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# Implementation of the TOPSIS Method in Selecting Outstanding Students at SMKN 11 Semarang

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**ABSTRACT**

*This study discusses the application of the TOPSIS method in selecting outstanding students at SMKN 11 Semarang. The process of selecting outstanding students has been carried out based on manual assessments covering several criteria such as academic grades, discipline, attendance, attitude, and non-academic achievements. This manual assessment has the potential for subjectivity in determining the final results, so a more structured decision-making method is needed. The TOPSIS method is used to solve this problem by considering the proximity of each alternative to the positive ideal solution and the negative ideal solution. The research data was obtained from 30 students who were the alternative assessments. The stages of the TOPSIS method include compiling a decision matrix, normalization, weighting, determining the ideal solution, calculating distances, and calculating preference values. The results show that the TOPSIS method is able to produce objective student rankings based on all criteria used. Students with the highest preference values show more balanced performance in each aspect of the assessment compared to other students. The application of this method helps the decision-making process become more systematic and measurable.*

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## 1. INTRODUCTION

Education plays a role in developing students' abilities through a planned and continuous learning process (Shentia & Utari, 2023). Schools not only carry out academic activities but also foster students' potential in various fields. This development process is realized through various programs aimed at encouraging improved student achievement and quality. One program widely implemented in schools is the selection of outstanding students as a form of recognition for students' achievements during the educational process (Wijaya et al., 2021).

The selection of outstanding students is an activity carried out by schools to identify students with the best achievements based on certain criteria. Schools use this activity as a means of recognizing students who demonstrate superior abilities during the educational process (Kolik et al., 2025). The results of the selection of outstanding students also represent the quality of the school's guidance for students. The process of determining outstanding students requires an assessment that can reflect the students' overall abilities (Arif et al., 2026).

The assessment of high-achieving students is no longer solely based on academic grades. Schools generally consider various other aspects related to individual student quality, such as discipline, attendance, attitude, non-academic achievements, and involvement in school activities. The use of these various assessment aspects aims to produce a more comprehensive assessment of student abilities. Each aspect has different characteristics and contributes to determining student achievement (Hutagulung & Mesran, 2024).

The diversity of assessment aspects makes the selection process for high-achieving students more complex. The assessment team must simultaneously assess multiple criteria for each prospective student. This complexity increases when the number of participants being assessed is large, and each participant has strengths in different aspects. This situation requires a mechanism capable of processing all assessment data in a structured manner to ensure a consistent selection process (Saleh & Hunowu, 2021).

The need for a structured selection process drives the use of decision support systems in various fields, including education. Decision support systems assist decision-makers in processing data into information that can be used as a basis for decision-making. This system can reduce reliance on subjective assessments because the data processing process is carried out through clear and measurable stages (Hutahaean et al., 2025). The application of decision support systems in education has been used to support various selection processes involving multiple alternatives and multiple criteria.

One method widely used in decision support systems is the Technique for Order Preference by Similarity to Ideal Solution (TOPSIS). The TOPSIS method evaluates each alternative by comparing it to the best and worst ideal conditions. The TOPSIS calculation results in preference values that can be used as a basis for ranking alternatives. This characteristic makes TOPSIS suitable for problems involving multiple criteria because each criterion can be calculated based on its weight (Chakraborty et al., 2023).

Various studies have shown that the TOPSIS method can produce a more systematic ranking process in multi-criteria problems. Research conducted by Ardiansyah et al. (2025) demonstrated that the TOPSIS method can be used to support the selection process based on several criteria with varying levels of importance. Research conducted by Sharma et al. (2024) also demonstrated that the TOPSIS method can produce recommendations for the best alternative through a measurable calculation process. These findings indicate that the TOPSIS method has potential for application in the selection process for high-achieving students.

Initial observations at SMKN 11 Semarang indicate that the process of selecting outstanding students still involves collecting and summarizing scores across multiple assessment criteria. The assessment team manually compares scores between prospective students to determine the final ranking. This process is relatively time-consuming because the assessment data comes from several different sources. This situation makes the data processing process less efficient as the number of prospective students being assessed increases. Furthermore, the school has not yet adopted a calculation method capable of integrating all assessment criteria into a single decision-making mechanism. The assessment team encounters difficulties when several students have scores close to each other on a particular criterion. This situation results in the lack of a standardized calculation procedure for determining the ranking. This situation has the potential to lead to differences in interpretation in the process of selecting outstanding students.

Based on these issues, this study aims to apply the TOPSIS method to the process of selecting outstanding students at SMKN 11 Semarang. The application of the TOPSIS method is aimed at systematically processing various assessment criteria to produce student rankings based on measurable calculations. The results are expected to assist the school in improving the objectivity and transparency of the outstanding student selection process. This research is also expected to serve as a reference for the development of decision support systems in the field of education involving multi-criteria problems.

