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Decision Support System Of Pandemic Aid Recipiennts Using AHP *(Analytical Hierarchy Process)* Method

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ABSTRACT

The Covid-19 pandemic has had a negative impact on the Indonesian economy, thus prompting the government to pay great attention to the people at the grassroots level by holding aid programs. There are problems that occur in determining the recipients of assistance, namely there are criticisms and rejections regarding the inappropriateness of the target of assistance and there are obstacles faced by village officials in collecting data and determining which beneficiaries are prioritized or prioritized with those that are not prioritized, so that it is not in accordance with the Government's expectations that families Vulnerable categories are prioritized beneficiaries that should not be missed. Researchers think about implementing a Decision Support System using the AHP (Analytical Hierarchy Process) method in this problem with the aim of knowing how to implement a Decision Support System in the problem of determining beneficiaries during a pandemic and to find out how to apply the AHP method in determining prioritized or prioritized recipients or those who are not. not prioritized by utilizing criteria and alternative data. This study uses a quantitative method, where the application of the AHP method, the criteria and alternative data obtained will be converted into quantitative data through pairwise comparisons based on the level of importance between one criterion and another or a comparison between one alternative and another, so that the results obtained are quantitative value in the form of numbers. The results obtained are that the application of the AHP method can determine the priority weights of criteria and alternatives so that it can be determined which recipients are prioritized and who are not prioritized to receive assistance, namely there are 2 out of 5 alternatives with the highest priority weights that are prioritized to receive assistance.

1. Introduction

The current Covid-19 pandemic has public attention, and is a global pandemic defined by the World Health Organization [1][2]. This pandemic has caused a negative impact on the Indonesian economy due to limited economic activities due to efforts to prevent the spread of the virus [3][4]. Realizing this impact, the government pays great attention to creating various types of assistance programs to support the basic needs of the community and increase the purchasing power of people with low or low economic power. The aid program that has been running is judged to have not been right on target based on criticism regarding the inappropriateness of the aid target, there are also obstacles in collecting data and determining which beneficiaries are prioritized and which are not prioritized, in accordance with Government directives[5]. This problem will be more appropriate if applied in the field of computer-

based technology, namely Decision Support Systems because Decision Support Systems can assist in making accurate and well-targeted decisions [6][7].

Decision Support System for beneficiaries is applied using the AHP (Analytical Hierarchy Process) method, which is a method that can help solve multifactorial problems by determining pairwise comparisons in discrete or continuous form[8]. AHP can also solve complex problems or the structure of the problem is not clear [9][10]. With the application of the AHP method, each criterion and alternative will be compared based on their level of importance[11][12][13]. The comparison assessment of the importance of criteria and alternatives can provide a value or priority weight in the form of numbers so that it can be determined which recipients are prioritized or prioritized or who are not prioritized to receive assistance based on the results of the ranking of the priority weights[14].

This study was made to find out how the Decision Support System is applied in determining beneficiaries during a pandemic and to find out how to apply the AHP (Analytical Hierarchy Process) method in determining beneficiaries based on qualitative criteria and alternative data which is converted into quantitative data through pairwise comparisons with the AHP method.

Based on previous research, the Decision Support System for Direct Cash Assistance Recipients is Right on Target Using the AHP and K-Means Methods has been successfully carried out where first the prospective beneficiaries are grouped and then the determination is made using the AHP method [10]. The difference with this study is that there is no proper grouping of potential beneficiaries, meaning that the K-Means method is not used in this study. In this study, the AHP method can determine whether or not prospective recipients are eligible and also determine which recipients are prioritized to receive assistance without first grouping them, besides that, based on the data obtained, the weight of each criterion does not exist, but is obtained from a comparative assessment of each criterion.

2. Research Methods

2.1 Data Collection

The data needed in this study were obtained by conducting documentation studies and interviews[15]:

a) Documentation Study
   Obtaining data by analyzing source documents regarding assistance during the Covid-19 pandemic, or indirectly obtained from the object under study.

b) Interviews
   Obtaining data by asking direct questions or interviews with resource persons, in this case the Head of the Sibaragas Village Government Affairs Division regarding policies in data collection and requirements for Village Fund BLT candidates.

