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Decision Support System To Recommend Scholarships Using AHP TOPSIS Methods In Education And Culture Office Of Pekanbaru

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ABSTRACT : *The selection of scholarship becomes important for the education office and school. The selected students must be in accordance with the desired criteria, therefore a method is need to assist the education authorities and school in selecting students who are eligible to receive scholarships. This research discusses decision support system to recommend scholarship at Junior High School level in Education and Culture Office of Pekanbaru. Decision support system using combination of Analytical Hierarchy Process (AHP) method and Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) method. The combination of AHP and TOPSIS has their respective the accuracy of the criteria weights use, while the TOPSIS Method is use in the ranking of students who are recommended to obtain a scholarship from the education and culture office of Pekanbaru. The criteria use by decision support systems in this study are in accordance with the criteria set by the education and culture office of Pekanbaru is average value of report card, parent income, the number of dependents of parents, the number of sibling, The usage of electrical power and ownership of transportation.*
Keywords *–Decision Support System, Scholarship, AHP, TOPSIS, Criteria*

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I. INTRODUCTION

Currently the development of information technology has been so rapid. The rapid development of not only hardware and software technology, but also the method of computing. One of the most commonly developed methods of computing today is the Decision Support System (DSS) method. Decision making is the selection process, among the various action alternatives aimed at fulfilling one or several goals. Decision support system has 4 phases, namely intelligence, design, choice, and implementation. Phase 1 to 3 are the basis for decision-making, ending with a recommendation. Problem solving is similar to decision making coupled with the implementation of the recommendations. Problem solving refers not only to solutions of problem areas/difficulties but also to investigation of opportunities.

One of the decision support issues faced with various criteria is the process of determining the scholarship recipients of education. Many methods can be used in decision support systems. One of the methods used in this research in Analytical Hierarchy Process (AHP) TOPSIS method. The combination of AHP and TOPSIS have their respective roles in order to produce optimal value. AHP is used for weighting criteria, while TOPSIS plays a role in determining priority ranking [2, 3, 4, 5].

II. METHODS

2.1. DECISION SUPPORT SYSTEM (DSS)

Decision Support System (DSS) is an interactive-based system that helps decision making utilize data and models to solve a problem. DSS consists of three components is model management, data management and interface. There are four phases in the development of Decision Support System is intelligence, design, choice and implementation [1, 2, 6, 7]

2.2 ANALITYCAL HIERARCHY PROCESS (AHP)

Analytical Hierarchy Proses (AHP) is a functional hierarchy with the main input of human perception. This method was develop by prof. Thomas Lorie Saaty from Warton Business School beginning in 1970, to search for rankings or priority sequences from various alternative in solving a problem [7, 8]

There are several principles that must be understood for solving the problem with AHP is as follows [7]:

1. Decomposition (Making Hierarchies)

Complex systems can be understood by separating them into smaller and easier to understand elements.

2. Comparative judgment (Assessment criteria and alternative)

Criteria and alternatives are done by pairwise comparisons so that it can be known the scale of importance of each criterion against other criteria. Table 1 is the comparison scale presented by Saaty [9]

3. Synthesis of priority

Determining the priorities of the criterion elements can be viewed as the weight/contribution of those analysis with a pairwise comparison method between two elements so that all elements are sufficient. This priority is determined based on the views of experts and stakeholder on decision-making, either directly (discussed) or directly.

4. Logical Consistency.

Consistency has two meanings. Firstly, similar objects can be grouped according to uniformity and relevance. Second is the level of relationship between object based on certain criteria (Kosasi)

Table 1. The fundamental scale of absolute numbers [7].

