe City Health Service and local health centers to make interventions for solving the malnutrition problems (Amalia, 2015).

Other research on nutritional status shows a condition where nutritional intake is much lower than the body's needs. Generally, this nutritional problem occurs because of the toddlers at that age experience a very sharp increase in energy and susceptibility towards the virus or bacterial infections. In this research, an expert system was made using the Forward Chaining method, which can diagnose the nutritional status through anthropometric measurement first to determine the toddlers' nutritional status then proceed to the stage of diagnosis based on identified symptoms to examine the nutritional status diseases in the toddlers precisely (Mulyani, 2015).

Another related research shows that some supplementary foods such as vitamins, fruits, and vegetables can be given to the children to support their nutrition. Greens vegetables are very suitable for food additives in toddlers, but the type and category of vegetables can vary according to the vitamin content. Knowledge development on the production rule model can represent the problems that prevent the symptoms. This research aims to classify the fresh vegetables. The decision support system for selecting the fresh vegetables is based on the color according to the expert system using the Production Rule model. The results are obtained from the system with the calculation model by the weighting model of each criterion (Fiati & Latubessy, 2013).

The production rule method can be applied in various research fields, such as the research on potential flood-prone areas. Based on the results of surveys and interviews, six parameters can be used to identify the potential flooding areas such as inundation area (km2, ha), depth or height of floodwater (meters), flow velocity (m/s, km/hour), materials washed away by the flood (rocks, stones, trees, and other solid objects), water concentration or thickness of mud (meters, centimeters), and duration of inundation (hours, days, or months). Therefore, this research uses six parameters which are then analyzed and used as a production rule model to identify the flood-prone areas using the production rule method, and as a material in constructing and designing systems for identifying the flood-prone areas based on the expert system (Fiati & Latubessy, 2015). Regional mapping can be done by identifying the flood-prone areas by combining the expert system knowledge and geographic information system/ GIS using the development of the production rule method (Fiati & Latubessy, 2016).

Based on the analysis of problems, the nutrient intake is much lower than the actual needs of the toddlers because there is a very sharp increase in energy and increased susceptibility towards viral or bacterial infections. In this research problem, an expert system is made using the Forward Chaining method, which can diagnose nutritional status through anthropometric measurements to determine the nutritional status of toddlers then proceed to the diagnosis stage based on the identified symptoms to show the nutritional status diseases in the toddlers. The purpose of this research is to build and create an expert system that can diagnose the nutritional status of children under the age of 1-5 years. This application can help many midwives in determining the nutritional status of the children under five based on their body weight per age and diagnose their nutrition status based on identified symptoms.

2. Method

2.1 Data Collective Method

Primary data were collected directly from relevant instances, both through observation and recording of research objects, including:

1. Interviews
   This method was done by asking questions directly to those who had knowledge in the field of children’s health. The parties to be interviewed were pediatricians who understood the nutritional status of the children.
2. Observation
   It was a method by observing and recording the results of children’s health checks.

2.2 Methods of the Development of Expert System

The stages in the development of expert system included:

1. Intelligence Stage
   The intelligence stage processed some criteria concerned with the expert system for determining the nutritional status of the children of 6 to 59 months covering their body height and weight.
2. Planning stage
   This stage analyzed the data needed to build a root system for determining the nutritional status of the children, then determined the modeling using the production rules method.
3. Implementation Stage
   At this stage, the computerized procedure was implemented to build a system for determining the nutritional status of the children.

2.3 Modeling the Determination of the Nutritional Status

The nutritional status could be identified in various ways, one of which was Z-Score towards median value. Z-Score was an anthropometric index that was used internationally to determine nutritional status and growth, which was expressed as a standard deviation unit (SD) of the population. Z-Score was used to calculate the anthropometric nutritional status of the bodyweight for age (BB / U), height for age (TB / U), and weight for height (BB / TB).

