

Application of Simple Additive Weighting (SAW) Method in Decision Support System for Selecting Study Programs At The University Of Papua

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ABSTRACT

To help prospective students choose a study program that suits their abilities and interests, it is necessary to design a decision support system. This system aims to facilitate the selection process of study programs for prospective students. This research aims to develop a decision support system that can help prospective students in choosing a study program at the Faculty of Engineering, University of Papua in an objective and structured manner. This study applies the Simple Additive Weighting method to facilitate the decision-making process by considering a number of relevant criteria. The evaluation is based on the following criteria: tuition fees, accreditation status, number of teaching staff and staff, and job prospects. The findings of the study revealed that the Informatics Engineering and Civil Engineering Study Programs, both at the S1 level, obtained the highest identical preference value, namely 1, outperforming other study programs. However, the best alternative is the S1 Informatics Engineering Study Program.

ABSTRAK

Untuk membantu calon mahasiswa memilih program studi yang cocok dengan kemampuan dan ketertarikan mereka, perlu dirancang sebuah sistem pendukung keputusan. Sistem ini bertujuan untuk mempermudah proses seleksi program studi bagi para calon mahasiswa. Penelitian ini bertujuan untuk mengembangkan sebuah sistem pendukung keputusan yang dapat membantu calon mahasiswa dalam memilih program studi di Fakultas Teknik, Universitas Papua secara objektif dan terstruktur. Penelitian ini menerapkan metode Simple Additive Weighting untuk memfasilitasi proses pengambilan keputusan dengan mempertimbangkan sejumlah kriteria yang relevan. Evaluasi didasarkan pada kriteria berikut: biaya SPP, status akreditasi, jumlah tenaga pengajar dan staf, serta prospek pekerjaan. Temuan penelitian mengungkapkan bahwa Program Studi Teknik Informatika dan Teknik Sipil, keduanya jenjang S1, memperoleh nilai preferensi tertinggi yang identik, yaitu 1, mengungguli program studi lainnya. Akan tetapi yang menjadi alternatif terbaik adalah Program Studi S1 Teknik Informatika.

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INTRODUCTION

In an era that is increasingly globally connected and technological advances are so rapid, determining a study program at a university is a crucial step that must be taken by students who will continue their higher education. These decisions can have a significant impact on their academic and career futures. At the University of Papua, especially at the Faculty of Engineering, there are various study programs that offer various opportunities and challenges. However, the complexity of information and the number of factors that need to be considered often make it difficult for prospective students to make the right decision. The use of a decision support system can be an efficient way to help prospective students determine the most suitable study program based on the criteria that have been set (Maharani et al., 2018).

The process of selecting a study program often involves considering various criteria, such as tuition fees, accreditation, job opportunities, the number of lecturers and other factors. Without the help of a system that can accommodate these criteria systematically, the process of selecting a study program can be complicated and difficult. Therefore, a decision-making assistance mechanism is needed to make it easier for prospective students to choose the study program that best suits their interests and capacity.

The Simple Additive Weighting (SAW) method, also known as the Simple Additive Weighting technique, is one of the approaches that can be implemented in this decision support system. SAW is a commonly used method in determining choices with many criteria. This technique applies the principle of summing the weighted values of each option to all existing parameters. The main advantage of SAW lies in its ease of implementation as well as its flexibility in accommodating various factors in the selection process (Firmansyah et al., 2020).

This study focuses on the implementation of the SAW technique in the decision-making assistance mechanism to determine the study program at the Faculty of Engineering, University of Papua. The five study programs that are the object of this research are S1 Informatics Engineering, D3 Computer Engineering, S1 Electrical Engineering, D3 Electrical Engineering and S1 Civil Engineering. The selection of these five study programs is based on the diversity of scientific fields and career prospects offered, as well as the high interest of prospective students in these study programs (Directorate General, 2020).

A number of previous researches have applied the SAW technique in decision-making assistance systems in various sectors. For example, Kurniawan and his colleagues used the SAW method to select the best employee candidates at PT. Indotama Graha Abadi. Meanwhile, Panjaitan and his team used SAW to select scholarship recipients at the Panca Budi Development University. The results of both studies show that the use of the SAW method in decision support systems has proven to be effective and able to produce accurate solutions (Kurniawan et al., 2021; Panjaitan et al., 2020).

