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Submission date: 10-Jun-2023 10:01AM (UTC+0300)
Submission ID: 2112606671
File name: Novia,_Rozzi,_Sujacka_tes_tes_7.docx (692.98K)
Word count: 1874
Character count: 10604

Jurnal TRANSFORMATIKA
Vol.15, No.1, Juli 2017, pp. 1 - xxx
P-ISSN: 1693-3656, E-ISSN: 2460-6731
https://journals.usm.ac.id/index.php/transformatika/

USM

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Analysis of the Topsis in the Recommendation System of PPA Scholarship Recipients at Universitas Islam Kebangsaan Indonesia

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ARTICLE INFO

History of the article :
Received 10 Juni 2023
Received in revised form 10 Juni 2023
Accepted 26 Juni 2023
Available online 8 July 2023

Keywords:

TOPSIS, Information System, Uniki

*** Correspondece:**

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ABSTRACT

This research implements the TOPSIS method on a recommendation system for Peningkatan Prestasi Akademik (PPA) scholarship recipients. The research data was obtained from the computer and multimedia faculty, UNIKI. The results showed that the TOPSIS method can provide the best alternative based on the highest rank. In this research, the highest rank was obtained from the results for predetermined criteria, namely GPA, achievements, parental dependents and parental income. The highest value obtained is 0.7489. The system built based on a website with the PHP programming language.

1. INTRODUCTION

Every University, especially Universitas Islam Kebangsaan Indonesia (UNIKI) offers many scholarships to outstanding students. Scholarships are income for recipients and the purpose of scholarships is to help the financial of UNIKI students while studying [1]. The distribution of scholarships includes the government in the Daftar Isian Pelaksanaan Anggaran (DIPA), social foundations and private companies [2]. To get the scholarship, it must meets the requirements in accordance with the rules of the scholarship that have been applied. The special requirements that are applied in this research are the cumulative grade point >= 3.00, Study Cards from the first semester to the final semester taken, parents' income letter or salary slip, general requirements that have been determined, etc.

The awarding of PPA scholarship is carried out routinely every year where the quota for the recipients are adjusted from the quota given by either the government, social foundations or private companies. Therefore, not all students who register as potential scholarship recipients will be accepted, only those who meet certain criteria will receive the scholarship.

Scholarships and tuition assistance for students include the PPA scholarships which are given to students who excel in academic. This scholarship is given to students for 1 (one) year [3].

Previous research on the application of the topsis method included research conducted by Muljadi et. al.[4], which applies the topsis method in determining the best employees. Research conducted by Nalatissifa et. al.[5], analyzing the topsis method in determining uninhabitable house assistance. Ridho et. al.[6], conducted research by combining the AHP and TOPSIS Methods to determine the Vocational High School Scholarship Recipients. Rahmalisa, et. al.[7], applying the topsis method to select scholarship recipients at SMAN 2 Tebing Tinggi Timur. Research on the topsis method was also conducted by Gunawan [8], who applied the topsis method for the Appointment of Contract Employees to Permanent Employees at PT Hanuraba Sawit Kencana. Furthermore, the research conducted by Sugiarto [9], applied the topsis method for housing selection.

In this research, we used TOPSIS (Technique For Order Preference By Similarity To Ideal Solution). This method was a form of a decision support model based on the concept that the best alternative was not only has the shortest distance from the positive ideal solution but it also has the longest distance from the negative ideal solution. The TOPSIS method will provide recommendations for scholarship recipients that are expected. The alternative is those who are recommended to get the scholarships based on the specified criteria [10].

With this research, it can make it easier for the University to find out which students are eligible to get the PPA scholarship obtained from implementing the TOPSIS method into a website-based system.

