Sinkron : Jurnal dan Penelitian Teknik Informatika
Volume 8, Number 3, July 2023 e-ISSN : 2541-2019
DOI : https://doi.org/10.33395/sinkron.v8i3.12673 p-ISSN : 2541-044X

Application of the WP and SAW Methods in the Decision Support System for Recipients of Free Electricity Installation Assistance

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Submitted : Jul 11, 2023 | **Accepted** : Jul 12, 2023| **Published** : Jul 13, 2023

Abstract: The main factors causing inequality and poverty in Indonesian are education, welfare, and access to essential systems such as clean water, sterilization, and of course electricity as the main energy supplier in human daily activities. Therefore, to reduce poverty in Indonesian, the main responsibility of the government is to close the gap between groups of people by providing access to various facilities such as electricity. One of the programs initiated by the government to increase access to electricity for the poor is the free electricity installation assistance scheme. However, when providing such assistance, potential recipients must be evaluated or qualified to ensure that aid funds are distributed effectively and efficiently. And in its implementation, problems often occur related to the selection of beneficiaries which are still subjective and less objective. This can have an impact on not being on target and misappropriating aid, so that aid programs do not reach their targets. Aidecisionisupportisystemithatican help evaluate theieligibility ofibeneficiaries inia more objective and transparent manner is needed to resolve this issue. One strategy that can be used is theiWeighted Producti(WP) andiSimpleiAdditiveiWeightingi(SAW) methods. Iniusing a combination of the WPimethod, it canigiveiweightito eachicriterion in determining the choice of free electricity installation assistance and theiSAWimethodiisiableito determineithe data ranking of free electricity installation assistance oLtdions. The resultsiofithisistudyicaniassistiin selecting beneficiaries of free electricity installation assistance in an objective and effective way.
Keywords: DSS; Electricity; System; WP; SAW

INTRODUCTION

The main factors causing inequality and poverty in Indonesian are education, welfare, and access to essential systems such as clean water, sterilization, and of course electricity as the main energy supplier in human daily activities. Therefore, to reduce poverty in Indonesian, the main responsibility of the government is to close the gap between groups of people by providing access to various facilities such as electricity.

Indonesian has participated in organizations in the power generation sector, one of the largest being LTD SEC Company which is a State-Owned Enterprise (SOE). Electricity is absolutely necessary for all life on Earth. Today's society is very dependent on electricity because without electricity some people may not be able to carry out their activities as usual.

Because almost every community activity is highly dependent on the availability of electricity, electricity has developed into a basic need for society. In addition, capital and technological power arrangements make electricity prices expensive and cannot be imported entirely from Indonesian. As a

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result, government intervention is urgently needed to promote a fairer and more cost-effective production and distribution process. The involvement of the government in paying electricity tariffs is one of its interventions in the electricity sector.

In Indonesian, LTD SEC Company has many units. The duties and functions of each Unit are different. The name of each unit is not the same. For example, units in charge of public administration, units in charge of transmission, or units in charge of distribution and so on. One of the units responsible for public administration in Medan Regency, specifically LTD. SEC (Company) CSU Medan City.

LTD. SEC (Company) CSU Medan City is an organization based in Medan Regency. LTD SEC CSU Medan City serves the electricity needs in the local area. Services such as submitting electricity installations, requests for voltage increases, checking SEC electricity bills, and paying for electricity to complaints are examples of these services. NEIA (New Electricity Installation Assistance) is a new electricity installation assistance program for underprivileged households covering the cost of installing electricity, the cost of Certification for Operation Worthiness (COW), other association fees with SEC to filling in the underlying electricity tokens. NEIA beneficiaries are registered in the Integrated Social Welfare Data (ISWD) of the Social Service.

One of the programs initiated by the government to increase access to electricity for the poor is the free electricity installation assistance scheme. However, when providing such assistance, potential recipients must be evaluated or qualified to ensure that aid funds are distributed effectively and efficiently. And in its implementation, problems often occur related to the selection of beneficiaries which are still subjective and less objective. This can have an impact on not being on target and misappropriating aid, so that aid programs do not reach their targets. A decision support system that an help evaluate the eligibility of beneficiaries in a more objective and transparent manner is needed to resolve this issue. One strategy that can be used is the Weighted Product (WP) and Simple Additive Weighting (SAW) methods.