2.2 Data Analysis

a) AHP (Analytical Hierarchy Process) Method

The AHP method is a method that is able to solve problems with various complex criteria into a hierarchical [16]. The stages of the AHP method are [17][18][19][20]:

1) Define the problem and determine the desired solution, namely by determining several possible solutions to solve the problem.
2) Create a hierarchical structure. There are 3 hierarchical structures, namely: objectives, criteria and alternatives.

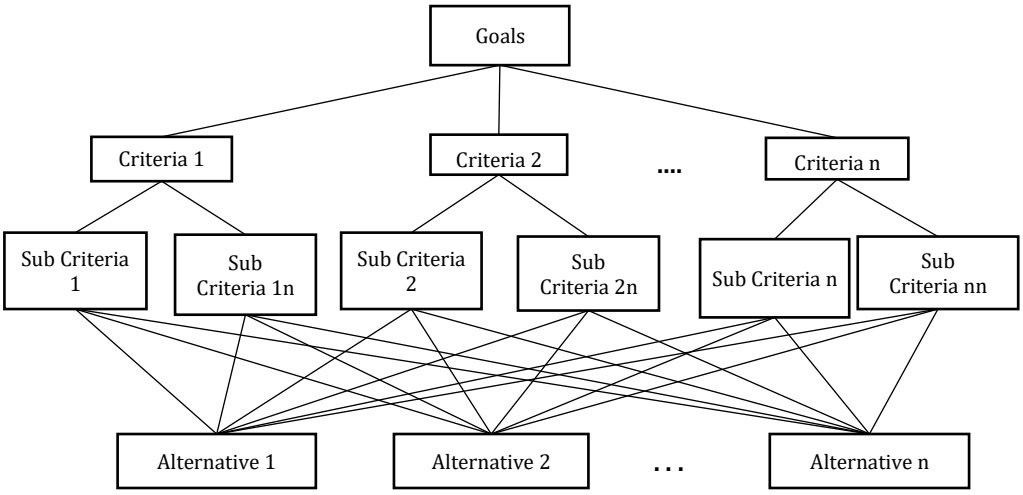

Fig. 1. AHP hierarchical structure[17][21]

3) Make a pairwise comparison matrix based on the judgment of decision makers by assessing the level of importance of an element compared to other elements, which is changed in the form of a matrix in order to perform the numerical calculation process. The following is a table of the importance of pairwise comparisons according to Saaty:

Table 1
Fundamental scale of paired comparison

Intensity of Interest on an absolute scale	Information	Explanation
1	Both elements are equally important *(Equal Importance)*	Two elements that have the same influence in decision making
3	One element is slightly more important than the other elements (moderate more importance).	A score is given when experience indicates that one element has little effect on the other elements.
5	One element is clearly more important than the other elements (essential, strong more importance)	One element is very influential compared to other elements.
7	One element is clearly more absolutely important than the other elements (demonstrate importance).	One very important and dominant element is seen in practice
9	One element is absolutely important than the other elements (absolutely more importance)	This value is given when one element is clearly more important
2,4,6,8	When in doubt between adjacent values (grey area).	This value is given when a compromise is needed regarding the priority scale.
1/(2-9)	Opposite	If criterion i gets one point when compared to criterion j, then j has the opposite value compared to i

4) Calculate the normalized Eigenvector which is the weight of each element. The way to calculate the normalized eigenvector is:
   a) Adding the results of the multiplication of rows and columns
   b) Sum the values of each column of the 1 matrix
   c) Divide each value from the column by the corresponding column total to obtain a normalized matrix.
   d) Add up the values of each row and divide by the number of elements to get the average.

5) Check the consistency of the hierarchy. The expected consistency is close to perfect, i.e. 10%, or 0.1, if it exceeds 0.1 it will cause consistency not 100% so it is advisable to re-do the pairwise comparison matrix[21][22].
   a) Determine the maximum eigenvalue (λMaks)
   b) Calculate the *Consistency Index* (CI) with the equation;

$$CI = \frac{\lambda \text{ maks} - n}{n-1} \quad (1)$$

Information:
n = Number of Criteria
CI = *Consistency Index*
λ = Eigen Value

   c) Calculate Ratio Consistancy with the equation;

$$CR = \frac{CI}{IR} \quad (2)$$

Information;
CR = Consistency Ratio
IR =Index Random Consistency
The value of the Random Consistency Index (IR) is obtained from the following table:

Table 2
Index random consistency

Ukuran Matriks (n)	1,2	3	4	5	6	7	8	9	10	11	12	13	14	15
Indeks Random(IR)	0,0	0,58	0,90	1,12	1,24	1,32	1,41	1,45	1,49	1,51	1,48	1,56	1,57	1,59

6) Repeat the calculation stages for each alternative to the criteria or sub-criteria.
7) Make a final calculation for each alternative by adding up the product of the normalized vector eigenvalues of each criterion with the normalized eigenvalues of each alternative.