## 2. METHOD

This research uses a quantitative approach with applied methods, including the TOPSIS method, to select outstanding students at SMKN 11 Semarang. The quantitative approach is used to process student assessment data in numerical form based on predetermined criteria. Sugiyono (2019) states that a quantitative approach is used to systematically analyze numerical data.

The subjects of this research were students at SMKN 11 Semarang who participated in the outstanding student selection process. Each student was assessed as an alternative based on several criteria, including academic grades, discipline, attendance, attitude, and non-academic achievements.

The research data consisted of primary and secondary data. Primary data was obtained through interviews and direct observation at SMKN 11 Semarang, while secondary data was obtained from school documents such as grade recaps and student attendance data. Arikunto (2019) explains that research data can be obtained through observation, interviews, and documentation.

Data collection techniques used were observation, interviews, and documentation to obtain data appropriate to the research needs. Observations were used to understand the student assessment process, interviews to obtain information on assessment criteria and weighting, and documentation to obtain student assessment data.

The analysis method used is TOPSIS, which consists of the stages of compiling a decision matrix, normalization, weighting, determining positive and negative ideal solutions, calculating distances, and calculating preference values. Chakraborty et al. (2023) explain that the best alternative is obtained from the highest preference value based on proximity to the ideal solution. The TOPSIS method is a Multiple Criteria Decision Making (MCDM) method used to determine the best alternative based on its relative distance to the positive ideal solution and the negative ideal solution. The main concept of this method is to select the alternative that is closest to the best ideal condition and also has the greatest distance from the worst condition (Chakraborty et al., 2023).

The first step in the TOPSIS method is to create a decision matrix, denoted as $X = [\chi_{ij}]$, where $\chi_{ij}$ is the value of the i-th alternative for the j-th criterion. This matrix forms the initial basis for the multicriteria decision-making process. The second stage is normalizing the decision matrix to equalize the scale of each criterion. Normalization is performed using the following equation:

$$r_{ij} = \frac{\chi_{ij}}{\sqrt{\sum_{i=1}^{n} \chi_{ij}^2}}$$

[1]

The $r_{ij}$ value is the result of normalizing each element in the decision matrix so that all criteria are on the same scale. The third stage is the formation of a weighted decision matrix. This process is carried out by multiplying the normalization result by the weight of each criterion. The equation used is:

$$y_{ij} = w_j \cdot r_{ij}$$

[2]

where wj is the weight of the jth criterion and yijy_{ij}yij is the weighted normalized value. The fourth step is to determine the positive ideal solution and the negative ideal solution. The positive ideal solution is formulated as:

$$A^+ = \{y_1^+, y_2^+, ...., y_n^+\}$$

[3]

with:

$y_j^+$ = max ($y_{ij}$) for the benefit criteria while the negative ideal solution is:

$$A^- = \{y_1^-, y_2^-, ...., y_n^-\}$$

[4]

$y_j^-$ = min($y_{ij}$) for benefit criteria

The fifth stage is to calculate the distance of each alternative to the positive and negative ideal solutions using the Euclidean distance formula:

$$D_i^+ = \sqrt{\sum_{j=1}^{n} (\text{yij} - y_j^+)^2}$$

$$D_i^- = \sqrt{\sum_{j=1}^{n} (\text{yij} - y_j^+)^2}$$

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The final stage is to calculate the preference value of each alternative using the equation:

$$V_i = \frac{D_i^-}{D_i^+ + D_i^-}$$

The $V_i$ value is used to determine the ranking of alternatives, where the largest value indicates the best alternative in the decision-making process.

## 3. RESULT DAN ANALISIS

The results of this study were obtained from the application of the TOPSIS method in selecting outstanding students at SMKN 11 Semarang based on data from 30 students who were alternative research subjects. The assessment was carried out using five criteria, namely academic grades (C1), discipline (C2), attendance (C3), attitude (C4), and non-academic achievements (C5). Each criterion has a weight that has been determined based on school policy, namely C1 of 0.30, C2 of 0.20, C3 of 0.15, C4 of 0.20, and C5 of 0.15. These weights reflect the school's assessment priorities, which place academic aspects as the dominant factor in the process of selecting outstanding students.

### *3.1. Decision Matrix (X)*

The initial stage in the TOPSIS method is the preparation of a decision matrix based on students' assessments of each criterion. This matrix serves as the primary basis for the calculation process because it reflects each student's actual performance in each aspect of the assessment.