RESEARCH METHODS

This research used the TOPSIS method which is applied in a web-based system for recommendations for PPA scholarship recipients at UNIKI. The stages of the TOPSIS method in this research are as follow:

a. Define the criteria and attributes
b. Define a match rate.
c. Conduct a normalized decision matrix. It requires a performance rating for each alternative Ai for each normalized Cj criterion, which is in equation 1.

$$r_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^{m} x_{ij}^2}} \quad \text{..... (1)}$$

d. Multiply the weight and the value for each attribute. This process is used to form a Y matrix, it can be established based on the normalized weight value (yij), as in equation 2.

$$y_{ij} = w_i\, r_{ij} \quad \text{..... (2)}$$

e. Define the positive and the negative ideal solution matrix.
f. Define the distance of the value from each alternative with the matrix of positive and negative ideal solutions. The distance between alternative Ai and the positive ideal solution is shown in equation 3. The distance between alternative Ai and the negative ideal solution is shown in equation 4.

$$D_i^+ = \sqrt{\sum_{j=1}^{n} (y_i^+ - y_{ij})^2} \quad \text{.....(3)}$$

$$D_i^- = \sqrt{\sum_{j=1}^{n} (y_{ij} - y_i^-)^2} \quad \text{.....(4)}$$

g. Define the preference value of each alternative [10], which shown in equation 5. A higher Vi value indicates that alternative Ai is recommended.

$$V_i = \frac{D_i^-}{D_i^- + D_i^+} \qquad (5)$$

The following are the stages of the research shown in Figure 1.

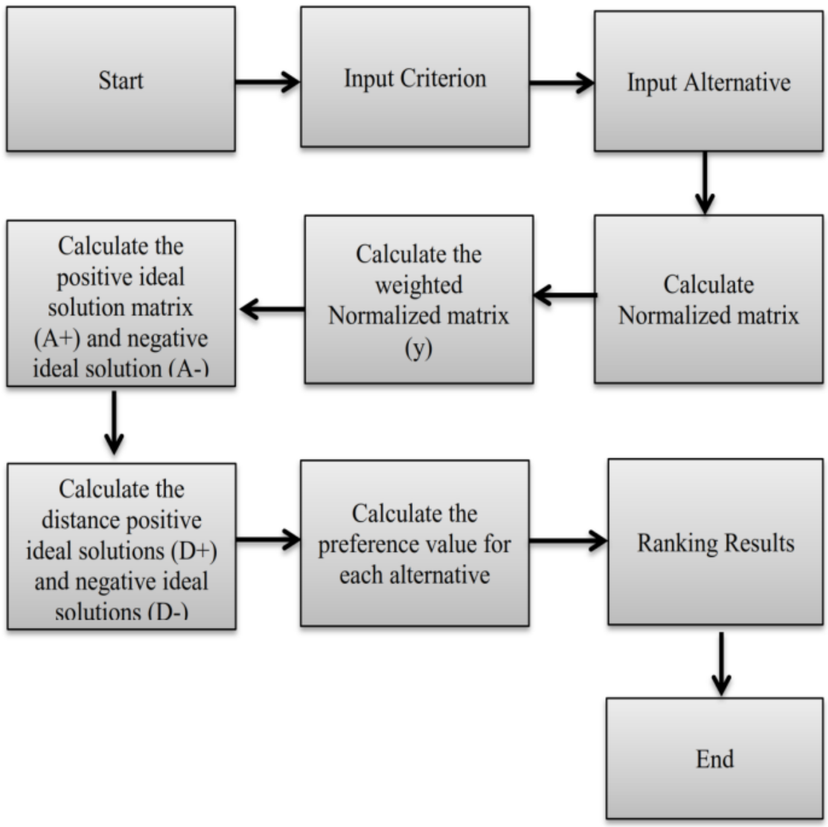

Figure 1. Research Framework with the TOPSIS Method

2.1 DSS (Decision Support System)

The Decision Support System is an interactive computer-based system with a function to help the decision makers to use data and models to solve many problems. DSS combine the intellectual resources with a computer capabilities to improve the quality of the decision [11]. Decision support systems can help facilitate human work in determining various things with certain methods.

2.2 TOPSIS

TOPSIS was one of many algorithm used for solving decision-making problems. The TOPSIS algorithm was based on a concept that the best alternative does not only have the shortest

DOI : https://doi.org/ 10.26623/transformatika.v18i2.xxxx

distance from the positive ideal solution, but also has the longest distance from the negative ideal solution. This algorithm is commonly used in several models of decision support systems for solving practical decision problems [12].

