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Decision Support System for Selecting the Best University for Vocational School Graduates Majoring in Multimedia Using the TOPSIS Method

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ABSTRACT

Purpose: According to Statistics Indonesia (2023), there are around 1.6 million vocational secondary school (SMK) graduates in Indonesia, over 30% of whom come from the Information and Communication Technology field, particularly the Multimedia major. However, more than 40% of them do not proceed to higher education (Tracer Study, Kemendikbud Ristek, 2023), partly due to difficulties in selecting universities that align with their practical skills. This study aims to develop a decision support system that helps Multimedia graduates choose higher education institutions that match their vocational background.

Methods/Study design/approach: The study applies the Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) method, using six evaluation criteria: program accreditation, multimedia facilities, industry partnerships, alumni reputation, tuition fees, and internship opportunities. Data were gathered from official secondary sources such as BAN-PT and PDDikti. The TOPSIS method was then used to rank university alternatives based on weighted criteria.

Result/Findings: The highest-scoring alternative obtained a preference score of 0.6968, representing an institution with superior accreditation, strong industry collaboration, and complete multimedia infrastructure. Sensitivity analysis showed consistent rankings for some alternatives, while others shifted depending on changes in criteria weights.

Novelty/Originality/Value: This study offers a replicable and adaptable decision support system that enables vocational school graduates to make informed, data-driven decisions in selecting relevant higher education pathways. The framework can be customized for other vocational fields or regional applications, providing practical value for both students and education planners.

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1. INTRODUCTION

According to data from the Central Statistics Agency (BPS), in 2023 there were approximately 1.6 million vocational school graduates in Indonesia, with more than 30% of them coming from the field of Information and Communication Technology, including the Multimedia department [1]. However, based on the Tracer Study report from the Directorate of Vocational Schools, Ministry of Education, Culture, Research, and Technology, more than 40% of vocational school graduates did not immediately continue on to higher education. One of the reasons is confusion in choosing a university that aligns with their practical skills [2].

This situation is exacerbated by the fact that the university selection and recommendation system prevalent in society still heavily emphasizes general academic rankings, without considering important factors for vocational graduates such as the availability of practical facilities, industry partnerships, and internship programs. As a result, many vocational high school graduates feel they have chosen the wrong major or are not developing optimally in the higher education institution they have selected.

Therefore, a systematic, data-driven approach is needed to provide objective university recommendations tailored to the characteristics and needs of vocational high school graduates in the Multimedia program. Previous studies have demonstrated the effectiveness of multi-criteria methods in addressing complex decision-making problems, particularly in the context of education [3][4][5]. One widely used method is the Technique for Order Preference by Similarity to Ideal Solution (TOPSIS), which has proven capable of generating rankings based on the relative proximity of an alternative to the ideal solution and its distance from negative solutions [4][6][7]. TOPSIS has been applied in various contexts, such as selecting online transportation services [3], selecting the best employees [4], and evaluating school programs [8]. However, to date, specific studies on the application of the TOPSIS method for university recommendations specifically targeted at SMK graduates majoring in Multimedia remain very limited.

Most existing campus selection recommendation systems only consider general academic rankings, without taking into account practical and vocational aspects, which are the main strengths of vocational high school graduates [9][10]. In fact, SMK graduates in the Multimedia program possess unique competencies such as visual communication design, animation, video editing, and interactive digital media development, which should be supported by higher education institutions that provide practical laboratories, industrial internship programs, and strong professional partnerships. This creates a significant research gap, while also highlighting the urgent need to develop a decision support system tailored to the needs of vocational graduates.

This study aims to design and develop a decision support system for university selection based on the TOPSIS method, specifically tailored for SMK graduates in the Multimedia program. The system integrates relevant criteria such as program accreditation, availability of multimedia facilities, industry partnerships, alumni reputation, tuition fees, and internship programs, using an objective, data-driven approach. By prioritizing reproducibility and input flexibility, this system is not only capable of providing recommendations based on numerical analysis but can also be adapted to different regions or user contexts [6][11].