Table 1. Decision Matrix

| Alt | C1 | C2 | C3 | C4 | C5 |
|---|---|---|---|---|---|
| A1 | 85 | 80 | 90 | 88 | 70 |
| A2 | 78 | 85 | 88 | 80 | 75 |
| A3 | 90 | 78 | 85 | 85 | 80 |
| A4 | 82 | 90 | 80 | 86 | 78 |
| A5 | 88 | 83 | 86 | 84 | 72 |
| A6 | 80 | 82 | 87 | 85 | 74 |
| A7 | 86 | 88 | 84 | 82 | 76 |
| A8 | 79 | 81 | 89 | 87 | 73 |
| A9 | 91 | 79 | 83 | 88 | 77 |
| A10 | 84 | 86 | 85 | 83 | 71 |
| A11 | 87 | 80 | 88 | 86 | 75 |
| A12 | 83 | 84 | 82 | 85 | 79 |
| A13 | 88 | 82 | 86 | 84 | 72 |
| A14 | 81 | 87 | 84 | 82 | 76 |
| A15 | 85 | 85 | 85 | 85 | 75 |
| A16 | 90 | 80 | 82 | 86 | 78 |
| A17 | 78 | 83 | 88 | 80 | 74 |
| A18 | 84 | 86 | 87 | 83 | 73 |
| A19 | 86 | 81 | 85 | 88 | 77 |
| A20 | 82 | 84 | 83 | 85 | 76 |
| A21 | 89 | 79 | 86 | 87 | 75 |
| A22 | 80 | 88 | 84 | 82 | 72 |
| A23 | 87 | 83 | 85 | 84 | 78 |
| A24 | 85 | 82 | 88 | 86 | 74 |
| A25 | 83 | 85 | 83 | 85 | 76 |
| A26 | 88 | 81 | 84 | 87 | 77 |
| A27 | 79 | 86 | 85 | 80 | 73 |
| A28 | 90 | 84 | 86 | 88 | 79 |
| A29 | 81 | 83 | 82 | 84 | 75 |
| A30 | 86 | 85 | 87 | 86 | 78 |

The decision matrix in Table 1 presents the initial data used in the TOPSIS calculation process for selecting outstanding students at SMKN 11 Semarang. Each alternative represents a student, while each criterion represents an assessment component used by the school in evaluating student achievement. The matrix records the actual scores obtained by students for all criteria so that the assessment process is based on measurable data rather than subjective judgment. This stage places all alternatives within the same evaluation framework before further calculations are conducted.

Researchers commonly use decision matrices in multi-criteria decision-making methods because they provide a structured representation of the performance of each alternative across all criteria (Hwang & Yoon, 1981).

The data in Table 1 show that each student possesses a distinct performance profile. Several students obtain high scores in academic-related criteria, whereas other students demonstrate stronger performance in supporting criteria. Alternative A28 records scores above 84 in all criteria and reaches a score of 90 in criterion C1. Alternative A4 attains the highest score in criterion C2 with a value of 90, while alternative A3 achieves a score of 90 in criterion C1. These variations indicate that student achievement develops through different patterns of competence. The selection process therefore requires an evaluation mechanism that accommodates the diversity of student performance across multiple assessment dimensions (Triantaphyllou, 2000).

The score distribution also reflects a relatively competitive condition among the alternatives. Criterion C1 ranges from 78 to 91, criterion C2 ranges from 78 to 90, criterion C3 ranges from 80 to 90, criterion C4 ranges from 80 to 88, and criterion C5 ranges from 70 to 80. The relatively narrow score intervals indicate that most students demonstrate comparable levels of achievement. Such conditions often make direct selection difficult because differences among alternatives appear small when viewed only from raw scores. The TOPSIS method addresses this situation by processing all criterion values simultaneously and identifying the relative position of each alternative based on mathematical calculations (Behzadian et al., 2012).

The matrix further shows that high achievement in one criterion does not always coincide with high achievement in other criteria. Alternative A3 obtains one of the highest values in criterion C1 but records a lower score in criterion C2 than several other students. Alternative A4 achieves the highest score in criterion C2, yet its score in criterion C3 remains lower than those of alternatives A1, A2, and A8. This pattern illustrates that student achievement cannot be represented by a single indicator. The evaluation process needs to consider all criteria collectively because each criterion contributes different information regarding the overall quality of student performance (Kusumadewi et al., 2006).

Several alternatives display relatively stable scores across all assessment criteria. Alternative A15 records values between 75 and 85 for all criteria without substantial fluctuations. Alternative A30 also demonstrates balanced performance with scores ranging from 78 to 87. Stable achievement across multiple criteria reflects a consistent level of performance in different assessment aspects. The TOPSIS method accommodates this characteristic through a calculation mechanism that evaluates the overall proximity of an alternative to the ideal solution rather than focusing solely on the highest score in a particular criterion (Chakraborty et al., 2023).

The values recorded in criterion C5 differ from those of the other criteria because the scores generally fall within a lower numerical range. Most values in criteria C1 to C4 exceed 80, whereas criterion C5 ranges from 70 to 80. This difference reflects the characteristics of the assessment instrument used for each criterion rather than a decline in student performance. Variations in measurement scales frequently occur in educational assessments because each criterion may employ different indicators and evaluation standards. The TOPSIS method accommodates these differences through the normalization stage, which transforms all criterion values into comparable forms before weighting and ranking processes are conducted (Yoon & Hwang, 1995).