This research aims to develop a decision support system that can help prospective students in choosing a study program at the Faculty of Engineering, University of Papua in a more objective and structured manner. By applying the SAW method, it is hoped that this system can produce study program recommendations that are in accordance with the preferences and abilities of prospective students, as well as consider various relevant factors in the selection of study programs.

This research is expected to provide dual benefits: first, improving the quality of the study program selection process for prospective students, and second, assisting the university in directing prospective students to the major that best suits their individual potential. Furthermore, this research has the potential to be a reference for the development of similar systems in other faculties or universities throughout Indonesia (Fadlan et al., 2021).

LITERATURE REVIEW

Decision Support System

The decision support system is a computer-based tool that is adaptive, flexible, and interactive in processing information. Decision support system is designed to assist the selection process in overcoming semi-structured or unstructured problems. This system makes it easier for decision-makers to review data and information regularly to find the right solution in dealing with complex situations. The main purpose of decision support system is to increase accuracy and efficiency in making decisions by presenting accurate and reliable information (Kahraman et al., 2020 ; Turban et al., 2021).

Simple Additive Weighting (SAW) Method

In the context of Decision Support Systems, the Simple Additive Weighting (SAW) method is one of the techniques that is widely used to overcome multi-criteria problems. Introduced by Yoon and Hwang in 1995, SAW operates on the principle of calculating the weighted amount of each option's performance value for all set criteria. This approach has become one of the most popular in resolving decision problems involving many factors of consideration (Kusumadewi et al., 2021).

The SAW method offers a number of advantages, including ease of calculation, openness in the decision-making process, and adaptability in determining the criteria and weight. With these advantages, this method can be applied in various sectors, including in helping prospective students choose a study program at a university.

The implementation of the SAW method in the Decision Support System for the selection of study programs in higher education can improve the ability of prospective students to make appropriate and appropriate decisions. Through the SAW technique, prospective students can assess various study program options based on a number of parameters that have been set, as well as provide interest values according to their individual preferences (Manalu et al., 2020).

Previous Research

Previous studies have proven the effectiveness of the SAW method when applied in the decision support system to choose a study program at a university. For example, a research applies the SAW method to help the selection of study programs at Bina Sarana Informatics University. The research findings indicate that this system is able to offer suggestions for study programs that match the criteria of prospective students, including aspects such as academic grades, interests, and learning ability (Sari et al., 2019).

In addition, there are also studies that implement the SAW technique to help the selection of study programs at Sari Mutiara University of Indonesia. This research considers factors such as National Exam scores, personal interests, education costs, and career opportunities. The results of this study show that the system developed has succeeded in recommending the right study program for prospective students, by referring to predetermined parameters. An additional study carried out by Zulkifli and Marini in 2022 applies the SAW technique to help the selection of study programs at Al-Azhar University Indonesia. This study considers aspects such as average report card scores, personal interests, job prospects, tuition fees, and the accreditation status of study programs. The findings of this research show that the system is able to present study program suggestions that match the wishes of prospective students (Zulkifli & Marini, 2022).

So far, there has been no study that specifically uses the SAW method in the study program selection assistance system at the University of Papua. This research is designed to answer unmet needs by applying the SAW method in the process of selecting study programs at this institution. The main goal is to increase the effectiveness of the study program selection process and help prospective students make more accurate decisions based on a number of predetermined criteria. Thus, it is hoped that this study can make a significant contribution to improving the existing study program selection system

METHOD

The study uses the Simple Additive Weighting (SAW) method, a technique in decision support systems. SAW was chosen because of its superiority in assessing various alternatives by giving weight to each criterion, then ranking to find the optimal option (Manalu et al., 2020). In its application, SAW uses the concept of summing the weighted value of the performance of each alternative on all the criteria considered (Nofriansyah & Defit, 2017). In general, the process in the SAW method includes several main steps:

1. Establish criteria that will be used as the basis in the decision-making process.
2. Determine the match rating of each alternative on each criterion.
3. Preparing a decision matrix according to existing criteria, then carrying out a normalization process on the matrix using a formula that is adjusted to the nature of the attributes, whether it is included in the profit or cost category.
4. The results of the normalized performance rating value form a normalized matrix.
5. Determines the weight of preferences or the level of importance (W) of each criterion.
6. Create a weighted normalized decision matrix by multiplying each element in the normalized matrix by a predefined preference weight.
7. Accumulate the results of multiplication to get the final score for each available alternative.
8. Ranking the final score of each alternative to determine the best alternative.