RESULTS AND DISCUSSION

3.1 The procedure for selecting student alternatives

The criteria used in this research were GPA, achievements obtained, parents' dependents, parents' income. GPA (C1), achievements (C2), parents' dependents (C3), parents' income (C4). The data analyzed was UNIKI student data at the Computer and Multimedia Faculty.

3.2 Alternative Data Sample

Table 1. Alternative

Alternative	C1	C2	C3	C4
Zulmiyati	3,58	1	1	1.500.000
Mardiah	3,45	1	1	2.000.000
Syahrul ramadhani	3,55	0	2	3.500.000
Aulia	3,2	0	1	3.500.000
Asrul aidil	3,64	1	2	1.200.000
Nisa	3,32	0	1	1.500.000
Nanda	3,42	0	2	1.800.000
Putri mustia	3,61	2	1	3.000.000
Maulidal	3,59	1	5	1.000.000

This study describes 9 alternative data consisting of 4 criteria, namely C1, C2, C3 and C4. The following are details of the range of parents' income (C4) which is shown in Table 2.

Table 2. Details of Parents' Income Criteria (C4)

Income	Value
0-1.000.000	5
1.000.000 - 2.000.000	4
2.000.000 - 3.000.000	3
3.000.000 – 4.000.000	2
> 4.000.000	1

The next step is to normalize the specified C4 data from the range as follows:

Table 3. Normalize Value

Alternative	C1	C2	C3	C4
Zulmiyati	3,58	1	1	4
Mardiah	3,45	1	1	4
Syahrul ramadhani	3,55	0	2	2
Aulia	3,2	0	1	2
Asrul aidil	3,64	1	2	4
Nisa	3,32	0	1	4

Nanda	3,42	0	2	4
Putri mustia	3,61	2	1	3
Maulidal	3,59	1	5	5

3.3 Calculating the normalized matrix

The steps in calculating the normalized matrix for each alternative on each criteria are normalized according to the equation (1).

$$x = \text{Criteria (C)},\ [x_1] = \sqrt{(3{,}58)^2 + (3{,}45)^2 + (3{,}55)^2 + (3{,}2)^2 + (3{,}64)^2} + \sqrt{(3{,}32)^2 + (3{,}42)^2 + (3{,}61)^2 + (3{,}59)^2}$$

$$= \sqrt{(12{,}8164) + (11{,}9025) + (12{,}6025) + (13{,}2496) + (10{,}24) + (12{,}8881) + (11{,}0224) + (11{,}6964) + (13{,}0321)}$$

$$= \sqrt{109{,}44} = 10{,}46$$

$$R_{11} = \frac{3{,}58}{10{,}46} = 0{,}34$$

$$R_{21} = \frac{3{,}45}{10{,}46} = 0{,}32$$

$$R_{91} = \frac{3{,}59}{10{,}46} = 0{,}34$$

The normalized matrix results are as follow:

$$R = \begin{bmatrix} 0{,}34 & 0{,}35 & 0{,}15 & 0{,}36 \\ 0{,}32 & 0.35 & 0{,}15 & 0{,}36 \\ 0{,}33 & 0 & 0{,}30 & 0{,}18 \\ 0{,}30 & 0 & 0{,}15 & 0.18 \\ 0{,}34 & 0{,}35 & 0{,}30 & 0{,}36 \\ 0{,}31 & 0 & 0{,}15 & 0{,}36 \\ 0{,}32 & 0 & 0{,}30 & 0{,}36 \\ 0{,}34 & 0{,}70 & 0{,}15 & 0{,}27 \\ 0{,}34 & 0{,}35 & 0{,}77 & 0{,}45 \end{bmatrix}$$

