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Implementation of the Simple Additive Weighting Method in Determining Program Beneficiaries in Stunting Focus Villages

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ABSTRACT

Stunting a serious nutritional problem often exacerbated by poor environmental sanitation, makes the Community-Based Sanitation (Sanimas) program vital for expanding sanitation access. Given that the manual selection process for Sanimas beneficiaries is time-consuming and inefficient , this study aims to develop a Decision Support System (DSS) to determine recipient priorities objectively and measurably. The research implements the Simple Additive Weighting (SAW) method, an effective Multi-Criteria Decision Analysis (MCDA) technique for multi-criteria decision problems. The SAW method operates by normalizing the decision matrix and calculating the weighted sum of performance ratings to obtain the final preference value . The criteria used are Low-Income Community (C1), Stunting Risk Family (C2), Sanitation Access (C3), Availability of Water Source (C4), Own House (C5), Priority Condition (C6), and Number of Family Members in the Household (C7) 7, with a total weight of 100. The implementation results on sample data in Molintogupo Village, Bone Bolango, show that alternative “SD” obtained the highest Preference Value of 97 (Rank 1). In conclusion, the SAW method is proven effective in systematically generating a ranking of beneficiaries 10; however, the presence of identical preference values among several candidates indicates that the final decision still requires contextual consideration and policy from village-level stakeholders.

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I. INTRODUCTION

Stunting reflects a chronic nutritional deficiency during the stages of growth and development since early life [1]. Stunting is a condition characterized by impaired growth and development in infants and children under five years of age, resulting from chronic malnutrition. This condition manifests as a deficit in height or length relative to the child's age. While nutritional deficiencies may initiate during the prenatal stage and early infancy, the clinical manifestation of stunting typically becomes evident after the child reaches two years of age [2]. Stunting can originate during the preconception period, occurring in instances such as adolescent pregnancies characterized by malnutrition and anemia. Other contributing factors include pregnant women suffering from chronic

energy deficiency (CED) and anemia, inadequate nutritional intake that fails to meet gestational requirements, and exposure to poor environmental sanitation during pregnancy [3]. According to data from the World Health Organization (WHO), the prevalence of stunting in children under five is classified as a significant public health concern when the percentage reaches or exceeds 20%. In Indonesia, the incidence of stunting is categorized as high, representing an urgent issue that necessitates immediate resolution through various comprehensive interventions [4].

Based on the 2018 National Basic Health Research (Riskesdas), the stunting prevalence in Indonesia was recorded at 30.8% [5]. Subsequently, the rate declined to 24% in 2021. The Indonesian government has set a strategic target to reduce the stunting rate to 14% by 2024 [6]. However, according to the 2024 Indonesian Nutritional Status Survey (SSGI), the prevalence decreased to 19.8%. This figure indicates that the current progress has yet to achieve the predetermined target. Consequently, stunting has emerged as a primary concern receiving significant attention from the Indonesian Government, with a strategic focus on accelerated stunting reduction programs [7]. This commitment is manifested through government initiatives providing direct community assistance, one of which is the Community-Based Sanitation program, known as SANIMAS (*Sanitasi Berbasis Masyarakat*).

SANIMAS is an initiative designed to promote the provision of community-based residential wastewater infrastructure and facilities through a demand-responsive approach. The primary focus of the SANIMAS program is the management of household wastewater, particularly human excreta, as well as the treatment of greywater originating from domestic kitchens [8]. SANIMAS program aims to establish and enhance the quality of life for both individuals and communities, encouraging active participation in addressing various issues related to the improvement of living standards, self-reliance, and societal welfare [8]. To ensure accurate distribution and reach the intended beneficiaries, a precise selection process is required so that the program may be utilized by those in greatest need. In determining potential beneficiaries, the SANIMAS program employs specific criteria established in the technical guidelines for the 2025 Community-Based Sanitation Program implementation. However, manual selection processes are often time-consuming, particularly when there is a significant number of eligible candidates. Through this research, the author aims to design a system capable of identifying prospective SANIMAS beneficiaries by implementing a Decision Support System (DSS) method.

