

Implementation of TOPSIS Algorithm for Evaluating Lecturer Performance

Fatkhurrochman^{a,1,*}, Kusrini^{b,2}, Hanif Alfatta^{c,3}

^{abc}Master of Information Engineering, Amikom University, Yogyakarta

¹fatkhurrochman.26@students.amikom.ac.id

* corresponding author

ARTICLE INFO

Article history

Received 2018-07-24

Revised 2018-08-11

Accepted 2018-08-16

Keywords

Decision Support System

TOPSIS

Evaluation

Lecturer

ABSTRACT

Type your abstract here Universities are higher education units that can organize academic programs, professions and vocations. Lecturers are professional educators and scientists with the main task of transforming and developing, and disseminating science, technology, and the arts through education, research, and community service. In assessing the performance of applying the seven criteria, namely: attendance, teaching, peneitian, devotion, loyalty, cooperation and responsibility. The problem that happened was the lecturer's performance appraisal that was not yet optimal because there was no special method in handling it. Therefore, it is necessary to build a decision support system by applying the Technique method for Others Reference by Similarity to Ideal Solution (TOPSIS). The TOPSIS method uses the principle that the chosen alternative must have the longest distance from the ideal solution from a geometric point of view by using the relative closeness of an alternative. Alternative in question is the performance of lecturers with predetermined criteria. This method generates the lecturer ranking based on the best performance in the form of numeric values and sorted by the greatest preference value. In this research using alternative 5 lecturers tested are Lecturer 1, Lecturer 2, Lecturer 3, Lecturer 4, and Lecturer 5. The result of this research shows that Lecturer 1 is the best lecturer with the biggest preference value is 0.612.

This is an open access article under the [CC-BY-SA](#) license.



1. Introduction

Higher education is a higher education unit that can organize academic, professional and / or vocational programs [1][2]. Lecturers are professional and scientific educators with the main task of transforming and developing, and disseminating science, technology and art through education, research, and community service [3].

Various activities are carried out in an effort to improve teaching and learning processes as well as graduates, one of which is to improve the quality of performance and quality of each lecturer. STMIK Bina Patria Magelang is a private university in the field of information and computers. In assessing the performance of lecturers, agencies still experience difficulties. This is due to the difficulty of assigning value to each assessment criterion where the data is separate. In evaluating the performance of lecturers, STMIK Bina Patria Magelang applies seven (7) criteria, namely: attendance, teaching, research, dedication, loyalty, cooperation and responsibility. Where for each criterion has different assessment weights.

Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) is a good settlement method in decision support systems [4][5]. The TOPSIS algorithm uses the principle that the chosen alternative must have the longest (farthest) distance from the negative ideal solution from a geometric point of view using the relative proximity of an alternative[6][7][8].

Several studies that have been conducted related to research conducted by researchers are research conducted, produce decision support systems in lecturer performance evaluation. In this study using 5 (criteria) as a decision-making consideration [9]. Research conducted by, C. Surya, (2018) produced a prototype decision support system by implementing the TOPSIS method. In this study using eight (8) criteria with the data of respondents as many as 5 lecturers[10], conducted a study on the assistance of poor students in elementary schools[11]. This study aims to measure the performance of lecturers by implementing the TOPSIS method in Decision Support Systems (DSS). The solution presented in this study is a recommendation assessment with a lecturer performance rating system through a decision support system built[12].

2. Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) Algorithm

TOPSIS is based on the concept that the best chosen alternative does not only have the shortest distance from the positive ideal solution, but also thinks of the longest distance from the ideal negative solution. The concept of the TOPSIS method is simple and easy to understand, the decision is efficient and has the ability to measure the relative performance of decision alternatives in a mathematical form[13]. First, confirm that you have the correct template for your paper size. This template has been tailored for output on the A4 paper size. If you are using US letter-sized paper, please close this file and download the file "MSW_USltr_format".

