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Recommendation for Self-Help Housing Stimulus Assistance (BSPS) Recipient Using Multi-Criteria Decision Making Methods

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Abstract

The Department of Housing and Settlement Areas aims to increase accuracy and efficiency in selecting recipients of the Self-Help Housing Stimulant Assistance Program (BSPS) using the Weighted Product (WP) method and Technique for Order Preference by Similarity to Ideal Solution (TOPSIS). This research was conducted in Sungkai Tengah District, North Lampung, involving six criteria: land ownership, employment, house condition, income, self-sufficiency, and number of household members. The WP method is used to determine the weight of each criterion by calculating the product of the criterion value raised to the power of the respective weight, which helps in ranking alternatives. TOPSIS is applied to identify the best alternative by comparing the geometric distance of each option to the ideal solution, which is the maximum or minimum value of each criterion. The research results show that the WP and TOPSIS methods can provide more objective and transparent rankings. The application of this method produces the highest ranking, namely alternative V3. It is hoped that the decision support system developed from this research can assist the Department of Housing and Settlement Areas in distributing aid more accurately, fairly and efficiently, thereby supporting the government's goals in improving the quality of housing and spatial planning.

Keywords: *decision support system, BSPS, Weighted Product, TOPSIS*

1. Introduction

The Housing and Settlements Service is an institution established by the government with a vision to achieve integrated, controlled, and dynamic spatial planning as part of efforts towards national advancement(Muhammad et al. 2023) One concrete step to realize this vision is through the implementation of the Self-Help Housing Stimulus Program (BSPS), which is conducted annually. This program aims to provide support and incentives to the community to actively participate in housing provision(Pramana et al. 2023). This aligns with the government's aspiration to improve housing quality and spatial planning(Wafa et al. 2023). Housing renovation assistance should be granted to recipients who meet the requirements and are entitled to it. Given the large number of people eligible for housing renovation assistance, the Housing and Settlements Service needs to conduct a meticulous selection process to ensure that the assistance is delivered accurately and efficiently(Yurika, Ningsih, and Aripin 2022).

The main problem in the distribution of housing renovation assistance is the inaccuracies that often arise in assessing the beneficiaries(Zulkarnain 2023). There is a tendency for family relationships to influence decisions, where individuals who are not actually entitled to receive the assistance may receive it, while those who should receive it do not. Issues also include the building's reliability not being met, the recipient's house

appearing incomplete, excessive self-help funds creating a sense of misallocation, and suboptimal use of existing material components. Quantitative assessment is deemed unsatisfactory due to the difficulty in measuring relevant parameters. In this context, the Housing and Settlements Service wants to ensure that the data used meets the established criteria, allowing for prompt feedback and improvements in the assistance distribution process.

The requirements to qualify for the housing renovation program according to the currently applicable government regulations are as follows(PUPR 2021): The applicant must be an Indonesian Citizen (WNI), categorized as Low-Income Communities (MBR), already have a family status, own or control land, and have an uninhabitable house.

Several studies have been conducted related to the distribution of assistance, such as those by Hutahaean W and Hasugian PS, who used the Weighted Product method to determine recipients of housing renovation assistance. The Weighted Product method will yield the highest value, which will then be selected as the best alternative(Hutahaean and Hasugian 2021). Fitriyani IN and colleagues proposed the Technique For Order of Preference by Similarity to Ideal Solution (TOPSIS) method for determining housing renovation assistance. The goal of this research is to produce a system that facilitates decision-making regarding the provision of uninhabitable housing assistance. Further research by Sunsanto and colleagues used the Weighted Product (WP) and Simple Additive Weighting (SAW) methods for determining housing renovation assistance recipients. The ranking results showed the same names, though with different values(Fitriyani, Defit, and Nurcahyo 2024). Ponidi and colleagues used the Weighted Product Method as an indicator for selecting renovation assistance recipients. The result of this research is the development of an effective and efficient assessment system for housing renovation assistance(Ponidi, Renaldo, and ... 2021). Nalatissifa H and Ramdhani Y employed TOPSIS (Technique for Order Preference by Similarity to Ideal Solution) to determine the eligibility for uninhabitable housing (RLTH) assistance. The availability of this decision support system can help villages determine eligibility for RTLH assistance(Nalatissifa and Ramdhani 2020).