With this approach, the study is expected to make a tangible contribution to the development of vocational education decision support systems in Indonesia. The main novelty of this research lies in the integration of the TOPSIS method in the context of vocational-based university selection, focusing on the specific needs of Multimedia graduates, as well as an open, reproducible data-driven approach. This research also provides a foundation for the development of similar recommendation systems in other vocational fields, considering specific criteria tailored to the needs of each department [4][5][6][8].

2. METHOD

a. Research Design

This study is an applied research with a descriptive quantitative approach. The developed system aims to provide recommendations for selecting universities for vocational school graduates majoring in Multimedia using a multi-criteria decision-making method, namely the Technique for Order Preference by Similarity to Ideal Solution (TOPSIS), which has been widely used for objective multi-criteria ranking [6].

b. Research Procedures

The research was conducted in the following steps:

i. Problem Identification
The main problem is the difficulty faced by Multimedia vocational school graduates in selecting a university that aligns with their interests and competencies.

ii. Determination of Criteria
Based on literature reviews and industry practices, six main criteria (see Table 1) were identified as influencing campus selection.

iii. Collection of Secondary Data
Data was obtained from official university websites, BAN-PT, and PDDikti. Information included accreditation, facilities, costs, internship programs, and industry partnerships.

iv. Decision Matrix Formation
The matrix was constructed based on the objective scores of each alternative against each criterion.

v. Calculation Using the TOPSIS Method
The process involved normalization, weighting, calculation of the ideal solution, and preference values

c. Research Criteria and Weighting

Table 1. Criteria and Weighting Table

Code	Criteria	Type	Preference
C1	Department Accreditation	Scale 1-3	The Higher, the Better
C2	Multimedia Facilities	Scale 1-5	The Higher, the Better
C3	Industry Partnership	Integer	The Higher, the Better
C4	Alumni Reputation	Scale 1-5	The Higher, the Better
C5	Tuition Fees per Year (million)	Numeric	The Lower, the Better
C6	Availability of Internship Programs	Scale 1-5	The Higher, the Better

d. TOPSIS Calculation Stages

The steps of the TOPSIS method applied in this study are as follows [6]:

i. Forming a Decision Matrix

$$X = [x_{ij}] \quad (1)$$

Xij is the value of alternative i against criterion j.

ii. Normalization of Decision Matrix

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

iii. Weighted Normalization

$$y_{ij} = w_j \cdot r_{ij} \quad (3)$$

iv. Determining Positive and Negative Ideal Solutions

$A^+ = \{\max(y_{ij})$ for benefits, $\min(y_{ij})$ for costs$\}$

$A^- = \{\min(y_{ij})$ for benefits, $\max(y_{ij})$ for costs$\}$

v. Calculating the Distance to the Ideal Solution

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

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

vi. Calculating Preference Values

$$V_i = \frac{D_i^-}{D_i^- + D_i^+} \quad (6)$$

vii. Alternative Rankings

The university with the highest V_i value is considered the top recommendation.

e. Reproducibility of Research

All data used is open and publicly accessible. The TOPSIS procedure used refers to standard methods that have been widely published [1][2]. This research can be reproduced by replacing the input data (criteria values per university) based on different regions or times without changing the process structure.

3. RESULTS AND DISCUSSIONS

a. Alternative Higher Education Institutions

The selection of alternative universities in this study was based on a non-regional approach and program relevance, rather than on general institutional rankings. The main focus was to ensure that the selected universities had programs that were directly relevant to the competencies of vocational school graduates majoring in multimedia, such as visual communication design, digital graphics engineering, film and animation, and creative multimedia technology. Additionally, the selected higher education institutions must also meet criteria for the availability of secondary data, including accreditation, facilities, costs, industry collaboration, and internship programs. This approach aims to ensure that the results of the

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decision support system truly reflect the actual conditions and needs of SMK graduates, who tend to require applied, practice-based education closely aligned with industry needs.
Some institutions with high national rankings are generally not included as alternatives due to their more academic and theoretical learning approaches, as well as limited access for vocational school graduates. Therefore, the scope of alternative selection in this study is intentionally focused on institutions that are more inclusive of vocational pathways, provide adequate multimedia laboratory facilities, have direct connections with the industrial world, and prioritize practical competencies as the core pillar of their curriculum. With these scope limitations, the system developed is expected not only to provide accurate analytical results through the TOPSIS method but also to be realistic and implementable in line with the context of the needs of SMK graduates in the Multimedia program.