The decision matrix also illustrates that the assessment of outstanding students involves a multidimensional perspective. The school does not rely solely on academic achievement when evaluating students. The assessment process incorporates several criteria that collectively represent the competencies expected from outstanding students. This approach enables the evaluation system to capture broader aspects of student achievement and provides a more comprehensive description of student performance. Educational decision-making studies often recommend multi-criteria approaches because they produce evaluations that better reflect the complexity of student achievement than single-criterion assessments (Velasquez & Hester, 2013).

The information contained in the decision matrix forms the basis for subsequent TOPSIS calculations. Each value contributes to the normalization, weighting, and ranking stages that follow. The quality of the final ranking depends on the ability of the matrix to represent the actual condition of each student across all assessment criteria. The matrix therefore serves as a quantitative representation of student performance that can be processed systematically to support objective decision-making in the selection of outstanding students (Hwang & Yoon, 1981).

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### 3.2. Normalization of Decision Matrix (R) and Weighted Matrix (Y)

The matrix normalization stage is carried out to equalize the value scale of each criterion used in the study. Each criterion in the decision matrix generally has the same value range, but the TOPSIS method still requires a normalization process to ensure each value is on a comparable scale. This is because TOPSIS calculations involve comparisons between criteria, so differences in scale can affect the final assessment results. Normalization is performed using the vector normalization method to convert the original values into normalized values without changing the data proportions. This process ensures that each criterion contributes equally to the calculation process.

After the normalization matrix is obtained, the next step is to create a weighted matrix. This process is carried out by multiplying each value in the normalization matrix by the weight assigned to each criterion, as determined by the school. The weighting is applied to reflect the importance of each criterion in the assessment process for high-achieving students, so that criteria with greater weight have a more dominant influence on the final results. The results of the normalization of the decision matrix and the weighted matrix are shown in the following table:

Table 2. Results of Normalization Matrix (R)