Intensity of Importance	Definition	Explanation
1	Equal Importance	Two activities contribute equally to the objective
2	Weak or Slight	
3	Moderate importance	Experience and judgment slight favour one activity over another
4	Moderate plus	
5	Strong Importance	Experience and judgment strongly favour one activity over another
6	Strong plus	
7	Very strong or demonstrated Importance	An activity is favoured very strongly over another, its dominance demonstrated in practice
8	Very, very strong	
9	Extreme Importance	The evidence favouring one activity over another is of the highest possible order of affirmation.
Reciprocals of above	If activity i has one of the above non-zero numbers assigned to it when compare with activity j, then j has the reciprocal value when compared with i	A reasonable assumption

In general, decision making with the AHP method is based on the following steps [7]:

1. Define the problem and determine the desired solution, then compile the hierarchy of problems encountered.
2. Determining the priority of the elements

a. The first step in defining the priority of the elements is to make a pair comparison is comparing the elements in pairs according to given criteria.

b. A pairwise comparison matrix is filled with number to represent the relative importance of an element against other elements.

3. Synthesis

Considerations for paired comparisons are synthesis to gain overall priority.

4. Measuring consistency in making decisions.
5. Calculate Consistency Index (CI) is represented as in the following formula.

$$CI = \frac{\lambda_{mak} - n}{n-1} \quad (1)$$

where:

n = The number of elements.

6. Calculate Consistency Ratio (CR) as given:

$$CR = \frac{CI}{IRC} \qquad (2)$$

where:
CR = Consistency Ratio;
CI = Consistency Index ;
IRC = Index Random Consistency

7. Check the consistency of hierarchy obtained from equation (2). If the value is more than 10%, then judgment data assessment should be improve. However, if the Consistency Ratio is less than or equal to 10%, then thee calculation results are stated true.

Table 2. Value of Consistency Ratio Index

N	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
IRC	0	0	0.58	0.90	1.12	1.24	1.32	1.41	1.45	1.49	1.51	1.53	1.56	1.57	1.58

2.3 Technique For Order Preference By Similarity To Ideal Solutions(TOPSIS)

TOPSIS method was initially presented by Hwang and Yoon [1]. It has been deemed one of the major decision making methods within the world [10]. The basic idea of TOPSIS is rather simple. It originates from the concept of a displaced ideal point from which the compromise solution has the shortest distance. TOPSIS is also developed into a new method [8]. A relative advantage of TOPSIS is its ability to identify the best alternative quickly. Hwang and Yoon [1] proposed that the ranking of alternatives will be based on the shortest distance from the positive ideal solution (PIS) and the farthest from the negative ideal solution (NIS) to determine the best alternative. The procedures of calculation TOPSIS are delineated as follow

1. Normalization of Decision Matrix

Determine normalized decision matrix using Euclidean length of a vector method

$$r_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^{m} x_{ij}^2}} \qquad (3)$$

where:

r_{ij} = result of normalized decision matrix R

$i = 1, 2, 3, \ldots, m,$

$j = 1, 2, 3, \ldots, n,$

2. Determine weighted normalized decision matrix with weight $W = w_1, w_2, \ldots, w_n)$

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

where: $i = 1, 2, 3, \ldots, m,$

$j = 1, 2, 3, \ldots, n,$

3. Determine the Positive Ideal and Negative Ideal Solution

The positive ideal solution and the negative ideal solution can be determined based on the normalized weight ranking (v_{ij})

$$A^+ = \left\{\left(\max y_{ij} \mid j \in J\right)\left(\min y_{ij} \mid j \in J'\right), i = 1, 2, \ldots, m\right\} = A_1^+, A_2^+, \ldots, A_m^+ \quad (4)$$

$$A^- = \left\{\left(\max v_{ij} \mid j \in J\right)\left(\min v_{ij} \mid j \in J'\right), i = 1, 2, \ldots, m\right\} = A_1^-, A_2^-, \ldots, A_m^- \quad (5)$$

