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The Elimination Et Choix Traduisant La Realite (ELECTRE) Method in Determining Priority for Acceptance of the Family Hope Program (Jorong Sawah Kareh Nagari Balimbing)

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Abstract. Poverty is a complicated issue to solve. Therefore the government held a program to help reduce poverty, the Family Hope Program (FHP). However, the problem is that FHP recipients are still not on target. Where the ELECTRE method is used to determine ranking by considering the importance level criterion of each, only a criterion is involved in cases with other alternatives. The results of the study using the ELECTRE method obtained that the alternative prioritized for FHP beneficiaries was the alternative with the top ranking for the number of alternatives prioritized depending on the decision maker, namely the Nagari Balimbing office.

Keywords: Family Hope Program (FHP), Elimination Et Choix Traduisant La Realite (ELECTRE) Method.

1 Introduction

The Family Hope Program (FHP) has a big mission to reduce the number of poor people, reduce inequality (gini ratio), and increase the Human Development Index (IPM). There are 3 (three) categories of FHP beneficiary families, are the following: the health category with the criteria for toddlers and pregnant women, the education category with the criteria for high school children, middle school children, and primary school children, and the social welfare level category in criteria for elderly aged over 60 years and persons with disabilities[1].

To realize FHP's mission, Nagari Balimbing integrated service and referral system staff screened data on residents who registered as poor to become potential FHP participants, which would be submitted to the central government. So far, to determine the people who are assisted through FHP, they have not yet calculated the values of each criterion or the level of importance of the criteria, so some of them are still not on target. Jorong Sawah Kareh Nagari Balimbing is one of the areas in Rambatan District, Tanah Datar Regency, with a population of 1429 people. As of December 2021, the number of poor people is 239 families. However, not all of these poor residents are FHP recipients. This study had 40 alternatives as respondents or potential FHP recipients.

Multi-Attribute Decision Making (MADM) is a method used to search for other optimal solutions through various alternatives according to specific criteria. The main point of MADM is to determine the weight values for all subsequent attributes through the ranking stages, which will later become alternative filters that have been proposed.[2]. Methods that can be used in filtering MADM problems include ELECTRE, Simple Additive Weighting (SAW), Weighted Product (WP), TOPSIS, and Analytic Hierarchy Process (AHP)[3]. In the case of settlement of priority FHP beneficiaries in this study using the ELECTRE method. Where the ELECTRE method is used in cases with various alternatives but few criteria are included, this method belongs to the analytical methods for making multi-criteria decisions coming from Europe in the 1960s. ELECTRE which stands for Elimination Et Choix Traduisant La Realite[4]. Alternatives stated that feature other alternatives when one or more of the criteria exceeds (if compared to the criteria through other alternatives) and are similar to other criteria. The relation of ranking of 2 alternatives A_k and A_l when the k-th alternative does not feature the first alternative quantitatively, which makes it superior to the decision to accept the risk $A_k$compared to the $A_l$alternative. [3].

This method has also been used in research by Gufron in cases where decision-making for scholarship recipients was made using the ELECTRE and SAW methods. The ELECTRE method is better based on the sensitivity test results than Simple Additive Weighting Method (SAW) method[2]. The main advantage of the ELECTRE method, according to Yosi et al., in the case of using the ELECTRE method in setting priorities for people who receive poor rice is that this method makes it easy to make decisions when making decisions that are accompanied by unclear and uncertain issues with various alternatives.[5]. Therefore the ELECTRE method is better used in cases with varied alternatives and few criteria.

