Indonesian Journal of Computer Science
ISSN 2549-7286 (*online*)
Jln. Khatib Sulaiman Dalam No. 1, Padang, Indonesia
Website: ijcs.stmikindonesia.ac.id | E-mail: ijcs@stmikindonesia.ac.id

IMPLEMENTATION OF THE VIKOR METHOD AND ANALYTICAL HIERARCHY PROCESS (AHP) IN PRIORITIZING THE RECEIPT OF UNINHABITABLE HOUSE ASSISTANCE FUNDS (RTLH)

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Article Information

Submitted : 8 Jan 2024
Reviewed: 18 Jan 2024
Accepted : 17 Feb 2024

Keywords

RTLH, SPK, VIKTOR, AHP, Prediction, Classification

Abstract

Uninhabitable House (RTLH) is one of the social problems often faced by the community. Funding programs for RTLH repairs are important to improve the quality of life and housing conditions of the underprivileged. However, with limited resources, prioritizing the receipt of RTLH funds is a challenge. In this study, two effective multi-criteria decision-making methods, VIKOR Method and Analytical Hierarchy Process (AHP), are implemented to prioritize the receipt of RTLH funds. The combination of these two methods is expected to provide more accurate and accountable results. It is hoped that this research can provide a more holistic and objective method in prioritizing the receipt of RTLH assistance funds. The integration of the VIKOR Method and AHP can provide benefits in making similar decisions in other social and humanitarian fields, as well as helping the government and related institutions in allocating resources more efficiently and fairly. The results of this research are expected to help decision makers prioritize the receipt of RTLH funds objectively and fairly, by considering various relevant criteria.

A. Introduction

Padang City, as one of the major cities in Indonesia, faces various challenges in addressing housing issues for underprivileged residents. Inadequate housing is a serious issue in the city, with many residents living in inadequate and uninhabitable conditions. This condition can have a negative impact on health, safety, and overall quality of life..

The government and social organizations in Padang City are trying to tackle the RTLH problem by allocating funds for home repair assistance to those in need. However, with limited resources, an appropriate method is needed to prioritize the receipt of RTLH grants. This decision must be efficient, fair, and based on objective evaluation.

The VIKOR method and Analytical Hierarchy Process (AHP) have proven to be effective methods in solving multi-criteria prioritization problems. Using these two methods together is expected to provide more accurate and comprehensive results in prioritizing the receipt of RTLH funds in Padang City.

The VIKOR method will help in balancing the advantages and disadvantages of each alternative house applying for assistance. Relevant criteria such as the physical condition of the house, family income level, number of family members, and access to basic services will be assessed and calculated to obtain an optimal compromise solution.

Meanwhile, the AHP method will be used to determine the relative weight of each criterion based on the assessment of various stakeholders in Padang City. Opinions from experts, citizens and relevant institutions will be taken to determine the relative importance of each criterion.

In the context of Padang City, where RTLH problems affect many residents and limited resources need to be managed wisely, the implementation of these two methods will provide significant benefits. Decisions on the prioritization of RTLH grants will be more transparent, supported by measurable data and assessments, and result in a more efficient and fair allocation of resources.

It is hoped that the results of this research can guide the government and related institutions in Padang City to make more informed decisions in prioritizing the receipt of RTLH funds. In addition, this research can also contribute to the development of similar decision-making methods in the context of housing and social welfare in other cities in Indonesia and around the world.

B. Research Method

RTLH is the opposite of a livable house, which is a house that does not meet the requirements of a livable house, is not structurally sound, does not meet the per capita standard, and is dangerous and/or unhealthy for its occupants [1]. Uninhabitable House (RTLH) can be classified as a dwelling or residence that is uninhabitable due to technical and non-technical failures in meeting housing requirements [2]. Realizing decent settlements and housing is stated in Law Number 1 of 2011 Article 54 Paragraph (2) and Paragraph (3) states that the government and / or local governments are obliged to provide ease of development and acquisition of housing through a gradual and sustainable housing development planning program. The Uninhabitable House Assistance Program is an assistance for the poor to occupy habitable houses. The purpose of the

Uninhabitable House Assistance Program is to help low-income people to have livable homes [3]. Based on data from the Central Bureau of Statistics of West Sumatra Province in 2022, the number of RTLH in Padang city amounted to 8400 housing units.