Based on the problems and previous research, our proposed study will use the Weighted Product (WP) and Technique For Order of Preference by Similarity to Ideal Solution (TOPSIS) methods for selecting recipients of the Self-Help Housing Stimulus. These two methods allow for a precise evaluation and weighting of each criterion, facilitating the formulation of optimal recommendations that address the specific issues faced, particularly in Sungkai Tengah District, North Lampung, in determining the allocation of Self-Help Housing Stimulus assistance.

2. Research Method

This research solves the problems faced in the selection of recipients of self-help housing stimulant assistance, using a decision support system. Research related to decision support systems has been carried out in previous years, including 2020, 2021-2022. This research was carried out in several stages, starting from conducting a literature study, collecting data related to the selection process for recipients of self-help home repair assistance, analyzing system decision-making needs, implementing the WP and TOPSIS methods, to analyzing system needs. results. The literature study was carried out by conducting a Systematic Literature Review (SLR)(Hajduk and Jelonek 2021) by collecting journal articles and conference papers related to existing decision-making systems and methods. Several literature study activities have been carried out, and material collection is still ongoing. Data collection related to the selection process for recipients of self-help home repair assistance was carried out using data from Sungkai Tengah District, North Lampung Regency. Data was obtained partly from last year's prospective recipients and the criteria used. At this stage the researcher prepares

the requirements for the WP and TOPSIS methods, including preparing the criteria to be used, weighting, alternative data to be selected, and so on. The application of the WP and TOPSIS methods includes a calculation process for selecting potential recipients of self-help home repair assistance using the WP and TOPSIS methods. Testing and analyzing multiple experiments and analyzing the results to ensure everything runs smoothly. The next stage is data grouping for applying the TOPSIS and WP methods. Input data is needed to ensure the output works as expected. The data required for implementation is categorized into internal and external data. External data refers to data on residents who will be selected to receive home repair assistance. Internal data includes data on criteria for recipients of house repair assistance from Sungkai Tengah District, North Lampung.

2.1 Weighted Product

Data analysis in this section includes explanation of formulas or equations. The Weighted Product (WP) method uses a multiplication technique to connect attribute ratings, where the rating of each attribute must first be raised to the power of each attribute's weight. The calculation steps in the Weighted Product (WP) method(Nurhayati, Hayami, and Fatma 2019) are as follows:

1. Determine the Criteria
2. Determine the Compatibility Rating
3. Perform Weight Normalization

To find the normalized weight, ensure that the total weight of the criteria equals 1 (or 100%). This can be done by dividing each weight by the total weight. The formula for this process is as follows:

$$Wj = \frac{w_j}{\sum w_j} \quad (1)$$

Information

Wj = is the normalized weight of criterion j,

wj = wj is the initial weight of the jth criterion

∑j = ∑wj is the total weight of all criteria

1. Calculating Vector S. This step is the same as the normalization step for preference values for alternatives calculated using a formula

$$s_{i=} \quad \prod_{j=1}^{n} X_{ij}^{Wj} \quad ; Dimana\ i = 1,2, \dots \dots, n \quad (2)$$

Information:

S = alternative preferences.

W = criteria weight.

X = criterion value.

i = alternative i to n.

j = criteria..

Vector S is calculated using all multiplications of the criteria values 1 to n by raising W as the normalized weight for each work, which will have a positive value if W is a benefit attribute and a negative value if W is a cost attribute.