3. Result and Discussion

3.1 Result

The following are the criteria for recipients of pandemic assistance;
C1 : Criteria for poor/poor families
C2 : Not a recipient of PKH/BPNT/Pre-Employment Card
C3 : Vulnerable Family
C4 : Domicile in Sibaragas Village
The alternatives obtained are as follows:
(A1) Mangihuthon Sihombing
(A2) Ranto Sihombing
(A3) Salow Nababan
(A4) Marnida Sarumpaet
(A5) Hasiholan Nababan

Table 3.
Matrix of comparison based on criteria

Criteria	C1	C2	C3	C4
C1	1	1	1/7	1
C2	1	1	1/7	1

Criteria	C1	C2	C3	C4
C3	7	7	1	7
C4	1	1	1/7	1

The table above is a pairwise comparison table between criteria made in the form of a square matrix / matrix A where; The diagonal of the matrix is worth 1 because it is the ratio between the same criteria. A12 is the comparison between the criteria for poor families (C1) and the criteria for not receiving PKH/BPNT/Pre-Employment (C2) is 1. A13 is the comparison between the criteria for poor families (C1) and the criteria for vulnerable families (C3) is 1/7. C1 is worth 1 while C3 is worth 7. A14 is a comparison between the criteria for poor families (C1) and the criteria for non-recipients. Domicile in Sibaragas Village (C4) is 1. And so on, comparisons are made based on the importance of the criteria.

Table 4
Result Of Comparative Matrix Of Criteria Pairs

Criteria	C1	C2	C3	C4
C1	1	1	0,14	1
C2	1	1	0,14	1
C3	7	7	1	7
C4	1	1	0,14	1
∑ Kolom	10	10	1,43	10

The table above is the result of a pairwise comparison of criteria where each fractional value is converted into decimal form and each element is added up per column (∑ Column).

a) Matrix normalization, which is dividing each element by the total column in question.

$$C_{11} = \frac{1}{10} = 0{,}10 \quad C_{12} = \frac{1}{10} = 0{,}10 \quad C_{13} = \frac{0{,}14}{1{,}43} = 0{,}10 \quad C_{14} = \frac{1}{10} = 0{,}10$$
$$C_{21} = \frac{1}{10} = 0{,}10 \quad C_{22} = \frac{1}{10} = 0{,}10 \quad C_{23} = \frac{0{,}14}{1{,}43} = 0{,}10 \quad C_{24} = \frac{1}{10} = 0{,}10$$
$$C_{31} = \frac{7}{10} = 0{,}70 \quad C_{32} = \frac{7}{10} = 0{,}70 \quad C_{33} = \frac{1}{1{,}43} = 0{,}70 \quad C_{34} = \frac{7}{10} = 0{,}70$$
$$C_{41} = \frac{1}{10} = 0{,}10 \quad C_{42} = \frac{1}{10} = 0{,}10 \quad C_{43} = \frac{1}{1{,}43} = 0{,}10 \quad C_{44} = \frac{1}{10} = 0{,}10$$

b) Determine the average priority weight

$$\text{Priority Weight C1} = \frac{0{,}10 + 0{,}10 + 0{,}10 + 0{,}10}{4} = 0{,}10$$
$$\text{Priority Weight C2} = \frac{0{,}10 + 0{,}10 + 0{,}10 + 0{,}10}{4} = 0{,}10$$
$$\text{Priority Weight C3} = \frac{0{,}70 + 0{,}70 + 0{,}70 + 0{,}70}{4} = 0{,}70$$
$$\text{Priority Weight C4} = \frac{0{,}10 + 0{,}10 + 0{,}10 + 0{,}10}{4} = 0{,}10$$

The results of normalization and priority weights are presented in the following table.

