Implementation of TOPSIS Algorithm for Selection of Prominent Student Class

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Abstract. This study aims to provide the right solution in overcoming the problem of selection for prominent class students senior high school at SMAN 2 Pematangsiantar. The solution is to make a decision support system for the selection of prominent class XI IPA students in determining rankings. The method used is the TOPSIS (Technique for Order Performance by Similarity to Ideal Solution) algorithm by using several criteria, namely: Mid Test Score, Final Exam Score, Extracurricular, Personality, and Attitude. The results of student data processing using the decision support system obtained weights of 1, 0.57188272655161, and 0.56259472567445 for rank 1 to rank 3. The implementation of this Decision Support System is beneficial and makes it easier for the school and the homeroom teacher to determine ranking for the selection of prominent class students.

1. Introduction

In this era of computer and information technology, various agencies, including government agencies engaged in any field need aids in data processing [1], [2], [3], [4], [5]–[8]. Information technology is an effort to collect, store, process, disseminate and use information covering the field of science and technology and engineering and management techniques.

In the field of information technology, decision-making systems are a branch of Science that lies between information systems and intelligent systems. In the decision-making process that is fast, on target, and can be accounted for is the key to success in the global competition in the future.

Having a lot of information is not enough if it is not able to compile it quickly into the best alternatives in the decision-making process. However, before the decision-making process is carried out from various options, a criterion is needed. Each rule must be able to answer a critical question about how well an alternative can solve a problem at hand.

SMA Negeri 2 Pematangsiantar is one of the best public high schools in Pematangsiantar City, which has long been top quality. The alumni are widely accepted at State Universities throughout Indonesia. Also, SMA Negeri 2 Pematangsiantar is known for its facilities and infrastructure, as well as organizational activities. SMAN 2 Pematangsiantar has pioneered excellent classes that are devoted to students and students. Currently, SMAN 2 has 1,162 students divided into 33 classes, namely 3 prominent classes with 102 students majoring in Science and 3 prominent classes of Social Studies with
102 students and regular (non-prominent) classes with 27 classes of 958 students. Meanwhile, the teaching staff is only 77 people.

In selecting prominent class students, SMA Negeri 2 still does it manually. The homeroom teacher performs filtering by manually calculating and comparing the UAS Value. After the results are obtained, the students can be classified based on the prominent class. This manual selection process is quite time-consuming, and the assessment can be objective because the criteria used in selecting excellent class students are still only based on grades.

To help and facilitate the selection process for the prominent class of SMAN 2 Pematangsiantar, a solution was given by creating a Decision Support System for the selection of excellent class students. Decision support systems are now widely used to help facilitate the problem-solving of decision-makers [9]–[13]. The method chosen to be implemented in the selection decision support system for this prominent class is to use the TOPSIS (Technique for Order Performance by Similarity to Ideal Solution) method [14]–[18]. The TOPSIS method is a multi-criteria decision-making method by applying weighted scores in each of the criteria.

This decision support system is made so that the selection of prominent class criteria can be more effective and efficient and can use various criteria so that it can select higher quality students. The decision support system is designed using 5 criteria, namely UTS Value, Final Exam Value, Personality, Expertise, Following Extracurricular Based on the subjects of class XI IPA students. This decision support system can help make it easier for teachers to find the best students who are eligible for entry into prominent classes.

2. Methodology

The steps taken to complete this research can be seen in Figure 1. The data collected were class XI IPA data. The criteria that are processed are mid-test score, final exam score, extracurricular, personality, and expert.

The preference weight is the weight for each test score. The weight of preference can be seen in table-1. Each existing criterion will be given a weight based on its importance in the selection process for prominent class students. The weights of the criteria can be seen in table-2. After the weights are determined, then data processing is carried out using the TOPSIS method.

| Test Results | Weight | Information | Weights Criteria |
|--------------|--------|-------------|-----------------|
| 80-100       | 5      | Very Good   | Highest         |
| 70-79        | 4      | Good        |                 |
| 60-69        | 3      | Satisfactory|                 |
| 50-59        | 2      | Poor        |                 |
| 0-49         | 1      | Very Poor   | Lowest          |

| Criteria Code | Provisions Criteria |
|---------------|---------------------|
| C1            | Mid Test Score      |
| C2            | Final Exam Score    |
| C3            | Extracurricular     |
| C4            | Personality         |
| C5            | Attitude            |
preference weight as: Vector Weight \( W = [30, 30, 20, 10, 10] \).