A. VIKOR

VIKOR is one of the methods used in multi-attribute decision making (MADM). The proposed procedure is to calculate the ideal solution for each criterion by considering the criteria and weights of each alternative as well as the corresponding utility and regret measures of each predetermined alternative [4]. The calculation stages using the vikor method are as follows [11]:

1. Criteria Normalization: The first step is to convert all criteria data into a uniform scale, thus allowing a fair comparison between the criteria. This normalization is often done by converting each criterion into a range of values between 0 and 1 [5]

$$R_{ij} = \frac{X_{ij} - X_{\min j}}{X_{\max j} - X_{\min j}} \quad (1)$$

Where :

- R_{ij} is the normalized value of alternative I against criterion J.
- X_{ij} is the initial value of alternative I against criterion J.
- $X_{\min j}$ is the minimum value of all alternatives against criterion J.
- $X_{\max j}$ is the maximum value of all alternatives against criterion j.

2. Giving Weight to Criteria: Decision makers give relative weight to each criterion, reflecting the degree of importance of each in the final decision. This weight reflects the preference or priority given to each criterion [6].
3. Determination of Positive and Negative Ideal Solutions: Positive ideal solutions are the alternatives with the highest score on each criterion, while negative ideal solutions are the alternatives with the lowest scores on each criterion. Positive ideal solutions are the most desirable for the criteria to be maximized (profit), while negative ideal solutions are the most desirable for the criteria to be minimized (sacrifice) [7].
4. VIKOR Score Calculation: For each alternative, VIKOR calculates a composite value reflecting the distance between a positive ideal solution and a negative ideal solution, taking into account the weight of the criterion. This score measures the degree to which each alternative approaches a positive ideal solution and to what extent it is far from a negative ideal solution [8],[9].

$$S_i = W_j\left(R_{ij}\frac{R_j^* - R_j}{R_j^* - R_j^{**}}\right) \quad (2)$$

Where:

- S_i is Vikor's score for alternative i.
- $R_{ij}$is the normalized value of alternative i against criterion j (calculated in Step 1).
- R_j^* is the positive ideal solution (maximum value) of criterion J.
- R_j^{**} is the negative ideal solution (minimum value) of criterion j.

5. Ranking and Selection of Optimal Solutions: The alternative that has the highest VIKOR score is considered the optimal solution or the best choice. This score reflects the degree of compromise between preferences and conflicts present in the criteria data [10].

$$V_i = \frac{S_i - S_{min}}{S_{max} - S_{min}} \quad (3)$$

Where:
- V_i is Vikor's index for alternative i.
- $S_i$is Vikor's score for alternative i (calculated in Step 3).
- S_{min} is the minimum Vikor score among all alternatives.
- S_{max} is the maximum Vikor score among all alternatives.

6. Solusi alternatif terbaik berdasarkan nilai Q minimum menjadi terbaik dengan menggunakan persamaan (4) dan (5)

$$Q(A^2) - Q(A^2) \geq DQ \quad (4)$$

Dimana :
- A^2 = alternatif urutan ke 2 pada perengkingan Q
- A^1 = alternatif urutan pertama pada perangkingan Q

$$DQ = \frac{1}{(m-1)} \quad (5)$$

Dimana :
- m = jumlah alternatif

The VIKOR method is suitable for use in the context of multi-criteria decision-making, such as site selection, product evaluation, project development, and preference studies such as in research on tourist destination preferences in West Sumatra. This approach helps map the preferences and interests of decision-makers more systematically, thus facilitating a more effective and data-driven decision-making process.

B. ANALYTICAL HIERARCHY PROCESS (AHP)

AHP assigns a subjective value to the relative importance of each variable and determines which variable has the highest priority to address its impact on the outcome. This is a method of solving complex and unstructured situations into several components in a hierarchical structure [12]. The calculation procedure/steps in using the AHP method are as follows [13]:

1. Determine the reference data.
2. Determine reference values through pairwise comparisons based on a comparison scale of 1 to 9 (according to theory). This data becomes the data matrix.
3. Sum the value of each column of the matrix that has been made before.
4. Divide each value in a column by the number of columns to get a normalization matrix. The resulting data is normalized data.
5. Sum the values in each row and divide by the number of elements to get the average value. The resulting data is priority data for each criterion.
6. Multiply each value in the first column by the relative priority of the first element, and multiply the value in the second column by the relative priority of the second element.
7. Add each row.
8. The sum of a row is divided by the corresponding relative priority factor.
9. Sum the above quotient and the number of elements present. The result is called λ max.
10. Calculate the consistency index (CI) with the following formula [14]::

$$Ci = \frac{(\lambda \max - n)}{n} \quad (6)$$

Where :

- CI = Consistency Index
- λ max = The largest eigenvalue of a matrix of order n
- n is the number of elements.

11. Calculate the consistency ratio (CR) using the following formula [14]:

$$CR = \frac{CI}{IR} \quad (7)$$

Where :

- CI = Consistency Index
- IR = indeks konsistensi acak.