The following is the formula for normalization:

$$rij = \begin{cases} \frac{x_{ij}}{\max x_{ij}} \\ \frac{\min x_{ij}}{x_{ij}} \end{cases} \quad (1)$$

Information:

The first formula: if j is an attribute of benefit

Second formula: if j is a cost attribute

Where:

rij = normalized performance rating

Max_{ij} = the maximum value of each row and column

Min_{ij} = minimum value of each row and column

X_{ij} = rows and columns of the matrix

where rij is the normalized performance rating of the A_i alternative to the C_j attribute; $i = 1, 2, \dots, m$ and $j = 1, 2, \dots, n$.

The preference value for each alternative (V_i) is given as:

$$v_i = \sum_{j=1}^n w_j \cdot rij \quad (2)$$

Where:

v_i = final value of the alternative

w_j = predetermined weight

rij = matrix normalization

n = number of alternatives

A larger V_i value indicates that A_i alternatives are more selective.

Research stages

In carrying out this research, there are several stages that must be carried out to achieve the goals as contained in the diagram below.

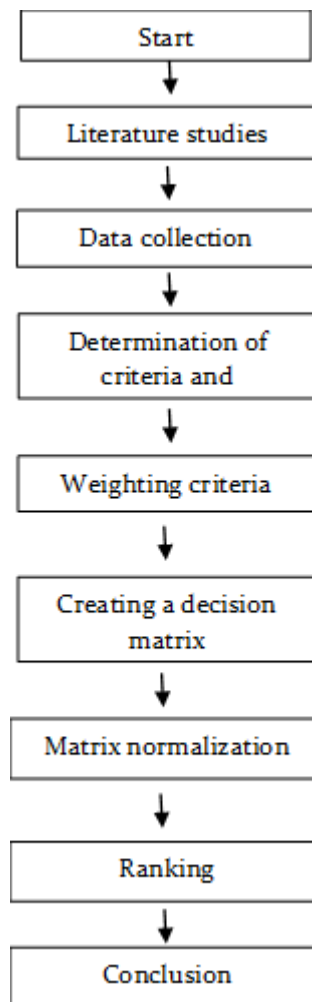


Figure 1. Diagram of the research stages

a. Literature studies

The initial step of this research involves a literature review that covers three main aspects: the Simple Additive Weighting (SAW) method, the decision support system, and the procedure for selecting study programs in higher education. Researchers collect and analyze a wide range of references, including books, scientific journal articles, as well as relevant publications.

b. Data collection

The next step is to collect information related to this study regarding the mechanism for assisting in the selection of study programs at the University of Papua. The data that will be used in this study are data on tuition fees, accreditation, the number of lecturers and staff, and job opportunities from each study program. The data was obtained from the results of interviews with each study program coordinator.

c. Determination of criteria and alternatives

After conducting a literature review and collecting information, the researcher set a number of criteria to select study programs, as well as identify the options for study programs at the University of Papua.

d. Weighting of criteria

The researcher assigns a weight value to each criterion according to its level of importance in the study program selection process.

e. Creating a decision matrix

At this stage, the researcher compiles alternative data and criteria in the form of a matrix.

f. Matrix normalization

Matrix normalization is the stage of converting data in the decision matrix so that comparisons between criteria are possible. The purpose of normalization is to standardize the values of

various criteria that may have different units or scales. This matrix normalization is important because it standardizes the value scale between criteria, allows for fair comparisons between criteria with different units or scales, and prepares data for the weighting and ranking stages in the SAW method (Nurjoko & Wibowo, 2022).

g. Ranking

The final stage in the SAW method is the preparation of rankings, which aims to compile a list of selections from the best based on the results of the completed calculations.

h. Conclusion

The conclusion is the final part of the research that presents a summary of the research results and answers the research objectives that have been set.