The ways to determine nutritional status by BMI and Z-Score as follows:

1. If the BB and TB values had been obtained, then look for the value of IMT (body mass index)/ U with the measurement taken from the BB / TB and the following formula:

$$\text{IMT U} = \frac{BB}{TB^2} \quad (1)$$

   For example:
   The weight of a toddler was 8.4 Kg and his height was 78 cm
   IMT U = $8.4 / 0.78^2$
   = 13.83 SD (Standard Deviation)

2. If the real value of the calculation of the body weight per age (BB / U), height per age (TB / U) or weight per height (BW / TB) was smaller than the median value:

$$ZScore = IMT - Median \quad (2)$$

3. Results and Discussion

3.1 Architecture Diagram

On the architecture diagram (Figure 1) it is shown that the expert system that can be applied to identify the children's nutritional status include:

1. Expert System Method
   The expert system method used in this system uses the PR (Production Rule) method.
2. Internal Data
   The internal data are taken from the local health center (Puskesmas) to support the expert system which includes income, age of parents, occupation, psychology, location, body height, body weight, and age.
3. External Data
   The external data are those taken from the Decree of the Ministry of Health of the Republic of Indonesia number 1995/MENKES/SK/XII/2010.

The following is an expert architecture diagram of the determination of malnutrition using the Production Rules method

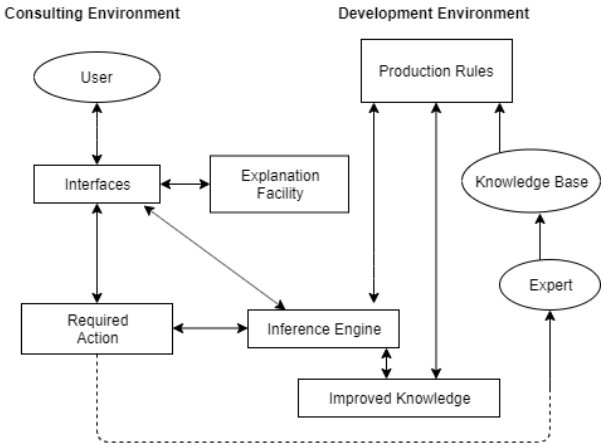

Figure 1. Expert system architecture diagram

3.2 Production Rules Inference Engine

The inference engine in this case study uses an expert system based on the inference strategy called Ponen mode if there is an "IF A THEN B" rule, and if it is known that A is true, it can be concluded that B is also true. The Ponen mode inference strategy is stated in the form of:

[A AND(AB)]B with A and AB are the propositions on a knowledge basis.

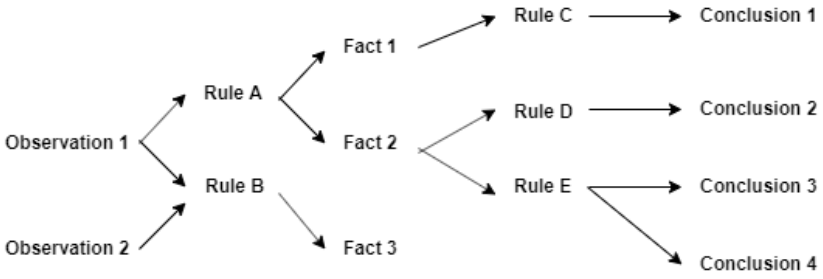

Figure 2. Tracking path of production rules nutritional diagnostic status

In Figure 2, it can be seen that the inference engine from the Production Rules is:
IF the threshold value <-3 SD, it is stated as very thin, else if the threshold> = -3 SD AND family psychology> 2 SD, it is said to be thin, else if -1 SD AND> -1 SD AND threshold value <= 2 SD AND> 2 then normal else fat.

3.3 Modeling of Calculation of Standards

An example of the calculation of IMTU (Body Mass Index) to determine a child's nutritional status:

Name : XXXX
Age : 32 months
Weight : 8.4 Kg
Height : 78 cm
IMT (Body Mass Index) = BB (Weight/ TB^2 (Height))
= 8.4 / 0.78^2
= 13.83 SD (Standard Deviation)
Z-Score = IMT – Median
= 13.8 – 15.5
= -1.7 (Normal)

Table 1. Standards of anthropometry of the Ministry of Health

Index	Nutritional Status	Value Threshold
BB/ TB	Very thin	< -3 SD
	Thin	-3 SD to <- 2 SD
	Normal	-2 SD to 2 SD
	Fat	> 2 SD

Table 2. IMT (Body Mass Index)/Age

Index	Nutritional Status	Value Threshold
BB/ TB	Very Thin	< -3 SD
	Thin	-3 SD to <- 2 SD
	Normal	-2 SD to 2 SD
	Fat	> 2 SD

3.4 Designing an Information System of Region Mapping

The decomposition development as an initial step before the composing process can be seen in Figure 3.