Where:

y_{ij} = The element matrix V of row the-i and column j

J = {j=1,2,3,…,n and j is benefit criteria}

J' = {j=1,2,3,…,n and j is cost criteria}

4. Calculate the separation measures, using the n-dimensional Euclidean distance. The separation of each

alternative from the positive ideal solution is given as

$$D_i^+ = \sqrt{\sum_{j=1}^{n}\left(y_{ij} - y_j^+\right)^2} \text{ , where } i = 1,2,3,\ldots,n \quad (6)$$

Similarly, the separation from negative ideal solution is given

$$D_i^- = \sqrt{\sum_{j=1}^{n}\left(y_{ij} - y_j^-\right)^2} \text{ , where } i = 1,2,3,\ldots,n \quad (7)$$

5. Calculate the relative closeness to the ideal solution is represented as in the following formula.

$$V_i = \frac{D_i^-}{D_i^- + D_i^+} \text{ , where } 0 < V_i < 1 \text{ and } i = 1,2,3,\ldots,m \quad (8)$$

6. Rank the preference order.

Alternatives can be ranked base on sequence V_i. Therefore, the best alternative is one of the shortest distance to the ideal solution and furthest away with the ideal negative solution.

III. MATERIAL AND METHODS

3.1. Application with AHP Method

1. Here is a table of criteria and weights used in decision support system of scholarship recipients of Education and Culture Office ofPekanbaru.

Table 3. Criteria

Criteria	Assessment	Weight
C1=Grade Point Average (GPA)	<= 7.5	1
	<= 8.0	2
	<= 8.5	3
	<= 9.0	4
	> 9.0	5
C2=Parents Income (IDR)	>5,000,000.00	1
	<= 5,000,000.00	2
	<= 4,000,000.00	3
	<= 3,000,000.00	4
	<= 2,000,000.00	5
C3=The Number of Dependents	<= 1	1
	<= 2	2
	<= 3	3
	<= 4	4
	>4	5
C4=The Number of Sibling	<= 1	1
	<= 2	2
	<= 3	3
	<= 4	4
	>4	5
C5= The usage of Electrical Power (VA)	>2200	1
	2200	2
	1300	3
	900	4
	450	5
Ownership of transportation	Motorcycle and car	1
	One car	2
	> One motorcycle	3
	One motorcycle	4
	No have	5

The assessment table above is based on the policy in Education and Culture Office of Pekanbaru to the system that has been running for this.

2. Make pairwise comparisons matrix for criteria

Make pairwise comparisons or weight and compare in pairs according to given criteria.

Table 4. Pairwise Comparisons

	C1	C2	C3	C4	C5	C6
C1	1	1/7	1/3	1/3	1/3	3
C2	7	1	3	3	3	5
C3	3	1/3	1	3	1/3	3
C4	3	1/3	1/3	1	1/3	3
C5	3	1/3	3	3	1	5
C6	1/3	1/5	1/3	1/3	1/5	1

3. Determine pairwise comparisons matrix value

This step is one by changing the value of the pairwise comparison matrix into the decimal form and sum each column.

Table 5. Pairwise Comparison

	C1	C2	C3	C4	C5	C6
C1	1.0000	0.1429	0.3333	0.3333	0.3333	3.0000
C2	7.0000	1.0000	3.0000	3.0000	3.0000	5.0000
C3	3.0000	0.3333	1.0000	3.0000	0.3333	3.0000
C4	3.0000	0.3333	0.3333	1.0000	0.3333	3.0000
C5	3.0000	0.3333	3.0000	3.0000	1.0000	5.0000
C6	0.3333	0.2000	0.3333	0.3333	0.2000	1.0000
Sum	17.33	2.34	8.00	10.67	5.20	20.00

4. Calculate Normalized Eigen Vector

The next step divides the criteria weights by the number of weight criteria. The Eigen Vector (EV) is derived from the sum of all the overall criterion value as well as dividing by the number of criteria.

