

Decision support system algorithm for the beneficiary of uninhabitable housing funds

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Abstract. Poverty is one of the big problems facing the people of Indonesia. This problem evidenced by the existence of 3.4 million Indonesians living in settlements that are not livable. This problem is also a concern of the government by providing financial assistance for homes that are not livable. But in reality, the available aid is often not on target, not on a budget, and not on time. The purpose of this research is to implement the El Choination El Choix Traduisant La Realite (ELECTRE) algorithm as a decision support system to provide recommendations for potential recipients who deserve assistance from the government. System testing is done by inputting 46 prospective beneficiary data with predetermined criteria. The results showed the ELECTRE algorithm was able to provide recommendations with an accuracy rate of 86.9%. This result indicates that the decision support system using the ELECTRE method can use as an alternative to the efficiency of determining the prospective beneficiaries of uninhabitable housing in Indonesia.

1. Introduction

Housing problems in Indonesia that occur up to 2018 are referred to as backlogs/housing shortages, especially for low-income people reaching 15.5 million units and slum conditions of 37,407 hectares, with a population of 3.4 million [1]. The feasibility of a place to live is seen not only from the state of the house but due to other factors, for example, due to natural disasters, the wrong choice of locations, pollution, environmental pollution, including the legality of land ownership is a consideration in the procurement of housing [1]. The Indonesian government has anticipated this problem by making the program to provide self-help housing funds or homes uninhabitable. This government regulation is regulated in Ministerial Decree Number 13/PRT/M/2016 [2]. But in practice, the assistance provided is sometimes not right on target or not the right amount [3]. For this reason, a decision support system is needed that can determine the eligibility of beneficiaries more objectively.

There have been many studies that utilize algorithms to provide easy decision making. One algorithm that famous is El Choination El Choix Traduisant La Realite (ELECTRE). The ELECTRE method was chosen because it can be used in situations where the selection criteria can be customized to the needs. Several previous studies have utilized this method in various aspects of life, including neutrosophic environment [4], recipients of poor rice [5], best employee/students [6–8], factors that



influence student laziness [9,10], election home industry [11], healthy food menu [12], best cooperative [13], even moisturizing cream selection [14], and cooking oil [15].

This study utilizes ELECTRE to facilitate the selection of prospective beneficiaries for uninhabitable housing. The reason for electing ELECTRE is that this method is a multi-criteria decision-making method that is used in conditions where alternatives that are less appropriate to the criteria are eliminated, and suitable options can be produced [16–19]. Prospective beneficiaries are selected based on criteria that are under the instruments of conducting the field survey.

2. Research method

In this study, the ELECTRE method is applied in the decision support system of determining the prospective recipient of non-livable self-help housing. The data tested is qualitative data conducted in West Java, Indonesia. Data collection in this study was carried out by observation in Ciamis District. The amount of data verified in this study is 46 data sourced from the results of field observations by the relevant agencies in 2018. The determination of prospective beneficiaries has several criteria and alternatives used. Assessment criteria include Age (C1), Work (C2), Income (C3), House atmosphere (C4), House roof condition (C5), House wall condition (C6), House floor condition (C7), and room area (C8).

Based on the assessment instruments used by the Republic of Indonesia Public Works and Housing Agency, weights were obtained for the eight criteria prepared. The weights for each measure shown in table 1.

Table 1. List assessment criteria and weights.