3. Result and Discussion

Data Processing with TOPSIS

The data that will be processed using the TOPSIS method includes 5 sample data contained in table 2.

| NO | NIS           | Weight Of Test Result | Test Result Value |
|----|---------------|------------------------|-------------------|
|    |               | C1  | C2  | C3  | C4  | C5  | C1  | C2  | C3  | C4  | C5  |
| 1  | 22114/002381218 | 5   | 4   | 4   | 4   | 88  | 76  | 76  | 77  | 78  |
| 2  | 21118/0026460329 | 5   | 5   | 4   | 4   | 85  | 82  | 78  | 76  | 71  |
| 3  | 22120/002215172  | 5   | 5   | 4   | 5   | 85  | 87  | 78  | 81  | 79  |
| 4  | 22127/002087132  | 5   | 5   | 5   | 5   | 91  | 88  | 87  | 86  | 85  |
| 5  | 21127/002213177  | 5   | 5   | 4   | 4   | 88  | 85  | 80  | 78  | 77  |

The steps performed in TOPSIS algorithm consist of:

a. Build a decision matrix. The decision matrix \( X \) refers to \( m \) alternatives to be evaluated based on \( n \) competencies, which consists of:

\[
X = \begin{pmatrix}
88 & 76 & 76 & 77 & 78 \\
85 & 82 & 78 & 76 & 71 \\
85 & 87 & 78 & 81 & 79 \\
91 & 88 & 87 & 86 & 85 \\
88 & 85 & 80 & 78 & 77 \\
\end{pmatrix}
\]

b. Normalized Decision Matrix

The results of the normalized matrix completion consist of:

1st Column C1

\[
R_{11} = \frac{88}{195.496803} = 0.45013523817411
\]

\[
R_{21} = \frac{88}{195.496803} = 0.43478971869091
\]

\[
R_{31} = \frac{88}{195.496803} = 0.43478971869091
\]

\[
R_{41} = \frac{88}{195.496803} = 0.46548075765732
\]

\[
R_{51} = \frac{88}{195.496803} = 0.45013523817411
\]

2nd Column C2

\[
R_{12} = \frac{76}{187.1844011} = 0.40601673841319
\]

\[
R_{22} = \frac{76}{187.1844011} = 0.43807069144581
\]

\[
R_{32} = \frac{76}{187.1844011} = 0.46478231897299
\]

\[
R_{42} = \frac{76}{187.1844011} = 0.47012464447843
\]

\[
R_{52} = \frac{76}{187.1844011} = 0.4549766796212
\]

3rd Column C3
R13 = \frac{76}{\sqrt{76^2 + 78^2 + 78^2 + 82^2 + 80^2}} = \frac{76}{178.6421003} = 0.4254316304605

R23 = \frac{78}{\sqrt{78^2 + 78^2 + 78^2 + 82^2 + 80^2}} = \frac{78}{178.6421003} = 0.43662719968315

R33 = \frac{78}{\sqrt{78^2 + 78^2 + 78^2 + 82^2 + 80^2}} = \frac{78}{178.6421003} = 0.43662719968315

R43 = \frac{82}{\sqrt{82^2 + 82^2 + 82^2 + 82^2 + 80^2}} = \frac{82}{178.6421003} = 0.48700726118505

R53 = \frac{80}{\sqrt{80^2 + 80^2 + 80^2 + 80^2 + 80^2}} = \frac{80}{178.6421003} = 0.4478276890579

4th Column C4

R14 = \frac{77}{\sqrt{77^2 + 76^2 + 81^2 + 86^2 + 78^2}} = \frac{77}{178.1740722} = 0.43216164425327

R24 = \frac{76}{\sqrt{76^2 + 76^2 + 81^2 + 86^2 + 78^2}} = \frac{76}{178.1740722} = 0.42654915536686

R34 = \frac{81}{\sqrt{81^2 + 76^2 + 86^2 + 82^2 + 78^2}} = \frac{81}{178.1740722} = 0.45461159979889

R44 = \frac{86}{\sqrt{86^2 + 76^2 + 86^2 + 82^2 + 78^2}} = \frac{86}{178.1740722} = 0.48267404423092

