# AHP

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**Submission date:** 12-Sep-2020 11:42PM (UTC+0700)
**Submission ID:** 1385312626
**File name:** AKW_RNT_NEW_2_Eng.docx (127.75K)
**Word count:** 2091
**Character count:** 10771

# The Best Selection of PIP Scholarship: AHP-TOPSIS Vs Fuzzy AHP-TOPSIS

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**Abstract.** The Smart Indonesia Program (PIP) is a program created by the government to address education problems in Indonesia. Selection of students who are entitled to PIP assistance is the main problem in this study, so this study aims to provide a comparison and evaluation of the selection of students who are entitled to PIP assistance. Previous research has been evaluated using the AHP-TOPSIS method and in this study comparing the method between AHP-TOPSIS vs Fuzzy AHP-TOPSIS, the purpose of this study is to obtain the effectiveness of both methods. The criteria in this study are the impact of natural disasters, physical disabilities, the convict's family, PKH / KPS / KKS holders, destitute, orphans, parents' income and conflict areas. In this study, the results show that the two methods have the same ranking results, even though they have different weight values. This is because the importance value of each criterion is close together so that the results of the ranking of the two methods are the same. From these results, it can be concluded that the two methods are feasible to be used in the PIP scholarship selection, where the ranking of the choices is in alternatives 2 3 and 4.

*Keywords: AHP-TOPSIS; Fuzzy AHP-TOPSIS; PIP; Scholarship; DSS*

## 1. Introduction

The Government of the Republic of Indonesia is mandated to educate the nation's life based on the preamble to the 1945 Constitution of the Republic of Indonesia. This means that the Government of the Republic of Indonesia is obliged to strive for and implement a national education system for all Indonesian citizens. The national education system must be able to guarantee equal opportunities and improve the quality of education, especially for the children of the next generation of the Indonesian nation. One of the real manifestations of the government in educating the nation's life, solving educational problems and equitable educational opportunities in Indonesia, the seventh President of the Republic of Indonesia, Mr Ir. H. Joko Widodo, created a Smart Indonesia Program (PIP).

PIP is assistance provided to children aged 6 to 21 years, registered in schools, madrasahs, Islamic boarding schools, study groups, or training or course institutions. Not all school-age children in Indonesia receive assistance from the Smart Indonesia Program; several criteria must be met by a child to get this assistance. The process of determining who is entitled to smart Indonesian assistance is complicated and takes a long time if the selection process is done manually by checking the criteria one by one from several children. For that, we need a method that can be used to select or determine who is entitled to receive PIP assistance so that it is right on target.

Previously, someone had researched the PIP acceptance selection. The research succeeded in determining which students were entitled to receive PIP assistance using the Analytical Hierarchy Process (AHP) and Technique For Others References By Similarity To Ideal Solution (TOPSIS) method. To test whether the method is effective enough or not, it is necessary to have a method used to compare it. This study compares the AHP-TOPSIS method with the Fuzzy AHP-TOPSIS method to determine the most effective method in selecting PIP based on conditions in the field. So that the selection of recipients of PIP assistance can be right on target as expected.

## 2. Method

This study compares the AHP-TOPSIS method with the Fuzzy AHP-TOPSIS method. This method is compared to know which method is more effective in selecting the recipient of PIP assistance—in this study, using the stages which can be seen in Figure 1.

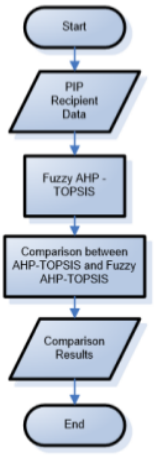


**Figure 1.** Research flow

The research begins by first preparing the PIP receiver data, and then the data will be obtained using the Fuzzy AHP-TOPSIS method. The AHP-TOPSIS calculation process was not carried out in this study because the previous research had been done. So in this study, only the Fuzzy AHP-TOPSIS calculation process is carried out, then comparing which method is more effective. The results of this study are the conclusions of the comparison between the Fuzzy AHP-TOPSIS and AHP-TOPSIS methods for PIP recipients.

