Analysis of Decision Support System in Determining the Nutritional Status of Toddlers Using Simple Additive Weighting

Ofan Sofian\textsuperscript{1}, Joseph\textsuperscript{2*, and Fauziyah\textsuperscript{3}}

\textsuperscript{1−3}Faculty of Computer Science, Universitas Bung Karno
Jakarta, 10310, Indonesia
Email: \textsuperscript{1}ofansofian@ubk.ac.id, \textsuperscript{2}joseph@ubk.ac.id, \textsuperscript{3}fauziyah@ubk.ac.id

Abstract—The problem that currently happens in the decision process of the nutritional status for toddlers is often based on manual calculation. However, the manual calculation is prone to data duplication, insufficient data, and a lack of availability of the data itself, which can hinder the monitoring status and the report. Therefore, to ease the determination and calculation process of the nutritional status of toddlers, the researchers conduct a study using the Simple Additive Weighting (SAW) method. The SAW method is selected because it defines the best alternative and some other alternatives based on specified or preferred criteria. This research is conducted by finding the weight value of each attribute and rating the data to determine the nutritional status of toddlers. For the result, the researchers find there are no toddlers with malnutrition in Pemberdayaan Kesejahteraan Keluarga, Program Kerja Kelompok Kerja IV (PKK POKJA IV) of Depok.

Index Terms—Decision Support System, Simple Additive Weighting (SAW), Nutritional Status, Multiple-Attribute Decision Making

I. INTRODUCTION

The nutritional status of toddlers needs to be monitored and checked periodically to prevent toddlers from malnourishment. It is because toddler is an important period in the child’s growth and development process. The range in the age is a period of growth with quantitative symptoms in the form of changes in size and number of cells [1].

There are several indications of malnourished toddlers. First, it is marasmus. It is characterized by their bodies which are very thin, with the elderly, concave stomach, and wrinkled skin. They can also be whiny. Second, it is kwashiorkor. The characteristics are toddlers with swelling bodies in all parts, especially on their feet, round and swollen face, reddish skin, shrinking muscles. They can also be fussy. Third, marasmus-kwashiorkor is when toddlers have both characteristics of marasmus and kwashiorkor.

Based on a report conducted by the Ministry of Health of the Republic of Indonesia in 2017, the observation was done based on weight versus age. It recorded that 38% of Indonesian toddlers were malnourished, and 14% were with nutritional deficiency. Meanwhile, observation done based on height versus age of toddlers showed that 9.8% of the toddlers had height below normal. Then, around 19.8% had very low height [2].

Several criteria that determine the nutritional status of toddlers are age, height, and weight. This research is conducted by calculating the three measures by using the Simple Additive Weighting (SAW) method.

SAW method is one of the Decision Support System (DSS) methods. DSS is a computer-based system that can help to make decisions and decision models for a problem [3]. It is a part of the Multi-Attribute Decision Making (MADM) method. MADM method is the most often used to determine optimal alternatives based on predetermined criteria [4]. The research processes data of toddlers with SAW method, which rates based on the value of each alternative criterion through the decision matrix normalization process.

The purpose of this research is to determine the nutritional status of toddlers using SAW method. The criteria used in determining nutritional status are weight, height, and age.

II. RESEARCH METHOD

SAW method is chosen as it can determine the best alternative based on predetermined criteria [5]. The steps in determining the nutritional status of toddlers using SAW method are as follows. First, the researchers identify the problem. The background of
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The research is the determination of nutritional status of toddlers. Meanwhile, the scope is limited to the area in Depok, Indonesia. However, there is no reference calculation in determining the health of toddlers in Pemberdayaan Kesejahteraan Keluarga, Program Kerja Kelompok Kerja IV (PKK POKJA IV) of Depok.

There are two types of studies used in the research. First, it is a literature study. The researchers search the theoretical approach to SAW. Second, it is a field study that observes the real conditions in the research area (Depok) to carry out the research.

Moreover, the researchers collect data that can determine the nutritional status of toddlers. Those are age, height, and weight of the toddlers. For secondary data, the researchers obtain it from literature, documents, books, journals, and other information related to the determination of the nutritional value of toddlers. Then, for primary data, it is obtained directly in the cooperation with PKK POKJA IV of Depok. Then, the researchers process the collected data using SAW method.

