Available online to ejournal.pnc.ac.id

**Journal of Innovation Information Technology and Application**

Journal Page is available to https://ejournal.pnc.ac.id/index.php/jinita

# Decision Making for The Most Outstanding Students Award using TOPSIS: A Case Study at Institut Teknologi Sumatera

*Borneo Satria Pratama* *[1], *Nike Dwi Grevika Drantantiyas* [2], *Ilham Marvie* [3], *Noveliska Br Sembiring* [4], *Muhammad Abi Berkah Nadi* [5]

[1] *Department of Informatics and Computer Engineering, Politeknik Elektronika Negeri Surabaya, Surabaya, Indonesia*
[2] *Engineering Physics Study Program, Institut Teknologi Sumatera, Lampung, Indonesia*
[3] *Food Technology Study Program, Institut Teknologi Sumatera, Lampung, Indonesia*
[4] *Agroindustrial Technology Study Program, Institut Teknologi Sumatera, Lampung, Indonesia*
[5] *Railway Engineering Study Program, Institut Teknologi Sumatera, Lampung, Indonesia*

*email:* [1] borneospratama.academia@gmail.com, [2] nike.drantantiyas@tf.itera.ac.id, [3] ilham.marvie@tp.itera.ac.id, [4] noveliska.sembiring@tip.itera.ac.id, [5] muhammad.nadi@si.itera.ac.id

**ARTICLE INFO**

**Article history:**
Received 11 November 2023
Revised 25 November 2023
Accepted 21 December 2023
Available online 30 December 2023

**Keywords:**
Decision
Making
TOPSIS
ITERA
Pilmapres

**IEEE style in citing this article:** B. Satria Pratama, N. Dwi Grevika Drantantiyas, I. Marvie, N. Br Sembiring, and M. Abi Berkah Nadi, "Decision Making for The Most Outstanding Students Award using TOPSIS: A Case Study at Institut Teknologi Sumatera," Journal of Innovation Information Technology and Application (JINITA), vol. 5, no. 2, pp. 176–182, Dec. 2023.

**ABSTRACT**

The internal selection of Pemilihan Mahasiswa Berprestasi, also known as Pilmapres, is an annual competition held by Institut Teknologi Sumatera (ITERA) to award the most outstanding student of the year which will be further sent to compete in the regional and national event of Pilmapres held by Balai Pengembangan Talenta Indonesia (BPTI). This study aimed to implement TOPSIS as a decision-making tool to determine the winner of Pilmapres ITERA in 2023. The criteria used in this study were general achievements, creative ideas, and English competencies, with the weight of 50, 30, and 20, respectively. The scores for the criteria for each student are obtained from nine members of the board of jury in the final stage of Pilmapres ITERA in 2023. The calculation result using TOPSIS concluded that the 1st, 2nd, and 3rd winners of the internal selection of Pilmapres ITERA in 2023 were Alpha, Beta, and Omega, with the final preference scores of 0.995, 0.799, and 0.795, respectively.

## 1. INTRODUCTION

To enhance the quality of Indonesian youth, Balai Pengembangan Talenta Indonesia (BPTI) annually held the national award for the most outstanding students, which is known in Bahasa as "Pemilihan Mahasiswa Berprestasi" or "Pilmapres". The implementation of Pilmapres is in harmony with the constitution in force in Indonesia about higher education (UU nomor 12 tahun 2012 tentang Pendidikan Tinggi), which the goal is to develop the college alumnus competencies by extracurricular, co-curricular, and extra-curricular activities, which one of the implementations is carried out by giving an award for the most outstanding students for their achievements during their bachelor's study period in the college. To choose the most outstanding students in the regional and national stage, the decision is made by calculating each student's points in (1) general achievements, (2) creative ideas, and (3) English competencies [1].



*) Corresponding Author: borneospratama.academia@gmail.com

Institut Teknologi Sumatera (ITERA), which is one of the technology institutes growing rapidly in Sumatera, annually sends its best students to compete in Pilmapres. To obtain the best students to be sent into the Pilmapres competition each year, ITERA's student task force (Satgas Kemahasiswaan ITERA) held an internal selection of Pilmapres. The best students from each faculty in ITERA are sent to compete with each other by exhibiting their general achievements and presenting their creative ideas to solve problems using English as the main language. The scores of each participant are given by a board of jury which come from each faculty in ITERA. However, the decision-making to obtain the 1st, 2nd, and 3rd place of the most outstanding students is complicated and potentially subjective, thus the final decision had the potential to be biased.