2.1. Maintaining the Integrity of the Specifications

The template is used to format your paper and style the text. All margins, column widths, line spaces, and text fonts are prescribed; please do not alter them. You may note peculiarities. For example, the head margin in this template measures proportionately more than is customary. This measurement and others are deliberate, using specifications that anticipate your paper as one part of the entire proceedings, and not as an independent document. Please do not revise any of the current designations.

In general the TOPSIS method has the following solutions to the solution:

- Make a normalized decision matrix
- Make a normalized decision matrix weighted
- Make a positive ideal solution matrix and a negative ideal solution matrix
- Determine the distance between the values of each alternative with the positive ideal solution matrix and the negative ideal solution matrix.
- Determine the preference value for each alternative

$$A = \begin{bmatrix} x_{11} & x_{12} & \cdots & x_{1n} \\ x_{21} & x_{22} & \ddots & x_{2n} \\ x_{31} & x_{32} & \cdots & x_{3n} \end{bmatrix} \quad (1)$$

With X_{ij} , the performance of the calculation for the third alternative to the j th attribute. In taking a solution, TOPSIS requires a performance rating of each alternative A_i on each normalized C_j criterion using Equation 2.

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

where $i=1,2,3, \dots, m$; and $j=1,2,3$

Calculate the positive A^+ ideal solution and the negative ideal solution A^- using Equation 4 and Equation 5 is determined based on the normalized weight rating (Y_{ij}) with Equation 3 according to the type of criteria according to Equation 6 and Equation 7.

$$Y_{ij} = W_i * R_{ij} \quad (3)$$

where $i=1,2,3, \dots, m$; and $j=1,2,3$

$$A^+ = (y_1^+, y_2^+, y_3^+, \dots, y_n^+) \quad (4)$$

$$A^- = (y_1^-, y_2^-, y_3^-, \dots, y_n^-) \quad (5)$$

In the condition :

$$Y_j^+ = \begin{cases} \max_i Y_{ij}, & \text{if } J \text{ is benefit attribute} \\ \min_i Y_{ij}, & \text{if } J \text{ is cost attribute} \end{cases} \quad (6)$$

$$Y_j^- = \begin{cases} \max_i Y_{ij}, & \text{if } J \text{ is benefit attribute} \\ \min_i Y_{ij}, & \text{if } J \text{ is cost attribute} \end{cases} \quad (7)$$

Calculating the distance between alternative A_i and the positive ideal solution is formulated in Equation 8.

$$D_i^+ = \sqrt{\sum_{j=1}^n (y_{ij} - y_i^+)^2} \quad (8)$$

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

Calculating the distance between alternative A_i and the negative ideal solution is formulated in Equation 9.

$$D_i^- = \sqrt{\sum_{j=1}^n (y_{ij} - y_i^-)^2} \quad (9)$$

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

Calculate the preference value of each alternative (V_i) against the ideal solution using Equation 11.

$$V = \frac{D_i^-}{D_i^- + D_i^+} \quad (10)$$

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

Then the ranking is based on the largest value (V_i)

3. Method

In this study using the approach with the waterfall method. At the data collection stage researchers used methods of observation, interviews to the staffing division and literature study. The data analysis method used is the TOPSIS method for the final ranking process in the performance evaluation of lecturers with the best criteria. The tool for modeling is using the Unified Modeling language (UML), while for the prototype implementation it uses the PHP programming language and the database uses MySQL.

4. Results and Discussion

In the data analysis, the TOPSIS method is used in evaluating the performance of lecturers based on the criteria in Table 1.

Table 1. Criteria of lecture evaluation

Criteria	Description
K1	Kehadiran
K2	Pengajaran
K3	Penelitian
K4	Pengabdian
K5	Loyalitas
K6	Kerjasama
K7	Tanggungjawab

Then the importance level used for each criterion is shown in Table 2.

Table 2. The importance level

Criteria	Description
5	Sangat Tinggi
4	Tinggi
3	Cukup
2	Rendah
1	Sangat Rendah

The weight value for each criterion is then determined, shown in Table 3.