### A. Simple Additive Weighting

SAW is a method that determines the weighting sum of performance ratings among alternatives from all attributes. This method requires a normalization process in the decision matrix $x = [x_{ij}]$ [6] as follows:

$$r_{ij} = \frac{x_{ij}}{\max x_{ij}} \quad \text{if} \ j \text{ is benefit attribute}$$

$$r_{ij} = \frac{\min x_{ij}}{x_{ij}} \quad \text{if} \ j \text{ is cost attribute},$$

where, $r_{ij}$ is normalized performance rating value; $x_{ij}$ is attribute value owned by each criterion; $\max x_{ij}$ is the largest value of each criterion; $\min x_{ij}$ is the smallest value of each criterion. It will be benefit if the greatest value is the best. Meanwhile, it will be cost if the smallest value is the best.

The $r_{ij}$ is normalized performance rating of alternative $A_i (i = 1, 2, \ldots, m)$ on criteria $C_j (j = 1, 2, \ldots, n)$. For the large value of $V_i$, it indicates that $A_i$ is preferred alternatives. For the preference of every alternative ($V_i$), the function uses Eqs. (1) and (2). It can be seen as follows:

$$V_i = \sum_{j=1}^{n} w_j r_{ij},$$

The $V_i$ is the ranking for each alternative and $w_j$ is the weight value of each criterion.

### III. Results and Discussion

The implementation of SAW method determines the toddler’s nutritional status such as malnutrition, nutritional deficiencies, medium nutrition, good nutrition. It can be calculated in the rating process. The following are the steps in determining the nutritional status of toddlers using SAW method.

#### A. Setting the Alternatives

The research is conducted at PKK POKJA IV of Depok. The data are from 60 toddlers under five years old in 2019. Then, they are set as alternatives. The data are in Table I.

#### B. Setting the Criteria

The research utilizes three criteria affecting the nutritional status of toddlers. Those are weight (C1), height (C2), and age (C3). The preference of weight determination follows the policy of management discretion of PKK POKJA IV of Depok. The detail of manual calculation is in Table II. Meanwhile, Table III shows the values of each criterion based on each alternative.

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### Table I

| No. | Criteria Name | Criteria Type | Criteria Weights |
|-----|---------------|---------------|------------------|
| 1   | Weight (C1)   | Benefit       | 0.4              |
| 2   | Height (C2)   | Benefit       | 0.3              |
| 3   | Age (C3)      | Benefit       | 0.3              |

---

### Table II

| No. | Criteria Name | Criteria Type |
|-----|---------------|---------------|
| 1   | Weight (C1)   | Benefit       |
| 2   | Height (C2)   | Benefit       |
| 3   | Age (C3)      | Benefit       |

---

### Table III

| Alternative ID | Toddler ID |
|----------------|------------|
| A1             | Toddler 1  |
| A2             | Toddler 2  |
| A3             | Toddler 3  |
| A4             | Toddler 4  |
| A5             | Toddler 5  |
| A6             | Toddler 6  |
| A7             | Toddler 7  |
| A8             | Toddler 8  |
| A9             | Toddler 9  |
| A10            | Toddler 10 |
| A11            | Toddler 11 |
| A12            | Toddler 12 |
| A13            | Toddler 13 |
| A14            | Toddler 14 |
| A15            | Toddler 15 |
| A16            | Toddler 16 |
| A17            | Toddler 17 |
| A18            | Toddler 18 |
| A19            | Toddler 19 |
| A20            | Toddler 20 |
| A21            | Toddler 21 |
| A22            | Toddler 22 |
| A23            | Toddler 23 |
| A24            | Toddler 24 |
| A25            | Toddler 25 |
| A26            | Toddler 26 |
| A27            | Toddler 27 |
| A28            | Toddler 28 |
| A29            | Toddler 29 |
| A30            | Toddler 30 |
| A31            | Toddler 31 |
| A32            | Toddler 32 |
| A33            | Toddler 33 |
| A34            | Toddler 34 |
| A35            | Toddler 35 |
| A36            | Toddler 36 |
| A37            | Toddler 37 |
| A38            | Toddler 38 |
| A39            | Toddler 39 |
| A40            | Toddler 40 |
| A41            | Toddler 41 |
| A42            | Toddler 42 |
| A43            | Toddler 43 |
| A44            | Toddler 44 |
| A45            | Toddler 45 |
| A46            | Toddler 46 |
| A47            | Toddler 47 |
| A48            | Toddler 48 |
| A49            | Toddler 49 |
| A50            | Toddler 50 |
| A51            | Toddler 51 |
| A52            | Toddler 52 |
| A53            | Toddler 53 |
| A54            | Toddler 54 |
| A55            | Toddler 55 |
| A56            | Toddler 56 |
| A57            | Toddler 57 |
| A58            | Toddler 58 |
| A59            | Toddler 59 |
| A60            | Toddler 60 |
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### TABLE III
\[ \text{The Data of the Toddlers.} \]