In a study conducted by Utiarahman and Dalai (2022) entitled "Application of the Analityal Hierarchy Process Method in the Decision Support System for Eligibility of Households Receiving Free Electricity", the calculation process was carried out based on the criteria, the results obtained were sub-criteria priority where the applicant with eligibility value = 1 get worthy status. On the other hand, applicant 2 with sub-criteria priority 0.2983 and applicant 3 with sub-criteria priority 0.0847 get unfit status because the value obtained is < 1. So it tends to be suspected that the AHP strategy can be used in a decision support system to assist related parties in determining the eligibility of recipient ho useholds free electricity (Utiarahman & Dalai, 2022).

The use of a combination method that makes it easier to identify eligible recipients of free electricity installation assistance, marks the differences and developments between this study and previous research. Then a combination of the two methods used, namely the Weighted Product (WP) and Simple Additive Weighting (SAW) methods where these two methods produce output in the form of the results of the eligibility of free electricity installation assistance in Medan City District, Medan City Regency.

Based on this background, the author is interested in developing a system with the title "Application of the Weighted Product (WP) and Simple Additive Weighting (SAW) Methods in a Decision Support System for the Eligibility of Recipients of Free Electricity Installation Assistance" which can be used by LTD SEC CSU Medan City to help in making decisions regarding the eligibility of recipients of free electricity installation assistance.

LITERATURE REVIEW

Decision Support System

Decision Support Systems (DSS) are interactive based systems, which assist decision makers in utilizing various data models to solve unstructured problems. DSS is intended to assist all phases of decision making starting from the phase of identifying problems, selecting relevant information, determining the approach used in the decision making process, to evaluating alternative selection activities. The information system is also able to support the company's processors and staff to analyze

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the company, customize the analysis overview through graphs and tables, and enable the creation of new products and services (Sriani & Putri, 2018) .

There are several types of decisions based on their nature and type , namely as follows: (Hasugian & Cipta, 2018):

a. Programmed Decisions
   is a decision that has a fixed procedure for handling it and is repetitive and routine.
b. Non-programmed Decisions
   Namely decisions that are new, unstructured and rarely consequential. There are no positive methods to manage the problem.

WP (Weighted Products)

According to Mulyani, et al (2019) One of the solution oLtdions for the Multi Attribute Decision Making (MADM) problem is the weighted product method. Because the mathematical structure eliminates one size, the WP method is also known as dimensional analysis . Therefore, normalization is not required for this method (Mulyani et al., 2019). The equation for improving the weight of the WP method is the limited array of choices described in several choice models:

$$\sum_{i=1}^{n} wj = \frac{wj}{\sum wj} \quad (1)$$

Equation 1 is the equation that underlies the calculation of normalized weights in the calculation of the WP method where W is the initial weight value and Wj is the jth index W
S vector calculation formula:

$$S_i = \prod_{j=1}^{n} X_{ij}^{W_j}, i = 1, 2, \dots, m \quad (2)$$

Equation 2 is the equation for calculating the rank in the WP method.
Vector V calculation formula:

$$Vi = \frac{\prod_{j=1}^{n} Xij\, Wj}{\prod_{j=1}^{n} (Xj*)\, Wj} \quad (3)$$

Equation 3 is an equation for calculating vector V
DescriLtdion :
V = Alternative analogous to vector V
S = Alternative preference which is analogous to vector S
X = Criteria value
W = weight of criteria sub-criteria
i = Alternative
j = Criteria
n = Number of criteria

Simple Additive Weighting (SAW)

The SAW method is a decision support system algorithm that is used to find the best alternative from a set of alternatives with certain criteria (Yusuf & Bachtiar, 2022). SAW is also known as the weighted sum method. The essence of this method is to calculate the sigma (sum) of the weighted performance rating for eachi criterion and alternative (Kusumantara et al., 2019). SAW solution steps are as follows:

a. Analyze problems, set goals, determine criteria/requirements (Ci) and standardized criteria weights (W).
b. Determine the complete alternative (A) along with its real value (match rating) for each criterion.
c. Arrange matrices according to alternatives (A) and criteria (Ci).
d. Perform matrix normalization based on attribute type (cost/benefit) to become normalized matrix (R).