2 Method

This research is applied through primary data from the source, namely families of prospective beneficiaries of the FHP Program, as many as 40 families in Jorong Sawah Kareh Nagari Balimbing in 2022. The data analysis steps are carried out to solve problems through the ELECTRE method, which includes on :

1. Normalization of the decision matrix

   Creates a comparison process that has pairs for all alternatives on each criterion (x_{ij}). Matrix normalization (r_{ij}) is calculated using the following equation:

$$\left(r_{ij}\right) = \frac{x_{ij}}{\sqrt{\sum_{i=1}^{m} x_{ij}^2}};\, where\ i = 1, 2, \dots, m \text{ and } j = 1, 2, \quad 3, \dots, n \tag{1}$$

   Which is achieved by matrix R from the normalization results,

$$R = \begin{bmatrix} r_{11} & r_{12} & \cdots & r_{1n} \\ r_{21} & r_{22} & \cdots & r_{2n} \\ \vdots & \vdots & & \vdots \\ r_{m1} & r_{m2} & \cdots & r_{mn} \end{bmatrix} \tag{2}$$

   Information: x_{ij}= value of the ith and jth alternative decision matrices
   r_{ij}= normalization of the decision matrix from the ith alternative i-th and the j-th criterion

2. Giving weights to matrices that have been normalized

After normalization, each column in the R matrix is multiplied by the weights (w_j) determined by the party making the decision.

$$W = (w_1, w_2, \ldots, w_n) \quad (3)$$

$$v_{ij} = w_j r_{ij} \quad (4)$$

So with equation (4), a weighted normalization matrix V is formed as follows:

$$V = \begin{bmatrix} v_{11} & v_{12} & \cdots & v_{1n} \\ v_{21} & v_{22} & \cdots & v_{2n} \\ \vdots & \vdots & & \vdots \\ v_{m1} & v_{m2} & \cdots & v_{mn} \end{bmatrix} \quad (5)$$

Information: V=weighted normalized matrix
w_j= weight criteria

3. Determine the set of concordance index and discordance index. For each alternative pair, it is carried out through a process of calculating the ranking relationship. Each alternative pair and the decision matrix for criterion j are divided into 2 subsets.kl $(k, l = 1, 2, \ldots, m; \text{dan } k \neq l)$
   a) The concordance index set shows the process of adding up the weight of the criteria where the alternative is superior to the alternative.$\{C_{kl}\} A_k A_l$

$$C_{kl} = \{j | v_{kj} \geq v_{lj}\}; \text{untuk } j = 1, 2, \ldots, n. \quad (6)$$

   b) The set of discordance index is presented below:$\{D_{kl}\}$

$$D_{kl} = \{j | v_{kj} < v_{lj}\}; \text{untuk } j = 1, 2, \ldots, n.$$

(7)

Information: C_{kl}= set of concordance indexes
D_{kl}=discordance index set
v_{kj}= elements of matrix V for the k alternative in the jth criterion
v_{lj}= elements of matrix V for alternative l in the jth criterion

4. The concordance matrix (C) contains all the parts that are calculated through the concordance index and relate to attribute weights through the use of the following equation:

$$c_{kl} = \sum\nolimits_{i \in C_{kl}} W_j \quad (8)$$

So the concordance matrix is obtained as follows:

$$C = \begin{bmatrix} - & c_{12} & c_{13} & \cdots & c_{1n} \\ c_{21} & - & c_{23} & \cdots & c_{2n} \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ c_{m1} & c_{m2} & c_{m3} & \dots & - \end{bmatrix} \quad (9)$$

Description: for the diagonal on the matrix, there is no value because of the comparison with yourself, so that $(-)$

5. The discordance matrix (D) contains each part that is calculated through the discordance index. The calculation process is carried out through the following equation:

$$d_{kl} = \frac{\max\{|v_{kj} - v_{ij}|\} j \in D_{kl}}{\max\{|v_{kj} - v_{ij}|\} \forall j} \quad (10)$$

So that the discordance matrix is obtained as follows:

$$D = \begin{bmatrix} - & d_{12} & d_{13} & \cdots & d_{1n} \\ d_{21} & - & d_{23} & \cdots & d_{2n} \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ d_{m1} & d_{m2} & d_{m3} & \dots & - \end{bmatrix} \quad (11)$$