| Alternative | Weight (kg) | Height (cm) | Age (month) |
|-------------|-------------|-------------|-------------|
| B1          | 7           | 62          | 7           |
| B2          | 5.8         | 65          | 8           |
| B3          | 6.5         | 64          | 8           |
| B4          | 11.5        | 72          | 8           |
| B5          | 9.5         | 74          | 9.5         |
| B6          | 6.9         | 63          | 10          |
| B7          | 8.3         | 71          | 12          |
| B8          | 6.9         | 63          | 12          |
| B9          | 7.6         | 73          | 12          |
| B10         | 10.1        | 68          | 16          |

### TABLE IV
\[ \text{The Criteria of Nutritional Status of Toddlers.} \]

| No. | Category            | Interval (%) | Value Rating |
|-----|---------------------|--------------|--------------|
| 1   | More Nutrition      | > 81         | 5            |
| 2   | Good Nutrition      | 61–80        | 4            |
| 3   | Medium Nutrition    | 41–60        | 3            |
| 4   | Nutritional Deficiencies | 21–40  | 2            |
| 5   | Malnutrition        | 0–20         | 1            |

### C. Setting the Weight

The researchers determine the weights and ratings for each criterion. Every criterion has a cut-off point and value rating. Table IV shows the nutritional status.

### D. Calculating the Normalization Value

Normalization is done to produce the \( r \) value using the Eqs. (1) and (2). The examples of implementation using Eqs. (1) and (2) are as follows:

\[
\begin{align*}
    r_{3,1} &= \frac{6.5}{14.8} = 0.439, \\
    r_{2,2} &= \frac{6.5}{98} = 0.063, \\
    r_{9,1} &= \frac{7.6}{14.8} = 0.514, \\
    r_{5,3} &= \frac{9.5}{39} = 0.244.
\end{align*}
\]

Then, the results of normalization are made in the form of a normalization matrix as follows:

\[
\begin{pmatrix}
    0.473 & 0.633 & 0.179 \\
    0.392 & 0.663 & 0.205 \\
    0.439 & 0.653 & 0.205 \\
    0.777 & 0.735 & 0.205 \\
    0.642 & 0.755 & 0.244 \\
    0.466 & 0.643 & 0.256 \\
    0.561 & 0.724 & 0.308 \\
    0.466 & 0.643 & 0.308 \\
    0.514 & 0.745 & 0.308 \\
    0.682 & 0.694 & 0.410 \\
    0.601 & 0.796 & 0.462 \\
    0.676 & 0.796 & 0.462 \\
    0.676 & 0.806 & 0.513 \\
    0.595 & 0.839 & 0.590 \\
    0.743 & 0.806 & 0.590 \\
    0.615 & 0.816 & 0.615 \\
    0.743 & 0.939 & 0.615 \\
    0.743 & 0.857 & 0.615 \\
    0.777 & 0.867 & 0.641 \\
    0.676 & 0.888 & 0.667 \\
    0.635 & 0.816 & 0.692 \\
    0.662 & 0.724 & 0.744 \\
    0.764 & 0.918 & 0.769 \\
    0.682 & 0.847 & 0.769 \\
    0.723 & 0.888 & 0.821 \\
    0.743 & 0.939 & 0.846 \\
    0.899 & 0.969 & 0.872 \\
    0.845 & 0.918 & 0.897 \\
    0.946 & 0.918 & 1.000 \\
    0.703 & 0.939 & 1.000 \\
\end{pmatrix}
\]

### E. Determining the Preference Value of Each Alternative (\( V_i \))

Each \( V_i \) is calculated using Eq. (3). It is based on the value of each criterion such as \( w = [0.4, 0.3, 0.3] \).

The implementation of Eq. (3) is in the Appendices.

From the preference value, the result of the nutritional status of toddlers for each alternative is found. The toddlers with malnutrition are 0. Then, toddlers with nutritional deficiencies are 3. There are 19 toddlers with medium nutrition. Around 28 toddlers have good nutrition. Last, 10 toddlers have more nutrition. The results can be seen in Table V. It is expected that the PKK POKJA IV of Depok consistently conducts counseling for parents. Thus, the parents can pay more attention to the nutrition of toddlers by providing food with appropriate nutrition intake.