To overcome the problem, The Technique for Order Preference by Similarity to Ideal Solution (TOPSIS), as one of the methods in multiple criteria decision-making (MCDM), was implemented as a decision support tool to obtain the most outstanding students from Pilmapres ITERA held in 2023. TOPSIS uses: (1) the longest distance from the negative ideal solution, and (2) the shortest distance from the positive ideal solution as the calculation basis for determining the optimal solution of alternatives and ranking the preferences. The optimal solution and rank generated by TOPSIS will further be used as a reference for decision-making [2]. The advantages of TOPSIS are the simplicity of the concept, ease of understanding, and a good level of computational efficiency [3].

In this study, TOPSIS was used as a decision support tool for choosing the most outstanding students in Pilmapres of Institut Teknologi Sumatera (ITERA) in 2023. The difference between this study and previous studies is that the criteria in this study are in according with the Puspresnas (Pusat Prestasi Nasional) guide of Pilmapres released in 2023, with a few modifications based on the discussion results between the members of the board of jury. Alternatives used in this study were the students of ITERA from various departments which competed in the process. The calculation results using TOPSIS were used as the reference for decision-making on selecting the most outstanding students for the event in 2023.

## 2. METHODOLOGY

The methodology used in this study consists of two stages: (1) data collection from all members of the board of jury, and (2) data processing using TOPSIS. The result of the TOPSIS calculation was used as the basis for selecting the winners of most outstanding students in the internal selection of Pemilihan Mahasiswa Berprestasi (Pilmapres) of Institut Teknologi Sumatera (ITERA) in 2023.

### 2.1 Data Collection

Nine members of the board of jury were assigned by the committees to give the scores for five students who participated in the final stage of internal selection of Pilmapres ITERA in 2023. Two members were assigned to give scores for the general achievements of students. Whereas, three members were assigned to give the scores for English competencies and four members were assigned to give the scores for creative ideas. The rubric used for the scoring activities was based on the guidelines provided by Puspresnas, which consists of several criteria related to general achievements, English competencies, and creative ideas, each with assigned weights. Data on the scores were collected by the committees using a Google Spreadsheet which was accessible from the notebooks provided for all members of the board of jury. The documentation of the scoring session by the board of jury is presented in Figure 1.

Figure 1. The scoring session by members of the board of jury

### 2.2 Data Processing

The collected scores which were given by all members of the board of jury to each student in each aspect and sub-aspects of general achievements, English competencies, and creative ideas were calculated, averaged, and further used for calculation using TOPSIS by the committees. The steps in the TOPSIS calculation are as follows: [4][5].

1) **Creating the decision matrix**
A decision matrix was created according to the number of criteria used. This study was using (1) general achievements, (2) creative ideas, and (3) English competencies as the criteria.
2) **Normalizing the decision matrix**
The decision matrix was normalized using the following equation:

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

Where *i = 1, 2, 3, ..., m* and *j = 1, 2, 3, ..., n.*
3) **Multiplying the weight of criteria to the normalized decision matrix**
Each data in the normalized decision matrix was multiplied by the weight of each criterion using the following equation:

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

Where *i = 1, 2, 3, ..., m* and *j = 1, 2, 3, ..., n.*
4) **Determining the positive ideal and negative ideal solutions**
The positive ideal solution (ID*) and negative ideal solutions (ID') were calculated by the following equations:

$$ID^* = (y_1^+, y_2^+, y_3^+, \dots, y_n^+) \quad (3)$$

$$ID' = (y_1^-, y_2^-, y_3^-, \dots, y_n^-) \quad (4)$$

With the following conditions:

$$y_1^+ = \begin{cases} \max y_{ij} \text{ ; if } j \text{ is } benefit\ criterion \\ \min y_{ij} \text{ ; } if\ j\ is\ cost\ criterion \end{cases} \qquad y_1^- = \begin{cases} \min y_{ij} \text{ ; if } j \text{ is } benefit\ criterion \\ \max y_{ij} \text{ ; if } j \text{ is } cost\ criterion \end{cases}$$