2. Calculate Vector V, or the relative preferences of each alternative. Using the following equation:

$$Vi = \frac{\prod_{j=1}^{n} X_{ij} \quad wj}{\prod_{j=1}^{n} \quad (x*_{ij}) \quad wj} \quad \text{;dengan I =1,2 …,n} \tag{3}$$

Information:

Vi = preference result for the ith alternative.

Xij = variable value of the alternative for each attribute.

wj = criteria weight value.

n = number of criteria.

i = alternative value.

j = criterion value.

* = the number of criteria that have been assessed in vector S.

These criteria are divided into two categories, namely those that have positive values which are included in the benefit criteria, and those that have negative values which are included in the cost criteria.

2.2 Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) Method

Topsis is a multi-criteria decision support method that was first introduced by Yoon and Hwang (Rahim et al. 2018). TOPSIS uses the principle that the selected alternative must have the shortest distance from the positive ideal solution and have the farthest distance from the negative ideal solution from the geometric point. Using Euclidean distance to determine the relative closeness between alternatives to the optimal solution(Ding et al. 2016).The TOPSIS algorithm calculation stages are as follows.

1. Normalized Decision Matrix (R)

$$rij = \frac{xij}{\sqrt{\sum_{i=1}^{m} X_{ij}^2}} \tag{4}$$

dengan i=1,2,...,m; nilai m menunjukkan jumlah alternatif yang dievaluasi, dan nilai X_{ij} menunjukkan nilai rating kecocokan alternatif ke-i terhadap kriteria ke-j

2. Weighted Normalized Decision Matrix (Y)
The value of each normalized data (R) is then multiplied by the weight (W) to get a weighted normalized decision matrix (Y)

$$Y_{ij} = W_i r_{ij} \tag{5}$$

Dengan w_j adalah pangkat bernilai positif untuk atribut keuntungan (*Benefit*), dan bernilai negatif untuk atribut biaya (*cost*). Nilai w_j menunjukkan nilai bobot dari kriteria C yang ke-j

3. Positive (A+) and Negative (A-) Ideal Solution Matrix

The positive ideal solution A+ and negative ideal solution A- can be determined based on the normalized weight ranking (yij)
The equation used to determine the positive ideal solution is:

$$A^{+} = (y_1^{+}, y_2^{+}, \dots\dots\dots\dots y_n^{+}) \quad (6)$$

The equation used to determine the positive ideal solution is:

$$A^{-} = (y_1^{-}, y_2^{-}, \dots\dots\dots\dots y_n^{-}) \quad (7)$$

4. Positive/Negative Ideal Solution Distance (D)
   Distance between Alternative Ai and Positive Ideal Solution (D+)
   a) The distance between Alternative Ai and the Positive Ideal Solution (D+) with equation

$$D_i^{+} = \sqrt{\sum_{j=1}^{n} (y_i^{+} - yij\ )^2} \quad (8)$$

   b) The distance between Alternative Ai and the Negative Ideal Solution (D-) with the equation:

$$D_i^{-} = \sqrt{\sum_{j=1}^{n} (yij - y_i^{-})^2} \quad (9)$$

   Information
   y+j = positive ideal solution for the jth attribute
   y-j = negative ideal solution for the jth attribute
   yij = element of the weighted normalized decision matrix Y

5. Preference Value (V)
   The preference value for each alternative (Vi) with the equation:

$$V_i = \frac{D_i^{-}}{D_i^{-} + D_i^{+})} \quad (10)$$

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

3. Results and Analysis

3.1. Collection And Determination Of Data Criteria For TOPSIS And WP Calculations

The research was conducted using six variables or criteria based on the results of observations and interviews with officers authorized to handle BSPS assistance at the Housing and Settlements Service. These six variables include: Land ownership with a weight of 5, Employment with a weight of 2, Condition of the house with a weight of 4, Income with a weight of 2, self-sufficiency with a weight of 4, Number of household occupants, with a weight of 3. Of the six criteria, only land ownership is the criterion. has a useful value and the Urgency criterion has the highest value, while the lowest weight is employment and income. The employment status criteria table is presented in Table 1.