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e. Calculating the final per-alternative preference value (Vi) using the sigma (sum) of the multiplication matrix R with weight (W).
f. The highest Vi value is the best alternative as a solution.

The matrix normalization process is carried out by calculating the following equation (Lorenzia & Zailani, 2022):

$$rij = \begin{cases} \frac{Xij}{Max\ i\ Xij} \ if\ j\ is\ the\ attribute\ advantage\ (benefit) & (4) \\ \frac{Min\ i\ Xij}{Xij} \ if\ j\ is\ the\ attribute\ cost\ (cost) & (5) \end{cases}$$

Description :
rij = Normalized performance evaluation value
Xij = Attribute value for each criterion
Max i Xij = Maximum value For each criterion
Min i Xij = Minimum value For each criterion
Benefit = If the greatest value is the best
Cost = If the smallest value is the best

To calculate the Ranking Value or Final Preference Value obtained from the alternatives, the following equation is used:

$$Vi = \sum_{j=1}^{n} Wjrij \quad (6)$$

Description :
Vi = Rank each alternative
Wj = Weight value of each criterion
Rij = Normalized performance rating value

METHOD

The research flowchart uses the WP and SAW methods:

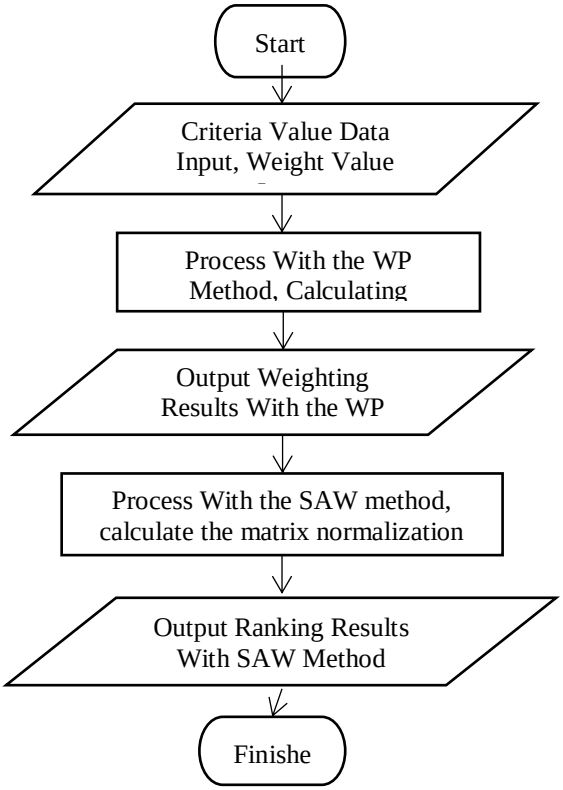

Figure 1. Flowchart of the Implementation of the WP and SAW Methods

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It was explained that the WP method is widely used because the weights are calculated based on the level of importance and can evaluate a set of attributes with alternative combinations in the stages of finding weight values and calculating weight preferences in this study. In addition, the advantages of the WP method include when the initial weighting is carried out to correct the weights (Sugianto & Situmorang, 2021). Even though the SAW method used in this study is normalization and ranking, it is explained that the use of the SAW method in a decision support system can be used to determine the weighted sum of performance ratings for each alternative on all attributes (Wantoro, 2020).

Data analysis

The process of processing data for the purpose of finding useful information that can be used as a basis for making decisions to solve a problem. This can be obtained by analyzing the system in advance or that is currently running. Because from this information, it can be seen how far the current system is running, what are the needs in running it and what needs are to be achieved but cannot be provided by the current system.

A. Alternative Data

After conducting interviews at LTD. SEC (Company) CSU Medan City has obtained alternative data as in table 1. and for this study used 25 alternatives.