5) **Determining the distance between alternatives to positive and negative ideal solutions**
The distance between each alternative to its positive ideal solution ($D_i^+$) and negative ideal solution ($D_i^-$) was calculated by following equation:

$$D_i^+ = \sqrt{\sum_{j=1}^{n} (y_1^+ - y_{ij})^2} \quad (5)$$

$$D_i^- = \sqrt{\sum_{j=1}^{n} (y_{ij} - y_1^-)^2} \quad (6)$$

6) **Determining the preference score for each alternative**
The preference score for each alternative was calculated by the following equation:

$$V_i = \frac{D_i^-}{D_i^+ + D_i^-} \quad (7)$$

The alternative that had the highest preference score is further selected as the final solution for the decision-making problem. The alternatives in this study were the students participating in the final stage of internal selection of Pilmapres ITERA in 2023. Further, the student who has the highest preference score would be selected as the 1st winner, followed by 2nd and 3rd winners.

## 3. RESULTS AND DISCUSSION

There are 5 ITERA students which were participating in the final stage of the internal selection: (1) Alpha, (2) Beta, (3) Omega, (4) Gamma, and (5) Delta. In this study, the real name of the students is concealed to avoid any potential conflicts in the future. The average scores obtained for general achievements, creative ideas, and English competencies from the board of jury for each student are presented in Tables 1, 2, and 3, respectively. The average scores of general achievements, the sum of weight

* average scores of English competencies, and the sum of weight * average scores of creative ideas for all students are further listed in the decision matrix presented in Table 4.

Table 1. The scores of general achievements of the students

| Student's Name | Alpha | Beta | Omega | Gamma | Delta |
|---|---|---|---|---|---|
| Average Scores of The General Achievements | 25.00 | 20.00 | 20.00 | 20.00 | 0.00 |

In this study, it should be noted that the weights used in Tables 2 and 3 were obtained from the rubric given by Puspresnas guidelines and used solely for calculating the sum of weight * average scores for each participant. Meanwhile, the weights used for TOPSIS calculations are determined by the joint decision between the committees and the jury board. The weight implemented for each criterion of (1) general achievement, (2) creative ideas, and (3) English competencies for TOPSIS calculation was 50, 30, and 20, respectively. These TOPSIS weights are also presented in Table 4.

Table 2. The scores of English competencies of the students

| Scoring Criteria for Creative Ideas | Weight | Average Score for Each Student | | | | |
|---|---|---|---|---|---|---|
| | | Alpha | Beta | Omega | Gamma | Delta |
| **1. Presentation** | | | | | | |
| 2.1 Performance | 0.15 | 86.00 | 80.00 | 75.00 | 70.33 | 73.67 |
| 2.2 Systematicity of Explanation | 0.15 | 84.33 | 78.33 | 74.33 | 70.67 | 71.67 |
| 2.3 The way to explain | 0.15 | 84.33 | 76.67 | 73.33 | 69.33 | 75.00 |
| 2.4 Punctuality | 0.05 | 81.67 | 82.33 | 81.67 | 81.67 | 81.67 |
| **2. Question and Answer Session** | | | | | | |
| 3.1 The accuracy of answers | 0.3 | 79.83 | 76.67 | 71.00 | 69.83 | 72.67 |
| 3.2 The way to answer | 0.2 | 81.50 | 75.33 | 74.33 | 71.67 | 72.83 |
| ∑ Weight * Average Score | | 82.53 | 77.43 | 73.65 | 70.92 | 73.50 |

