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

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***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.

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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 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

TABLE I
THE CODE OF THE TODDLERS.

Alternative	ID	Alternative	ID
B1	Toddler_1	B31	Toddler_31
B2	Toddler_2	B32	Toddler_32
B3	Toddler_3	B33	Toddler_33
B4	Toddler_4	B34	Toddler_34
B5	Toddler_5	B35	Toddler_35
B6	Toddler_6	B36	Toddler_36
B7	Toddler_7	B37	Toddler_37
B8	Toddler_8	B38	Toddler_38
B9	Toddler_9	B39	Toddler_39
B10	Toddler_10	B40	Toddler_40
B11	Toddler_11	B41	Toddler_41
B12	Toddler_12	B42	Toddler_42
B13	Toddler_13	B43	Toddler_43
B14	Toddler_14	B44	Toddler_44
B15	Toddler_15	B45	Toddler_45
B16	Toddler_16	B46	Toddler_46
B17	Toddler_17	B47	Toddler_47
B18	Toddler_18	B48	Toddler_48
B19	Toddler_19	B49	Toddler_49
B20	Toddler_20	B50	Toddler_50
B21	Toddler_21	B51	Toddler_51
B22	Toddler_22	B52	Toddler_52
B23	Toddler_23	B53	Toddler_53
B24	Toddler_24	B54	Toddler_54
B25	Toddler_25	B55	Toddler_55
B26	Toddler_26	B56	Toddler_56
B27	Toddler_27	B57	Toddler_57
B28	Toddler_28	B58	Toddler_58
B29	Toddler_29	B59	Toddler_59
B30	Toddler_30	B60	Toddler_60

TABLE II
THE CRITERIA OF NUTRITIONAL STATUS OF TODDLERS.

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

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:

$$r_{ij} = \frac{x_{ij}}{\max\ x_{ij}} \text{ if } j \text{ is benefit attribute} \quad (1)$$

$$r_{ij} = \frac{\min\ x_{ij}}{x_{ij}} \text{ if } j \text{ is cost attribute,} \quad (2)$$

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 $A_i(i = 1, 2, \cdots, m)$ on criteria $C_j(j = 1, 2, \cdots, n)$. 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:

$$V_i = \sum_{j=1}^{n} w_j r_{ij}. \quad (3)$$

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, more 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 III
THE DATA OF THE TODDLERS.

Alternative	Criteria		
	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
.	.	.	.
.	.	.	.
.	.	.	.
B56	11.2	88.5	30
B57	14.8	87	30
B58	11	83	30
B59	14.6	71	31
B60	13	90	31

TABLE IV
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:

$$r_{3,1} = \frac{6.5}{14.8} = 0.439,$$
$$r_{2,2} = \frac{6.5}{98} = 0.663,$$
$$r_{9,1} = \frac{7.6}{14.8} = 0.514,$$
$$r_{5,3} = \frac{9.5}{39} = 0.244.$$

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

$$r = \begin{pmatrix} 0.473 & 0.633 & 0.179 \\ 0.392 & 0.663 & 0.205 \\ 0.439 & 0.653 & 0.205 \\ 0.777 & 0.735 & 0.205 \\ 0.642 & 0.755 & 0.244 \\ 0.466 & 0.643 & 0.256 \\ 0.561 & 0.724 & 0.308 \\ 0.466 & 0.643 & 0.308 \\ 0.514 & 0.745 & 0.308 \\ 0.682 & 0.694 & 0.410 \\ 0.601 & 0.796 & 0.462 \\ 0.676 & 0.796 & 0.462 \\ 0.676 & 0.806 & 0.513 \\ 0.595 & 0.839 & 0.590 \\ 0.743 & 0.806 & 0.590 \\ 0.615 & 0.816 & 0.615 \\ 0.743 & 0.939 & 0.615 \\ 0.743 & 0.857 & 0.615 \\ 0.777 & 0.867 & 0.641 \\ 0.676 & 0.888 & 0.667 \\ 0.635 & 0.816 & 0.692 \\ 0.662 & 0.724 & 0.744 \\ 0.764 & 0.918 & 0.769 \\ 0.682 & 0.847 & 0.769 \\ 0.723 & 0.888 & 0.821 \\ 0.743 & 0.939 & 0.846 \\ 0.899 & 0.969 & 0.872 \\ 0.845 & 0.918 & 0.897 \\ 0.946 & 0.918 & 1.000 \\ 0.703 & 0.939 & 1.000 \end{pmatrix} \begin{pmatrix} 0.318 & 0.520 & 0.051 \\ 0.453 & 0.464 & 0.154 \\ 0.338 & 0.643 & 0.154 \\ 0.439 & 0.622 & 0.205 \\ 0.493 & 0.722 & 0.256 \\ 0.655 & 0.745 & 0.282 \\ 0.642 & 0.765 & 0.308 \\ 0.547 & 0.663 & 0.308 \\ 0.541 & 0.704 & 0.333 \\ 0.655 & 0.745 & 0.385 \\ 0.946 & 1.000 & 0.385 \\ 0.622 & 0.724 & 0.410 \\ 0.703 & 0.847 & 0.462 \\ 0.541 & 0.878 & 0.462 \\ 0.642 & 0.663 & 0.462 \\ 0.703 & 0.842 & 0.513 \\ 0.676 & 0.827 & 0.513 \\ 0.811 & 0.867 & 0.513 \\ 0.878 & 0.888 & 0.538 \\ 0.777 & 0.878 & 0.615 \\ 0.622 & 0.684 & 0.615 \\ 0.811 & 0.867 & 0.641 \\ 0.946 & 0.867 & 0.667 \\ 0.676 & 0.847 & 0.744 \\ 0.676 & 0.837 & 0.744 \\ 0.757 & 0.903 & 0.769 \\ 1,000 & 0.888 & 0.769 \\ 0.743 & 0.847 & 0.769 \\ 0.986 & 0.724 & 0.795 \\ 0.878 & 0.918 & 0.795 \end{pmatrix}$$

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.