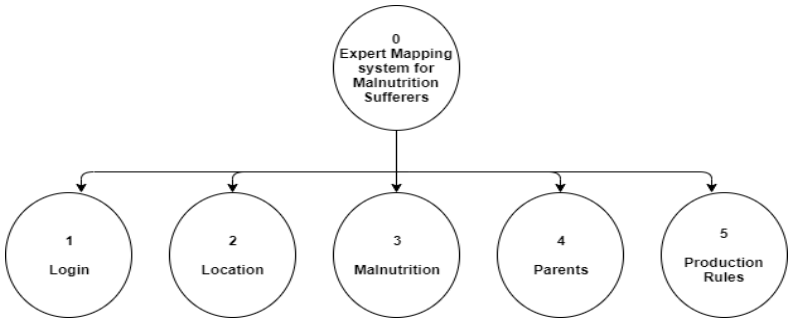

Figure 3. Composition diagram

After referring to the decomposition diagram process, the next step is to make DFD Level 0 in Figure 4 and design the system to be built. The following is a system design of DFD Level 0 shown in the diagram below.

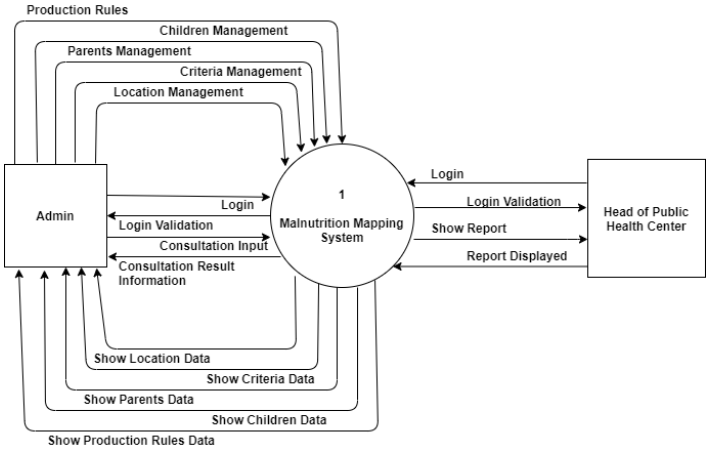

Figure 4. Data of flow diagram level O

The next is to make a flow diagram explaining the consultation activities to determine the status of malnutrition using the level 1 diagram shown in Figure 5.

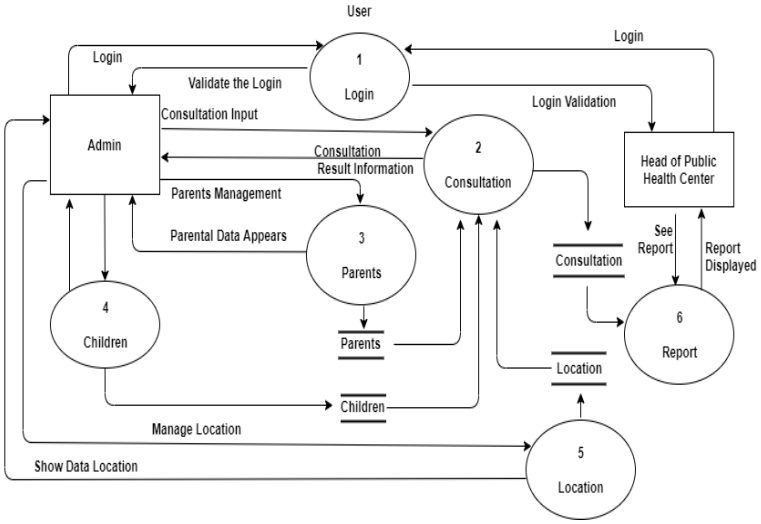

Figure 5. Data of flow diagram level 1

3.5 Implementation of Remote Areas Mapping System

The figures 6 and 7 below show the geographic information system that has been created by the researcher in mapping some locations or areas to identify the nutritional status of the children in the Rengging village, Pecangaan sub-district of Jepara Regency.