Table 1. Data Alternative

Code	Alternative
A1	Fatima
A2	Mardina
A3	Ucok Sinambela
A4	Muhammad Fahri
A5	Suparman
A6	Gustami
A7	Budi
A8	Arifin
A9	Toyib Munthe
A10	Nangran
A11	Early
A12	Rita Komala
A13	Rudiantono

Code	Alternative
A14	Yuyud Wahyudi
A15	Jodi Hernandi
A16	Rohana
A17	Jannah
A18	Aisha
A19	Iyan Yuliandi
A20	Farida
A21	Ramadan Siagian
A22	Mohammed Salman
A23	Soraya Zairina
A24	Intan Nurainiza
A25	Sultan

B. Criteria Data

To assess the weight of alternative data, it is necessary to use criterion data as a benchmark for evaluating alternative data. The following criteria data below :

Table 2. Criteria Data

Code	Criteria	weight
C1	dependents	25
C2	Ownership	20
C3	Income	35
C4	Condition	20

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The sub-criteria for each of the criteria are in table 2. The use of these sub-criteria is to assist in evaluating alternatives, along with an explanation of the sub-criteria below .

a. Dependent Criteria

Table 3. Subcriteria for Dependents

Sub-criteria	Weight
1 – 2	1
3 – 5	3
5 – 10	5

b. Ownership Criteria

Table 4. Ownership Sub-criteria

Subcriteria	Weight
One's own	1
Commonly Owned	3
Rent	5

c. Income Criteria

Table 5. Income Sub-criteria

Subcriteria	Weight
2.5 million and above	1
1 – 2.5 million and above	3
500 – 1 million and below	5

d. Condition Criteria

Table 6. Condition sub-criteria

Subcriteria	Weight
Permanent	1
Semi Permanent	3
Board	5

C. Respondent Assessment Data

On alternative data and criteria, then give weight to alternative data as shown by the criteria and sub-criteria described.

Table 7. Respondent Assessment Data

Alternative	C1	C2	C3	C4
A1	3	Rent	1.5 million	Semi Permanent
A2	2	Rent	1.5 million	Semi Permanent
A3	5	One's own	2 million	Semi Permanent
A4	3	Rent	1.3 million	Semi Permanent
A5	2	Rent	1 million	Board
A6	4	Rent	1.5 million	Board
A7	4	One's own	1.5 million	Semi Permanent
A8	5	Rent	2 million	Board
A9	2	One's own	1.5 million	Semi Permanent
A10	3	One's own	1.7 million	Semi Permanent
A11	2	Rent	1 million	Semi Permanent
A12	3	Rent	1.5 million	Board

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A13	5	One's own	1.5 million	Semi Permanent
A14	4	Rent	1.5 million	Semi Permanent
A15	4	Rent	1.2 million	Board
A16	3	One's own	1.5 million	Semi Permanent
A17	4	Rent	1.3 million	Board
A18	3	Rent	1.5 million	Board
A19	5	One's own	2 million	Permanent
A20	2	one's own	1.5 million	Board
A21	2	Rent	2 million	Permanent
A22	3	One's own	1 million	Semi Permanent
A23	4	One's own	2 million	Board
A24	5	Rent	1.5 million	Board
A25	5	Rent	2 million	Semi Permanent

After getting the respondent's assessment of the alternative data, the assessment data is converted into a matrix which is converted into numbers with the provisions of the criteria and sub-criteria data presented.

Table 8. Alternative Assessment Matrix

Alternative	C1	C2	C3	C4
A1	3	5	3	3
A2	1	5	3	3
A3	3	1	3	3
A4	3	5	3	3
A5	1	5	5	5
A6	3	5	3	5
A7	3	1	3	3
A8	3	5	3	5
A9	1	1	3	3
A10	3	1	3	3
A11	1	5	5	3
A12	3	5	3	5
A13	3	1	3	3
A14	3	5	3	3
A15	3	5	3	5
A16	3	1	3	3
A17	3	5	3	5
A18	3	5	3	5
A19	3	1	3	1
A20	1	1	3	5
A21	1	5	3	1
A22	3	1	3	3
A23	3	1	3	5
A24	3	5	3	5
A25	3	5	3	3