Table 6. Normalized Eigen Vector

	C1	C2	C3	C4	C5	C6	Sum	EV
C1	0.057692	0.060976	0.041667	0.031250	0.064103	0.150000	0.405687	0.067615
C2	0.403846	0.426829	0.375000	0.281250	0.576923	0.250000	2.313848	0.385641
C3	0.173077	0.142276	0.125000	0.281250	0.064103	0.150000	0.935706	0.155951
C4	0.173077	0.142276	0.041667	0.093750	0.064103	0.150000	0.664873	0.110812
C5	0.173077	0.142276	0.375000	0.281250	0.192308	0.250000	1.413911	0.235652
C6	0.019231	0.085366	0.041667	0.031250	0.038462	0.050000	0.265975	0.044329
Sum	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	6.000000	1.000000

5. Compute the Consistency Ratio

Counting the consistency ratio is done to find out whether the criteria comparison assessment is consistent. For that we need to calculate λ_{maks}, we get

$$\lambda_{maks} = 17.33(0.067615) + 2.34(0.385641) + 8(0.155951) + 10.67(0.110812 + 5.2(0.235652) + 20(0.044329)$$

$$= 6.61706$$

Then. Will be calculated the value of Consistency Index (CI) by using equation (1), we obtain

$$CI = \frac{6.61706 - 6}{6 - 1}$$

$$= 0.123413$$

Then calculated the Consistency Ratio (CR) by using equation (2), so it is generated,

$$CR = \frac{0.123413}{1.24}$$

$$= 0.099526$$

From the calculation the consistency ratio is 0.099526. Because $CR \leq 0.10$, then CR is consistent and acceptable.

3.2. Application with TOPSIS Method

1. The next step is to convert to weight.

Table 7. Value Weight of Survey Results Data

Number	Name	C1	C2	C3	C4	C5	C6
1	S1	4	3	2	1	3	2
2	S2	3	4	4	5	2	3
3	S3	5	2	3	2	4	2
4	S4	4	3	4	3	2	4
5	S5	2	2	3	2	1	3
6	S6	3	1	4	3	3	1
7	S7	4	5	2	3	5	5
8	S8	5	4	4	2	4	4
9	S9	5	4	2	3	3	4
10	S10	4	2	5	3	2	3
11	S11	4	4	3	1	4	5
12	S12	5	1	4	2	1	2
13	S13	4	5	3	1	3	4
14	S14	3	4	4	2	3	5
15	S15	2	5	3	1	3	4
Sum		**15**	**14**	**13**	**10**	**12**	**14**

2. Change to normalized form

Table 8. Normalized Value

Number	Name	C1	C2	C3	C4	C5	C6	SUM	EV
1	S1	0.2632	0.2194	0.1499	0.1031	0.2526	0.1432	1.1315	0.051757
2	S2	0.1974	0.2925	0.2998	0.5157	0.1684	0.2148	1.6887	0.077245
3	S3	0.3290	0.1463	0.2249	0.2063	0.3369	0.1432	1.3865	0.06342
4	S4	0.2632	0.2194	0.2998	0.3094	0.1684	0.2864	1.5467	0.070749
5	S5	0.1316	0.1463	0.2249	0.2063	0.0842	0.2148	1.0080	0.04611
6	S6	0.1974	0.0731	0.2998	0.3094	0.2526	0.0716	1.2040	0.055074
7	S7	0.2632	0.3656	0.1499	0.3094	0.4211	0.3581	1.8673	0.085414
8	S8	0.3290	0.2925	0.2998	0.2063	0.3369	0.2864	1.7509	0.08009
9	S9	0.3290	0.2925	0.1499	0.3094	0.2526	0.2864	1.6199	0.074099
10	S10	0.2632	0.1463	0.3748	0.3094	0.1684	0.2148	1.4769	0.067557
11	S11	0.2632	0.2925	0.2249	0.1031	0.3369	0.3581	1.5786	0.07221
12	S12	0.3290	0.0731	0.2998	0.2063	0.0842	0.1432	1.1356	0.051947
13	S13	0.2632	0.3656	0.2249	0.1031	0.2526	0.2864	1.4959	0.068427
14	S14	0.1974	0.2925	0.2998	0.2063	0.2526	0.3581	1.6067	0.073494
15	S15	0.1316	0.3656	0.2249	0.1031	0.2526	0.2864	1.3643	0.062407
SUM		**3.7503**	**3.5832**	**3.7477**	**3.5068**	**3.6213**	**3.6522**	**21.8615**	**1.0000**