### *2.1 Fuzzy AHP*

The steps taken to implement Fuzzy AHP are as follows :

- Create a hierarchical structure of the problem to be solved and determine the pairwise matrix comparisons between criteria with a Triangular Fuzzy Number scale.
- Determine the fuzzy priority synthesis (*Si*) value.

  $Si = \sum_{j=1}^{m} M_i^j \; x \; \frac{1}{\sum_{i=1}^{n}\sum_{j=1}^{m} M_i^j}$
- Determine the vector value (V) and defuzzification ordinate value (d '). For k = 1,2, ... n; k ≠ i, then we get the vector weight values :

  W' = (d'(A1), d'(A2),...,d'(An))

  Let A1 = (l1, u1); A2 = (l2, u2). Then the combined assessment matrix is formulated as follows:

  (l,u) = $\sqrt[2]{(l_1 * l_2), (u_1 * u_2)}$
- ormalization of fuzzy vector weight values (W).

  W = (d(A1), d(A2),...,d(An))$^T$

  Where W is a non fuzzy number. The formulation of normalization is :

$$d(A_n) = \frac{d'}{\sum_{i=1}^{n} d'(A_n)}$$

*2.2 TOPSIS*

The steps taken to implement TOPSIS are as follows:

- Create a normalized decision matrix from the collected data.

$$r_{ij} = \frac{Xij}{\sum_{i}^{m} X_{ij}^2}$$

- Create a weighted normalization matrix.

$$y_{ij} = w_j r_{ij}$$

- After obtaining weighted normalization matrix data, then determining the ideal solution is positive (A +) and the ideal solution is negative (A-). To determine the ideal solution, the attributes of each criterion are first determined, such as the benefit attribute or the cost attribute.

$$A^+ = y_1^+, y_2^+, \ldots, y_n^+$$

$$A^- = y_1^-, y_2^-, \ldots, y_n^-$$

- Determine $D_i^+$ and $D_i^-$

$$D_i^+ = \sqrt{\sum_{j=1}^{n} \left(y_j^+ - y_{ij}\right)^2}$$

$$D_i^- = \sqrt{\sum_{j=1}^{n} \left(y_{ij} - y_j^+\right)^2}$$

- Determine the preference value ($v_i$) of each alternative.

$$v_i = \frac{D_i^-}{D_i^- + D_i^+}$$

- After the $v_i$ value is obtained, then an alternative ranking process is carried out based on the order of the $v_i$ values. The best alternative is the one with the most considerable $v_i$ value.

## 3. Results and Discussions

Alternative data and criteria used to test Fuzzy AHP-TOPSIS calculations in this study were taken from previous studies. Alternative data can be seen in Table 1 below.

**Table 1**. List of alternative value data

| PIP Assistance Candidate Students | Impact of Natural Disasters | Physical Disabilities | Convict's Family | PKH / KPS / KKS Holders | Poor | Orphans | Parents' Income | Conflict Areas |
|---|---|---|---|---|---|---|---|---|
| Afifah Pramudita | 7 | 1 | 1 | 1 | 8 | 1 | 600000 | 1 |
| Anang Kasiron | 7 | 1 | 1 | 9 | 8 | 1 | 600000 | 1 |
| Singgih Ragil Rio R. | 3 | 1 | 1 | 1 | 1 | 5 | 1600000 | 1 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Elisa | 6 | 1 | 1 | 9 | 7 | 1 | 750000 | 1 |
| Fai Ruzul Ma'tuf | 1 | 1 | 1 | 9 | 1 | 1 | 1700000 | 1 |

Alternative data in table 1 is used when ranking using the TOPSIS method. However, before ranking, the steps that must be taken are to create a hierarchical structure of the problem and determine the pairwise matrix comparisons between criteria with a triangular fuzzy number scale. The paired matrix can be seen in table 2.