Table 3. Weight value for each criterion

Criteria	Description	values
K1	Kehadiran	3
K2	Pengajaran	4
K3	Penelitian	5
K4	Pengabdian	3
K5	Loyalitas	5
K6	Kerjasama	2
K7	Tanggungjawab	5

In the data analysis, this study uses sample data from 5 lecturers so that the weighting preference data is generated in Table 4.

$$W = \{3, 4, 5, 3, 5, 2, 5\}$$

Table 4. The preference weight of each lecturer

Alternative	Criteria						
	K1	K2	K3	K4	K5	K6	K7
Dosen 1	4	2	2	4	5	3	4
Dosen 2	3	2	4	5	1	5	3
Dosen 3	2	3	2	3	3	3	3
Dosen 4	3	4	3	2	4	5	3
Dosen 5	2	2	4	2	3	3	2

In the data analysis with TOPSIS method with sample data of 5 lecturers in Table 4, the analysis will be carried out as follows:

4.1. Make normalized data / matrices

In determining normalized matrix values, Equation 2 is used.

$$|x_1| = \sqrt{4^2 + 3^2 + 2^2 + 3^2 + 2^2} = 6.481$$

$$r_{11} = \frac{x_{11}}{|x_i|} = \frac{4}{6.481} = 0.617$$

$$r_{21} = \frac{x_{21}}{|x_i|} = \frac{3}{6.481} = 0.463$$

$$r_{31} = \frac{x_{31}}{|x_i|} = \frac{2}{6.481} = 0.309$$

$$r_{41} = \frac{x_{41}}{|x_i|} = \frac{3}{6.481} = 0.463$$

$$r_{51} = \frac{x_{51}}{|x_i|} = \frac{2}{6.481} = 0.309$$

And so on for each alternative value, so that a matrix is produced in Table 5.

Table 5. Normalized matrix

0.617	0.329	0.286	0.525	0.645	0.342	0.583
0.463	0.329	0.571	0.657	0.129	0.570	0.438
0.309	0.493	0.286	0.394	0.387	0.342	0.438
0.463	0.658	0.429	0.263	0.516	0.570	0.438
0.309	0.329	0.571	0.263	0.387	0.342	0.292

Building a normalized weighted matrix (Yij)

At the stage of building the weighted matrix is done with Equation 3.

$$Y_{1,1} = 0.617 * 3 = 1.852$$

And so on for each normalized matrix value, so that the normalized matrix values are weighted in Table 6.

Table 6. The normalized matrix is weighted

1.852	1.315	1.429	1.576	3.227	0.684	2.917
1.389	1.315	2.857	1.970	0.645	1.140	2.188
0.926	1.973	1.429	1.182	1.936	0.684	2.188
1.389	2.630	2.143	0.788	2.582	1.140	2.188
0.926	1.315	2.857	0.788	1.936	0.684	1.459

Make a positive ideal solution (A+) and negative (A-)

Equation 4, whereas for the ideal negative solution (A-) Equation 5 is used

$$(A^+) = \{1.852, 1.389, 0.926, 1.389, 0.926\} = 1.852$$

And so on for each normalized matrix value is weighted.

$$(A^-) = \{1.852, 1.389, 0.926, 1.389, 0.926\} = 0.926$$

And so on for each normalized matrix value is weighted. So as to produce the ideal positive (A+) dan negative (A-) solution values in Table 7.

Table 7. Positive and negative ideal solutions

A ⁺	1.852	2.630	2.857	1.970	3.227	1.140	2.917
A ⁻	0.926	1.315	1.429	0.788	0.645	0.684	1.459

4.2. Calculating the distance between values of each alternative (D)

In determining the distance between the alternative values of the positive ideal solution (D+) digunakan Persamaan 8 Equation 8 is used while to calculate the distance between values the ideal negative solution (D-) is used Equation 9.

$$D_i^+ = \sqrt{(1.852 - 1.852)^2 + (1.315 - 2.630)^2 + (1.429 - 2.857)^2 + (1.576 - 1.970)^2 + (3.227 - 3.227)^2 + (0.684 - 1.140)^2 + (2.917 - 2.917)^2}$$

$$= 2.033$$

$$D_i^- = \sqrt{(1.852 - 0.926)^2 + (1.315 - 1.315)^2 + (1.429 - 1.429)^2 + (1.576 - 0.788)^2 + (3.227 - 0.645)^2 + (0.684 - 0.684)^2 + (2.917 - 1.459)^2}$$

$$= 3.205$$

And so on, so that data is generated in Table 7.