Table 5.
Normalization and weighting priority criteria

Criteria	C1	C2	C3	C4	Priority Weight
C1	0,10	0,10	0,10	0,10	0,10
C2	0,10	0,10	0,10	0,10	0,10
C3	0,70	0,70	0,70	0,70	0,70
C4	0,10	0,10	0,10	0,10	0,10

Calculate the consistency index (CI)

$$CI = \frac{\lambda maks - n}{n - 1}$$

$$CI = \frac{4 - 4}{4 - 1} = 0{,}00$$

Calculating consistency ratio (CR) Based on the provisions of the Random Consistency Index (IR) that a matrix of size 4 has a Random Index (IR) value of 0.90, then;

$$CR = \frac{CI}{IR}$$

$$CR = \frac{0{,}00}{0{,}90} = 0{,}00$$

The CR value is 0.1, then the calculation of the comparison matrix is consistent and acceptable, so the calculation process continues for alternatives Repeat the same calculation process for alternatives against each criterion.

Table 6
Alternative weight of criteria

Alternative/ criteria	C1	C2	C3	C4
A1	0,33	14	0,05	0,20
A2	0,11	14	0,05	0,20
A3	0,33	14	0,35	0,20
A4	0,11	14	0,50	0,20
A5	0,11	0,03	0,05	0,20

The table above is the result of the calculation or weight of each alternative against each criterion, where the weight value will be used for the final calculation or ranking.

Table 7
The final result

Alternative/Criteria	C1	C2	C3	C4	Hasil
A1	0,33 * 0,10	0,24 * 0,10	0,05* 0,70	0,20 * 0,10	0,11
A2	0,11 * 0,10	0,24 * 0,10	0,05* 0,70	0,20 * 0,10	0,09
A3	0,33 * 0,10	0,24 * 0,10	0,35* 0,70	0,20 * 0,10	0,32
A4	0,11 * 0,10	0,24 * 0,10	0,50 * 0,70	0,20 * 0,10	0,41
A5	0,11 * 0,10	0,03 * 0,10	0,05 * 0,70	0,20 * 0,10	0,09

The ranking results show that alternative A1 gets 0.11, alternative A2 gets a weight of 0.09, alternative A3 gets a weight of 0.32, alternative A4 gets a weight of 0.41, alternative A5 gets a weight of 0.09. Alternatives A4 and A3 are alternatives with the highest weight gain or prioritized alternatives.

The results of the application of the AHP method in this study can be stated that the weight of the criteria depends on the value of the comparison of the importance of these criteria with other criteria and the priority weight of each alternative depends on the comparison value of the alternative with other alternatives and the level of importance of the criteria fulfilled by the alternative compared to the level of importance of the criteria. filled with other alternatives.

After calculating the system implementation, which includes:

a) Criteria Menu Display

The Criteria Data menu displays the input form and the criteria table that has been inputted. The following is an image of the Criteria Data menu display;

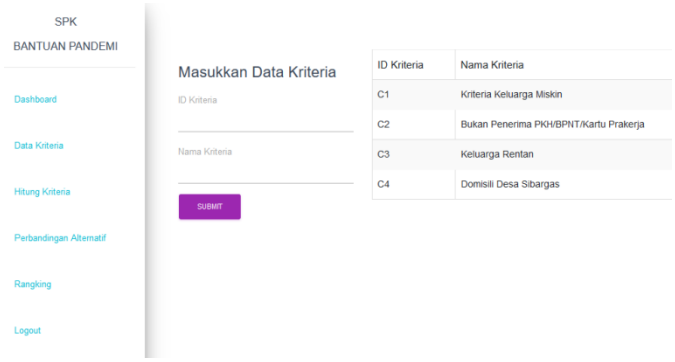

Fig 2. Data Criteria

This menu can only be accessed by Super Admin, namely to add criteria data. If criteria data is added, automatically the number of criteria to be compared will also increase on the Calculate Criteria menu.

b) Counting Criteria Menu Display

The Compute Criteria menu displays the criteria comparison input form and the calculation results of the AHP method. The following is the menu for calculating criteria.