**Table 2**. Paired matrix

| | Impact of Natural Disasters | | | Physical Disabilities | | | Convict's Family | | | PKH / KPS / KKS Holders | | | Poor | | | Orphans | | | Parents' Income | | | Conflict Areas | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Impact of Natural Disasters | 1,00 | 1,00 | 1,00 | 1,00 | 1,00 | 1,00 | 1,00 | 1,00 | 1,00 | 1,00 | 1,00 | 1,00 | 1,00 | 1,00 | 1,00 | 1,00 | 1,00 | 1,00 | 1,00 | 2,00 | 3,00 | 1,00 | 1,00 | 1,00 |
| Physical Disabilities | 1,00 | 1,00 | 1,00 | 1,00 | 1,00 | 1,00 | 1,00 | 2,00 | 3,00 | 1,00 | 1,00 | 1,00 | 1,00 | 1,00 | 1,00 | 1,00 | 1,00 | 1,00 | 1,00 | 1,00 | 1,00 | 1,00 | 1,00 | 1,00 |
| Convict's Family | 1,00 | 1,00 | 1,00 | 0,33 | 0,50 | 1,00 | 1,00 | 1,00 | 1,00 | 1,00 | 1,00 | 1,00 | 1,00 | 1,00 | 1,00 | 0,33 | 0,50 | 1,00 | 1,00 | 1,00 | 1,00 | 1,00 | 1,00 | 1,00 |
| PKH / KPS / KKS Holders | 1,00 | 1,00 | 1,00 | 1,00 | 1,00 | 1,00 | 1,00 | 1,00 | 1,00 | 1,00 | 1,00 | 1,00 | 1,00 | 1,00 | 1,00 | 1,00 | 1,00 | 1,00 | 1,00 | 2,00 | 3,00 | 1,00 | 1,00 | 1,00 |
| Poor | 1,00 | 1,00 | 1,00 | 1,00 | 1,00 | 1,00 | 1,00 | 1,00 | 1,00 | 1,00 | 1,00 | 1,00 | 1,00 | 1,00 | 1,00 | 1,00 | 1,00 | 1,00 | 1,00 | 2,00 | 3,00 | 1,00 | 1,00 | 1,00 |
| Orphans | 1,00 | 1,00 | 1,00 | 1,00 | 1,00 | 1,00 | 1,00 | 2,00 | 3,00 | 1,00 | 1,00 | 1,00 | 1,00 | 1,00 | 1,00 | 1,00 | 1,00 | 1,00 | 1,00 | 2,00 | 3,00 | 1,00 | 1,00 | 1,00 |
| Parents' Income | 0,33 | 0,50 | 1,00 | 1,00 | 1,00 | 1,00 | 1,00 | 1,00 | 1,00 | 0,33 | 0,50 | 1,00 | 0,33 | 0,50 | 1,00 | 0,33 | 0,50 | 1,00 | 1,00 | 1,00 | 1,00 | 1,00 | 1,00 | 1,00 |
| Conflict Areas | 1,00 | 1,00 | 1,00 | 1,00 | 1,00 | 1,00 | 1,00 | 1,00 | 1,00 | 1,00 | 1,00 | 1,00 | 1,00 | 1,00 | 1,00 | 1,00 | 1,00 | 1,00 | 1,00 | 1,00 | 1,00 | 1,00 | 1,00 | 1,00 |

The next step is to make the geometric mean of fuzzy; table 3 is the result of the geometric mean of fuzzy in this study.

**Table 3**. The geometric mean of fuzzy

| Criteria | l | m | u |
|---|---|---|---|
| Impact of Natural Disasters | 1,0000 | 1,0905 | 1,1472 |
| Physical Disabilities | 1,0000 | 1,0905 | 1,1472 |
| Convict's Family | 0,7598 | 0,8409 | 1,0000 |
| PKH / KPS / KKS Holders | 1,0000 | 1,0905 | 1,1472 |
| Poor | 1,0000 | 1,0905 | 1,1472 |
| Orphans | 1,0000 | 1,1892 | 1,3161 |
| Parents' Income | 0,5774 | 0,7071 | 1,0000 |
| Conflict Areas | 1,0000 | 1,0000 | 1,0000 |
| Total | 7,3372 | 8,0992 | 8,9049 |
| P(-1) | 0,1363 | 0,1235 | 0,1123 |

The value of fuzzy synthesis in this study is 0.1363 (lower), 0.1235 (medium), and 0.1123 (upper). Furthermore, after the fuzzy synthesis value is obtained, the next step is to determine the fuzzy weight *Si*. The results of the calculation of fuzzy weight Si can be seen in table 4.