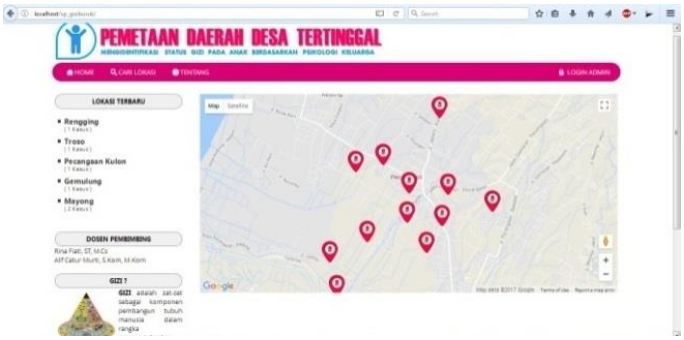

Figure 6. Geographic information system of remote areas mapping

Figure 7. Geographic information system to manage the village data

Figure 8 presents a page on the application that displays the criteria data in the local health center (Puskesmas).

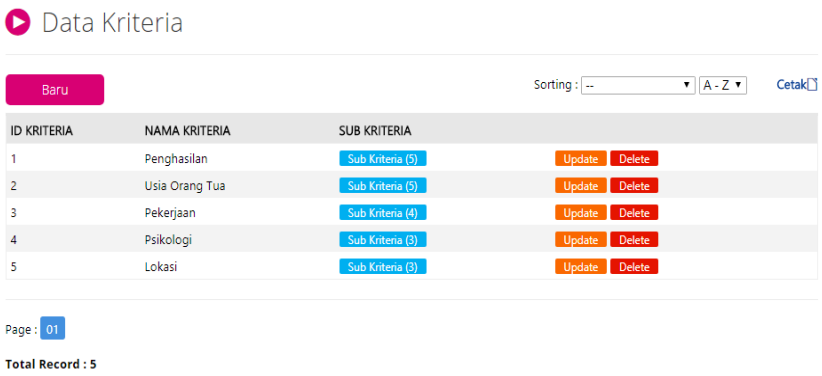

Figure 8. Criteria Display

The following Figure 9 shows the system for consultation. This page is specifically used to provide information on the areas where there are children suffering from malnutrition problems.

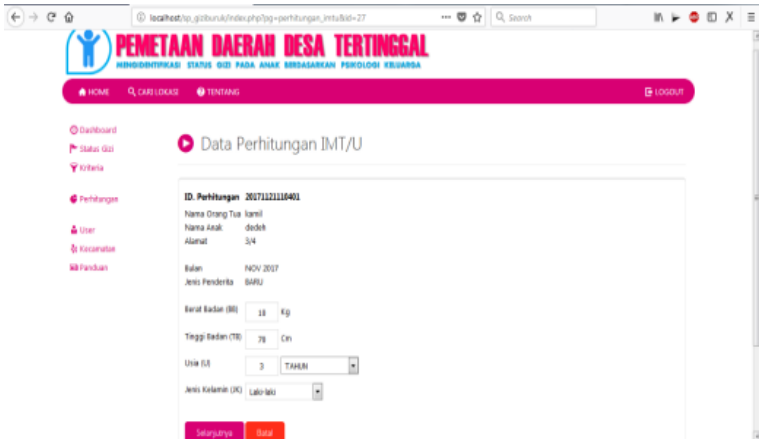

Figure 9. Geographic information system to manage the information on the determination of children's nutritional status

4. Conclusion

The malnutrition can be influenced by the children's family who has less knowledge of their health and does not yet understand the nutritional needs. The results of the data processing using the production rule method show that if the bodyweight divided by the height has the same value with the standard deviation, it is said that the child has normal nutritional status. From the geographical mapping information, it can be concluded that there are more malnourished children in remote and underdeveloped villages.

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