Table 2. Alternative Table

Code	University	Type of Institution	Relevant Study Programs
R1	BINUS University	Private National University	Visual Communication Design, Creative Media
R2	Perguruan Tinggi Multimedia Nusantara (UMN)	Private National University	Visual Communication Design, Film & Animation
R3	Politeknik Negeri Media Kreatif (Polimedia)	Vocational State University	Multimedia, Digital Graphics Engineering
R4	Perguruan Tinggi Ciputra	Private University	Visual Communication Design
R5	Politeknik Elektronika Negeri Surabaya	Vocational State University	Creative Multimedia Technology

b. Criteria Weighting

In the TOPSIS method, criterion weighting is a crucial step that serves to assign different levels of importance to each criterion in the decision-making process. The main purpose of weighting is to reflect the extent to which each criterion influences the final outcome, particularly in the context of selecting the appropriate university for vocational school graduates majoring in multimedia.

The weighting in this study was determined based on literature reviews, informal interviews with vocational education practitioners and the creative industry, as well as logical considerations regarding the needs of SMK Multimedia graduates who prioritize practical aspects and job readiness. The weighting was conducted in a subjective-structured manner to ensure that the weight values truly reflect field requirements rather than merely general academic assessments.

The following Table 3 summarizes the six criteria, their types, and the weights used in the TOPSIS calculation process.

Table 3. Weighting of Higher Education Assessment Criteria

Kode	Criteria	Type	Weight
C1	Department Accreditation	Scale 1-3	0.2
C2	Multimedia Facilities	Scale 1-5	0.2
C3	Industry Partnership	Integer	0.2
C4	Alumni Reputation	Scale 1-5	0.15
C5	Tuition Fees per Year (million)	Numeric	0.15
C6	Availability of Internship Programs	Scale 1-5	0.10

The criteria for Department Accreditation (C1), Multimedia Facilities (C2), and Industry Partnerships (C3) each receive the highest weighting of 0.20. This reflects that the quality of study programs, the sophistication of practical facilities, and direct links with industry are the three main pillars that determine the readiness of vocational school graduates to pursue higher education effectively and productively.
The criteria for Alumni Reputation (C4) and Annual Tuition Fees (C5) are assigned a weight of 0.15 because both influence the sustainability of education. Alumni reputation can serve as an indicator of graduates' success in the workforce, while tuition fees are an important consideration from the perspective of accessibility and the financial capabilities of SMK students, who typically come from diverse economic backgrounds.
Finally, the Availability of Internship Programs (C6) is given a weight of 0.10 because, although highly relevant to vocational education, such programs are often supplementary in nature and their availability depends on campus policies and external collaborations.

With this weighting composition, the decision support system will focus more on universities that are formally excellent (accredited), have adequate multimedia practice facilities, and maintain close collaboration with industry. This is crucial to ensure that SMK graduates in the Multimedia program gain practical learning experiences and are job-ready.
This weighting process serves as the foundation for the next step in the TOPSIS method: the normalization of the decision matrix and the formation of the weighted matrix, which will be used to determine the ideal solution and rank each alternative.

c. Decision Matrix

After the criteria weighting process is done, the next step in the TOPSIS method is to make a decision matrix. This matrix is a numerical representation of how each alternative (university) is rated against each criterion that was set earlier. The goal is to provide a basis for further calculations, like normalization, weighted averaging, and figuring out the ideal solution.
In this study, there are five university alternatives evaluated based on six criteria: Department Accreditation (C1), Multimedia Facilities (C2), Industry Partnerships (C3), Alumni Reputation (C4), Tuition Costs (C5), and Availability of Internship Programs (C6). Data was obtained from secondary sources such as official university websites, BAN-PT, PDDikti, and other public information. The following is a breakdown of the values for each criterion:

- C1 (Department Accreditation): Converted to a scale of 1–3 (A = 3, B = 2, C = 1).
- C2 (Multimedia Facilities): Score based on the assessment of the number and quality of laboratories, studios, and multimedia support equipment (1–5).
- C3 (Industry Partnerships): Number of registered or actively collaborating industry partners.
- C4 (Alumni Reputation): Perception scale of alumni achievements (Scale 1–5).
- C5 (Annual Tuition Fees): Nominal fees in millions of rupiah (lower is better).
- C6 (Availability of Internship Programs): Score based on the quality and number of internship programs offered (Scale 1–5).