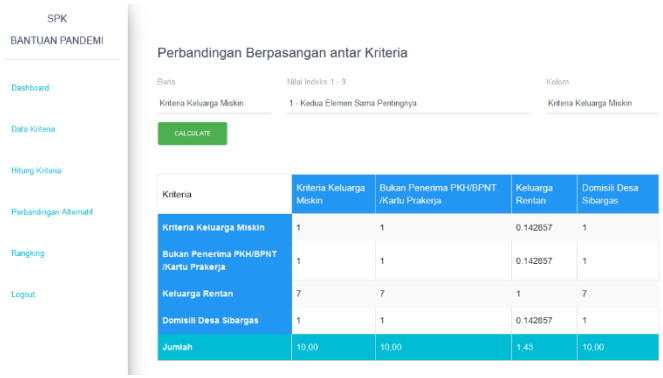

Fig 3. Criteria Counting

The user who has the right to access this menu is the Super Admin, where the Super Admin inputs the pairwise comparison value of each criterion according to the value of the criteria comparison provisions. After the value is input, the system will automatically perform calculations using the AHP method to obtain the priority weight of each criterion. The value of the priority weight of this criterion will later be multiplied by the weight of each alternative to determine the final value or ranking.

c) Alternative Data Menu Display

This menu displays input forms and alternative data tables or potential recipients of pandemic assistance. Here is the Alternative Data menu

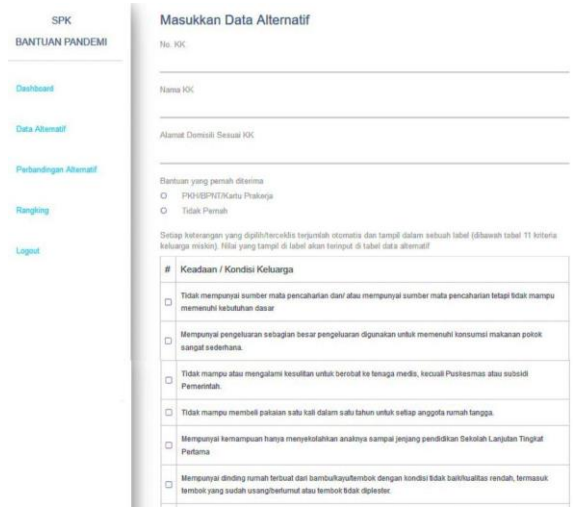

Fig 4. Alternative Data Menu

This menu can only be accessed by the admin, where the admin will input alternative data or the families of the prospective beneficiaries. The inputted data is automatically compared between one alternative to another, so from the results of the comparison the system will perform calculations using the AHP method to obtain the priority weight of each alternative.

d) Alternative Comparison Menu Display

Displays a table of criteria list as well as a “Compare” button to enter the alternative calculation view. Here's what the Alternative Comparison menu looks like

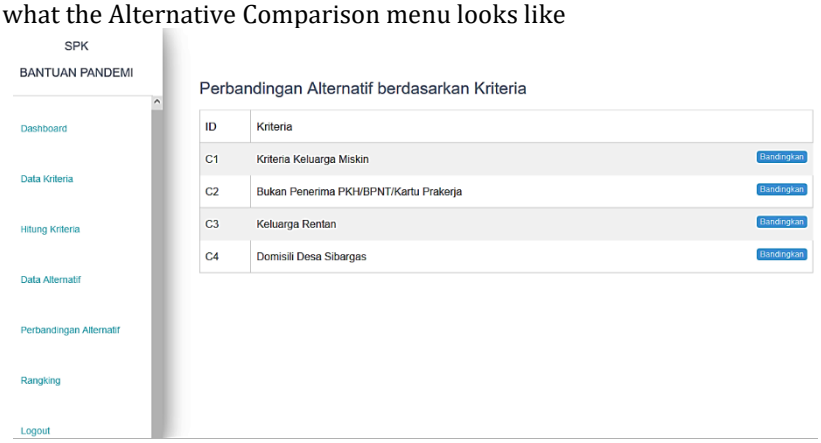

Fig 5. Alternative Comparison Menu

This menu is a form to display the calculation of each alternative against each criterion. Users can press the "Compare" button according to the position of the criteria row they want to display.