R54 = \frac{78}{\sqrt{78^2 + 76^2 + 86^2 + 82^2 + 78^2}} = \frac{78}{178.1740722} = 0.43777413313967

5th Column C5

R15 = \frac{78}{\sqrt{78^2 + 77^2 + 79^2 + 85^2 + 77^2}} = \frac{78}{174.6997424} = 0.44648033775883

R25 = \frac{77}{\sqrt{77^2 + 78^2 + 79^2 + 85^2 + 77^2}} = \frac{77}{174.6997424} = 0.40641158949843

R35 = \frac{79}{\sqrt{79^2 + 77^2 + 79^2 + 85^2 + 77^2}} = \frac{79}{174.6997424} = 0.4522044465318

R45 = \frac{85}{\sqrt{85^2 + 77^2 + 79^2 + 85^2 + 77^2}} = \frac{85}{174.6997424} = 0.48654908601924

R55 = \frac{77}{\sqrt{77^2 + 77^2 + 79^2 + 85^2 + 77^2}} = \frac{77}{174.6997424} = 0.44075623086499

c. Weighted Normalized Decision Matrix

Each coordinate matrix above is multiplied based on the level of importance of each required criterion, with the following results:

\[
\begin{bmatrix}
0.45013523817411 & 0.40601673841319 & 0.4254316304605 & 0.43216164425327 & 0.44648033775883 \\
0.43478971869091 & 0.43807069144591 & 0.43662719968315 & 0.43662719968315 & 0.4377413313967 \\
0.43478971869091 & 0.4343695697572 & 0.43662719968315 & 0.43662719968315 & 0.4377413313967 \\
0.4654075765732 & 0.47012446447843 & 0.48700726118505 & 0.48700726118505 & 0.48700726118505 \\
0.45013523817411 & 0.45409766796212 & 0.44782276890579 & 0.4377413313967 & 0.44075623086499
\end{bmatrix}
\]

d. Determine the ideal solution matrix.

The positive ideal solution and the negative ideal solution are as follows:

\[
A^+ = (13.96442273, 14.10373933, 9.740145224, 4.826740442, 4.865490861)
\]

\[
A^- = (13.04369156, 12.18050215, 8.508632609, 4.265491553, 4.064115895)
\]
e. Calculating the Separations

The alternative distance from the positive and the negative ideal solution consists of:

\[
S^+ = \begin{bmatrix}
2.41659160802989 \\
1.9347707874578 \\
1.4432532695269 \\
0
\end{bmatrix}
\]

\[
S^- = \begin{bmatrix}
0.61290292869263 \\
0.98676086262073 \\
1.8556791209689 \\
2.6489875424369 \\
1.6192214178425
\end{bmatrix}
\]

f. Preference Value

The result of the calculation of the preference value obtained can be seen in Figure 2.

![Preference Results](image)

**Figure 2.** Preference Results

The calculation result of the preference value in Figure 2 is the sequence of eligibility of class XI students of SMA Negeri 2 Pematangsiantar to be able to enter the prominent class.

4. Conclusion

From the results of data processing using the topsis method decision support system in selecting students for the prominent class above, it can be concluded that the decision support system used can run well and can provide information that can be used as decision support in selecting students for prominent class based on the order from the results of the preference value obtained through the calculation of the decision support system. Thus the system designed can be used as a media aid in decision making by the homeroom teacher to determine the value of prominent class students.

References

[1] S. P. Tamba, M. D. Batubara, W. Purba, M. Sihombing, V. M. Mulia Siregar, and J. Banjarnahor, “Book data grouping in libraries using the k-means clustering method,” *J. Phys. Conf. Ser.*, vol. 1230, no. 1, p. 012074, Jul. 2019.

[2] V. M. Mulia Siregar and H. Sugara, “Implementation of artificial neural network to assessment the lecturer’s performance,” *IOP Conf. Ser. Mater. Sci. Eng.*, vol. 420, no. 1, p. 012112, Oct. 2018.