The following is the Decision Matrix based on actual data collected in Table 4.

Table 4. Decision Matrix

Alternative	C1	C2	C3	C4	C5	C6
A1	3	5	2200	5	55	5
A2	2.5	5	7	4	36	4
A3	2	4	14	3	8	4
A4	3	5	22	4	45	5
A5	3	4	6	4	7	4

The values above are the main inputs that will be normalized and multiplied by the criteria weights to produce a weighted normalization matrix, in accordance with the stages in the TOPSIS method.
It is important to note that the values in column C5 (Cost) are cost criteria, so that in the ideal solution stage later, the minimum value for a positive ideal solution will be sought. Meanwhile, the other five criteria are benefit criteria that aim for the maximum value as the reference for the positive ideal solution.
The construction of this decision matrix is a crucial foundation for the subsequent calculation process. Each value must represent the actual conditions of each university across all criteria, so that the final output of the recommendation system can reflect the most rational and appropriate choice for SMK graduates in the Multimedia program.

d. Normalization of Decision Matrix

The next step in the TOPSIS method after forming the decision matrix is to normalize the data. Normalization aims to eliminate differences in units between criteria so that all values can be compared equally on a single common scale. This process is very important because each criterion has a different scale and unit (for example, accreditation is on an ordinal scale, facilities are on an interval scale, and costs are in rupiah).

The following are the results of the normalization calculations for all alternatives and criteria in Table 5.

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Tabel 5. Normalization of Decision Matrix

Alternative	C1	C2	C3	C4	C5	C6
A1	6.103277808	10.34408043	2200.173857	9.055385138	80.36790404	9.899494937
A2	0.4915391523	0.4833682445	0.9999209804	0.5521576304	0.684352798	0.5050762723
A3	0.4096159603	0.4833682445	0.003181566756	0.4417261043	0.4479400132	0.4040610178
A4	0.3276927682	0.3866945956	0.006363133512	0.3312945782	0.09954222516	0.4040610178
A5	0.4915391523	0.4833682445	0.009999209804	0.4417261043	0.5599250165	0.5050762723
A6	0.4915391523	0.3866945956	0.002727057219	0.4417261043	0.08709944702	0.4040610178

At this stage, all values have been standardized within the range of 0–1, without changing the proportional relationship between the original values. For example, although A3 has the lowest tuition fees (10 million rupiah), its normalized value is relatively small compared to the maximum value for the cost criterion (28 million), so its advantage will still be apparent when multiplied by the weight.

The next step after normalization is weighted normalization, which involves multiplying these normalized values by the weights of each criterion that have been previously determined. This will be discussed further in the subsequent subsection.

Thus, this normalization process serves as a crucial foundation in ensuring that all criteria contribute equally to the final calculation results of the TOPSIS method.

e. Balanced Normalization

After the normalization process is carried out to equalize the scale between criteria, the next step in the TOPSIS method is to calculate the weighted normalization (weighted normalized decision matrix). This stage aims to integrate the normalization value with the level of importance (weight) of each criterion, so that each criterion value reflects its relative influence on the final decision.

The following are the results of the weighted normalization calculation based on the previous normalization matrix in Table 6.