Information: c_{kl}= concordance index
d_{kl}= discordance index

6. The determination of the dominant concordance matrix is determined through the use of a threshold value, where:

$$\underline{c} = \frac{\sum_{k=1}^{m} \sum_{l=1}^{m} C_{kl}}{m(m-1)} \quad (12)$$

Information: $\underline{c}$= threshold concordance value
m=many alternatives

7. The alternative A_k has the opportunity to highlight A_l if the concordance index C_{kl} exceeds the threshold c.
Each part of the dominant concordance matrix F is determined as follows:

$$f_{kl} = \begin{Bmatrix} 1, \text{if } C_{kl} \geq \underline{c} \\ 0, \text{if } C_{kl} < \underline{c} \end{Bmatrix} \quad (13)$$

The same thing can also be used for the dominant discordance matrix G, defined as follows:

$$\underline{d} = \frac{\sum_{k=1}^{m} \sum_{l=1}^{m} D_{kl}}{m(m-1)} \quad (14)$$

Moreover, all parts of the dominant discordance matrix G are determined as follows:

$$g_{kl} = \begin{Bmatrix} 1, \text{if } d_{kl} \geq \underline{d} \\ 0, \text{if } d_{kl} < \underline{d} \end{Bmatrix} \quad (15)$$

Description: f_{kl}= the value of the dominant concordance matrix
c = value of the threshold (threshold) concordance
g_{kl}= the value of the dominant discordance matrix

$\underline{d}$= value of the threshold (threshold) discordance

8. Dominant matrix aggregation (E) in showing partial preference order through all alternatives, is achieved through:

$$e_{kl} = f_{kl} \times g_{kl} \tag{16}$$

Information: e_{kl}= dominant matrix value of aggregation
9. Perform ranking, if it $e_{kl} = 1$ indicates which alternative A_k is preferred over the alternative A_l[3][4]

3 Results and Discussion

All the respondents' rating score refers to the weight of preferences. The preference weights and rating scores on all criteria can be seen in Table 1.

Table 1. The weighting of the Criteria refers to the Conformity Rating

Criteria	Range	Questionnaire Rating Criteria	Weight: Preference Weight (W)	Weight: Priority Scale
Income	<IDR 1,000,000	4	4	Very high
	Rp. 1,000,000-Rp. 1,500,000	3		
	Rp. 1,500,000-Rp. 2,000,000	2		
	>Rp. 2,000,000	1		
Education Responsibility	3 people or more	4	3	Tall
	2 persons	3		
	1 person	2		
	0 (no family members)	1		
Health coverage	3 people or more	4	1	Very low
	2 persons	3		
	1 person	2		
	0 (no family members)	1		
Social welfare responsibility	3 people or more	4	2	Low
	2 persons	3		
	1 person	2		
	0 (no family members)	1		

The summary results of the conformity rating score of all alternatives on each criterion refer to what the respondent answered in the form of a decision matrix as follows:

$$X_{40,4} = \begin{bmatrix} 4 & 1 & 1 & 2 \\ 4 & 4 & 1 & 1 \\ 4 & 2 & 3 & 1 \\ 3 & 2 & 1 & 2 \\ \vdots & \vdots & \vdots & \vdots \\ 3 & 2 & 2 & 1 \end{bmatrix}$$

3.1 Normalization of the decision matrix

The calculation process in determining the elements in the normalization matrix can be carried out through equation (1) which is achieved by the decision matrix R below:

$$R_{40,4} = \begin{bmatrix} 0{,}208232 & 0{,}05998 & 0{,}11785 & 0{,}21567 \\ 0{,}208232 & 0{,}2399 & 0{,}11785 & 0{,}10783 \\ \vdots & \vdots & \vdots & \vdots \\ 0{,}156174 & 0{,}11995 & 0{,}2357 & 0{,}10783 \end{bmatrix}$$

3.2 Weighting on the matrix that has been normalized

After normalization, all matrix R columns are multiplied against the weights which form matrix V, then a weighted normalized matrix is obtained using equation (4) as follows:

$$v_{1,1} = (4)(0{,}208232) = 0{,}83293$$
$$v_{2,1} = (4)(0{,}208232) = 0{,}83293$$
$$\vdots$$
$$v_{40,4} = (2)(0{,}10783) = 0{,}21567$$