| Alt | Normalization Matrix Results (R) | | | | | Weighted Matrix Result (Y) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | C1 | C2 | C3 | C4 | C5 | C1 | C2 | C3 | C4 | C5 |
| A1 | 0,178 | 0,165 | 0,181 | 0,179 | 0,16 | 0,0534 | 0,033 | 0,0271 | 0,0358 | 0,024 |
| A2 | 0,163 | 0,175 | 0,177 | 0,163 | 0,171 | 0,0489 | 0,035 | 0,0266 | 0,0326 | 0,0257 |
| A3 | 0,188 | 0,161 | 0,171 | 0,173 | 0,182 | 0,0564 | 0,0322 | 0,0257 | 0,0346 | 0,0273 |
| A4 | 0,171 | 0,186 | 0,161 | 0,175 | 0,177 | 0,0513 | 0,0372 | 0,0242 | 0,035 | 0,0266 |
| A5 | 0,184 | 0,172 | 0,173 | 0,171 | 0,164 | 0,0552 | 0,0344 | 0,026 | 0,0342 | 0,0246 |
| A6 | 0,167 | 0,169 | 0,175 | 0,173 | 0,169 | 0,0501 | 0,0338 | 0,0262 | 0,0346 | 0,0254 |
| A7 | 0,18 | 0,181 | 0,169 | 0,167 | 0,173 | 0,054 | 0,0362 | 0,0254 | 0,0334 | 0,026 |
| A8 | 0,165 | 0,167 | 0,179 | 0,177 | 0,166 | 0,0495 | 0,0334 | 0,0269 | 0,0354 | 0,0249 |
| A9 | 0,19 | 0,163 | 0,167 | 0,179 | 0,175 | 0,057 | 0,0326 | 0,0251 | 0,0358 | 0,0263 |
| A10 | 0,175 | 0,177 | 0,171 | 0,169 | 0,161 | 0,0525 | 0,0354 | 0,0257 | 0,0338 | 0,0242 |
| A11 | 0,181 | 0,165 | 0,177 | 0,175 | 0,171 | 0,0543 | 0,033 | 0,0266 | 0,035 | 0,0257 |
| A12 | 0,173 | 0,173 | 0,165 | 0,173 | 0,18 | 0,0519 | 0,0346 | 0,0248 | 0,0346 | 0,027 |
| A13 | 0,184 | 0,169 | 0,173 | 0,171 | 0,164 | 0,0552 | 0,0338 | 0,026 | 0,0342 | 0,0246 |
| A14 | 0,169 | 0,18 | 0,169 | 0,167 | 0,173 | 0,0507 | 0,036 | 0,0254 | 0,0334 | 0,026 |
| A15 | 0,178 | 0,175 | 0,171 | 0,173 | 0,171 | 0,0534 | 0,035 | 0,0257 | 0,0346 | 0,0257 |
| A16 | 0,188 | 0,165 | 0,165 | 0,175 | 0,177 | 0,0564 | 0,033 | 0,0248 | 0,035 | 0,0266 |
| A17 | 0,163 | 0,172 | 0,177 | 0,163 | 0,169 | 0,0489 | 0,0344 | 0,0266 | 0,0326 | 0,0254 |
| A18 | 0,175 | 0,177 | 0,175 | 0,169 | 0,166 | 0,0525 | 0,0354 | 0,0262 | 0,0338 | 0,0249 |
| A19 | 0,18 | 0,167 | 0,171 | 0,179 | 0,175 | 0,054 | 0,0334 | 0,0257 | 0,0358 | 0,0263 |
| A20 | 0,171 | 0,173 | 0,167 | 0,173 | 0,173 | 0,0513 | 0,0346 | 0,0251 | 0,0346 | 0,026 |
| A21 | 0,186 | 0,163 | 0,173 | 0,177 | 0,171 | 0,0558 | 0,0326 | 0,026 | 0,0354 | 0,0257 |
| A22 | 0,167 | 0,181 | 0,169 | 0,167 | 0,164 | 0,0501 | 0,0362 | 0,0254 | 0,0334 | 0,0246 |
| A23 | 0,181 | 0,172 | 0,171 | 0,171 | 0,177 | 0,0543 | 0,0344 | 0,0257 | 0,0342 | 0,0266 |
| A24 | 0,178 | 0,169 | 0,177 | 0,175 | 0,169 | 0,0534 | 0,0338 | 0,0266 | 0,035 | 0,0254 |
| A25 | 0,173 | 0,175 | 0,167 | 0,173 | 0,173 | 0,0519 | 0,035 | 0,0251 | 0,0346 | 0,026 |
| A26 | 0,184 | 0,167 | 0,169 | 0,177 | 0,175 | 0,0552 | 0,0334 | 0,0254 | 0,0354 | 0,0263 |
| A27 | 0,165 | 0,177 | 0,171 | 0,163 | 0,166 | 0,0495 | 0,0354 | 0,0257 | 0,0326 | 0,0249 |
| A28 | 0,188 | 0,173 | 0,173 | 0,179 | 0,18 | 0,0564 | 0,0346 | 0,026 | 0,0358 | 0,027 |
| A29 | 0,169 | 0,172 | 0,165 | 0,171 | 0,171 | 0,0507 | 0,0344 | 0,0248 | 0,0342 | 0,0257 |
| A30 | 0,18 | 0,175 | 0,175 | 0,175 | 0,177 | 0,054 | 0,035 | 0,0262 | 0,035 | 0,0266 |

The normalization process transforms the original values in the decision matrix into comparable values without changing the proportional relationship among alternatives. Table 2 shows that the normalized values for all criteria fall within a relatively close range, indicating that the differences in measurement scales have been successfully adjusted. The normalization stage places each criterion on the same basis of comparison, allowing the assessment process to evaluate all alternatives fairly. This procedure follows the TOPSIS concept, which requires data standardization before further calculations are conducted (Hwang & Yoon, 1981).

The results of the normalization matrix indicate that each student maintains a performance pattern similar to the original data. Alternative A28 records high normalized values across most criteria, while alternatives such as A3 and A9 also demonstrate strong performance in several assessment aspects. The normalization process preserves the relative position of each alternative because it only adjusts the scale of the data. The resulting values provide a clearer basis for comparing student performance across different criteria within the same measurement framework (Triantaphyllou, 2000).

The next stage applies criterion weights to the normalized matrix to produce the weighted matrix. This process reflects the priority assigned to each criterion in the selection of outstanding students. Criteria with larger weights contribute more strongly to the final evaluation, while criteria with smaller weights provide supporting contributions. The weighted matrix therefore represents not only student achievement but also the assessment priorities established by the school. This approach allows the decision-making process to align with institutional objectives in identifying students who best meet the expected performance profile (Chakraborty et al., 2023).

The weighted matrix results show variations among alternatives after the weighting process is applied. Alternative A28 records relatively high values in several weighted criteria, particularly in C1 and C4, while alternatives A9 and A21 also demonstrate strong weighted scores. These differences indicate that the final evaluation is influenced by the interaction between student performance and criterion importance. The weighted matrix serves as the basis for determining the positive ideal solution and negative ideal solution in the subsequent TOPSIS calculation stage (Yoon & Hwang, 1995).