D _i ⁺	2.033	3.024	2.521	1.752	2.826
D _i ⁻	3.205	2.096	1.669	2.635	1.925

4.3. Calculating preference values for each alternative (V)

The preference value is used to determine the value of the lecturer ranking. In calculating the preference value used Equation 10.

$$V1 = 3.205 / (2.033 + 3.205) = 0.612$$

$$V2 = 2.096 / (3.024 + 2.096) = 0.409$$

$$V3 = 1.669 / (2.521 + 1.669) = 0.398$$

$$V4 = 2.635 / (1.752 + 2.635) = 0.601$$

$$V5 = 1.925 / (2.826 + 1.925) = 0.405$$

In the analais data using the TOPSIS method above it is produced that the best value in the performance evaluation of lecturers is Lecturer 1 with the preverence value V1. So for the ranking sequence is V1, V4, V2, V5, and V3.

4.4. Design of System with UML

In designing the prototype to be built, this study uses the Unified Modeling language (UML). The UML consists of use case diagrams, activity diagrams, and squared diagrams. In Figure 1, the usecase diagram explains that the admin processes user data and checks user data. While the user is in charge of carrying out lecturer data, Criteria data, Criteria value data and TOPSIS process.

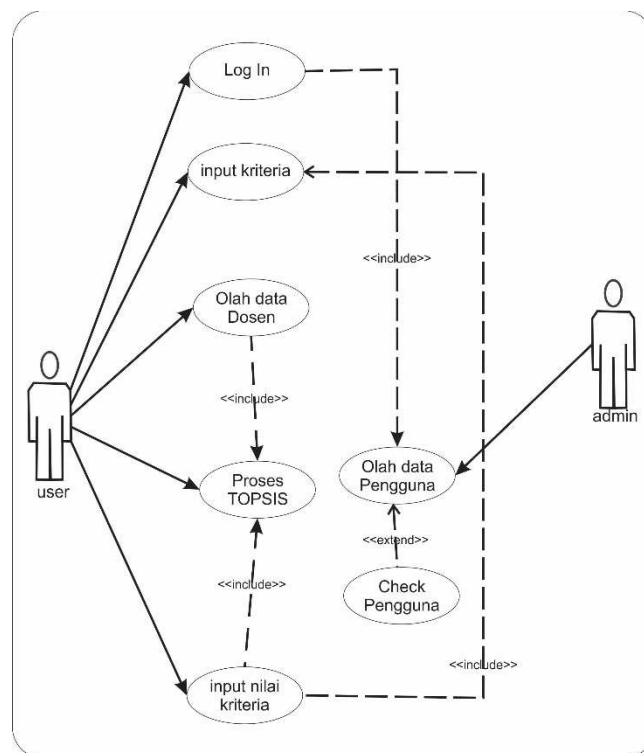


Fig. 1. Usecase Diagram

While the TOPSIS process will be shown in the digram activity in Figure 2. In the topsis process, the user will select the TOPSIS menu and the system will retrieve data, including lecturer data, Criteria data and Criteria value data. Then the system will calculate the normalized matrix, the normalized matrix is weighted, calculate the ideal solution, calculate the distance and calculate the preference value. The system will then check the data. If there is no data, the system will save the data, but if the data already exists, the system will update the existing data. The system ranks lecturer data by DESC and displays ranking data to the user.