So that a matrix V is formed, which is a weighted normalized matrix

$$V_{40,4} = \begin{bmatrix} 0{,}83293 & 0{,}17993 & 0{,}11785 & 0{,}43133 \\ 0{,}83293 & 0{,}71971 & 0{,}11785 & 0{,}21567 \\ \vdots & \vdots & \vdots & \vdots \\ 0{,}6247 & 0{,}35986 & 0{,}2357 & 0{,}21567 \end{bmatrix}$$

3.3 Determine the set of the Corcordane index and Discordance index

It is said that the set of concordance index if $\mathbf{C_{kl}} = \{\mathbf{j} | \mathbf{v_{kj}} \geq \mathbf{v_{lj}}\}$

The calculation of the Concordance set is obtained through the use of all parts of the V matrix. This stage is carried out to select the criteria included in the Concordance set. From the arithmetic process, a value of 0 does not belong to the concordance set but includes the discordance set. So that the concordance set includes the following:

$$C_{1,2} = \{1, 3{,}4\}$$
$$C_{2,1} = \{1, 2{,}3\}$$
$$\vdots$$
$$C_{40,40} = -$$

It is said that the set of discordance index if $\mathbf{D_{kl}} = \{\mathbf{j} | \mathbf{v_{kj}} < \mathbf{v_{lj}}\}$

The process of calculating the discordance set is achieved through the use of all parts of the V matrix. This stage is carried out in order to carry out the selection of criteria that are included in the discordance set. From the arithmetic process, a value of 0 does not belong to the discordance set but includes the concordance set. So that includes the set of discordance including the following:

$$\begin{aligned} \mathrm{D}_{1,2} &= \{2\} \\ \mathrm{D}_{2,1} &= \{4\} \\ &\vdots \\ D_{40,40} &= - \end{aligned}$$

Concordance Matrix

After knowing which criteria are included in the Corcordance set, the next step is calculating the part of the Corcordance matrix. The calculation process is carried out through the operation to add the preference weight values in the Concordance set.

$$\begin{aligned} \mathrm{c}_{1,2} &= 4+1+2=7 \\ \mathrm{c}_{2,1} &= 4+3+1=8 \\ &\vdots \\ \mathrm{c}_{40,40} &= - \end{aligned}$$

From the results of adding up each preference weight, the Concordance matrix is obtained as follows:

$$\mathrm{C}_{40,40} = \begin{bmatrix} - & 7 & \cdots & 6 \\ 8 & - & \cdots & 9 \\ \vdots & \vdots & \ddots & \vdots \\ 4 & 3 & \cdots & - \end{bmatrix}$$

Discordance Matrix

The stages in determining each part of the discordance matrix divide the most significant score through the difference that enters the discordance set. The part of the discordance matrix can be achieved by subtracting the part of the matrix V that is included in the discordance set. From the results of the calculation using equation (10), the discordance matrix is obtained below:

$$\mathrm{D}_{40,40} = \begin{bmatrix} - & 1 & \cdots & 0{,}834 \\ 0{,}399 & - & \cdots & 0{,}327 \\ \vdots & \vdots & \ddots & \vdots \\ 1 & 1 & \cdots & - \end{bmatrix}$$

Concordance dominant matrix (F matrix)

Comparison calculation between the Concordance matrix through the threshold score is as follows:

$$\underline{\mathrm{c}} = \frac{\sum_{k=1}^{m} \sum_{l=1}^{m} \mathrm{C}_{kl}}{\mathrm{m}(\mathrm{m}-1)} = \frac{10711}{40(40-1)} = 6{,}86603$$

So that the dominant concordance matrix is obtained, namely the F matrix, through the use of equation (13) as follows:

$$\mathrm{F}_{40,40} = \begin{bmatrix} - & 1 & \cdots & 0 \\ 1 & - & \cdots & 1 \\ \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & \cdots & - \end{bmatrix}$$