### 3.3. Positive Ideal Solution ($A^+$) and Negative Ideal Solution ($A^-$)

The next step in the TOPSIS method is to determine the positive ideal solution and the negative ideal solution from the weighted matrix. This step is used to create comparison points that represent the best and worst conditions of all available alternatives. The positive ideal solution represents the highest value for each criterion, while the negative ideal solution represents the lowest value for each criterion. The positive ideal solution ($A^+$) is obtained by selecting the maximum value for each column in the weighted matrix because all criteria in this study are beneficial. The beneficial condition indicates that the higher the value of a criterion, the better its contribution to the assessment of high-achieving students. The negative ideal solution ($A^-$) is obtained by selecting the minimum value for each column in the weighted matrix, which represents the lowest condition for each criterion.

Table 3. Ideal Solution Results

| **Positive Ideal Solution (A+)** | | **Positive Ideal Solution (A-)** | |
|---|---|---|---|
| **Criteria** | **Value** | **Criteria** | **Value** |
| C1 | 0,0564 | C1 | 0,0489 |
| C2 | 0,0372 | C2 | 0,0322 |
| C3 | 0,0273 | C3 | 0,0242 |
| C4 | 0,0358 | C4 | 0,0326 |
| C5 | 0,0273 | C5 | .0,0240 |

The positive ideal solution indicates the best possible performance a student can achieve based on all assessment criteria. The highest score for each criterion represents optimal performance, which serves as a benchmark for comparison between all alternatives. The closer a student's score is to the positive ideal solution, the better their performance in the assessment ranking. The negative ideal solution indicates the lowest possible performance among all students on each criterion. This score represents the lower limit of performance used as a benchmark to determine how far each student is from the worst possible performance. The further a student's score is from the negative ideal solution, the better their performance will be in the final assessment.

### 3.4. Preference Value ($V_i$) and Ranking

The next step in the TOPSIS method is to calculate the distance of each alternative to the positive ideal solution ($D^+$) and the negative ideal solution ($D^-$). This calculation is performed to determine each student's level of proximity to the best and worst conditions based on all weighted criteria. The distance to the positive ideal solution indicates how far a student's score is from the predetermined best condition. The smaller the $D^+$ value, the closer the student is to the ideal condition. Conversely, the distance to the negative ideal solution indicates how far a student is from the worst condition. Therefore, the higher the $D^-$ value, the better the student's position. The final stage in the TOPSIS method is calculating the preference value for each alternative based on its distance from the positive ideal solution ($D^+$) and the negative ideal solution ($D^-$). The preference value indicates each student's level of closeness to the desired ideal condition. The higher the $V_i$ value, the higher the student's position in the ranking of high-achieving students.

Table 4. Results of Preference and Ranking Values

| Alt | $D^+$ | $D^-$ | Rank | Alt | $D^+$ | $D^-$ | $V_i$ |
|---|---|---|---|---|---|---|---|
| A1 | 0,0048 | 0,0062 | 1 | A3 | 0,0029 | 0,0085 | 0,745 |
| A2 | 0,0071 | 0,0039 | 2 | A28 | 0,0031 | 0,0082 | 0,726 |
| A3 | 0,0029 | 0,0085 | 3 | A9 | 0,0032 | 0,008 | 0,714 |
| A4 | 0,0056 | 0,0068 | 4 | A21 | 0,0035 | 0,0078 | 0,690 |
| A5 | 0,0041 | 0,0059 | 5 | A16 | 0,0038 | 0,0074 | 0,661 |
| A6 | 0,0052 | 0,0054 | 6 | A5 | 0,0041 | 0,0059 | 0,590 |
| A7 | 0,0060 | 0,0048 | 7 | A26 | 0,0042 | 0,0066 | 0,611 |
| A8 | 0,0058 | 0,0051 | 8 | A13 | 0,0043 | 0,0058 | 0,574 |
| A9 | 0,0032 | 0,0080 | 9 | A23 | 0,0044 | 0,0067 | 0,603 |
| A10 | 0,0059 | 0,0047 | 10 | A11 | 0,0045 | 0,0065 | 0,591 |
| A11 | 0,0045 | 0,0065 | 11 | A19 | 0,0046 | 0,0063 | 0,578 |
| A12 | 0,0063 | 0,0050 | 12 | A30 | 0,0047 | 0,0064 | 0,576 |
| A13 | 0,0043 | 0,0058 | 13 | A1 | 0,0048 | 0,0062 | 0,564 |
| A14 | 0,0061 | 0,0049 | 14 | A24 | 0,0049 | 0,0060 | 0,550 |
| A15 | 0,0050 | 0,0056 | 15 | A15 | 0,0050 | 0,0056 | 0,528 |
| A16 | 0,0038 | 0,0074 | 16 | A6 | 0,0052 | 0,0054 | 0,509 |
| A17 | 0,0070 | 0,0040 | 17 | A25 | 0,0053 | 0,0053 | 0,500 |
| A18 | 0,0057 | 0,0052 | 18 | A20 | 0,0054 | 0,0055 | 0,505 |
| A19 | 0,0046 | 0,0063 | 19 | A4 | 0,0056 | 0,0068 | 0,548 |
| A20 | 0,0054 | 0,0055 | 20 | A18 | 0,0057 | 0,0052 | 0,477 |
| A21 | 0,0035 | 0,0078 | 21 | A8 | 0,0058 | 0,0051 | 0,468 |
| A22 | 0,0065 | 0,0042 | 22 | A10 | 0,0059 | 0,0047 | 0,443 |
| A23 | 0,0044 | 0,0067 | 23 | A7 | 0,0060 | 0,0048 | 0,444 |
| A24 | 0,0049 | 0,0060 | 24 | A14 | 0,0061 | 0,0049 | 0,445 |
| A25 | 0,0053 | 0,0053 | 25 | A29 | 0,0062 | 0,0046 | 0,426 |
| A26 | 0,0042 | 0,0066 | 26 | A12 | 0,0063 | 0,0050 | 0,442 |
| A27 | 0,0067 | 0,0041 | 27 | A22 | 0,0065 | 0,0042 | 0,393 |
| A28 | 0,0031 | 0,0082 | 28 | A27 | 0,0067 | 0,0041 | 0,380 |
| A29 | 0,0062 | 0,0046 | 29 | A17 | 0,0070 | 0,0040 | 0,364 |
| A30 | 0,0047 | 0,0064 | 30 | A2 | 0,0071 | 0,0039 | 0,354 |