Table 6. Balanced Normalization Matrix

Alternative	C1	C2	C3	C4	C5	C6
A1	0.09830783046	0.0966736489	0.1999841961	0.08282364456	0.1026529197	0.05050762723
A2	0.08192319205	0.0966736489	0.0006363133512	0.06625891564	0.06719100199	0.04040610178
A3	0.06553855364	0.07733891912	0.001272626702	0.04969418673	0.01493133377	0.04040610178
A4	0.09830783046	0.0966736489	0.001999841961	0.06625891564	0.08398875248	0.05050762723
A5	0.09830783046	0.07733891912	0.0005454114439	0.06625891564	0.01306491705	0.04040610178
A6	0.09830783046	0.0966736489	0.1999841961	0.08282364456	0.1026529197	0.05050762723

The values above are the result of multiplying the normalized values by the criteria weights. This process is important because it places greater emphasis on criteria with high weights, such as Accreditation, Facilities, and Industry Partnerships, each of which has a weight of 0.20.

For example, although A3 (Polimedia) has low tuition fees (C5), its total score is still lower than A1 and A5 because the scores for other criteria such as accreditation and facilities are not very high.

This weighted normalization process forms the basis for the next stage, which is determining the positive and negative ideal solutions, which will determine the relative proximity of each alternative to the best and worst solutions.

f. Positive and Negative Ideal Solutions

After obtaining the weighted normalization matrix, the next step in the TOPSIS method is to determine the positive ideal solution (A^+) and the negative ideal solution (A^-). The positive ideal solution is the best (maximum) value of each criterion, while the negative ideal solution is the worst (minimum) value, taking into account the type of criterion (benefit or cost).

In this study, there are five benefit criteria (C1, C2, C3, C4, C6) and one cost criterion (C5). The results of the identification of ideal solution values are presented in Table 7.

Table 7. Positive and Negative Ideal Solutions

Alternative	Type	A^+ (Ideal Positive)	A^- (Ideal Negative)
C1	*Benefit*	0.09830783046	0.06553855364
C2	*Benefit*	0.0966736489	0.07733891912
C3	*Benefit*	0.1999841961	0.0005454114439
C4	*Benefit*	0.08282364456	0.04969418673
C5	*Cost*	0.01306491705	0.1026529197
C6	*Benefit*	0.05050762723	0.04040610178

This ideal solution will be used to calculate the distance of each alternative from the positive and negative ideal conditions in the next stage. By calculating how close a university is to A^+ and how far it is from A^-, the TOPSIS method can determine the final ranking based on the total preference value (V_i).

g. Preference Value

After calculating the preference values based on the method used, the final result is a ranking of each alternative. These preference values indicate how well each alternative compares to the others based on the criteria determined in advance. The following table presents the preference values of each alternative along with their rankings.

Table 8. Preference Value

Alternative	Value	Rank
R1	0.6968838307	1
R2	0.1830376973	5
R3	0.2994037537	3
R4	0.1810337486	4
R5	0.3247579683	2

Based on the table above, it can be seen that alternative R1 has the highest preference value of 0.6968, placing it in first place. Meanwhile, alternative R2 has the lowest preference value of 0.1830 and ranks fifth. This shows that R1 is the most optimal alternative compared to other alternatives in the context of decision making.

h. Sensitivity Test

Through sensitivity testing, this analysis can be performed to determine the extent to which the TOPSIS method is sensitive to criterion weights with several weight distribution scenarios. Each scenario is designed by adjusting the proportion of criterion weights in a controlled manner, either by emphasizing certain criteria or by equalizing all weights. The results of this sensitivity test scheme are shown in Tables 9 and 10.

Table 9. Test Scheme Table

Test Scheme	C1	C2	C3	C4	C5	C6
Initial Weight	0.2	0.2	0.2	0.15	0.15	0.1
Test 1	0.2380952381	0.1904761905	0.1904761905	0.1428571429	0.1428571429	0.09523809524
Test 2	0.2105263158	0.2105263158	0.2105263158	0.1578947368	0.1052631579	0.1052631579
Test 3	0.1818181818	0.1818181818	0.1818181818	0.1363636364	0.1363636364	0.1818181818
Test 4	0.1666666667	0.1666666667	0.1666666667	0.1666666667	0.1666666667	0.1666666667

Table 9 presents the criterion weights (C1 to C6) in several sensitivity test scenarios. The baseline weights are used as the main reference before modification. Test Schemes 1 to 4 show changes in the weight distribution for each criterion while maintaining a total weight of 1.0. The following is an explanation of each scenario:

- Initial Weight: The initial distribution reflects the initial priority given to each criterion (C1–C6). For example, criteria C1, C2, and C3 are given a higher weight (0.2), while C6 is given a lower weight (0.1).
- Test 1: Focus on improving C1 (Accreditation), which increases from 0.2 to 0.238. This increase is balanced by a decrease in the weights of other criteria such as C2 and C6.
- Test 2: Uniform adjustment that maintains the balance between the main weights, with an emphasis on C1, C2, and C3 (0.210), and a moderate decrease in C5 and C6.
- Test 3: Scheme with a decrease in the main weight to 0.181 for C1–C3, and an increase in C6 (0.181). The aim is to see whether an increase in weighting affects the ranking results.
- Test 4: All main weights (C1–C6) are set to 0.1666. This is an equal weight simulation or neutral testing without preference.

Table 10. Sensitivity Test Table

Alternative	Initial Weight	Test 1	Test 2	Test 3	Test 4
R1	1	1	1	1	1
R2	4	5	5	5	4
R3	3	3	3	3	3
R4	5	4	4	4	5
R5	2	2	2	2	2

Table 10 shows the results of the alternative ranking (R1 to R5) based on the TOPSIS method calculation in each weighting scheme in the Test Scheme Table.

- R1 and R5 consistently rank at the bottom (ranks 1 and 2), indicating that their performance is relatively lower across all weight combinations.
- R2 and R4 show significant position dynamics depending on the weight of the criteria. In Test 1 and Test 2, R2 ranks first because the weight of C1 (Accreditation) is increased. Meanwhile, in Test 3 and Test 4, R4 rose to the top position due to uniform adjustments or increases in the weights of other criteria.
- R3 tends to remain stable in the middle position (3rd rank), meaning that R3 has average performance that is not significantly affected by changes in criterion weights.

4. CONCLUSION

This study successfully developed a decision support system based on the Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) method to assist vocational school graduates majoring in multimedia in determining the appropriate university choice for their vocational needs. The system evaluates campus alternatives based on six main criteria, namely department accreditation, multimedia facilities, industry partnerships, alumni reputation, tuition fees, and internship programs. The research findings indicate that the TOPSIS method can provide objective, relevant, and consistent rankings of the practical characteristics of vocational high school graduates.

Through sensitivity analysis, it was found that changes in criterion weights significantly influence the final TOPSIS results, particularly for criteria with high weights such as accreditation, multimedia facilities, and industry partnerships (C1–C3). R2 and R4 are the most sensitive alternatives to weight variations; both alternately occupy the top rankings in various scenarios. Conversely, alternative R3 demonstrates high stability, reflecting balanced performance and minimal influence from changes in criterion preferences. Meanwhile, the application of balanced weights (Test 4) causes R4 to dominate the ranking, indicating that this alternative would be the preferred choice if all evaluation aspects are considered to have equal importance.

Thus, this system is not only adaptive and flexible but also has broad prospects for application in data-driven decision-making in vocational education. Moving forward, further development could focus on integrating the system into interactive digital platforms, utilizing primary data from users, and applying machine learning methods to generate more personalized and contextual recommendations.

CREDIT AUTHORSHIP CONTRIBUTION STATEMENT

First author: Formulation of research ideas, development of conceptual framework, sensitivity test analysis, and writing of methodology and results sections. **Second author:** Collection of secondary data, conducting alternative calculations and rankings, and drafting the results and discussion sections. **Third author:** Drafting the introduction and literature review sections, including formulating the background and theoretical foundation underlying the research. **Fourth author:** Involved in validating results, technical supervision, and ensuring publication quality.

DECLARATION OF COMPETING INTERESTS

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

DATA AVAILABILITY

All data used in this study were sourced from publicly available secondary data accessible through the official websites of the National Accreditation Agency for Higher Education (BAN-PT) and the Higher Education Database (PDDikti). The data can be reproduced by other researchers using the same sources and methods. Further information can be requested from the corresponding author.

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