3. Change to a weighted normalized value form

Table 9. Weight Normalized Value

Number	Name	C1	C2	C3	C4	C5	C6
1	S1	0.0178	0.0846	0.0234	0.0114	0.0595	0.0063
2	S2	0.0133	0.1128	0.0468	0.0571	0.0397	0.0095
3	S3	0.0222	0.0564	0.0351	0.0229	0.0794	0.0063
4	S4	0.0178	0.0846	0.0468	0.0343	0.0397	0.0127
5	S5	0.0089	0.0564	0.0351	0.0229	0.0198	0.0095
6	S6	0.0133	0.0282	0.0468	0.0343	0.0595	0.0032
7	S7	0.0178	0.1410	0.0234	0.0343	0.0992	0.0159
8	S8	0.0222	0.1128	0.0468	0.0229	0.0794	0.0127
9	S9	0.0222	0.1128	0.0234	0.0343	0.0595	0.0127
10	S10	0.0178	0.0564	0.0584	0.0343	0.0397	0.0095
11	S11	0.0178	0.1128	0.0351	0.0114	0.0794	0.0159
12	S12	0.0222	0.0282	0.0468	0.0229	0.0198	0.0063
13	S13	0.0178	0.1410	0.0351	0.0114	0.0595	0.0127
14	S14	0.0133	0.1128	0.0468	0.0229	0.0595	0.0159
15	S15	0.0089	0.1410	0.0351	0.0114	0.0595	0.0127

4. Determination of A^+ and A^- by using equation (4) and equation (5), so obtained

Table 10. Value of Positive Ideal Solutions and Negative Ideal Solutions

Solution	C1	C2	C3	C4	C5	C6
A^+	0.0222	0.1410	0.0584	0.0571	0.0992	0.0159
A^-	0.0089	0.0282	0.0234	0.0114	0.0198	0.0032

5. The Determination of the final value of calculating the separation measure value using equation (6) and equation (7), then calculated the relative closeness to the ideal solution using equation (8). So obtained as the following table.

Table 11.Prediction Result

No.	Name	D^+	D^-	V
1	S1	0.0904810	0.0696116	0.434820755
2	S2	0.0677937	0.1012333	0.598918157
3	S3	0.0967696	0.0692483	0.417113505
4	S4	0.0861091	0.0693824	0.446213670
5	S5	0.1240957	0.0332094	0.211114596
6	S6	0.1232866	0.0516161	0.295113157
7	S7	0.0420953	0.1406736	0.769680141
8	S8	0.0501151	0.1079267	0.682899742
9	S9	0.0642881	0.0975926	0.602867481
10	S10	0.1062300	0.0553248	0.342451989
11	S11	0.0620125	0.1052579	0.629267874
12	S12	0.1429305	0.0294170	0.170684238
13	S13	0.0651296	0.1208574	0.649816278
14	S14	0.0613363	0.0979345	0.614893249
15	S15	0.0663340	0.1205294	0.645013570

Based on the calculation of TOPSIS, students who are prioritized to get a scholarship are the students who get the best value.

IV. CONCLUTION

The selection of students who are better to get scholarships is the right decision taken in the learning process at school. Mistakes in making decisions can cause students to drop out of school because they do not have fees for school. By using the AHP TOPSIS method can help the education and culture office of Pekanbaru in selecting students who are eligible to get scholarships and can be an alternative decision-making solution in determining scholarship recipients.

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