[3] W. Purba, S. Tamba, and J. Saragih, “The effect of mining data k-means clustering toward students profile model drop out potential,” *J. Phys. Conf. Ser.*, vol. 1007, no. 1, p. 12049, 2018.
[4] Sunandar, A. Buchori, and N. D. Rahmawati, “Development of media kocerin (Smart box interactive) to learning mathematics in Junior High School,” *Glob. J. Pure Appl. Math.*, vol. 12, no. 6, pp. 5253–5266, 2016.

[5] P. D. P. Adi and A. Kitagawa, “Performance evaluation of E32 long range radio frequency 915 MHz based on internet of things and micro sensors data,” *Int. J. Adv. Comput. Sci. Appl.*, vol. 10, no. 11, pp. 38–49, 2019.

[6] P. D. P. Adi and A. Kitagawa, “ZigBee Radio Frequency (RF) performance on Raspberry Pi 3 for Internet of Things (IoT) based blood pressure sensors monitoring,” *Int. J. Adv. Comput. Sci. Appl.*, 2019.

[7] P. Adi, D. Prasetya, A. Setiawan, N. Nachrowie, and R. Arifuddin, “Design Of Tsunami Detector Based Sort Message Service Using Arduino and SIM900A to GSM/GPRS Module,” *Proc. Proc. 2nd Int. Conf. Adv. Sci. Innov. ICASI 2019, 18 July, Banda Aceh, Indones.*, 2019.

[8] P. D. P. Adi and A. Kitagawa, “A Study of LoRa Performance in Monitoring of Patient’s SPO2 and Heart Rate based IoT,” *Int. J. Adv. Comput. Sci. Appl.*, vol. 11, no. 2, 2020.

[9] M. Mesran, G. Ginting, S. Sugimam, and R. Rahim, “Implementation of Elimination and Choice Expressing Reality ( ELECTRE ) Method in Selecting the Best Lecturer ( Case Study STMIK BUDI DARMA ),” *Int. J. Eng. Res. Technol.*, vol. 6, no. 02, February-2017, pp. 141–144, 2017.

[10] M. Sevkli, “An application of the fuzzy ELECTRE method for supplier selection,” *Int. J. Prod. Res.*, vol. 48, no. 12, pp. 3393–3405, Jun. 2010.

[11] K. M. A. S. Al-Harbi, “Application of the AHP in project management,” *Int. J. Prof. Manag.*, vol. 19, no. 1, pp. 19–27, 2001.

[12] Angelina et al., “Application Selection Lending Houses Subsidized by the Method of AHP and SAW,” *J. Phys. Conf. Ser.*, vol. 1230, p. 012082, Jul. 2019.

[13] D. Bambang, T. Wijaya, T. Wahyono, and A. N. S. Hapsari, “TOPSIS Method Implementation for Employee Performance Information System,” *Int. J. Inf. Technol. Bus.*, vol. 2, no. 1, pp. 21–26, 2019.

[14] M. A. G. Fonseca, L. S. De Faria, and S. R. Lourenço, “Original Research Article Original Research Article Open Access Selection of Energy Efficiency Industrial Projects Using Topsis Method,” *Int. J. Dev. Res.*, vol. 09, no. 03, pp. 26719–26724, 2019.

[15] R. O. S. Gurning, W. Busse, and M. Lubnan, “Decision Making of Full Speed, Slow Steaming, Extra Slow Steaming and Super Slow Steaming using TOPSIS,” *Int. J. Mar. Eng. Innov. Res.*, vol. 2, no. 1, 2017.

[16] V. D. Iswari, F. Y. Arini, and M. A. Muslim, “Decision Support System for the Selection of Outstanding Students Using the AHP-TOPSIS Combination Method,” *Lontar Komput. J. Ilm. Teknol. Inf.*, vol. 10, no. 1, p. 40, May 2019.

[17] A. Azizi, D. O. Aikhuele, and F. S. Souleman, “A Fuzzy TOPSIS Model to Rank Automotive Suppliers,” *Procedia Manuf.*, vol. 2, no. February, pp. 159–164, 2015.

[18] A. I. Nurani, A. T. Pramudyaningrum, S. R. Fadhila, S. Sangadjii, and W. Hartono, “Analytical Hierarchy Process (AHP), Fuzzy AHP, and TOPSIS for Determining Bridge Maintenance Priority Scale in Banjarsari, Surakarta,” *Int. J. Sci. Appl. Sci. Conf. Ser.*, vol. 2, no. 1, p. 60, 2017.