Table 3. The scores of creative ideas of the students

| Scoring Criteria for Creative Ideas | Weight | Average Score for Each Student | | | | |
|---|---|---|---|---|---|---|
| | | Alpha | Beta | Omega | Gamma | Delta |
| **1. Presentation of Ideas** | | | | | | |
| 1.1 Good and correct use of Indonesian | 0.05 | 79.50 | 77.50 | 71.25 | 73.50 | 74.75 |
| 1.2 Conformity of citing and referencing with applicable rules/standards | 0.05 | 70.75 | 69.75 | 66.75 | 70.00 | 68.75 |
| **2. The Substances of Creative Ideas** | | | | | | |
| 2.1 Facts in the environment/surroundings that are interesting to study | 0.08 | 75.50 | 74.75 | 68.00 | 64.75 | 75.75 |
| 2.2 Identification of problems contained in facts in the environment/surroundings | 0.08 | 70.00 | 76.75 | 69.00 | 65.50 | 70.50 |
| 2.3 Problems formulation as a result of problems identification | 0.1 | 70.50 | 69.75 | 67.25 | 68.25 | 74.50 |
| 2.4 The description of the consequences of ignoring problems that are detrimental to the environment/surroundings | 0.08 | 73.25 | 72.50 | 65.75 | 66.25 | 68.50 |
| 2.5 The description of solutions | 0.15 | 77.75 | 74.25 | 68.75 | 70.00 | 71.75 |
| 2.6 The description of the subsequent impact (snowball effect) of achieving a solution | 0.08 | 70.50 | 72.25 | 65.25 | 66.75 | 68.00 |
| 2.7 The detailed description of action steps to reach a solution | 0.08 | 71.25 | 72.50 | 67.50 | 66.25 | 72.75 |
| 2.8 The description of obstacles/obstacles to implementing ideas and the anticipations | 0.05 | 69.50 | 70.00 | 67.50 | 67.50 | 70.00 |
| **3. The Quality of Creative Ideas** | | | | | | |
| 3.1 The Uniqueness and originality of creative ideas | 0.1 | 71.25 | 78.75 | 67.50 | 63.75 | 73.25 |
| 3.2 Implementation of Creative Ideas | 0.1 | 74.25 | 75.00 | 69.25 | 70.00 | 75.00 |
| ∑ Weight * Average Score | | 73.09 | 73.85 | 67.83 | 67.61 | 72.15 |

The values in each column of the decision matrix from Table 4 were normalized to obtain a normalized decision matrix, which is done by using equation (1). Furthermore, the weights were multiplied by the values in the normalized decision matrix to create a weighted normalized matrix. The weighted normalized matrix calculated based on equation (2) is presented in Table 5. Hereafter, the positive ideal solution and negative decision value can be determined. All criteria used in this study were categorized as benefits, thus the value of the positive ideal solution for each criterion would be max $y_{ij}$. Whereas, the value

of the negative ideal solution for each criterion would be min $y_{ij}$. The positive and negative ideal solutions are also presented in Table 5.

Table 4. Decision matrix

| Student's Name | Criterion | | |
|---|---|---|---|
| | General Achievements (weight: 50) | Creative Ideas (weight: 30) | English Competencies (weight: 20) |
| Alpha | 25.00 | 82.53 | 73.09 |
| Beta | 20.00 | 77.43 | 73.85 |
| Omega | 20.00 | 73.65 | 67.83 |
| Gamma | 20.00 | 70.92 | 67.61 |
| Delta | 0.00 | 73.50 | 72.15 |

Table 5. Weighted and normalized decision matrix and its positive and negative ideal solutions

| Student's Name | Criterion | | |
|---|---|---|---|
| | General Achievements | Creative Ideas | English Competencies |
| Alpha | 29.26 | 13.82 | 9.75 |
| Beta | 23.41 | 13.96 | 9.15 |
| Omega | 23.41 | 12.82 | 8.70 |
| Gamma | 23.41 | 12.78 | 8.38 |
| Delta | 0.00 | 13.64 | 8.68 |
| Positive ideal solution (ID*) | 29.26 | 13.96 | 9.75 |
| Negative ideal solution (ID') | 0.00 | 12.78 | 8.38 |

Furthermore, the relative distance between each alternative to the positive ideal solution ($D_i^+$) obtained by each criterion was calculated. The results of calculating the relative distance to the positive ideal solution based on equation (5) can be seen in Table 6. Whereas, the relative distance between each alternative to the negative ideal solution ($D_i^-$) obtained from each criterion was also calculated. The results of calculating the relative distance to the negative ideal solution based on equation (6) can be observed in Table 7. The result showed that Delta has the longest relative distance to the positive ideal solution, whereas Alpha has the longest relative distance to the negative ideal solution.