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RESULTS

The WP and SAW systems were combined with the intention of facilitating the processing of large amounts of data, such as 200 beneficiaries' data with varying assessment criteria. Obviously, if this is done manually, it will take a long time. If the data to be processed is in the hundreds or thousands, MS-Excel assistance for manual calculations will also not yield the best results because MS-Excel must manually enter the formula multiple times in its calculations. this issue can be overwhelmed by building a framework that can carry out the WP and SAW techniques naturally. The consequences of the execution of framework testing and manual estimations utilizing MS-Succeed are as per the following:

The WP method

Calculating preference weights manually is as follows:

$$C1 => \sum_{i=1}^{n} wj = \frac{wj}{\sum wj}$$
$$\sum_{i=1}^{n} wj = \frac{25}{100}$$
$$= 0{,}25$$

$$C2 => \sum_{i=1}^{n} wj = \frac{wj}{\sum wj}$$
$$\sum_{i=1}^{n} wj = \frac{20}{100}$$
$$= 0{,}2$$

$$C3 => \sum_{i=1}^{n} wj = \frac{wj}{\sum wj}$$
$$\sum_{i=1}^{n} wj = \frac{35}{100}$$
$$= 0{,}35$$

$$C4 => \sum_{i=1}^{n} wj = \frac{wj}{\sum wj}$$
$$\sum_{i=1}^{n} wj = \frac{20}{100}$$
$$= 0{,}2$$

Table 9Preference Weight

Criteria	Weight	Weight fix
C1	25	0.25
C2	20	0.2
C3	35	0.35
C4	20	0.2

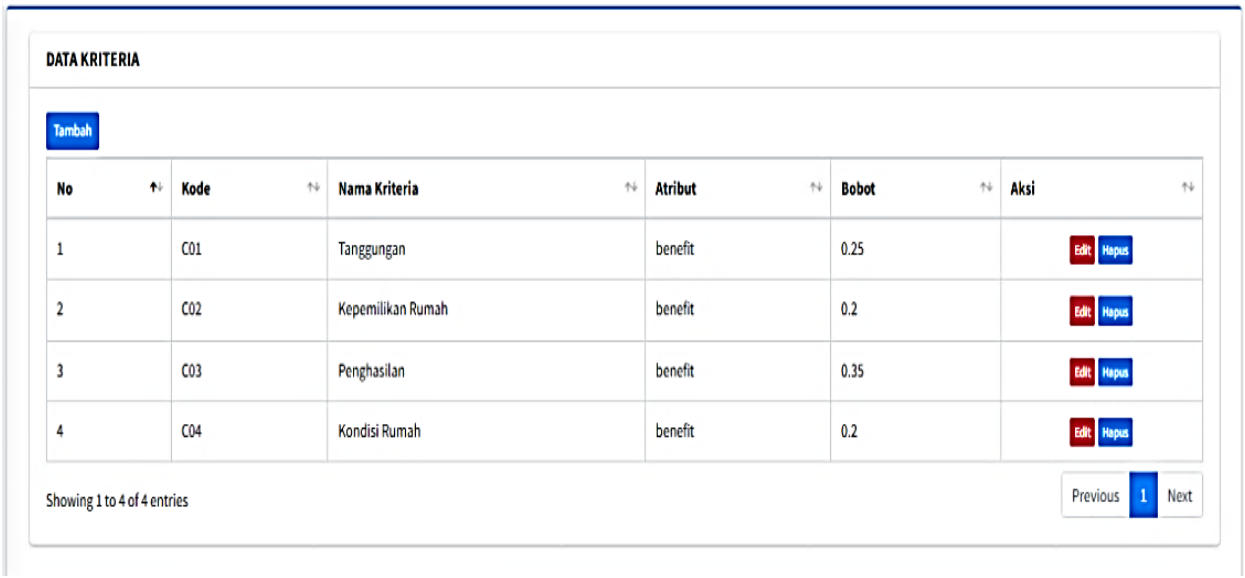

Figure 2. WP system based calculation display

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The SAW method

a. Determine the value of the min weight and max weight .