No.	Criteria	Preference weight	Requirements	Value
1	Age	3	>= 65 years old	3
			60 – 64 years old	2
			<= 59 years	1
2	Occupation	4	Small traders, taxi bike (medium)	2
			Fertility, porters (poor)	1
3	Income	4	>= IDR 1.000.000 (good)	3
			IDR 501.000 – IDR 999.000 (medium)	2
			<= IDR 500.000 (poor)	1
4	Ambiance	3	Clean	2
			Moderate	1
			Grumpy	3
5	Roof	5	Concrete (good)	3
			Roof tiles, asbestos (medium)	2
			Leaves, planting tile, reeds (poor)	1
6	House Wall	5	Walls, concrete (good)	3
			Zinc, plywood (medium)	2
			Bamboo, wood, rattan booths (poor)	1
7	House Floor	5	Ceramics, marble (fine)	3
			Wall, cement (medium)	2
			Soil, wood, sand, bamboo (poor)	1
8	Room size	5	>= 14 m ² (width)	3
			10 – 13 m ² (medium)	2
			<= 9 m ² (narrow)	1

Based on the research scenarios, the following is a list of the suitability ratings for each criterion, which is an example of calculating the implementation of the ELECTRE algorithm, as shown in table 2. After

knowing the suitability rating of each criterion, each candidate's conditions will convert into the value specified above contained in table 3.

Table 2. List of suitability ratings for each criterion.

Criteria	Name of Alternatives				
	Sair	Karna	Tatang	Enoh	Iwa
C1	62 years	66 years	64 years	64 years	60 years
C2	Construction laborer	Odd jobs	Taxi bike	Taxi bike	The trader
C3	IDR 600.000	IDR 450.000	IDR 700.000	IDR 1.000.000	IDR 500.000
C4	Moderate	Slums	Clean	Medium	Medium
C5	Asbestos	Leaf	Tile	Roof	Tile
C6	Zinc	Wood	Plywood	Zinc	Rattan
C7	Cement	Soil	Cement	Cement	Brick wall
C8	11 m ²	8 m ²	9 m ²	9 m ²	12 m ²

Table 3. List of alternative values.

Candidates	Criteria							
	C1	C2	C3	C4	C5	C6	C7	C8
Sair	2	1	2	2	2	2	2	2
Karna	3	1	1	1	1	1	1	1
Tatang	2	2	2	3	2	2	2	1
Enoh	2	2	3	2	2	2	2	1
Iwa	2	2	1	2	2	1	2	2

Table 3 is a table of criteria values of each alternative, as outlined in the table form. Then the weight update will be done first. From the previous weighting $W = (3, 4, 4, 3, 5, 5, 5, 5)$. Several steps of the algorithm must be completed in the ELECTRE algorithm, including the following steps [20–23]:

2.1. Normalization of the provision matrix can be changed to a comparable value

$$R_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^m x_{ij}^2}} \text{ for } i=1,2,3,\dots,m \text{ and } j=1,2,3,\dots,n$$

C1-C8 calculations are done by applying the formula above. So, we get the normalized R matrix, as shown below:

$$= \begin{bmatrix} 0,4 & 0,2673 & 0,4588 & 0,4264 & 0,4851 & 0,5345 & 0,4851 & 0,6030 \\ 0,6 & 0,2673 & 0,2294 & 0,2132 & 0,2425 & 0,2673 & 0,2425 & 0,3015 \\ 0,4 & 0,5354 & 0,4588 & 0,6396 & 0,4851 & 0,5345 & 0,4851 & 0,3015 \\ 0,4 & 0,5354 & 0,6882 & 0,4264 & 0,4851 & 0,5345 & 0,4851 & 0,3015 \\ 0,4 & 0,5354 & 0,5345 & 0,4264 & 0,4851 & 0,2673 & 0,4851 & 0,6030 \end{bmatrix}$$

2.2. Weighting in a normalized matrix

After normalizing, the column of matrix R will be multiplied with the weights (w_j) that have been determined by the decision-maker. The respective criteria that have been determined are $W = (3,4,4,3,5,5,5,5)$. From the calculation, get the matrix results below:

$$= \begin{bmatrix} 1,2 & 1,0692 & 1,8352 & 1,2792 & 2,4255 & 2,6725 & 2,4255 & 3,015 \\ 1,6 & 1,0692 & 0,9176 & 0,6396 & 1,2125 & 1,3365 & 1,2125 & 1,5075 \\ 1,2 & 2,138 & 1,8352 & 1,9188 & 2,4255 & 2,6725 & 2,4255 & 1,5075 \\ 1,2 & 2,138 & 2,7528 & 1,2792 & 2,4255 & 2,6725 & 2,4255 & 1,5075 \\ 1,2 & 2,138 & 0,9176 & 1,2792 & 2,4255 & 1,3365 & 2,4255 & 3,015 \end{bmatrix}$$