A Decision Support System (DSS) is a component of a computer-based information system utilized to support decision-making processes within an organization or business. It is also defined as a computerized system that processes data into information to facilitate decision-making regarding specific semi-structured problems [9]. The objective of a DSS is to provide relevant information, offer guidance, generate predictions, and direct users toward more effective and informed decision-making [10]. This research employs the Simple Additive Weighting (SAW) method in the process of determining recipients for the SANIMAS program. The Simple Additive Weighting method is a weighted summation technique used to resolve Multi-Attribute Decision Making (MADM) problems. The fundamental concept of this method involves calculating the weighted sum of performance ratings for each alternative across all predefined attributes [11]. The concept of the Decision Support System using the SAW method represents one of the most fundamental and widely utilized decision-making techniques across various fields. The SAW method is employed to assist in decision-making scenarios where multiple alternatives must be evaluated based on several distinct criteria or factors. This method is considered an appropriate choice for resolving DSS problems that involve clear and measurable criteria [12]. Consequently, the author posits that the SAW method is a highly ideal approach for determining prospective beneficiaries of the SANIMAS program. Previous research was conducted by [13], in which the author implemented the Simple Additive Weighting (SAW) method to determine the selection of academic specializations for students (Case Study: Informatics Study Program, UMM). Another study by [14], resulted in a decision support system application for smartphone selection designed to assist consumers in their decision-making process. Furthermore, [15] utilized the SAW method to determine the optimal location for a final waste disposal site in the Kendawangan Kiri District.

II. METHODOLOGY

A. Literature Study

The initial step in conducting this research is performing a comprehensive literature review. This review aims to obtain a thorough understanding of the research object as well as the theoretical foundation that supports the overall study. In this research, reference sources include electronic journals (E-Journals), relevant books, and the Technical Guidelines for Sanimas Activities for Fiscal Year 2025. The literature review process is intended to strengthen the conceptual framework and ensure the validity of the chosen approach. The main focus of this review is directed toward exploring the Simple Additive Weighting (SAW) method and its application within the context of Decision Support Systems (DSS), as well as the latest regulations and technical guidelines regarding the Sanimas program, which serve as the basis for determining the assessment criteria and indicators.

B. Problem Identification

The problem identification stage is carried out through observations of the current process for determining beneficiaries of the Sanimas program. Based on these observations, it was found that the manual process implemented requires a considerable amount of time for evaluation and calculation to determine the priority of prospective beneficiaries. This condition makes the selection process less efficient and requires a long time to produce a final decision. Based on this issue, there is a need to develop a Decision Support System using the SAW method, which can accelerate the evaluation process and produce objective and measurable results in determining priority recipients of the Sanimas program.

C. SAW Method Design

The application of the SAW method is conducted at the initial stage before system development, serving to determine the various alternative prospective beneficiaries and assessment criteria in the decision-making process for the Sanimas program. This method becomes the main foundation of the Decision Support System framework designed to identify the most qualified and prioritized beneficiaries. The advantage of the Simple Additive Weighting (SAW) model compared to other decision-making methods lies in its ability to produce accurate and consistent assessments, as it is based on predetermined criteria values and preference weights that refer to the technical guidelines of the Sanimas program.

III. RESULT AND DISCUSSION

A. Implementation of the SAW Method

The following are the stages of the SAW method used to determine the beneficiaries of the Sanimas program: Determining the criteria and criteria weights; Determining preference weights based on the criteria; Creating the decision matrix; Creating the normalized matrix according to the criteria; Establishing preference values Ranking and Determining the criteria and criteria weights.

TABLE I. CRITERIA

Criteria	Description	Weight (W)
C1	Low-Income Community (MBR)	25
C2	Stunting Risk Family (KRS)	10
C3	Sanitation Access	20
C4	Availability of Water Source	15
C5	Own House	15
C6	Priority Condition	10
C7	Number of Family Members in the Household	5

All the criteria in Table 1 are benefit-type criteria. Determination of Preference Weights Based on Criteria.