Table 1 Criteria

ALTERNATIVE	Criteria	Weight Value	Status
A1	Land ownership	5	Profit

A2	Work	2	profit
A3	House condition	4	profit
A4	Income	2	profit
A5	self-sufficiency	4	profit
A6	Number of household residents	3	profit

3.1.1. WP Calculation Method

Based on table 1 of the criteria, the next step is to determine the relative value of the initial weight (wj), equal to = 1 with equation formula number 1 based on six criteria so that the initial weight is obtained in accordance with Table 2.

Table 2. Normalized Weights

Criteria Weight	**A1**	**A2**	**A3**	**A4**	**A5**	**A6**
Weight of Importance	0.25	0.1	0.2	0.1	0.2	0.15

From the initial weight, it can be seen that the criterion with the highest value is A1 at 0.25, while the lowest criteria are A2 and A4 with a value of 0.1 of the initial weight value. The next step is the formation of a comparison matrix of alternatives and criteria, where the criteria data is obtained from survey results at the research location, as shown in Table 3..

Table 3. Criteria Matrix

ALTERNATIVE	**CI**	**C2**	**C3**	**C4**	**C5**	**C6**
V1	5	5	5	4	4	3
V2	4	4	4	3	2	3
V3	5	5	5	4	5	3
V4	3	3	2	3	5	5
V5	5	2	2	2	3	1
V6	5	2	2	2	2	2
V7	3	4	4	3	4	3
V8	5	5	5	3	5	3
V9	5	3	4	3	5	5
V10	1	5	3	3	1	2

Based on Tables 2 and 3, the S factor value is obtained from equation number 2, and the vector V value is obtained from equation 3. These values are shown in Table 4.

Table 4 Vector S And Vector V

ALTERNATIVE	**Vector S**	**Vector V**	**Ranking**
V1	4.3313	0.1260	3
V2	3.2406	0.0943	7
V3	4.5290	0.1317	1
V4	3.3079	0.0962	6

V5	2.458	0.0715	9
V6	2.5149	0.0732	8
V7	3.4641	0.1008	5
V8	4.4006	0.1280	2
V9	4.3174	0.1256	4
V10	1.8121	0.0527	10

Based on Table 4, it can be concluded that the highest score for calculations using the WP method, the highest score for vector S and vector V is owned by alternative V3 with a vector S value of 4.529 and vector V 0.1317.

3.1.2. TOPSIS Calculation Method

With alternative samples and criteria based on Tables 1 and 2, the next step is to find the weight of each criterion by creating a normalized decision matrix. This process is important to ensure that each criterion has the same impact on decision making. By following these steps carefully, we can ensure that the final results of the TOPSIS analysis will provide an optimal and reliable solution. This can be presented using the formula in equation IV as shown in Table 5.

Table 5 Normalization Matrix

ALTERNATIVE	CI	C2	C3	C4	C5	C6
V1	0.3676	0.3978	0.4167	0.424	0.3266	0.2942
V2	0.2941	0.3182	0.3333	0.318	0.1633	0.2942
V3	0.3676	0.3978	0.4167	0.424	0.4082	0.2942
V4	0.2206	0.2387	0.1667	0.318	0.4082	0.4903
V5	0.3676	0.1591	0.1667	0.212	0.2449	0.0981
V6	0.3676	0.1591	0.1667	0.212	0.1633	0.1961
V7	0.2206	0.3182	0.3333	0.318	0.3266	0.2942
V8	0.3676	0.3978	0.4167	0.212	0.4082	0.2942
V9	0.3676	0.2387	0.3333	0.318	0.4082	0.4903
V10	0.0735	0.3978	0.25	0.318	0.0816	0.1961

Based on Table 5, it can be concluded that the criteria values C1, C2, C3, C4, C5, and C6 each represent alternatives V1 to V10. The normalization matrix shows ten alternatives identified as V1 to V10. From this table, the highest value of C1 is represented by the aternatives V1, A3, V5, V6, V8, and V9. The highest values for C2 are represented by the aternatives V1, V3, V8, V10. The highest values for C3 are represented by the aternatives V1, V3, and V8. The highest value for C4 is represented by the aternatives V1, V3. The highest values for C5 are represented by the aternatives V3, V4, V8, and V9. And the highest value for C6 is represented by the ateranatives V4 and V9. Next, the process of normalization and determining the weight of these values is carried out. Calculation of criteria weights for each alternative uses equation number 5, with the results presented in Table 6.