The min weight is taken from the smallest number of alternative data while the max weight is taken from the largest number of alternative data values. It can be seen from the table as follows:

Table 10Min and Max Weight Values

Criteria	Min weight	Max. Weight
C1	1	3
C2	1	5
C3	3	5
C4	1	5

b. Matrix Normalization

Table 11. Matrix Normalization

Alternative	C1	C2	C3	C4
A1	1	1	0.6	0.6
A2	0.33	1	0.6	0.6
A3	1	0.2	0.6	0.6
A4	1	1	0.6	0.6
A5	0.33	1	1	1
A6	1	1	0.6	1
A7	1	0.2	0.6	0.6
A8	1	1	0.6	1
A9	0.33	0.2	0.6	0.6
A10	1	0.2	0.6	0.6
A11	0.33	1	1	0.6
A12	1	1	0.6	1
A13	1	0.2	0.6	0.6
A14	1	1	0.6	0.6
A15	1	1	0.6	1
A16	1	0.2	0.6	0.6
A17	1	1		1
A18	1	1	0.6	1
A19	1	0.2	0.6	0.2
A20	0.33	0.2	0.6	1
A21	0.33	1	0.6	0.2
A22	1	0.2	0.6	0.6
A23	1	0.2	0.6	1
A24	1	1	0.6	1
A25	1	1	0.6	0.6

An example of how to calculate matrix normalization in A1 manually is as follows:

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$$r11 = \frac{Xij}{Max\ i\ Xij}$$
$$r11 = \frac{3}{3}$$
$$r11 = 1$$

$$r13 = \frac{Xij}{Max\ i\ Xij}$$
$$r13 = \frac{3}{5}$$
$$r13 = 0{,}6$$

$$r12 = \frac{Xij}{Max\ i\ Xij}$$
$$r12 = \frac{5}{5}$$
$$r12 = 1$$

$$r14 = \frac{Xij}{Max\ i\ Xij}$$
$$r14 = \frac{3}{5}$$
$$r14 = 0{,}6$$

NORMALISASI

	Tanggungan	Kepemilikan Rumah	Penghasilan	Kondisi Rumah
FATIMAH	1	1	0.6	0.6
MARDINA	0.33	1	0.6	0.6
HALIM	1	0.2	0.6	0.6
MUHAMMAD FAHRI	1	1	0.6	0.6
SUPARMAN	0.33	1	1	1
GUSTAMI	1	1	0.6	1

Figure 3. Display of matrix normalization calculation based on SAW system

c. Calculating Final Value

And finally, the ranking from the results of calculating the weight value multiplied by the normalization matrix using the SAW method, as shown in the image below :

Table 12. Final score

Alternative	Results	Rank
A1	0.78	7
A2	0.61	17
A3	0.62	12
A4	0.78	7
A5	0.83	6
A6	0.86	1
A7	0.62	12
A8	0.86	1
A9	0.45	20
A10	0.62	12
A11	0.75	10
A12	0.86	1
A13	0.62	12
A14	0.78	7