TABLE II. CRITERIA WEIGHTS BASED ON MBR

MBR (C1)	Weight
Yes	1
No	0

TABLE III. CRITERIA WEIGHTS BASED ON KRS

KRS (C2)	Weight
Yes	1
No	0

TABLE IV. CRITERIA WEIGHTS BASED ON SANITATION ACCESS

Sanitation Access (C3)	Weight
No sanitation access	2
Has sanitation access but not proper	1
Has proper sanitation access	0

TABLE V. CRITERIA WEIGHTS BASED ON AVAILABILITY OF WATER SOURCE

Water Source Availability (C4)	Weight
Yes	1
No	0

TABLE VI. CRITERIA WEIGHTS BASED ON HOME OWNERSHIP

Home Ownership (C5)	Weight
Yes	1
No	0

TABLE VII. CRITERIA WEIGHTS BASED ON PRIORITY CONDITION

Priority Condition (C6)	Weight
No family members with priority conditions	0
Having a family member with a disability	1
Having a family member with stunting	2
Having a baby family member under 2 years old	3
Having a pregnant family member	7

TABLE VIII. CRITERIA WEIGHTS BASED ON NUMBER OF FAMILY MEMBERS IN THE HOUSEHOLD

Number of Family Members in the Household (C7)	Weight
1	1
2	2
3	3
4	4
5	5
and so on	and so on

The weight values in Table 8 are adjusted according to the number of family members in the household.

TABEL IX. ALTERNATIVE DECISION MATRIX TO CRITERIA

Alternative (A)	C1	C2	C3	C4	C5	C6	C7
HH	1	2	2	1	1	3	10
SD	1	2	2	1	1	7	4
RE	1	2	2	1	1	1	3

Creating the Decision Matrix. The alternatives in Table 9 represent a sample of 3 prospective beneficiaries from one of the villages designated as the Sanimas program location, Molintogupo Village in Suwawa District, Bone Bolango Regency, Gorontalo Province. Creating the Normalized Matrix According to the Criteria. To determine the normalized matrix values, the following normalization formula is used:

$$Rij = \begin{cases} \frac{xij}{Max\ xij} & if\ j\ is\ a\ benefit\ attribute \\ \frac{Min\ xij}{i} & \\ \frac{i}{xij} & if\ j\ is\ a\ cost\ attribute \end{cases} \quad (1)$$

(1)

Where :
Rij = normalized rating value
Max Xij = highest value for each criterion
Min Xij = lowest value for each criterion
Xij = actual value owned by each criterion

Based on the values in the Decision Matrix in Table IX, the normalization results of the sample data decision matrix are as follows:

$$r11 = \frac{1}{\max(1;1;1)} = \frac{1}{1} = 1$$
$$r21 = \frac{1}{\max(1;1;1)} = \frac{1}{1} = 1 \quad (2)$$
$$r31 = \frac{1}{\max(1;1;1)} = \frac{1}{1} = 1$$

$$r12 = \frac{2}{\max(2;2;2)} = \frac{2}{2} = 1$$
$$r22 = \frac{2}{\max(2;2;2)} = \frac{2}{2} = 1 \quad (3)$$
$$r32 = \frac{2}{\max(2;2;2)} = \frac{2}{2} = 1$$

$$r13 = \frac{2}{\max(2;2;2)} = \frac{1}{2} = 1$$
$$r23 = \frac{2}{\max(2;2;2)} = \frac{1}{2} = 1 \quad (4)$$
$$r33 = \frac{2}{\max(2;2;2)} = \frac{1}{2} = 1$$

$$r14 = \frac{1}{\max(1;1;1)} = \frac{1}{1} = 1$$
$$r24 = \frac{1}{\max(1;1;1)} = \frac{1}{1} = 1 \quad (5)$$
$$r34 = \frac{1}{\max(1;1;1)} = \frac{1}{1} = 1$$

$$r15 = \frac{1}{\max(1;1;1)} = \frac{1}{1} = 1$$
$$r25 = \frac{1}{\max(1;1;1)} = \frac{1}{1} = 1 \quad (6)$$
$$r35 = \frac{1}{\max(1;1;1)} = \frac{1}{1} = 1$$

$$r16 = \frac{3}{\max(3;7;1)} = \frac{3}{7} = 0{,}43$$
$$r26 = \frac{7}{\max(3;7;1)} = \frac{7}{7} = 1 \quad (7)$$
$$r36 = \frac{1}{\max(3;7;1)} = \frac{1}{7} = 0{,}14$$

$$r17 = \frac{10}{\max(10;4;3)} = \frac{10}{10} = 1$$
$$r27 = \frac{4}{\max(10;4;3)} = \frac{4}{10} = 0{,}4 \quad (8)$$
$$r37 = \frac{3}{\max(10;4;3)} = \frac{3}{10} = 0{,}3$$