C. Result and Discussion

The data used in the analysis using AHP and Vikor methods amounted to 30 primary data which can be seen in table 1 below:

Table 1. Primaty Data

Name	Jobs	Total Income	Home Ownership Status	Floor Type	Number of Dependents / person
A1	Retired civil servants	Rp 4,000,000	Sendiri	Keramik	0
A2	Fisherman	Rp 1,500,000	Sendiri	Semen	3
A3	Farmers	Rp 2,000,000	Sendiri	Semen	4
A4	Farmers	Rp 2,000,000	Orang Tua	Keramik	3
A5	Driver	Rp 3,000,000	Orang Tua	Keramik	3
A6	Farmers	Rp 1,000,000	Sendiri	Semen	4
A7	Housewife	Rp 1,000,000	Sendiri	Keramik	0
A8	Housewife	Rp 300,000	Sendiri	Semen	0
A9	Farmers	Rp 700,000	Keluarga	Semen	4
A10	Farmers	Rp 1,000,000	Sendiri	Semen	2
A11	Farmers	Rp 400,000	Sendiri	Semen	3
A12	Fisherman	Rp 1,000,000	Orang Tua	Semen	2
A13	Fisherman	Rp 1,000,000	Orang Tua	Semen	4
A14	Civil Servant	Rp 7,000,000	Sendiri	Semen	3
A15	Mechanic	Rp 5,000,000	Keluarga	Semen	3
A16	Retired civil servants	Rp 3,500,000	Sendiri	Keramik	2
A17	Farmers	Rp 400,000	Sendiri	Semen	0
A18	Indonesian National Army	Rp 6,000,000	Orang Tua	Keramik	4
A19	Furniture craftsmen	Rp 3,000,000	Sendiri	Semen	5
A20	Fisherman	Rp 500,000	Sendiri	Semen	4
A21	Merchant	Rp 1,000,000	Sendiri	Semen	2
A22	Merchant	Rp 2,000,000	Kontrak	Semen	3
A23	Merchant	Rp 900,000	Sendiri	Semen	3
A24	Farmers	Rp 500,000	Orang Tua	Semen	3
A25	Civil Servant	Rp 7,500,000	Sendiri	Keramik	0
A26	Mechanic	Rp 500,000	Sendiri	Keramik	2
A27	Honorary Employee	Rp 1,500,000	Orang Tua	Keramik	2
A28	Farmers	Rp 1,000,000	Orang Tua	Semen	1
A29	Farmers	Rp 1,000,000	Sendiri	Semen	3
A30	Farmers	Rp 700,000	Sendiri	Semen	3

Analytical Hierarchy Process (AHP)

Based on the data in the table above, the first step that must be taken is to determine the value of criteria using pairwise comparisons based on a comparison scale of 1-9 which can be seen in table 2 below:

Table 2. Pairwise Criteria Matrix

Criteria	C1	C2	C3	C4	C5
C1	1.00	0.50	0.20	5.00	3.00
C2	2.00	1.00	0.33	5.00	7.00
C3	5.00	3.00	1.00	0.33	5.00
C4	0.20	0.20	3.00	1.00	0.50
C5	0.33	0.14	0.20	2.00	1.00

From the calculation of the matrix table above, then calculate the weight value of the criteria which can be seen in the table below:

Table 3. Criteria Weight Value

Criteria	C1	C2	C3	C4	C5	P. VECTOR	WEIGHT
C1	0.12	0.10	0.04	0.38	0.18	**0.82**	**0.16**
C2	0.23	0.21	0.07	0.38	0.42	**1.31**	**0.26**
C3	0.59	0.62	0.21	0.03	0.30	**1.74**	**0.35**
C4	0.02	0.04	0.63	0.08	0.03	**0.80**	**0.16**
C5	0.04	0.03	0.04	0.15	0.06	**0.32**	**0.06**

Vikor

The first step in calculating using the vikor method is to identify the alternative weight values for each criterion used and find the normalization matrix value using equation (1).

Table 4. Normalization Data

Alternative	C1	C2	C3	C4	C5
A1	0.86	1.00	0.50	1.00	1.00
A2	0.43	0.50	0.50	0.00	0.50
A3	0.71	0.50	0.50	0.00	0.50
A4	0.71	0.50	1.00	1.00	0.50
A5	0.29	0.50	1.00	1.00	0.50
A6	0.71	0.00	0.50	0.00	0.50
A7	1.00	0.00	0.50	1.00	1.00
A8	1.00	0.00	0.50	0.00	1.00
A9	0.71	0.00	1.00	0.00	0.50
A10	0.71	0.00	0.50	0.00	0.50
A11	0.71	0.00	0.50	0.00	0.50
A12	0.43	0.00	1.00	0.00	0.50
A13	0.43	0.00	1.00	0.00	0.50
A14	1.00	1.00	0.50	0.00	0.50
A15	0.14	1.00	1.00	0.00	0.50
A16	0.86	1.00	0.50	1.00	0.50