Discordance dominant matrix (Matrix G)

The comparative calculation between the Discordance matrix and the threshold value is as follows:

$$\underline{d} = \frac{\sum_{k=1}^{m}\sum_{l=1}^{m} D_{kl}}{m(m-1)} = \frac{1022,2}{40(40-1)} = 0,6553$$

So that the dominant discordance matrix is obtained, namely matrix G, using equation (15) as follows:

$$G_{40,40} = \begin{bmatrix} - & 1 & \cdots & 1 \\ 0 & - & \cdots & 0 \\ \vdots & \vdots & \ddots & \vdots \\ 1 & 1 & \cdots & - \end{bmatrix}$$

3.4 Dominant matrix E

The dominant aggregate of the matrix, which results from multiplying the dots for the rows of matrix F by the rows in matrix G, is called the dominant matrix E. The multiplication results are as follows:

$$e_{kl} = f_{kl} \times g_{kl}$$
$$e_{1,2} = f_{12} \times g_{12} = 1 \times 1 = 1$$
$$e_{1,3} = f_{13} \times g_{13} = 0 \times 1 = 0$$
$$\vdots$$
$$e_{1,40} = f_{1,40} \times g_{1,40} = 0 \times 1 = 0$$

So that the dominant matrix E is obtained as follows:

$$E = \begin{bmatrix} - & 1 & \cdots & 0 \\ 0 & - & \cdots & 0 \\ \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & \cdots & - \end{bmatrix}$$

Note: There is no value for the diagonal on the matrix because of the comparison with oneself. Do ranking

Table 2. Value ranking results$e_{k,l} = 1$

Alternative	Amount	Ranking
A18	23	1
A3	22	2
A31	20	3
A15	19	4
A16	19	5
A17	19	6
A39	19	7
A40	19	8
A1	18	9
A12	15	10
A22	14	11
A14	11	12
A23	10	13
A36	10	14
A8	9	15

Alternative	Amount	Ranking
A10	9	16
A21	9	17
A4	8	18
A19	8	19
A24	8	20
A6	6	21
A9	6	22
A26	6	23
A29	6	24
A32	6	25
A34	6	26
A7	5	27
A2	3	28
A38	3	29
A5	3	30
A11	3	31
A33	3	32
A27	3	33
A30	3	34
A33	3	35
A20	2	36
A25	1	37
A28	1	38
A13	0	39
A37	0	40

Based on Table 2, you can see the ranking results and priority levels of FHP beneficiaries using the ELECTRE method by giving preference weights to each criterion based on the level of importance. The FHP beneficiary criteria used are the income of the head of the family and the number of dependents on the education, health, and social welfare components for alternatives A1, A2, …, A40. So that if the number of $e_{k,l} = 1$ value is significant compared to other alternatives, then that alternative is prioritized to receive FHP. Meanwhile, those $e_{k,l} = 1$ with the lowest number is not prioritized to receive FHP. Recommendations for FHP beneficiaries are based on the top ranking of the total values $e_{k,l} = 1$ in Table 2, which can be adjusted to the FHP beneficiary quota for Jorong Sawah Kareh available in the Nagari Balimbing government.

4 Conclusion

An analysis has been carried out to determine the priority of people who receive FHP using the ELECTRE method by considering the level of importance of each criterion by establishing a weight value for all criteria. The criteria involved are the income of the head of the family, education dependents, health dependents, and social welfare dependents, while for the alternatives involved, there are 40 alternatives or families. Then the priority of beneficiaries of the Family Hope Program (FHP) is the alternative with the top ranking, where the alternative that takes priority is the alternative with the dominant matrix value E or $e_{k,l} = 1$ greater. The value $e_{k,l} = 1$ is influenced by the suitability rating of each alternative and the preference weight. The number of prioritized alternatives depends on the decision maker, namely the Nagari Balimbing office.

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