TABLE X. NORMALIZED MATRIX VALUES

Alternative(A)	C1	C2	C3	C4	C5	C6	C7
HH	1	1	1	1	1	0,43	1
SD	1	1	1	1	1	1	0,4
RE	1	1	1	1	1	0,14	0,3

Determining the Preference Value for each alternative (*Vi*) is given as follows:

$$V_i = \sum_{j=1}^{n} w_j r_{ij} \quad (2)$$

Where:
rij is the normalized performance rating of alternative Ai for attribute *Cj*; *i* = 1,2,…,*m* and *j* = 1,2,…,*n*..

A larger value of Vi indicates that the alternative Ai is more preferred.

Based on Table I, the weight values W = (25, 10, 20, 15, 15, 10, 5)
Alternative 1 (HH) = (1)* (25) + (1)*(10) + (1) * (20) + (1) * (15) + (1) * (15) + (0,43) * (10) + (1) * (5) = 94,3

Alternative 2 (SD) = (1)* (25) + (1)*(10) + (1) * (20) + (1) * (15) + (1) * (15) + (1) * (10) + (0,4) * (5) = 97

Alternative 3 (RE) = (1)* (25) + (1)*(10) + (1) * (20) + (1) * (15) + (1) * (15) + (0,14) * (10) + (0,3) * (5) = 87,9

From the preference value calculation results of each alternative, the ranking is arranged as follows: (SD) Rank 1, (HH) Rank 2, and (RE) Rank 3.

B. Implementation on Beneficiary Candidate Data

In this research, the author implements the SAW method on beneficiary candidate data from one of the villages, which is the stunting focus location, namely Molintogupo Village, Suwawa Selatan District, Bone Bolango Regency, Gorontalo Province, for which the ranking of beneficiary candidates who will receive the Sanimas program will be determined. The following are the results of implementing the SAW method on the beneficiary candidate data in Molintogupo Village.

TABLE XI. RANKING OF BENEFICIARY CANDIDATES IN MOLINTOGUPO VILLAGE USING THE SAW METHOD

Alternative	Preference Value	Ranking
SD	97	1
HH	94,28571429	2
RP	91,78571429	3
IRP	91,78571429	4
TH	91,28571429	5
IG	90,78571429	6
RE	89,35714286	7
IP	78,5	8
BP	78	9
SH	78	10
AA	77,5	11
AH	77,5	12
TM	77,5	13
PH	77	14
RH	77	15
DI	77	16
MM	77	17
WH	77	18

Alternative	Preference Value	Ranking
ID	77	19
MT	76,5	20
FL	76,5	21
HT	76,5	22
YH	76,5	23
RHu	76,5	24
YL	76,5	25
FY	76	26
MMi	76	27
BB	76	28
AHu	76	29
BPa	75,5	30
AHu	56,5	31
RPa	52,5	32

IV. CONCLUSION

Based on the research that has been conducted, several conclusions can be drawn as follows: First, this research successfully produced a ranking of beneficiary candidates for the Sanimas program in Molintogupo Village that is systematically and measurably arranged. This ranking system provides a priority order of beneficiaries based on predetermined criteria, so it can help make the selection process more objective and transparent. Second, the Simple Additive Weighting (SAW) method is proven to be effectively applicable in the process of determining beneficiary candidates for the Sanimas program. This method is capable of accommodating various relevant criteria and producing preference values that can serve as a basis for decision-making with relatively simple yet accurate calculations. Third, the ranking results indicate the possibility of identical values among several alternative beneficiary candidates. This condition indicates that the final decision cannot be entirely entrusted to the system, but still requires consideration and policy from stakeholders at the village level as the location of the Sanimas program implementation. This is important to ensure that the decisions made still consider contextual and social aspects that may not be fully accommodated in the assessment criteria. Fourth, this research has development potential to be implemented in the form of computer-based or mobile applications. Development into an application will facilitate the calculation process, increase time efficiency, and minimize human error in determining beneficiary candidates for the Sanimas program in the future.

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