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TABLE V
THE RESULTS OF NUTRITIONAL STATUS OF TODDLERS.

No.	Value Rating	Total
1	1	0
2	2	3
3	3	19
4	4	28
5	5	10

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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REFERENCES

[1] M. Rosmiati and N. Hidayatun, “Implementasi metode Simple Additive Weighting dalam menentukan status gizi balita berbasis web,” *Paradigma-Jurnal Komputer dan Informatika*, vol. 20, no. 2, pp. 113–122, 2018.

[2] Kementerian Kesehatan Republik Indonesia. (2017) Buku saku pemantauan status gizi tahun 2017. [Online]. Available: http://www.kesmas.kemkes.go.id/assets/upload/dir_519d41d8cd98f00/files/Buku-Saku-Nasional-PSG-2017_975.pdf

[3] E. Turban, J. E. Aronson, and T. P. Liang, *Decision Support Systems and intelligent systems (7th Edition)*. United States: Prentice Hall, 2004.

[4] A. Setyawan, F. Y. Arini, and I. Akhlis, “Comparative analysis of Simple Additive Weighting method and weighted product method to new employee recruitment Decision Support System (DSS) at PT. Warta Media Nusantara,” *Scientific Journal of Informatics*, vol. 4, no. 1, pp. 34–42, 2017.

[5] N. Setiawan, M. Nasution, Y. Rossanty, A. R. S. Tambunan, M. Girsang, R. Agus, M. Yusuf, R. Vebrianto, O. N. Purba, A. Fauzi, S. Perdana, and K. Nisa, “Simple Additive Weighting as Decision Support System for determining employees salary,” *International Journal of Engineering & Technology*, vol. 7, no. 2.14, pp. 309–313, 2018.

[6] F. Haswan, “Decision Support System for election of members unit patients Pamong Praja,” *International Journal of Artificial Intelligence Research*, vol. 1, no. 1, pp. 21–25, 2017.

APPENDICES

The appendices can be seen in the next page. It is the implementation of Eq. (3).

$$
\begin{aligned}
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
\end{aligned}
$$

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$$V_{41} = (0.946 \times 0.4) + (1.000 \times 0.3) + (0.385 \times 0.3) = 0.794$$
$$V_{42} = (0.622 \times 0.4) + (0.724 \times 0.3) + (0.410 \times 0.3) = 0.589$$
$$V_{43} = (0.703 \times 0.4) + (0.847 \times 0.3) + (0.462 \times 0.3) = 0.674$$
$$V_{44} = (0.541 \times 0.4) + (0.878 \times 0.3) + (0.462 \times 0.3) = 0.618$$
$$V_{45} = (0.642 \times 0.4) + (0.663 \times 0.3) + (0.462 \times 0.3) = 0.594$$
$$V_{46} = (0.703 \times 0.4) + (0.842 \times 0.3) + (0.513 \times 0.3) = 0.687$$
$$V_{47} = (0.676 \times 0.4) + (0.827 \times 0.3) + (0.513 \times 0.3) = 0.672$$
$$V_{48} = (0.811 \times 0.4) + (0.867 \times 0.3) + (0.513 \times 0.3) = 0.738$$
$$V_{49} = (0.878 \times 0.4) + (0.888 \times 0.3) + (0.538 \times 0.3) = 0.779$$
$$V_{50} = (0.777 \times 0.4) + (0.878 \times 0.3) + (0.615 \times 0.3) = 0.759$$
$$V_{51} = (0.622 \times 0.4) + (0.684 \times 0.3) + (0.615 \times 0.3) = 0.638$$
$$V_{52} = (0.811 \times 0.4) + (0.867 \times 0.3) + (0.641 \times 0.3) = 0.777$$
$$V_{53} = (0.946 \times 0.4) + (0.867 \times 0.3) + (0.667 \times 0.3) = 0.839$$
$$V_{54} = (0.676 \times 0.4) + (0.847 \times 0.3) + (0.744 \times 0.3) = 0.747$$
$$V_{55} = (0.676 \times 0.4) + (0.837 \times 0.3) + (0.744 \times 0.3) = 0.744$$
$$V_{56} = (0.757 \times 0.4) + (0.903 \times 0.3) + (0.769 \times 0.3) = 0.804$$
$$V_{57} = (1.000 \times 0.4) + (0.888 \times 0.3) + (0.769 \times 0.3) = 0.897$$
$$V_{58} = (0.743 \times 0.4) + (0.847 \times 0.3) + (0.769 \times 0.3) = 0.782$$
$$V_{59} = (0.986 \times 0.4) + (0.724 \times 0.3) + (0.795 \times 0.3) = 0.850$$
$$V_{60} = (0.878 \times 0.4) + (0.918 \times 0.3) + (0.795 \times 0.3) = 0.865$$