The calculation results above show that each student has a different distance from the positive and negative ideal solutions. Students with a lower $D^+$ value indicate that they are closer to the best possible outcome based on all assessment criteria. Conversely, students with a higher $D^-$ value indicate that they are further away from the worst possible outcome.

Students A28, A3, and A9 exhibited relatively higher $D^-$ values compared to the other alternatives, indicating that these three students performed closer to the ideal outcome. Meanwhile, students with higher $D^+$ values indicated a greater distance from the best possible outcome, resulting in lower rankings in the final TOPSIS process. Meanwhile, the preference score calculations showed that each student had varying levels of proximity to the ideal solution. Student A3 achieved the highest preference score of 0.745, indicating that she performed closest to the ideal outcome compared to the other students. This position was influenced by the balance of scores across all criteria. Students A28 and A9 were ranked next with high preference scores due to their relatively stable scores on academic, discipline, and attitude criteria. Meanwhile, students with low preference scores showed an imbalance in several criteria, resulting in a greater distance from the ideal condition. These final results demonstrate that the TOPSIS method is capable of producing objective student rankings based on quantitative data and predetermined criteria weights.

## 4. DISCUSSION/CONCLUSION

The application of the TOPSIS method to the selection of outstanding students at SMKN 11 Semarang demonstrated a multi-criteria decision-making process that utilized quantitative data from five aspects of student assessment. This data was processed into a decision matrix that represented each student's objective performance across each criterion. The TOPSIS model was used because it is capable of ranking alternatives based on the concept of proximity to the ideal solution, as proposed by Chakraborty et al. (2023), which places the best alternative as the one with the closest distance from the positive ideal condition.

The decision matrix development process not only serves as the initial step in the TOPSIS calculation but also represents the actual condition of each student based on indicators established by the school. The data used comes from various assessment aspects, each with its own distinct characteristics, necessitating a quantitative approach capable of simultaneously accommodating all variables. The use of five assessment criteria provides a more comprehensive picture of student achievement than assessments that focus solely on academic achievement. This approach allows the system to capture the variations in student abilities that arise from a combination of academic achievement, discipline, activeness, and other indicators determined in the selection process. This situation suggests that determining high-achieving students can be done through a more comprehensive evaluation of all aspects of student competency (Hwang & Yoon, 1981).

The results showed that each student had a different position in the assessment system due to variations in scores for each criterion. These differences emerged during the decision matrix development stage, which was based on students' academic and non-academic data. This finding aligns with research by Kusumadewi et al. (2006), which found the TOPSIS method to be effective in decision-making cases involving multiple criteria with differing value characteristics.

The differences in scores across alternatives indicate that student achievement characteristics are multidimensional. Some students achieve high academic scores but show lower performance in other aspects, while others perform more evenly across all criteria. This variation reflects a common condition in educational settings, as each individual possesses distinct strengths. A TOPSIS-based decision support system can accommodate this diversity through an evaluation process that considers all criteria simultaneously. This mechanism results in a more proportional assessment of student abilities compared to a selection approach that uses only one assessment indicator (Kusumadewi et al., 2006).The normalization process resulted in equal scores across criteria, eliminating scale differences that could affect the calculation results. The normalized scores demonstrated a proportional distribution across all alternatives, ensuring that each student had an equal opportunity in the evaluation process. This step supports the TOPSIS calculation principle, which emphasizes data equality before weighting (Triantaphyllou, 2000).

