

# Determination of KIP Kuliah Scholarship Recipients Using the AHP and TOPSIS Method (Case Study: UMKT Student Division)

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## Abstract

Student Division Universitas Muhammadiyah Kalimantan Timur manage various scholarship for student, one of them is Kartu Indonesia Pintar Kuliah scholarship, the process include is where UMKT Student Division need to estimate eligible student receiving scholarship based on 4 criteria, the problem may occur is to many scholarships applicant but scholarship quota is limited it's hard to choose eligible scholarship recipient among student applicant. By using AHP and TOPSIS to determine KIP Kuliah Scholarship Recipients, AHP used to given weight to all criteria, DTKS (0.539), Family Condition (0.086), Family economy (0.093), House Condition (0.282) and topsis used to process all student applicant year 2022 or alternatives, by using ahp and topsis to determine scholarship recipients the model gain 77% accuracy rates.

**Keywords:** Scholarship, AHP, TOPSIS, Criteria, KIP Kuliah

## Abstrak

Bagian Kemahasiswaan Universitas Muhammadiyah Kalimantan Timur mengelola berbagai beasiswa untuk mahasiswa, salah satunya adalah beasiswa Kartu Indonesia Pintar Kuliah, prosesnya antara lain dimana Bagian Kemahasiswaan UMKT perlu memperkirakan mahasiswa yang berhak menerima beasiswa berdasarkan 4 kriteria, permasalahan yang mungkin terjadi adalah banyaknya pendaftar beasiswa tetapi kuota beasiswa terbatas sulit untuk memilih penerima beasiswa yang memenuhi syarat di antara pendaftar beasiswa. Dengan menggunakan AHP dan TOPSIS untuk menentukan Penerima Beasiswa KIP Kuliah, AHP digunakan untuk memberi bobot pada semua kriteria, DTKS (0,539), Kondisi Keluarga (0,086), Ekonomi Keluarga (0,093), Kondisi Rumah (0,282) dan topsis digunakan untuk memproses semua pendaftar beasiswa tahun 2022 atau alternatif, dengan menggunakan AHP dan TOPSIS untuk menentukan penerima beasiswa model mendapatkan tingkat akurasi 77%.

**Kata Kunci:** Beasiswa, AHP, TOPSIS, Kriteria, KIP Kuliah

## I. INTRODUCTION

Universitas Muhammadiyah Kalimantan Timur student division manage various scholarship for student, one of them is Kartu Indonesia Pintar Kuliah scholarship, KIP Kuliah offer financial fund for student with condition willing to finish college and maintaining grade, there are several process for determining KIP scholarship recipient, one of the process is where UMKT student division need to estimate eligible student receiving scholarship based on 4 criteria ,DTKS status, Family Condition, Family economy, House Condition, The problem may occur is to many scholarship applicant but scholarship quota is limited it's hard to choose eligible scholarship recipient among student applicant.

AHP method is multi-criteria decision-making techniques that build hierarchy with different levels of importance to create weight with acceptable level of consistency[1]. TOPSIS or Technique for Order of Preference by Similarity to Ideal Solution are multicriteria decision-making methods. (Ramadiani et al., 2018), the method is simple and easy to understand, efficient computation, and has the ability to measure the relative performance of the alternatives in the form of simple mathematics[2].

There is similar study by A. Wardana “*Ahp-Topsis Pada Seleksi Penerimaan Bantuan Program Indonesia Pintar*”, using hybrid method ahp-topsis to determine kip scholarship recipient with 8 criteria and 5 alternatives, end result was ranking scholarship recipient 1-5 and the highest prefersion point was 0.5338[3]. The next study was conducted by P. Hasan “*Selection of Scholarship Acceptance Using AHP And TOPSIS Methods*” AHP-TOPSIS model to select recommendation students to get PPA scholarship based on 5 criteria, the results were students ranked 1-5 PPA scholarship recipients[4]. The caveat here was the difference between this study and previous study was the criteria was different and alternative quantity was different.