Table 6.Weighted Normalization Matrix Y

ALTERNATIVE	CI	C2	C3	C4	C5	C6
V1	1,838	0.7956	1.6667	0.825	1.3064	0.8825
V2	1.470	0.6364	1.3333	0.619	0.6532	0.8825
V3	1,838	0.7956	1.6667	0.825	1,633	0.8825

V4	1.102	0.4773	0.6667	0.619	1,633	1.4709
V5	1,838	0.3182	0.6667	0.413	0.9798	0.2942
V6	1,838	0.3182	0.6667	0.413	0.6532	0.5883
V7	1.102	0.6364	1.3333	0.619	1.3064	0.8825
V8	1,838	0.7956	1.6667	0.619	1,633	0.8825
V9	1,838	0.4773	1.3333	0.619	1,633	1.4709
V10	0.367	0.7956	10,000	0.619	0.3266	0.5883

Based on Table 6, there is information about the highest scores for several criteria (C1, C2, C3, C4, C5, and 6). Once these values are obtained, the next step is to determine the positive ideal solution and negative ideal solution based on the normalized weight ranking. This is done using equations 6 and 7, and the results are presented in Table 7.

Table 7.Value Of Positive And Negative Ideal Solutions

Information	1	2	3	4	5	6
Positive Ideal Solution (A+)	1,838	0.7956	1.6667	0.8251	1,633	1.4709
Negative Ideal Solution (A-)	0.3676	0.3182	0.6667	0.4126	0.3266	0.2942

The highest positive value is in category 1 and the lowest is in category 2. The highest negative value is in category 3 and the lowest is in category 6. Next, the distance between each alternative and the positive ideal solution, negative ideal solution, and the preference value of each alternatives are calculated using equations 8 and 9. . The results are presented in Table 8.

Table 8. The Distance Between Positive And Negative Ideals

INTRODUCTION	Positive(+)	Negative(-)	Nilai Preferensi (V)
V1	0.9565	2.2226	0.6991
V2	1.6249	1.7929	0.5246
V3	0.7670	2.2949	0.7495
V4	1.5051	1.8946	0.5573
V5	1.9316	1.4573	0.4300
V6	1.9400	1.4461	0.4271
V7	1.5345	1.8709	0.5494
V8	1.0062	2.2006	0.6862
V9	0.9293	2.2341	0.7062
V10	2.1303	1.1475	0.3501

Based on Table 8 above, we can see that the highest positive value is in alternative V10 and the lowest is in alternative V3. Likewise, the highest negative value is alternative V10 and the lowest is in alternative V3. Next, the preference value for each alternative is calculated using equation 10. From the results of this calculation, alternatives V3, V9, and V1 are the best criteria.

4 . Conclusion

Based on the results of research that has been carried out, the best alternative for receiving self-help housing stimulus assistance was obtained using six main criteria. Calculations using the TOPSIS and WP methods produce three main priority alternatives, namely V3, V9, and V1. The Weighted Product (WP) method helps in determining the weight of each criterion by calculating the product of the criterion value

raised to the power of each weight, while the TOPSIS method is applied to identify the best alternative by comparing the geometric distance of each option to the ideal solution. This research shows that these two methods can provide more objective and transparent rankings. It is hoped that the decision support system developed from this research can assist the Department of Housing and Settlement Areas in distributing aid more accurately, fairly and efficiently, thereby supporting the government's goals in improving the quality of housing and spatial planning.

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