The normalization stage transforms the data from its initial value to a value that can be directly compared between alternatives. This change is necessary because each criterion has a different value range, potentially leading to dominance in the calculation process. Normalization eliminates the influence of differences in measurement units and maintains the consistency of each criterion's contribution to the evaluation process. The normalized values show a more balanced distribution, allowing each alternative to receive equal treatment in subsequent stages. This characteristic makes the decision-making process more objective because the assessment results are not influenced by the scale of the data for a particular criterion (Triantaphyllou, 2000).

The weighting results indicate that the academic score criterion has the greatest influence on the final outcome compared to other criteria. A higher weighting of the academic aspect results in changes in the score on that criterion having a significant impact on a student's ranking. This finding aligns with research by Chakraborty et al. (2023), which states that criterion weights in TOPSIS determine the level of contribution of each variable to the final decision-making process.

The weighting assigned to each criterion reflects the policy priorities implemented in the selection process for high-achieving students. Schools prioritize academic aspects as the indicator with the highest contribution because academic achievement remains a key measure of student success. However, other criteria still play a role in shaping the final outcome, ensuring that the selection process does not rely solely on academic grades. This combination of weights allows the system to produce a more balanced assessment of students' intellectual abilities and character. This weighting structure is often used in educational decision support systems because it aligns institutional needs with the desired student profile (Chakraborty et al., 2023).

The positive ideal solution and negative ideal solution formed from the weighted matrix indicate the existence of reference boundaries used to assess all students. The positive ideal solution represents the best score on each criterion, while the negative ideal solution represents the lowest score. This concept is used to measure the distance of each alternative from the optimal and worst-case conditions simultaneously (Yoon & Hwang, 1995).

The creation of a positive ideal solution and a negative ideal solution provides a clear basis for evaluating all alternatives being assessed. These two solutions serve as reference points, depicting the best and worst conditions based on all criteria used. Each student is then compared against these two reference points, so the assessment process does not simply examine individual achievement in isolation. This approach creates a more systematic evaluation mechanism because all alternatives are measured using the same standard. This model of comparing these two reference points is one of the key characteristics that distinguishes TOPSIS from other multicriteria decision-making methods (Yoon & Hwang, 1995).

The Euclidean distance calculation shows that students with high preference scores have a smaller distance from the positive ideal solution and a larger distance from the negative ideal solution. This pattern indicates that these students have more stable performance across all assessment criteria. These results are consistent with research by Triantaphyllou (2000), which explains that the TOPSIS method measures the relative closeness of alternatives to the ideal solution mathematically.

The Euclidean distance calculation results indicate that changes in scores on a single criterion can affect the position of alternatives relative to the ideal solution. Students who consistently score on most criteria tend to be closer to the positive ideal solution than students who excel in only one particular aspect. This pattern suggests that the system not only values high achievement on a single indicator but also considers the stability of overall performance. This characteristic aligns with the goal of selecting high-achieving students, which requires students to demonstrate strong qualities across multiple assessment aspects. This distance calculation mechanism allows the selection process to proceed more rationally and measurably based on available data (Triantaphyllou, 2000).

The resulting preference scores indicate that student rankings are determined by a combination of all criteria, not just a single assessment aspect. Students with the highest scores in this study demonstrated a balance of performance across academic and non-academic criteria. These results align with previous research on decision support systems in education, which demonstrated that the TOPSIS method can provide more objective results than conventional assessment methods, which tend to be subjective in the selection process for high-achieving students (Kusumadewi et al., 2006).

The preference scores obtained by each student reflect the relative level of closeness to the student profile deemed to best meet all assessment criteria. The differences in preference scores between alternatives indicate that the final result is not determined by the dominance of a single indicator, but rather by the accumulated contribution of all criteria used in the system. This situation provides an opportunity for students with balanced abilities to achieve a better ranking than those who excel in only one aspect. The ranking results also demonstrate that the multi-criteria approach is capable of producing a ranking of alternatives that is more representative of actual conditions in the field. This pattern supports the use of TOPSIS as an appropriate selection method for educational environments that involve multiple assessment indicators in the decision-making process (Kusumadewi et al., 2006).

The application of TOPSIS in this study demonstrates that the selection process for high-achieving students can be conducted in a structured manner, from initial data processing to final ranking determination. Each calculation stage is interconnected, forming a unified, systematic decision-making process. The results demonstrate that this method can reduce subjectivity in the assessment process because all alternatives are evaluated based on the same mathematical procedure. This characteristic provides an opportunity for educational institutions to implement a more transparent and consistent selection system. The use of the TOPSIS method also opens up space for developing decision support systems that can be adapted to future school needs and policies (Chakraborty et al., 2023; Triantaphyllou, 2000).

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