Table 6. Relative distances between alternatives to the positive ideal solution

| Student's Name | Criterion | | | $D_i^+$ |
|---|---|---|---|---|
| | General Achievements | Creative Ideas | English Competencies | |
| Alpha | 0.00 | 0.02 | 0.00 | 0.14 |
| Beta | 34.25 | 0.00 | 0.36 | 5.88 |
| Omega | 34.25 | 1.30 | 1.10 | 6.05 |
| Gamma | 34.25 | 1.39 | 1.88 | 6.13 |
| Delta | 856.16 | 0.10 | 1.14 | 29.28 |

Table 7. Relative distances between alternatives to the negative ideal solution

| Student's Name | Criterion | | | $D_i^-$ |
|---|---|---|---|---|
| | General Achievements | Creative Ideas | English Competencies | |
| Alpha | 856.16 | 1.07 | 1.88 | 29.31 |
| Beta | 547.95 | 1.39 | 0.59 | 23.45 |
| Omega | 547.95 | 0.00 | 0.10 | 23.41 |
| Gamma | 547.95 | 0.00 | 0.00 | 23.41 |
| Delta | 0.00 | 0.74 | 0.09 | 0.91 |

The preference scores were calculated by equation (7) using the relative distance values between the alternatives to the positive and negative ideal solutions from Table 6 and Table 7. The calculation result of the preference scores for all student is presented in Table 8, which shows that Alpha had the highest preference score, followed by Beta, Omega, Gamma, and Delta, respectively. The preference score obtained by Alpha is relatively high compared to the other students due to (1) his higher general achievements score, and (2) his higher English competencies score compared to the other students. Despite the lower score of the creative ideas of Alpha compared to Beta, the difference in their scores is not too large, thus not significantly affecting the position of the preference scores. Therefore, the 1st, 2nd, and 3rd winners of the internal selection of Pilmapres ITERA in 2023 were Alpha, Beta, and Omega, respectively.

Table 8. The preference score of each student

| Student's Name | Alpha | Beta | Omega | Gamma | Delta |
|---|---|---|---|---|---|
| Preference Score | 0.995 | 0.799 | 0.795 | 0.793 | 0.030 |

Before this study, TOPSIS had been used to choose the most outstanding students in various educational institutions. Triatmoko et. al. [6] used TOPSIS in a web-based decision support system to choose the most outstanding students in the Computer Science Faculty of UPN Veteran Jakarta. Radillah [7] used TOPSIS as a decision support tool for selecting the most outstanding students in SMAN 2 Mandau. Fitriatien [8] used TOPSIS as a decision support tool for electing the most outstanding students in the Mathematics Department of Universitas PGRI Adi Buana Surabaya. Ningtias and Iskandar [9] used TOPSIS as a decision support tool for selecting the most outstanding students in the Mathematics Department of Universitas Negeri Medan. The notable difference between this research compared to previous studies is the utilization of official guidelines provided by Puspresnas as a basis for determining the criteria used in the decision-making using TOPSIS. This novelty emphasizes the application of TOPSIS as a method of multiple criteria decision-making to solve a real-world problem, especially in the case of the most outstanding student determination as a preparation to compete in an official competition.

However, this study lacks the calculation for comparing TOPSIS accuracy performance to the other methods in multiple criteria decision-making. Previous studies have concluded the excellence and shortcomings of TOPSIS compared to the Analytical Hierarchy Process (AHP) and Weighted Product (WP). Novianti [10] found that TOPSIS is more accurate to use as a method for determining the most outstanding students compared to AHP. However, Fatahillah & Pratama [11] found that Weighted Product (WP) is more accurate compared to TOPSIS for determining the most outstanding students. The accuracy may be different for each different case. Thus, the comparison of the multiple criteria decision-making methods for determining the most outstanding students shall be done for future research and the preference scores result of the most accurate method shall be used for the final decision.