**Tabel 4**. Fuzzy weight Si

| Criteria | l | m | u | Mi | Ni |
|---|---|---|---|---|---|
| Impact of Natural Disasters | 0,1123 | 0,1346 | 0,1564 | 0,4033 | 0,1328 |
| Physical Disabilities | 0,1123 | 0,1346 | 0,1564 | 0,4033 | 0,1328 |
| Convict's Family | 0,0853 | 0,1038 | 0,1363 | 0,3254 | 0,1071 |
| PKH / KPS / KKS Holders | 0,1123 | 0,1346 | 0,1564 | 0,4033 | 0,1328 |
| Poor | 0,1123 | 0,1346 | 0,1564 | 0,4033 | 0,1328 |
| Orphans | 0,1123 | 0,1468 | 0,1794 | 0,4385 | 0,1444 |
| Parents' Income | 0,0648 | 0,0873 | 0,1363 | 0,2884 | 0,0950 |
| Conflict Areas | 0,1123 | 0,1235 | 0,1363 | 0,3721 | 0,1225 |

| | | | |
|---|---|---|---|
| 1 | Total | 3,0376 | 1,0000 |

The weight of each criterion that has been normalized by the Fuzzy AHP method can be seen in table 4 in column Ni. After that, enter the ranking processing TOPSIS. The first step is to find the value of the normalized decision matrix. The results of the normalized decision matrix are in table 5.

**Table 5**. Normalized decision matrix

| PIP Assistance Candidate Students | Impact of Natural Disasters | Physical Disabilities | Convict's Family | PKH / KPS / KKS Holders | Poor | Orphans | Parents' Income | Conflict Areas |
|---|---|---|---|---|---|---|---|---|
| Afifah Pramudita | 0,5833 | 0,4472 | 0,4472 | 0,0639 | 0,5979 | 0,1857 | 0,2312 | 0,4472 |
| Anang Kasiron | 0,5833 | 0,4472 | 0,4472 | 0,5750 | 0,5979 | 0,1857 | 0,2312 | 0,4472 |
| Singgih Ragil R. R. | 0,2500 | 0,4472 | 0,4472 | 0,0639 | 0,0747 | 0,9285 | 0,6166 | 0,4472 |
| Elisa | 0,5000 | 0,4472 | 0,4472 | 0,5750 | 0,5232 | 0,1857 | 0,2891 | 0,4472 |
| Fai Ruzul Ma'tuf | 0,0833 | 0,4472 | 0,4472 | 0,5750 | 0,0747 | 0,1857 | 0,6552 | 0,4472 |

After the value of the normalized decision matrix is obtained, the next step is to find a weighted normalized matrix. The results of the weighted normalization matrix are in table 6.

**Table 6**. Weighted normalization matrix

| PIP Assistance Candidate Students | Impact of Natural Disasters | Physical Disabilities | Convict's Family | PKH / KPS / KKS Holders | Poor | Orphans | Parents' Income | Conflict Areas |
|---|---|---|---|---|---|---|---|---|
| Afifah Pramudita | 0,0774 | 0,0594 | 0,0479 | 0,0085 | 0,0794 | 0,0268 | 0,0220 | 0,0548 |
| Anang Kasiron | 0,0774 | 0,0594 | 0,0479 | 0,0763 | 0,0794 | 0,0268 | 0,0220 | 0,0548 |
| Singgih Ragil R. R. | 0,0332 | 0,0594 | 0,0479 | 0,0085 | 0,0099 | 0,1340 | 0,0586 | 0,0548 |
| Elisa | 0,0664 | 0,0594 | 0,0479 | 0,0763 | 0,0695 | 0,0268 | 0,0274 | 0,0548 |
| Fai Ruzul Ma'tuf | 0,0111 | 0,0594 | 0,0479 | 0,0763 | 0,0099 | 0,0268 | 0,0622 | 0,0548 |

After obtaining the weighted normalization matrix value, it is then determining the value of the positive ideal solution (A +) and the negative ideal solution (A-) by taking into account the criteria attributes, such as the benefit attribute or the cost attribute which can be seen in table 7.