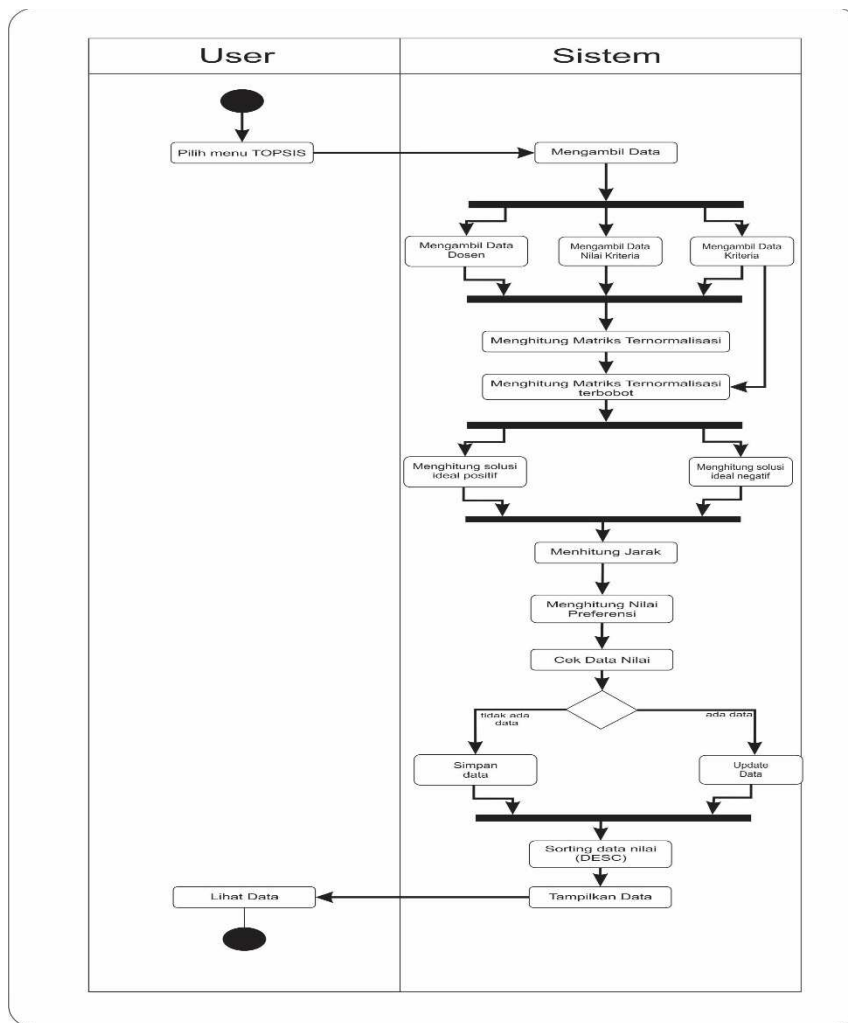


Fig. 2. Activity diagram of TOPSIS Algorithm

4.5. System implementation

Furthermore, in carrying out the process of evaluating the performance of the lecturer, the user performs the data on the value of each Criteria on the TOPSIS process page in Table 8.

Table 8. Lecturer performance results based on TOPSIS calculations

No	Nama Dosen	Kehadiran	Pengajaran	penelitian	pengabdian	loyalitas	kerja sama	Tanggung jawab	Nilai hasil
1	Dosen1	4	2	2	4	5	3	4	0.612
2	Dosen2	3	4	3	2	4	5	3	0.601
3	Dosen3	3	2	4	5	1	5	3	0.409
4	Dosen4	2	2	4	2	3	3	2	0.405
5	Dosen5	2	3	2	3	3	3	3	0.398

5. Conclusion

Based on the results of the research implementation of the technique for others reference by similarity to ideal solution (TOPSIS) in the decision support system for lecturer performance evaluation concluded that TOPSIS can provide recommendations in lecturer performance evaluation, where the results of calculations based on the highest preference value (V_i) of each alternative. The highest score is the first priority as the best performance lecturer. In analyzing data using 5 lecturer samples, the preference value was 0.612 for lecturers 1, 0.409 for lecturers 2, 0.398 for lecturers 3,

0.601 for lecturers 4, and 0.405 for lecturers 5. this study produced a WEB-based decision support system prototype using the PHP programming language and its database using MySQL.