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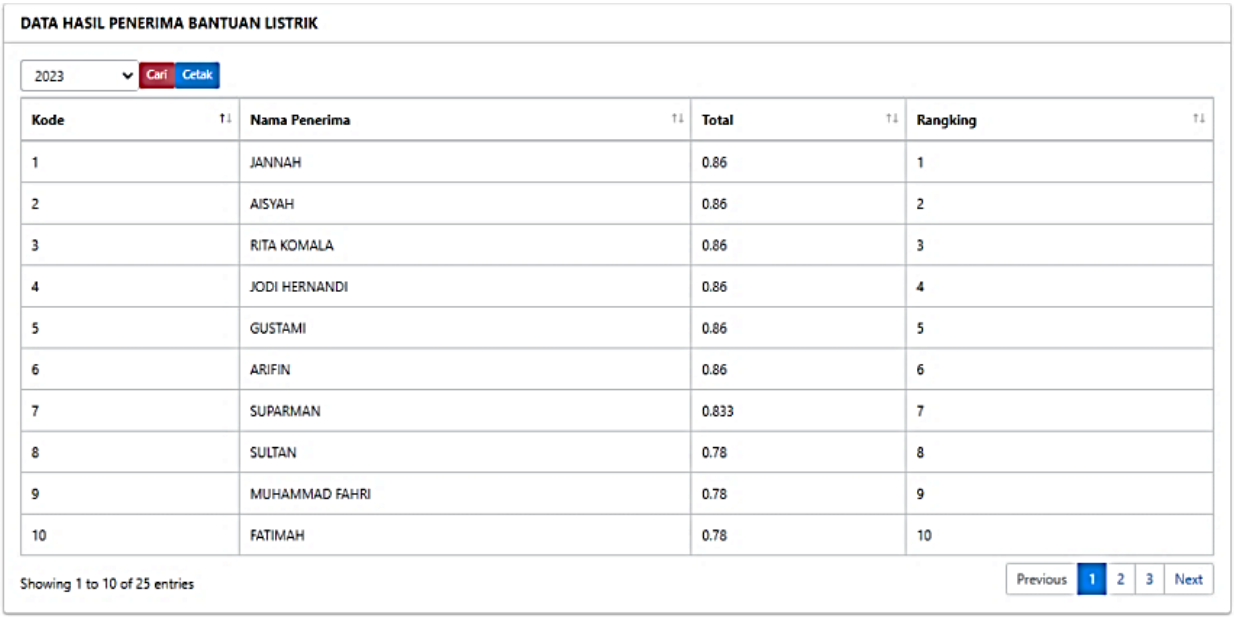
A15	0.86	1
A16	0.62	12
A17	0.65	11
A18	0.86	1
A19	0.54	18
A20	0.53	19
A21	0.53	23
A22	0.62	15
A23	0.70	14
A24	0.86	1
A25	0.78	9

An example of how to calculate ranking results on A1, A2, and A3 manually is as follows:

$$Vi = \sum_{j=1}^{n} Wjrij$$
$$V1 = (025 * 1) + (0{,}2 * 1) + (0{,}35 * 0{,}6) + (0{,}2 * 0{,}6)$$
$$V1 = 0{,}78$$

$$Vi = \sum_{j=1}^{n} Wjrij$$
$$V2 = (025 * 0{,}33) + (0{,}2 * 1) + (0{,}35 * 0{,}6) + (0{,}2 * 0{,}6)$$
$$V2 = 0{,}61$$

$$Vi = \sum_{j=1}^{n} Wjrij$$
$$V3 = (025 * 1) + (0{,}2 * 0{,}2) + (0{,}35 * 0{,}6) + (0{,}2 * 0{,}6)$$
$$V3 = 0{,}62$$


DATA HASIL PENERIMA BANTUAN LISTRIK

2023 Cari Cetak

Kode	Nama Penerima	Total	Rangking
1	JANNAH	0.86	1
2	AISYAH	0.86	2
3	RITA KOMALA	0.86	3
4	JODI HERNANDI	0.86	4
5	GUSTAMI	0.86	5
6	ARIFIN	0.86	6
7	SUPARMAN	0.833	7
8	SULTAN	0.78	8
9	MUHAMMAD FAHRI	0.78	9
10	FATIMAH	0.78	10

Showing 1 to 10 of 25 entries

Previous 1 2 3 Next

Figure 4. Display of SAW system based ranking results

*name of correspondence author

DISCUSSION

The combination of the two WP and SAW methods which aims to select recipients of free electricity installation using several criteria and sub criteria. The WP method is used to improve weights while SAW is used to determine ranking from matrix normalization calculations. This research is different from previous studies which used a combination method to make it easier to determine recipients of free electricity installation assistance. So that the results of this study are obtained, it is proven that the combination of these methods can perform maximum calculations and can process properly and there is a print feature or save data reports on the results of calculations.

CONCLUSION

Based on the results of the analysis and testing in this study on the combination of the WP and SAW methods in selecting free electricity installation assistance, the authors draw the conclusion that the decision support system in selecting free electricity installation assistance is expected to be a reference in developing the system to be used, making it easier and time efficiency in selecting free electricity installation assistance, using a combination of the WP method can give weight to each criterion in determining the choice of free electricity installation assistance and the SAW method is able to determine data ranking of free electricity installation assistance oLtdions, and can perform maximum calculations using the WP method and SAW and can process properly and there is a print feature or distorted calculation results data reports

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