## 4. CONCLUSION

In this study, TOPSIS was successfully implemented as a decision-making tool to determine the most outstanding students in the internal selection of Pilmapres ITERA in 2023. The criteria used were general achievements, creative ideas, and English competencies with the TOPSIS weight of 50, 30, and 20, respectively. All the criteria used were categorized as benefits. The calculation result using TOPSIS showed that the preference scores obtained by Alpha, Beta, Omega, Gamma, and Delta were 0.995, 0.799, 0.795, 0.793, and 0.030, respectively. This result concluded that the 1st, 2nd, and 3rd winners of the internal selection of Pilmapres ITERA in 2023 were Alpha, Beta, and Omega, respectively. However, the comparison between TOPSIS and other multiple criteria decision-making (MCDM) methods and their accuracy calculation should be done for future research or implementation, in which the final preference scores obtained by the method with the most accurate result will be used as the basis for decision-making for determining the most outstanding students.

## REFERENCES

[1] R. W. Matindas, I. Sailah, Haryanto, N. S. Indrasti, D. A. Aruan, T. Simanjuntak, R. Subekti, L. Brida, "Pedoman pemilihan mahasiswa berprestasi program sarjana tahun 2023," Jakarta: Kementerian Pendidikan, Kebudayaan, Riset dan Teknologi, 2023.

[2] I. Muzakkir, "Penerapan metode TOPSIS untuk sistem pendukung keputusan penentuan keluarga miskin pada Desa Panca Karsa II," ILKOM Jurnal Ilmiah, vol. 9, no. 3, pp. 274-281, 2017.

[3] S. Kusumadewi, "Fuzzy Multi-Attribute Decision Making (Fuzzy MADM)," Yogyakarta: Graha Ilmu, 2006.

[4] S. Siswanti, L.W. Fatwa, K. Andriani, "Penerapan metode Analytical Hierarchy Process dan Technique for Order Preference by Similiarity to Ideal Solution sebagai Pendukung Keputusan dalam Menentukan Kenaikan Jabatan bagi Guru," Jurnal Ilmiah Sinus (JIS), vol. 18, no. 1, pp. 35-48, 2020.

[5] M. R. Ridho, Hairani, A. L. Kurniadin, H. Rifqi, "Kombinasi metode AHP dan TOPSIS untuk rekomendasi penerima beasiswa SMK berbasis sistem pendukung keputusan," Jurnal TEKNO KOMPAK, vol. 15, no. 1, pp. 26-39, 2021.

[6] H. Triatmoko, N. H. Matondang, Sarika, "Rancang bangun penentuan mahasiswa berprestasi berbasis web dengan metode TOPSIS pada Fakultas Ilmu Komputer UPN Veteran Jakarta," in Seminar Nasional Mahasiswa Ilmu Komputer dan Aplikasinya (SENAMIKA), April 2021, no. April 2021, pp. 419-430.

[7] T. Radilah, "Analisis perhitungan metode topsis dalam menyeleksi beasiswa berprestasi pada SMAN 2 Mandau," Jurnal Informatika, Manajemen, dan Komputer, vol. 14, no. 1, pp. 49-55, 2022.

[8] S. R. Fitriatien, "Sistem pendukung keputusan mahasiswa berprestasi menggunakan metode TOPSIS," Prosiding Seminar Matematika dan Pendidikan Matematika November 2016, pp. 1009-1024, 2016.

[9] R. I. A. Ningtias, S. Iskandar, "Pemanfaatan metode Technique for Order Preference by Similiarity to Ideal Solution (TOPSIS) dalam pemilihan mahasiswa berprestasi," KARISMATIKA, vol. 7, no. 3, pp. 1-7, 2021.

[10] T. A. Novianti, "Analisis perbandingan metode AHP dan metode TOPSIS untuk seleksi mahasiswa berprestasi (Mawapres) Universitas Muhammadiyah Jember," Bachelor thesis, Department of Informatics Engineering, Faculty of Engineering, Universitas Muhammadiyah Jember, 2019.
[11] A. Fatahillah, M. R. Pratama, "Perbandingan akurasi metode TOPSIS dan metode Weight Product untuk menentukan siswa berprestasi," BIOS Jurnal Teknologi Informasi dan Rekayasa Komputer, vol. 1, no. 2, pp 70-79, 2020.