Then objective of this research is to build AHP-TOPSIS model to determine KIP Kuliah scholarship recipients, AHP was used to establish weight value of all criteria set by student division UMKT, while TOPSIS method used for ranking all alternative based criteria weight value set by AHP, the result was rank of KIP Kuliah scholarship recipient candidates the rank are based on TOPSIS ideal solution results value, then find out if AHP method combine with TOPSIS would fit to determine scholarship, judge based on method accuracy.

## II. LITERATURE REVIEW

### A. Analytical Hierarchy Process

Analytical hierarchy process was developed in 1970's by Thomas Saaty[5], The AHP divides complex multi-criteria decision problems into sets of subproblems, associated through a hierarchical structure. The problems are then solved via pairwise comparisons on the relative importance of each subproblem and respective criteria/alternatives, the advantages of Analytical Hierarchical Process are the AHP technique does not require any other tool for evaluating weights of decision criteria as the tool can determine decision criteria weights and ranking of alternatives and the second is the approach with AHP is capable of utilizing both quantitative and qualitative data in the decision-making process[6]

The basic of analytical hierarchy process to solve problem is simple it can break into several steps first calculate the scale of relative importance using the original scale by Thomas L. Saaty the scale is consist of 1-9 odd number for importance scale and even number for scale in between, transform the scale into matrix, to build matrix  $A = a_{ij}/a_{ij}$  and for the reverse,  $A = 1/a_{ij}$

$$\lambda_{max} = \sum_{i=1}^n \frac{(Aw)_i}{nw_i} \quad (1)$$

Based on formula (1) multiply the elements in  $A$  by the row, then calculate  $n$  times square of the obtained product, normalize the root square vector to get the final ranking vector  $w$ , last the maximum eigenvalue is  $\lambda_{max}$  calculated by the formula (2), where  $(Aw)_i$  means the  $i$  the elements of  $A_w$

The last step is to test consistency, after  $\lambda_{max}$  value obtained to find Consistency Index or C.I  $\lambda_{max}$  minus total criterion then divide by total criteria minus one, to get the Random Index value is by using R.I table value, then to find Consistency Ratio are C.I divided by R.I if the results less than 0.1 the whole consistent[7][4][1].

*B. Technique for Others Reference by Similarity to Ideal Solution*

Procedure of TOPSIS calculation it's quite simple first normalized decision matrix by using formula (2) alternative matrix or  $X$  value divided by square root of sum on every  $X$  matrix power by 2 as much as length of matrix columns or  $m$  value

$$r_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^m x_{ij}^2}} \tag{2}$$

Next step is to determine weighted normalized decision matrix or  $y_{ij}$  value by just multiply  $r$  and criteria weight value or  $w_m$

$$y_{ij} = \begin{bmatrix} w_{11}r_{11} & \dots & w_{1n}r_{1n} \\ \vdots & \ddots & \vdots \\ w_{m1}r_{m1} & \dots & w_{mn}r_{mn} \end{bmatrix} \tag{3}$$

Next step is to find  $y^+$  and  $y^-$  value from  $y$  matrix by using formula (4) to find  $y^+$  and formula (5) to find  $y^-$

$$y^+ = \{(\max y_{ij} | j \in J')(\min y_{ij} | j \in J')\} = y_1^+, y_2^+, \dots, y_m^+ \tag{4}$$

$$y^- = \{(\max v_{ij} | j \in J')(\min v_{ij} | j \in J')\} = y_1^-, y_2^-, \dots, y_m^- \tag{5}$$

Where  $j$  for benefit and  $J'$  for cost, if benefit on  $y^+$  take the maximal value on columns matrix  $y$  and if it is cost on  $y^+$  then take the minimal value on columns matrix  $y$ , The opposite applies for  $y^-$  like shown in formula (5), then calculate the ideal positive solution and the ideal negative solution

$$D_i^+ = \sqrt{\sum_{j=1}^n (y_{ij} - y_j^+)^2} \tag{6}$$

$$D_i^- = \sqrt{\sum_{j=1}^n (y_{ij} - y_j^-)^2} \tag{7}$$

Where to find positive ideal solution means square root of sum on every matrix  $y_{ij}$  minus  $y_j^+$  power by 2 as much as length of matrix rows or  $n$  value, almost identical solution to calculate ideal negative solution the different were  $y_{ij} - y_j^-$ , the last step is to calculate the ideal solution or  $V$  value by ideal negative divided by sum value of ideal positive plus ideal negative

$$V_i = \frac{D_i^-}{D_i^- + D_i^+} \tag{8}$$

Then rank the order Alternatives can be ranked based on sequence  $V_i$ . Therefore, the best alternative is one of the shortest distances to the ideal solution and furthest away with the ideal negative solution[8][9][10].