Acknowledgment

On this occasion the author would like to thank all those who have helped and provided support and motivation. And also to STMIK Bina Patria Magelang which has become a place of research

References

- [1] R. A. Krohling and A. G. C. Pacheco, "A-TOPSIS – An Approach Based on TOPSIS for Ranking Evolutionary Algorithms," *Procedia Comput. Sci.*, vol. 55, pp. 308–317, Jan. 2015.
- [2] M. Yazdi, "Risk assessment based on novel intuitionistic fuzzy-hybrid-modified TOPSIS approach," *Saf. Sci.*, no. November 2017, pp. 0–1, 2018.
- [3] J. Ouenniche, B. Pérez-Gladish, and K. Bouslah, "An out-of-sample framework for TOPSIS-based classifiers with application in bankruptcy prediction," *Technol. Forecast. Soc. Change*, vol. 131, no. April, pp. 111–116, 2018.
- [4] B. C. Ervural, S. Zaim, O. F. Demirel, Z. Aydin, and D. Delen, "An ANP and fuzzy TOPSIS-based SWOT analysis for Turkey's energy planning," *Renew. Sustain. Energy Rev.*, vol. 82, pp. 1538–1550, 2018.
- [5] H. Gupta and M. K. Barua, "A framework to overcome barriers to green innovation in SMEs using BWM and Fuzzy TOPSIS," *Sci. Total Environ.*, vol. 633, pp. 122–139, 2018.
- [6] A. Vega, J. Aguarón, J. García-Alcaraz, and J. M. Moreno-Jiménez, "Notes on Dependent Attributes in TOPSIS," *Procedia Comput. Sci.*, vol. 31, pp. 308–317, 2014.
- [7] H. Gupta, "Assessing organizations performance on the basis of GHRM practices using BWM and Fuzzy TOPSIS," *J. Environ. Manage.*, vol. 226, pp. 201–216, 2018.
- [8] M. chih Hsieh, E. M. yang Wang, W. chiang Lee, L. wen Li, C. yi Hsieh, W. Tsai, C. ping Wang, J. li Huang, and T. chu Liu, "Application of HFACS, fuzzy TOPSIS, and AHP for identifying important human error factors in emergency departments in Taiwan," *Int. J. Ind. Ergon.*, vol. 67, no. October 2017, pp. 171–179, 2018.
- [9] L. Lu and Y. Yuan, "A novel TOPSIS evaluation scheme for cloud service trustworthiness combining objective and subjective aspects," *J. Syst. Softw.*, vol. 143, pp. 71–86, 2018.
- [10] V. A. Bhosale and R. Kant, "Examining the solutions to overcome the SCKFBS using fuzzy AHP and fuzzy TOPSIS method," *IEEE Int. Conf. Ind. Eng. Eng. Manag.*, vol. 2017–Decem, pp. 403–407, 2018.
- [11] Z. Wang, H. Hao, F. Gao, Q. Zhang, J. Zhang, and Y. Zhou, "Multi-attribute decision making on reverse logistics based on DEA-TOPSIS: A study of the Shanghai End-of-life vehicles industry," *J. Clean. Prod.*, vol. 214, pp. 730–737, 2019.
- [12] B. M. dos Santos, L. P. Godoy, and L. M. S. Campos, "Performance evaluation of green suppliers using entropy-TOPSIS-F," *J. Clean. Prod.*, vol. 207, pp. 498–509, 2019.
- [13] K. M. Naim Ku Khalif, A. Gegov, and A. S. Abu Bakar, "Z-TOPSIS Approach for Performance Assessment using Fuzzy Similarity," *IEEE Int. Conf. Fuzzy Syst.*, pp. 1–6, 2017.