A17	0.71	0.00	0.50	0.00	1.00
A18	1.00	1.00	1.00	1.00	0.50
A19	0.57	0.50	0.50	0.00	0.00
A20	0.43	0.00	0.50	0.00	0.50
A21	0.57	0.00	0.50	0.00	0.50
A22	0.57	0.50	0.00	0.00	0.50
A23	0.57	0.00	0.50	0.00	0.50
A24	0.71	0.00	1.00	0.00	0.50
A25	1.00	1.00	0.50	1.00	1.00
A26	0.14	0.00	0.50	1.00	0.50
A27	0.00	0.50	1.00	1.00	0.50
A28	0.71	0.00	1.00	0.00	1.00
A29	0.71	0.00	0.50	0.00	0.50
A30	0.71	0.00	0.50	0.00	0.50

Based on the table above, the next step is to multiply the weight value of the criteria that have been obtained in the calculation process using the AHP method with the normalization value using equation (2).

Table 5. Weight Multiplication Data

Alternative	**C1**	**C2**	**C3**	**C4**	**C5**
A1	0.14	0.26	0.17	0.16	0.06
A2	0.07	0.13	0.17	0.00	0.03
A3	0.12	0.13	0.17	0.00	0.03
A4	0.12	0.13	0.35	0.16	0.03
A5	0.05	0.13	0.35	0.16	0.03
A6	0.12	0.00	0.17	0.00	0.03
A7	0.16	0.00	0.17	0.16	0.06
A8	0.16	0.00	0.17	0.00	0.06
A9	0.12	0.00	0.35	0.00	0.03
A10	0.12	0.00	0.17	0.00	0.03
A11	0.12	0.00	0.17	0.00	0.03
A12	0.07	0.00	0.35	0.00	0.03
A13	0.07	0.00	0.35	0.00	0.03
A14	0.16	0.26	0.17	0.00	0.03
A15	0.02	0.26	0.35	0.00	0.03
A16	0.14	0.26	0.17	0.16	0.03
A17	0.12	0.00	0.17	0.00	0.06
A18	0.16	0.26	0.35	0.16	0.03
A19	0.09	0.13	0.17	0.00	0.00
A20	0.07	0.00	0.17	0.00	0.03
A21	0.09	0.00	0.17	0.00	0.03
A22	0.09	0.13	0.00	0.00	0.03
A23	0.09	0.00	0.17	0.00	0.03

A24	0.12	0.00	0.35	0.00	0.03
A25	0.16	0.26	0.17	0.16	0.06
A26	0.02	0.00	0.17	0.16	0.03
A27	0.00	0.13	0.35	0.16	0.03
A28	0.12	0.00	0.35	0.00	0.06
A29	0.12	0.00	0.17	0.00	0.03
A30	0.12	0.00	0.17	0.00	0.03

The next step is to calculate the vikor value using equation (3) with a value of v = 0.5 which can be seen in the table below:

Table 6. Vikor Value and Ranking

Alternative	**Q**	**RANK**
A1	0.68	23
A2	0.21	14
A3	0.24	15
A4	0.87	29
A5	0.83	28
A6	0.15	5
A7	0.32	16
A8	0.20	13
A9	0.67	21
A10	0.15	5
A11	0.15	5
A12	0.64	18
A13	0.64	18
A14	0.56	17
A15	0.79	26
A16	0.66	20
A17	0.17	10
A18	1.00	30
A19	0.20	12
A20	0.11	2
A21	0.13	3
A22	0.00	1
A23	0.13	3
A24	0.67	21
A25	0.70	25
A26	0.19	11
A27	0.79	27
A28	0.69	24
A29	0.15	5
A30	0.15	5

From the ranking results above, the next step is to find the value of the compromise solution using equations (4) and (5). Where the DQ value of 0.034 is smaller than the resulting difference value, so that the Acceptable Advantage condition can be met..

D. Conclusion

A decision support system using the Vikor and AHP methods can help and facilitate in determining the acceptance of uninhabitable house assistance. Using the AHP method can determine the weight of each criterion that will be used in the calculation of the VIKOR method which is very useful for making decisions and ranking compromising alternatives from several available alternatives. Of the 30 alternatives tested, the value of alternative A22 is ranked 1 with a value of 0.0.

E. Acknowledgment

Acknowledgments Thanks researchers speak to Mr / Mrs Chairman of the Higher Education Foundation University Putra Indonesia YPTK Padang has funded research in the Research Grants Lecturer Year 2022. And thanks to Mr. Chancellor and leaders, lecturers and parties who have helped in this research.

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