2.3. Determine and calculation of the concordance and discordance set on the index

Concordance. A criterion in an alternative in concordance if: $C_{kl} = \{j, V_{kj} \geq V_{ij}, \text{ for } j = 1, 2, 3, \dots, n$

From the above calculation, the concordance matrix shown below:

$$C = \begin{bmatrix} - & 31 & 27 & 26 & 30 \\ 7 & - & 8 & 8 & 12 \\ 29 & 31 & - & 30 & 29 \\ 29 & 31 & 31 & - & 29 \\ 25 & 31 & 22 & 25 & - \end{bmatrix}$$

Discordance. A criterion in an alternative is in discordance if: $D_{kl} = \{j, V_{kj} < V_{ij}, \text{ for } j = 1, 2, 3, \dots, n$

From the calculation above we get the discordance matrix as follows:

$$D = \begin{bmatrix} - & 0,2653 & 0,7090 & 0,7090 & 0,8 \\ 1 & - & 1 & 1 & 1 \\ 1 & 0,2994 & - & 1 & 1 \\ 1 & 0,2180 & 0,6970 & - & 0,8214 \\ 1 & 0,2653 & 0,8862 & 1 & - \end{bmatrix}$$

2.4. Determine the concordance and discordance dominant matrices

Concordance. The F matrix as the dominant concordance matrix can be designed with the help of a threshold value, namely by comparing each element value of the concordance matrix with the threshold value.

$$C = \begin{bmatrix} - & 31 & 27 & 26 & 30 \\ 7 & - & 8 & 8 & 12 \\ 29 & 31 & - & 30 & 29 \\ 29 & 31 & 31 & - & 29 \\ 25 & 31 & 22 & 25 & - \end{bmatrix}$$

Threshold value with the following formula:

$$C_{ij} = \subseteq \\ \subseteq = \frac{31 + 27 + 26 + 30 + 7 + 8 + 8 + 12 + 29 + 31 + 30 + 29 + 29 + 31 + 31 + 29 + 25 + 31 + 22 + 25}{5(5 - 1)} = \frac{491}{20} = 24,55$$

So, the concordance matrix is shown as follows:

$$F = \begin{bmatrix} - & 1 & 1 & 1 & 1 \\ 0 & - & 0 & 0 & 0 \\ 1 & 1 & - & 1 & 1 \\ 1 & 1 & 1 & - & 1 \\ 1 & 1 & 0 & 1 & - \end{bmatrix}$$

Discordance. Matrix G, as the dominant discordance matrix, can be built with the help of a threshold value d.

$$D = \begin{bmatrix} - & 0,2653 & 0,7090 & 0,7090 & 0,8 \\ 1 & - & 1 & 1 & 1 \\ 1 & 0,2994 & - & 1 & 1 \\ 1 & 0,2180 & 0,6970 & - & 0,8214 \\ 1 & 0,2653 & 0,8862 & 1 & - \end{bmatrix}$$

The threshold value obtained is the following matrix elements:

$$G_{ij} = 1 \text{ if } G_{ij} \geq d \text{ and } 0 \text{ if } G_{ij} < d$$

$$d = \frac{0,2653 + 0,7090 + 0,7090 + 0,8 + 1 + 1 + 1 + 1 + 1 + 1 + 0,2994 + 1 + 1 + 1 + 0,2180 + 0,6970 + 0,8214 + 1 + 0,2653 + 0,8862 + 1}{5(5 - 1)} = \frac{15,6706}{20} = 0,78353$$