3.4 Calculating a weighted normalized matrix (y)

Calculating a normalized matrix with weights (y) to the predetermined weights (w). The weight values that have been determined are C1=4, C2=3, C3=1, C4=2, calculated by equation (2) as follows:

$$y_{11} = 4 * 0{,}34 = 1{,}36$$

$$y_{21} = 4 * 0{,}32 = 1{,}31$$

$$y_{94} = 2 * 0{,}45 = 0{,}90$$

The results obtained by the y_ij matrix are as follows:

$$Y_{ij} = \begin{bmatrix} 1,36 & 1,06 & 0,15 & 0,72 \\ 1,31 & 1,06 & 0,15 & 0,72 \\ 1,35 & 0 & 0,30 & 0,36 \\ 1,22 & 0 & 0,15 & 0,36 \\ 1,39 & 1,06 & 0,30 & 0,72 \\ 1,26 & 0 & 0,15 & 0,72 \\ 1,30 & 0 & 0.30 & 0,72 \\ 1,38 & 2,12 & 0,15 & 0,54 \\ 1,37 & 1,06 & 0,77 & 0,90 \end{bmatrix}$$

3.5 Determine the (A+) and (A-)

Results in determining the positive (A+) and negatif (A-) ideal solution matrix are calculated by equation (3) as shown in Table 4.

Table 4. A+ and A-

y_n	Ideal Solution	Max	Min
y_1	1,36;1,31;1,35;1,22;1,39;1,26;1,30;1,38;1,37	1,39	1,22
y_2	1,06; 1,06;0;0; 1,06;0;0; 2,12; 1,06	2,12	0
y_3	0,15;0,15;0,30;0,15;0,30;0,15;0,30;0,15;0,77	0,77	0,15
y_4	0,72;0,72;0,36;0,36;0,72;0,72;0,72;0,54;0,90	0,90	0,36

Matrix results of positive and negative ideal solutions are as follows:

$A^+[1,39 \quad 2,12 \quad 0,77 \quad 0,90]$ and $A\text{-}[1,22 \quad 0 \quad 0,15 \quad 0,36]$.

3.6 Calculating the distance between D+ and D-)

This step is to find the weighted distance between each alternative (D+ and D-) to the positive ideal solution according to equation (4) as follows:

$$\begin{aligned} D_1^+ &= \sqrt{(1,39-1,36)^2 + (2,12-1,06)^2 + (0,77-0,15)^2 +} \\ &= \sqrt{(0,90-0,72)^2} \\ &= \sqrt{(0,03)^2 + (1,06)^2 + (0,62)^2 + (0,18)^2} \\ &= \sqrt{(0,0009) + (1,1236) + (0,3844) + (0,0324)} \\ &= \sqrt{(1,5413)} = 1.24 \end{aligned}$$

$$\begin{aligned} D_2^+ &= \sqrt{(1,39-1,31)^2 + (2,12-1,06)^2 + (0,77-0,15)^2 +} \\ &= \sqrt{(0,90-0,72)^2} \\ &= \sqrt{(0,08)^2 + (1,06)^2 + (0,62)^2 + (0,18)^2} \\ &= \sqrt{(0,0064) + (1,1236) + (0,3844) + (0,0324)} \\ &= \sqrt{(1,5468)} \\ &= 1,24 \end{aligned}$$

The results of the positive solution distance (D+) are in Table 5.

Table 5. Positive ideal solution (D+)

D_i^+ Value	
D_1^+ Value	1,24
D_2^+ Value	1,24
D_3^+ Value	2,23
D_4^+ Value	2,28
D_5^+ Value	1,17
D_6^+ Value	2,22
D_7^+ Value	2,18
D_8^+ Value	0,71
D_9^+ Value	1,06

$$D_1^- = \sqrt{(1{,}22-1{,}36)^2+(0-1{,}06)^2+(0{,}15-0{,}15)^2+}$$
$$= \sqrt{(0{,}36-0{,}72)^2}$$
$$= \sqrt{(-0{,}14)^2+(-1{,}06)^2+(0)^2+(-0{,}36)^2}$$
$$= \sqrt{(0{,}0196)+(1{,}1236)+(0{,}1296)}$$
$$= \sqrt{(1{,}2728)}$$
$$= 1{,}13$$

The results of the positive solution distance (D-) are in Table 6.