**Table 7**. Criteria Attribute Value

| Criteria | Attribute |
|---|---|
| Impact of Natural Disasters | Benefit |
| Physical Disabilities | Benefit |
| Convict's Family | Benefit |
| PKH / KPS / KKS Holders | Benefit |
| Poor | Benefit |
| Orphans | Benefit |
| Parents' Income | Cost |
| Conflict Areas | Benefit |

Before finding the value of the positive ideal solution and the negative ideal solution, we must first find the largest and the smallest value of each criterion. If the criterion is a benefit, the value taken is the value that is the greatest of all the criteria column. In contrast, the criterion is cost; the value taken is the

smallest value of the value of all the criteria column. From this statement, the max value and min value for each criterion can be obtained, which can be seen in table 8.

**Table 8**. Positive And Negative Ideal Solutions

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| A+ | 0,0774 | 0,0594 | 0,0479 | 0,0763 | 0,0794 | 0,1340 | 0,0220 | 0,0548 |
| A- | 0,0111 | 0,0594 | 0,0479 | 0,0085 | 0,0099 | 0,0268 | 0,0622 | 0,0548 |

Tabel 9 adalah nilai dari $Di^{+}$ dan $Di^{-}$

**Table 9**. Distance Between the Value of Each Matrix $Di^{+}$ and $Di^{-}$

| D+ | D- |
|---|---|
| 0,1269 | 0,1042 |
| 0,1072 | 0,1243 |
| 0,1128 | 0,1095 |
| 0,1084 | 0,1114 |
| 0,1495 | 0,0679 |

In table 10 is the preference value which is denoted by $v_i$. Table 10 shows the overall preference value for each alternative candidate.

**Table 10**. Preference Value of Each AHP-TOPSIS Fuzzy Alternative

| PIP Assistance Candidate Students | Value |
|---|---|
| Afifah Pramudita | 0,4508 |
| Anang Kasiron | 0,5369 |
| Singgih Ragil Rio Romandani | 0,4926 |
| Elisa | 0,5069 |
| Fai Ruzul Ma'tuf | 0,3122 |

In table 10 it can be seen that the best alternative for selecting students who are entitled to PIP assistance is Anang Kasiron, Elisa, Singgih Ragil Rio Romandani, followed by Afifah Pramudita and finally Fai Ruzul Ma'tuf. The comparison table between the rankings of AHP-TOPSIS PIP recipients and Fuzzy AHP-TOPSIS can be seen in table 11.

**Table 11**. Comparison of AHP-TOPSIS and Fuzzy AHP-TOPSIS

| PIP Assistance Candidate Students | AHP-TOPSIS | Fuzzy AHP-TOPSIS | Alternative | Alternative Ranking |
|---|---|---|---|---|
| Afifah Pramudita | 0.4474 | 0,4508 | 1 | 4 |
| Anang Kasiron | 0.5338 | 0,5369 | 2 | 1 |
| Singgih Ragil Rio Romandani | 0.4957 | 0,4926 | 3 | 3 |
| Elisa | 0.5040 | 0,5069 | 4 | 2 |
| Fai Ruzul Ma'tuf | 0.3125 | 0,3122 | 5 | 5 |

The results obtained from ranking with the Fuzzy AHP-TOPSIS method for the selection of PIP recipients are not much different from the calculations obtained from the AHP-TOPSIS method [].

## 4. Conclusion

AHP-TOPSIS and Fuzzy AHP-TOPSIS methods can be used to select recipients of PIP assistance. Both of these methods can be used well to assist in making decisions. The results of the AHP-TOPSIS and Fuzzy AHP-TOPSIS ranking in this study are the same, although they have different weight values. This is because the importance value of each criterion is close together so that the results of the AHP-TOPSIS and Fuzzy AHP-TOPSIS ranking methods get the same results.

## References

# AHP

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