### IV. Conclusion

The nutritional status of toddlers can be determined with the SAW method by incorporating the criteria.
TABLE V
THE RESULTS OF NUTRITIONAL STATUS OF TODDLERS.

| No. | Value | Rating | Total |
|-----|-------|--------|-------|
| 1   | 4     | 2      | 6     |
| 2   | 3     | 3      | 15    |
| 3   | 4     | 19     | 41    |
| 4   | 5     | 30     | 28    |
| 5   | 2     | 21     | 59    |

The criteria that affect the nutritional status of toddlers are weight, height, and age of the toddlers.

For further research, the researcher can make a decision support system to determine the nutritional status of toddlers. It can help PKK POKJA IV of Depok in data storage and data processing. Moreover, from the data, it can produce information for the nutritional status of toddlers.

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APPENDICES

The appendices can be seen in the next page. It is the implementation of Eq. (3).
\( V_1 = (0.473 \times 0.4) + (0.633 \times 0.3) + (0.179 \times 0.3) = 0.433 \)
\( V_2 = (0.391 \times 0.4) + (0.663 \times 0.3) + (0.205 \times 0.3) = 0.417 \)
\( V_3 = (0.439 \times 0.4) + (0.653 \times 0.3) + (0.205 \times 0.3) = 0.433 \)
\( V_4 = (0.777 \times 0.4) + (0.735 \times 0.3) + (0.205 \times 0.3) = 0.593 \)
\( V_5 = (0.642 \times 0.4) + (0.755 \times 0.3) + (0.244 \times 0.3) = 0.556 \)
\( V_6 = (0.466 \times 0.4) + (0.643 \times 0.3) + (0.256 \times 0.3) = 0.456 \)
\( V_7 = (0.561 \times 0.4) + (0.724 \times 0.3) + (0.308 \times 0.3) = 0.534 \)
\( V_8 = (0.466 \times 0.4) + (0.643 \times 0.3) + (0.308 \times 0.3) = 0.472 \)
\( V_9 = (0.514 \times 0.4) + (0.745 \times 0.3) + (0.308 \times 0.3) = 0.521 \)
\( V_{10} = (0.682 \times 0.4) + (0.694 \times 0.3) + (0.410 \times 0.3) = 0.604 \)
\( V_{11} = (0.601 \times 0.4) + (0.796 \times 0.3) + (0.462 \times 0.3) = 0.618 \)
\( V_{12} = (0.676 \times 0.4) + (0.796 \times 0.3) + (0.462 \times 0.3) = 0.648 \)
\( V_{13} = (0.676 \times 0.4) + (0.806 \times 0.3) + (0.513 \times 0.3) = 0.666 \)
\( V_{14} = (0.595 \times 0.4) + (0.839 \times 0.3) + (0.590 \times 0.3) = 0.666 \)
\( V_{15} = (0.743 \times 0.4) + (0.806 \times 0.3) + (0.590 \times 0.3) = 0.716 \)
\( V_{16} = (0.615 \times 0.4) + (0.816 \times 0.3) + (0.615 \times 0.3) = 0.675 \)
\( V_{17} = (0.743 \times 0.4) + (0.939 \times 0.3) + (0.615 \times 0.3) = 0.764 \)
\( V_{18} = (0.743 \times 0.4) + (0.857 \times 0.3) + (0.615 \times 0.3) = 0.739 \)
\( V_{19} = (0.777 \times 0.4) + (0.867 \times 0.3) + (0.641 \times 0.3) = 0.763 \)
\( V_{20} = (0.676 \times 0.4) + (0.888 \times 0.3) + (0.667 \times 0.3) = 0.737 \)
\( V_{21} = (0.635 \times 0.4) + (0.816 \times 0.3) + (0.692 \times 0.3) = 0.707 \)
\( V_{22} = (0.662 \times 0.4) + (0.724 \times 0.3) + (0.744 \times 0.3) = 0.705 \)
\( V_{23} = (0.764 \times 0.4) + (0.918 \times 0.3) + (0.769 \times 0.3) = 0.812 \)
\( V_{24} = (0.682 \times 0.4) + (0.847 \times 0.3) + (0.769 \times 0.3) = 0.758 \)