### III. RESEARCH METHOD

#### A. The Flowchart of Research

Research stages consist with many steps shown in research flow chart from start to finish.

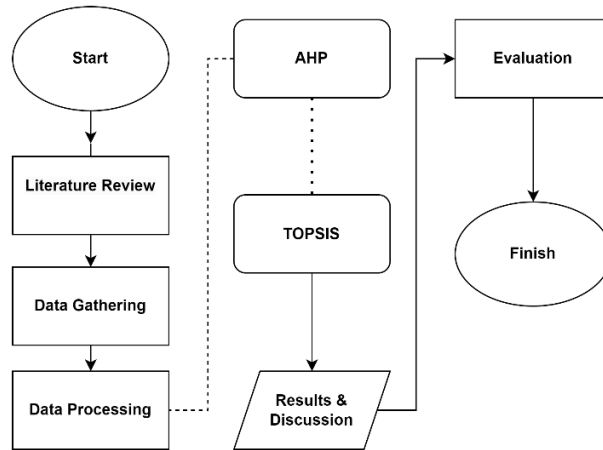


Fig. 1. Research Flowchart

Literature Review, gathered information and fact check about AHP-TOPSIS method also studied previous research, gathering Data, obtaining data for this research main objective was to get criteria and alternatives, data Processing, process gained from set both criteria and alternatives, AHP, for processing all criteria the result was criteria with weight value, TOPSIS, process all alternatives with criteria and weight from AHP, results where is rank all list alternatives based on point TOPSIS, and the discussion were to test the results and discuss the research findings.

#### B. Data Collection

The data were gained through and interview to division unit of Universitas Muhammadiyah Kalimantan Timur that in charge of selection of candidate scholarship recipients, the criterion data then convert into hierarchal order that shown in Figure Criteria hierarchal order

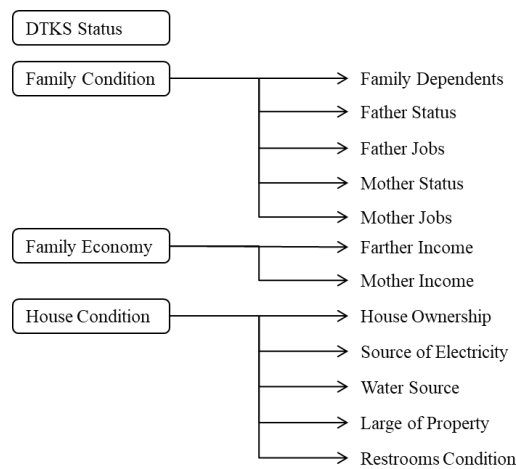


Fig. 1. Criterion Hierarchy

There are 4 criteria groups, Family Condition contain 5 sub criteria, Family Economic contain 2 sub criteria and House condition contain 6 criteria, total was 13 criteria, 4 Criteria in layer 1 and 13 sub criteria in layer 2. The next data gathered from UMKT student division is KIP Kuliah scholarship applicant student year 2022 total student data are 170, and receive KIP Kuliah scholarship recipients report of year 2022.

*C. Criterion Processing*

Process the criterion data then process first pairwise comparison matrix table:

TABLE I  
PAIRWISE COMPARISON

Criteria	DTKS Status	Family Condition	Family Economy	House Condition
DTKS Status	1.0	5.0	5.0	3.0
Family Condition	0.2	1.0	1.0	0.2
Family Economy	0.2	1.0	1.0	0.3
House Condition	0.3	5.0	3.0	1.0
Sum Columns	1.7	12.0	10.0	4.5

The sum of the columns is w value divide per columns w and then sum each row the results then divided with n value to get eigen vector or weight value of each criterion:

TABLE II  
NORMALIZATION MATRIX AND EIGEN VECTOR

Criteria	DTKS Status	Family Condition	Family Economy	House Condition	Sum of Columns	Sum of Rows	Weight
DTKS Status	0.58	0.42	0.50	0.66	1.733	2.155	0.539
Family Condition	0.12	0.08	0.10	0.04	12.00	0.343	0.086
Family Economy	0.12	0.08	0.10	0.07	10.00	0.372	0.093
House Condition	0.19	0.42	0.30	0.22	4.533	1.130	0.282

Then next step is to test the consistency, first find lambda by value of sigma Sum of Columns multiply by W value, then to get C.I value  $4.173 - 4$  then divided with 3, to get R.I value by using table Random Index[1]:

TABLE III  
RANDOM INDEX TABLE

n	RI	n	RI
2	0	9	1.45
3	0.58	10	1.49
4	0.90	11	1.51
5	1.12	12	1.48
6	1.24	13	1.56
7	1.32	14	1.57
8	1.41	15	1.59

To calculate the C.R, divide C.I with R.I if the results is less than 0.1 the results is consistent, and if not consistent the eigen vector value can't be used for criteria weight value the and need

$$C.R = \frac{0.05776102}{0.90} = 0.06417891$$

*D. Alternative Processing*

The alternatives are total 170 alternatives to calculate the alternatives first convert the student data to weight value, the weight value are the results of AHP calculation the weight on layer two are sharing the value from layer one, for TOPSIS calculation weight layer 2 are the matrix W, and value on layer 3 is value for matrix x

TABLE IV  
 CRITERIA WEIGHT RESULTS

Criterion	Weight(w)	Criteria	Weight	Description	Attribute
Status DTKS	0.539	DTKS Status	12	Registered	Benefit
			88	Not Registered	
Family Condition	0.086	Number of Family Dependents	4	1 to 2 People	Benefit
			9	3 to 4 People	
			42	5 to 6 People	
			45	More than 6 People	
		Father Status	7	Life	Benefit
			18	Death	
			75	Divorced	
		Father Job	4	Civil Servant	Benefit
			17	Entrepreneur	
			19	Private / Honorary Employee	
		Mother Status	8	Life	Benefit
			13	Death	
			79	Divorced	
		Mother Job	4	Civil Servant	Benefit
17	Entrepreneur				
19	Private / Honorary Employee				
60	Farmers / Labor				
Family Economy	0.093	Father Income	5	More Than IDR 10M	Cost
			13	IDR 5-10M	
			26	IDR 3-5M	
			55	IDR 0-2M	
		Mother Income	5	More Than IDR 10M	Cost
			11	IDR 5-10M	
			19	IDR 3-5M	
			65	IDR 0-2M	
House Condition	0.282	House Ownership	11	Own by Family	Benefit
			26	Indwelling in Relatives House	
			63	Rent	
		Source of Electricity	8	PLN	Benefit
			19	Generator/Solar Panel	
			74	None	
		Water Source	14	PDAM	Benefit
			43	River	
			43	Well	
		Large of Property	6	More than 112M2	Cost
			12	73M2 - 112M2	
			26	33M2 - 72M2	
			56	9M2 - 32M2	
		Restrooms Condition	11	Private Restrooms	Benefit
26	Family Sharing Restrooms				
63	Public Restrooms				

The alternatives data after convert to the weight preferential value or the x matrix:

TABLE V  
MATRIX X TABLE

<b>A1</b>	12	60	55	7	60	65	8	4	11	8	26	43	11
<b>A2</b>	12	17	55	7	17	65	8	9	26	8	26	43	11
<b>A3</b>	88	19	55	75	17	65	8	9	11	74	12	43	26
:	:	:	:	:	:	:	:	:	:	:	:	:	:
<b>A169</b>	12	17	26	7	17	65	8	4	11	8	56	14	11
<b>A170</b>	12	17	55	7	17	65	8	4	11	8	12	14	11

By using formula (2) matrix x divided with square root sigma x power by 2, the results are matrix R:

TABLE VI  
MATRIX R TABLE

<b>A1</b>	0.019	0.112	0.083	0.018	0.097	0.078	0.026	0.014	0.020	0.016	0.047	0.103	0.025
<b>A2</b>	0.019	0.032	0.083	0.018	0.028	0.078	0.026	0.032	0.048	0.016	0.047	0.103	0.025
<b>A3</b>	0.141	0.036	0.083	0.197	0.028	0.078	0.026	0.032	0.020	0.146	0.022	0.103	0.059
:	:	:	:	:	:	:	:	:	:	:	:	:	:
<b>A169</b>	0.019	0.032	0.039	0.018	0.028	0.078	0.026	0.014	0.020	0.016	0.101	0.033	0.025
<b>A170</b>	0.019	0.032	0.083	0.018	0.028	0.078	0.026	0.014	0.020	0.016	0.022	0.033	0.025

The next to calculate the matrix Y or normalization matrix are matrix R multiply by matrix W, then find the positive and negative of matrix Y using formula (4) and formula (5):

TABLE VII  
MATRIX Y AND POSITIVE NEGATIVE TABLE

<b>A1</b>	0.010	0.010	0.008	0.002	0.008	0.007	0.002	0.001	0.006	0.004	0.013	0.029	0.007
<b>A2</b>	0.010	0.003	0.008	0.002	0.002	0.007	0.002	0.003	0.014	0.004	0.013	0.029	0.007
<b>A3</b>	0.076	0.003	0.008	0.017	0.002	0.007	0.002	0.003	0.006	0.041	0.006	0.029	0.017
:	:	:	:	:	:	:	:	:	:	:	:	:	:
<b>A169</b>	0.010	0.003	0.004	0.002	0.002	0.007	0.002	0.001	0.006	0.004	0.029	0.009	0.007
<b>A170</b>	0.010	0.003	0.008	0.002	0.002	0.007	0.002	0.001	0.006	0.004	0.006	0.009	0.007
<b>y<sup>+</sup></b>	0.076	0.010	0.002	0.017	0.008	0.002	0.022	0.014	0.033	0.041	0.003	0.029	0.041
<b>y<sup>-</sup></b>	0.010	0.001	0.008	0.002	0.002	0.007	0.002	0.001	0.006	0.004	0.029	0.009	0.007

The next step is to find the ideal positive and ideal negative solution, then find the ideal solution value by ideal negative divide with results sum of ideal positive and ideal negative, ranking the alternative based on ideal solution or v value:

TABLE VIII  
TOPSIS CALCULATION RESULTS

Alternative	D <sup>+</sup>	D <sup>-</sup>	Ideal Solution	Rank
Alternative 1	0.0921	0.0271	0.2272	101
Alternative 2	0.0904	0.0262	0.2244	107
Alternative 3	0.0445	0.0830	0.6511	43
Alternative 4	0.0373	0.0903	0.7077	18
:	:	:	:	:
Alternative 169	0.0973	0.0046	0.0450	169
Alternative 170	0.0941	0.0226	0.1935	140

#### IV. RESULTS AND DISCUSSION

##### A. Accuracy Test

To find the accuracy of AHP and TOPSIS model for determining KIP Kuliah Scholarship recipients are using error rate formula, which is the percentage of incorrect predictions made by AHP and TOPSIS method. The formula is  $\text{Error Rate} = 100 - ((\text{total correct predictions} / \text{total predictions}) * 100)$ , first find the errors the model produce, to find it first slice the alternative results to the quota of scholarship based on scholarship recipient report from student division the quota were 111 so slice the data from 170 into 111 top rank then compare to KIP Kuliah scholarship recipient report year 2022 if the name in the table does not exist in the report the data is count as an error, the results are there is 26 errors or 26 alternatives from 111 scholarship quota that should not in the scholarship recipients list, then calculate the accuracy:

$$\text{Accuracy} = 100\% - \left( \frac{26}{111} \times 100 \right) = 76.57657657657657$$

The results were 76.57657657657657 and if it is rounded up to 77%, so the results of the accuracy of the AHP and TOPSIS models in determining the KIP Kuliah scholarship recipients are 77%.

#### V. CONCLUSION

In this study successfully found how to determine scholarship recipients by using Analytical Hierarchy Process combined with TOPSIS method with accuracy rate of 77%, another find was criteria weight value affected accuracy results.

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