So, the obtained discordance matrix is as follows:

$$G = \begin{bmatrix} - & 0 & 0 & 0 & 1 \\ 1 & - & 1 & 1 & 1 \\ 1 & 0 & - & 1 & 1 \\ 1 & 0 & 0 & - & 1 \\ 1 & 0 & 1 & 1 & - \end{bmatrix}$$

2.5. Determine the dominant aggregate matrix

The E matrix as the dominant aggregate matrix is a matrix where each element is a multiplication of the elements of the matrix F with the element matrix G corresponding to the formula as follows:

$$E = \begin{bmatrix} - & 1 & 1 & 1 & 1 \\ 0 & - & 0 & 0 & 0 \\ 1 & 1 & - & 1 & 1 \\ 1 & 1 & 1 & - & 1 \\ 1 & 1 & 0 & 1 & - \end{bmatrix} \times \begin{matrix} E_{kl} = F_{kl} \times G_{kl} \\ \begin{bmatrix} - & 0 & 0 & 0 & 1 \\ 1 & - & 1 & 1 & 1 \\ 1 & 0 & - & 1 & 1 \\ 1 & 0 & 0 & - & 1 \\ 1 & 0 & 1 & 1 & - \end{bmatrix} \end{matrix} E = \begin{bmatrix} - & 0 & 0 & 0 & 1 \\ 0 & - & 0 & 0 & 0 \\ 1 & 0 & - & 1 & 1 \\ 1 & 0 & 0 & - & 1 \\ 1 & 0 & 0 & 1 & - \end{bmatrix}$$

2.6. Eliminate alternatives that are less favorable

The results of calculations using the ELECTRE method then obtained the highest rank, namely: Karna, Sair, Enoh, Iwa Udiwa, and Tatang.

3. Results and discussion

Tests conducted in this study were conducted in 2 ways, namely: black-box testing and Accuracy testing. Blackbox testing is done to test the functionality of the software created [24,25]. As for what is tested are: login to admin and agency officials, add criteria, edit criteria, delete criteria data, add alternatives, edit alternative data, delete alternative data, add assessments, display ELECTRE calculation results, display a list of candidates for potential beneficiaries, view the results calculations, display user lists, display user profiles, edit user profiles, add user lists, edit user levels, add web features, display admin profiles that are currently logged in, change passwords, edit admin profiles, and print ranking results. Based on the results of the black box test, all functions successfully display the results in accordance with the given command. This result indicates that the software can function correctly.

Accuracy testing is done by comparing the results displayed by the system with pre-existing results data. The data used is data from the relevant agencies regarding the list of recipients who are entitled to receive housing assistance in 2018. The formula for the accuracy of the data is as follows:

$$\text{Accuracy} = \frac{\text{Corresponding number}}{\text{Number of cases}} \times 100\%$$

Of the 46 data tested, 40 results were obtained that matched the results of the previous data. Inaccurate data, there are six alternatives or data on potential recipients of uninhabitable housing funds. This happens because there are several alternatives whose status in the data is eligible to receive financial assistance, but the system becomes inappropriate. Vice versa, the previous year's data was declared

unfeasible, and when tested in the system, it became feasible. Then the level of system accuracy is as follows:

$$\text{Accuracy} = \frac{40}{46} \times 100\% = 86,956 \%$$

4. Conclusion

A decision support system has been made to provide recommendations for potential recipients of uninhabitable housing. The system was built with the ELECTRE algorithm through 7 stages of calculation. Criteria in the assessment of decision making are in accordance with the instruments used by agencies in Indonesia, namely: age, occupation, income, the atmosphere around the house, roof, house walls, floor, and building area. Based on test results, the system is able to succeed through black-box testing. The level of system accuracy is 86.956%. This indicates that the system has a high degree of accuracy and can be used properly. In order to make it easier during the field survey, in the future, a better system can be made in the mobile version.

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