\( V_{25} = (0.723 \times 0.4) + (0.888 \times 0.3) + (0.821 \times 0.3) = 0.802 \)
\( V_{26} = (0.743 \times 0.4) + (0.939 \times 0.3) + (0.846 \times 0.3) = 0.833 \)
\( V_{27} = (0.899 \times 0.4) + (0.969 \times 0.3) + (0.872 \times 0.3) = 0.912 \)
\( V_{28} = (0.845 \times 0.4) + (0.918 \times 0.3) + (0.897 \times 0.3) = 0.883 \)
\( V_{29} = (0.946 \times 0.4) + (0.918 \times 0.3) + (1.000 \times 0.3) = 0.954 \)
\( V_{30} = (0.703 \times 0.4) + (0.939 \times 0.3) + (1.000 \times 0.3) = 0.863 \)
\( V_{31} = (0.318 \times 0.4) + (0.520 \times 0.3) + (0.051 \times 0.3) = 0.299 \)
\( V_{32} = (0.453 \times 0.4) + (0.464 \times 0.3) + (0.154 \times 0.3) = 0.367 \)
\( V_{33} = (0.338 \times 0.4) + (0.643 \times 0.3) + (0.154 \times 0.3) = 0.374 \)
\( V_{34} = (0.439 \times 0.4) + (0.622 \times 0.3) + (0.205 \times 0.3) = 0.424 \)
\( V_{35} = (0.493 \times 0.4) + (0.722 \times 0.3) + (0.256 \times 0.3) = 0.491 \)
\( V_{36} = (0.655 \times 0.4) + (0.745 \times 0.3) + (0.282 \times 0.3) = 0.570 \)
\( V_{37} = (0.642 \times 0.4) + (0.765 \times 0.3) + (0.308 \times 0.3) = 0.579 \)
\( V_{38} = (0.547 \times 0.4) + (0.663 \times 0.3) + (0.308 \times 0.3) = 0.510 \)
\( V_{39} = (0.541 \times 0.4) + (0.704 \times 0.3) + (0.333 \times 0.3) = 0.527 \)
\( V_{40} = (0.655 \times 0.4) + (0.745 \times 0.3) + (0.385 \times 0.3) = 0.601 \)
\begin{align*}
V_{41} &= (0.946 \times 0.4) + (1.000 \times 0.3) + (0.385 \times 0.3) = 0.794 \\
V_{42} &= (0.622 \times 0.4) + (0.724 \times 0.3) + (0.410 \times 0.3) = 0.589 \\
V_{43} &= (0.703 \times 0.4) + (0.847 \times 0.3) + (0.462 \times 0.3) = 0.674 \\
V_{44} &= (0.541 \times 0.4) + (0.878 \times 0.3) + (0.462 \times 0.3) = 0.618 \\
V_{45} &= (0.642 \times 0.4) + (0.663 \times 0.3) + (0.462 \times 0.3) = 0.594 \\
V_{46} &= (0.703 \times 0.4) + (0.842 \times 0.3) + (0.513 \times 0.3) = 0.687 \\
V_{47} &= (0.676 \times 0.4) + (0.827 \times 0.3) + (0.513 \times 0.3) = 0.672 \\
V_{48} &= (0.811 \times 0.4) + (0.867 \times 0.3) + (0.513 \times 0.3) = 0.738 \\
V_{49} &= (0.878 \times 0.4) + (0.888 \times 0.3) + (0.538 \times 0.3) = 0.779 \\
V_{50} &= (0.777 \times 0.4) + (0.878 \times 0.3) + (0.615 \times 0.3) = 0.759 \\
V_{51} &= (0.622 \times 0.4) + (0.684 \times 0.3) + (0.615 \times 0.3) = 0.638 \\
V_{52} &= (0.811 \times 0.4) + (0.867 \times 0.3) + (0.641 \times 0.3) = 0.777 \\
V_{53} &= (0.946 \times 0.4) + (0.867 \times 0.3) + (0.667 \times 0.3) = 0.839 \\
V_{54} &= (0.676 \times 0.4) + (0.847 \times 0.3) + (0.744 \times 0.3) = 0.747 \\
V_{55} &= (0.676 \times 0.4) + (0.837 \times 0.3) + (0.744 \times 0.3) = 0.744 \\
V_{56} &= (0.757 \times 0.4) + (0.903 \times 0.3) + (0.769 \times 0.3) = 0.804 \\
V_{57} &= (1.000 \times 0.4) + (0.888 \times 0.3) + (0.769 \times 0.3) = 0.897 \\
V_{58} &= (0.743 \times 0.4) + (0.847 \times 0.3) + (0.769 \times 0.3) = 0.782 \\
V_{59} &= (0.986 \times 0.4) + (0.724 \times 0.3) + (0.795 \times 0.3) = 0.850 \\
V_{60} &= (0.878 \times 0.4) + (0.918 \times 0.3) + (0.795 \times 0.3) = 0.865 \\
\end{align*}