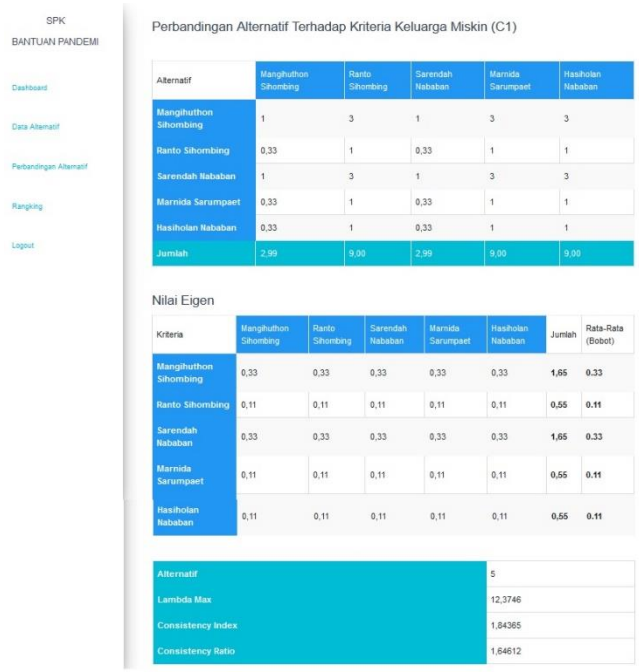

Fig 6. Compare Menu Calculations

The Fig. above is a display of the calculation of each alternative against the criteria after the "Compare" button is clicked. In this view, the user can only see the calculation results without having to input alternative comparison values, because the system has automatically made comparisons based on alternative data.

e) Ranking Menu Display

Displays the calculation of the weight of the criteria with alternative weights and an alternative ranking table. This menu can be accessed by Super admin or admin. The following is a display of the Ranking menu.

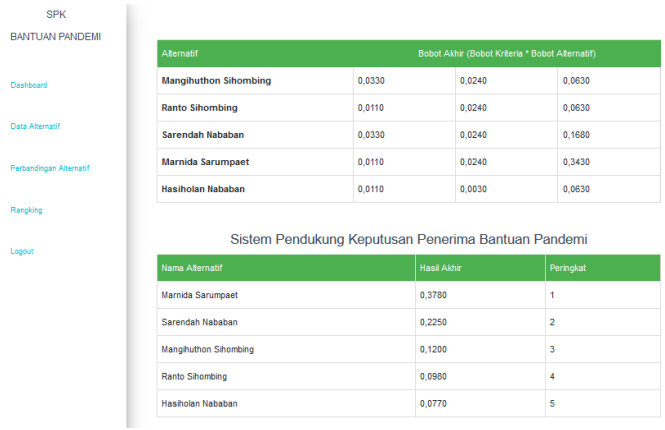

Fig 7. Ranking Menu

This menu can be accessed by Super Admin or admin. This menu is a display of the final calculation results and calculations to determine alternative rankings based on the weights obtained.

Alternatives or families of prospective beneficiaries will be automatically sorted starting from the alternative that has the highest weight.

3.2 Discussion

Based on the results obtained, the comparison of the level of importance between a criterion or other alternative greatly affects the priority weight of the criteria or alternative. In contrast to previous research, the criteria and alternatives already have weights or points in the form of numbers first, then these weights are compared with one another using pairwise comparisons using the AHP method [10]. While in this study the weight of the criteria and alternatives has not been determined, but by comparing the data on which criteria are prioritized based on the Fundamental Scale of Pairwise Comparison of the AHP method for values in the form of numbers.

The comparison assessment can be tested for accuracy by calculating the CR (Consistency Ratio), if the results of the CR calculation are not accurate (> 0.1), the assessment must be repeated, while the CR calculation results obtained are 0.0 which means the assessment is accurate. The application of the AHP method in this study can give results in the form of ranking results from the five alternatives where the alternatives Marnidan Sarumpaet and Salow Nababan are the alternatives with the highest scores, namely 0.41 and 0.3, which means that the two alternatives are the recipients of the most prioritized assistance.

4. Conclusion

Based on research on the Decision Support System for Pandemic Assistance Recipients Using the AHP (Analytical Hierarchy Process) Method, the following conclusions can be drawn: (a). The Decision Support System can be applied to the problem of recipients of pandemic assistance, where this system can simplify and speed up decision making in a pandemic situation. (b). The AHP (Analytical Hierarchy Process) method can be applied without grouping eligible or undeserved recipients and without any weighting of criteria and alternatives in the form of numbers to determine the comparison of criteria or alternatives. Based on the comparison value based on the level of importance, the beneficiaries can be distinguished who are prioritized to receive assistance or not prioritized or who are eligible or not eligible. (c). For further research, it is expected that the application of the AHP method can be carried out using more than three hierarchies or the addition of sub-criteria that do not have a numerical value weight, but are based on values in the form of information on the level of importance of the sub-criteria, to find out whether such a comparison assessment is accurate or not if measured using the AHP method Consistancy Ratio calculation.

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