Table 6. Negative ideal solution (D-)

D_i^- Value	
D_1^- Value	1,13
D_2^- Value	1,12
D_3^- Value	0,20
D_4^- Value	0
D_5^- Value	1,14
D_6^- Value	0,36
D_7^- Value	0,40
D_8^- Value	2,13
D_9^- Value	1,35

3.7 Calculating the preference value for each alternative

The closest of each alternative is calculated to (Vi) calculated according to equation (5) as follows:

$$V_1 = \frac{1{,}13}{1{,}13+1{,}24} = \frac{1{,}13}{2{,}37} = 0{,}476$$

$$V_2 = \frac{1{,}12}{1{,}12+1{,}24} = \frac{1{,}12}{2{,}36} = 0{,}475$$

$$V_3 = \frac{0{,}20}{0{,}20+2{,}23} = \frac{0{,}20}{2{,}43} = 0{,}08$$

$$V_4 = \frac{0}{0+2{,}28} = 0$$

The results obtained from the calculation (Vi) are shown in Table 7:

Table 7. Preference Value

V_i Value	
V_1 Value	0,476
V_2 Value	0,475
V_3 Value	0,08
V_4 Value	0
V_5 Value	0,49
V_6 Value	0,14
V_7 Value	0,15
V_8 Value	0,75
V_9 Value	0,56

3.8 Rank

From the value of Vi it can be seen that V8 has the highest value, which is shown in Table 8:

Table 8. Ranking of PPA Scholarship Recipients

Alternative	Total Value	Rank
Putri mustia	0,748	1
Maulidal hafdha	0,56	2
Asrul aidil	0,494	3
Zumiyati	0,476	4
Mardiah	0,475	5
Cut nanda rihal	0,155	6
Zahratul annisa	0,141	7
Syahrul ramadhani	0,083	8
Aulia	0	9

Based on the overall Topsis calculation process that has been done, the last procedure is to rank. The highest value is 0.748 and the second highest value is 0.56. The lowest value is 0.

3.9 System Implementation

The following is a form of the dashboard page which is shown in figure 2, and a display of the results of the recommendations for PPA scholarship recipients using the website-based TOPSIS method, which is shown in figure 3.

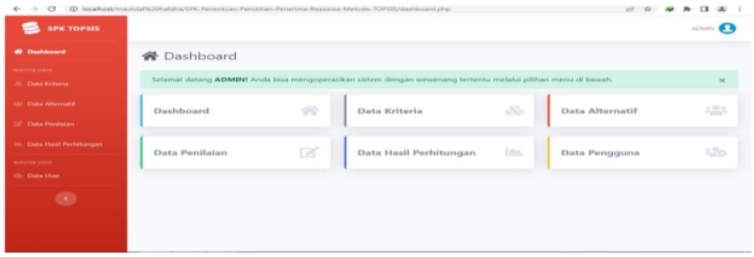

Figure 2. Dashboard Page

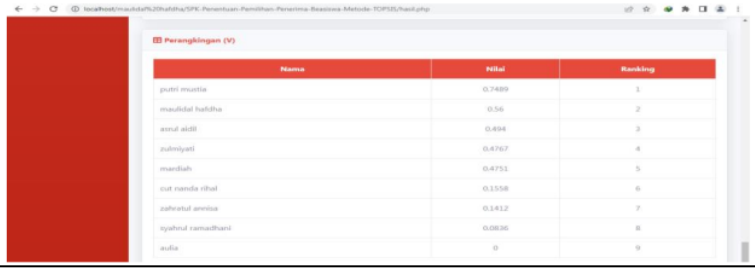

Figure 3. TOPSIS Rank Page

CONCLUSIONS

Based on tests that have been carried out using alternative data and criterion data, this research can determine the students who are eligible to get the PPA scholarship at the Universitas Islam Kebangsaan Indonesia. The results of this research indicate that the highest value of the decision-making system using the TOPSIS method is obtained with a value of 0.78. With this system, it easier for academics to find out the recommendations of outstanding students to get a PPA scholarship.

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