RESULT AND DISCUSSION

Calculation of the Simple Additive Weighting (SAW) method.

Study Program Data

Below is the data that will be the basis for calculation using the SAW method. All of this data was obtained through a question and answer session with the coordinators of each study program.

Tabel 1. Study Program Data

Courses	Tuition Fees	Accreditation	Number of lecturers and staff	Job opportunities
Informatics Engineering (S1)	IDR 2,000,000	B	11	Big
Computer Engineering (D3)	IDR 2,400,000	B	11	Big
Electrical Engineering (S1)	IDR 2,000,000	B	13	Keep
Electrical Engineering (D3)	IDR 2,400,000	B	13	Keep
Civil Engineering (S1)	IDR 2,000,000	B	11	Big

Define Criteria

There are 5 study programs that are alternative to this study, namely: A1 = S1 Informatics Engineering , A2 = D3 Computer Engineering , A3 = S1 Electrical Engineering, A4 = D3 Electrical Engineering , and A5 = S1 Civil Engineering. The criteria used in the decision support system for selecting study programs in this study are C1 = Tuition fees, C2 = Accreditation, C3 = Number of lecturers and staff, and C4 = Job opportunities. Job opportunity criteria play a crucial role when choosing a study program, as shown in a study by Nurjoko and Wibowo (2022). In an effort to create a decision support system to choose a study program in higher education, they use the simple additive weighting (SAW) technique. The system considers various aspects, including graduate career opportunities as one of the important criteria in the evaluation process (Rokhmah & Assegaff, 2021).

Here is the description and weight of each criterion:

Table 2. Tuition Fee Criteria

Value	Information	Weight
IDR 500,000 – 2,000,000	Cheap	0,5
IDR 2,100,000 – 4,000,000	Keep	0,75
>Rp4,000,000	Expensive	1

Table 2. This shows the criteria for SPP (Educational Development Contribution) Fees used in the Simple Additive Weighting (SAW) method. This criterion is divided into three categories based on the range of tuition fees. This indicates that in the context of SAW, this criterion will be treated as a cost criterion, where a lower value is actually preferred.

Table 3. Accreditation Criteria

Value	Weight
A	1
B	0,75
C	0,5

Table 3. Showing the Accreditation criteria, this criterion is divided into three categories based on the accreditation value of an educational institution. The highest weight (1) is given to A accreditation, indicating that this is the most desirable rating. The weight decreases along with the decline in accreditation rankings. This indicates that in the context of SAW, this criterion is treated as a benefit criterion, where a higher value is preferred.

Table 4. Criteria for the Number of Lecturers and Staff

Information	Weight
>15	1
5-15	0,5

Table 4. shows the criteria for the Number of Lecturers and Staff, this criterion is divided into two categories based on the number of lecturers and staff in an educational institution. The highest weight (1) is given for a larger number of lecturers and staff (>15). This indicates that in the context of SAW, this criterion is treated as a benefit criterion, where a higher value is preferred.

Table 5. Job Opportunity Criteria

Chance	Weight
Very small	1
Small	2
Keep	3
Big	4
Very large	5

Table 5. describes the Job Opportunity criteria used in the Simple Additive Weighting (SAW) method to evaluate the career prospects of graduates from an educational program or institution. This criterion is divided into five categories that reflect different levels of job opportunities, ranging from very small to very large. The weight increases as job opportunities increase, from 1 (very small) to 5 (very large). This criterion is also treated as a benefit criterion in the SAW method, where a higher value is preferred.

Table 6. Alternative Matches and Criteria

Alternative	Criterion			
	C1	C2	C3	C4
A1	0,5	0,75	0,5	4
A2	0,75	0,75	0,5	4
A3	0,5	0,75	0,5	3
A4	0,75	0,75	0,5	3
A5	0,5	0,75	0,5	4

Table 6. shows the matrix of matches between alternatives and criteria in the context of the Simple Additive Weighting (SAW) method. This table is a key component in the decision-making process using SAW, where each alternative is assessed based on several predetermined criteria. In the application of the SAW method, this weight will be used to calculate the final score

of each alternative. A higher score for this criterion will make a greater positive contribution to the final ranking of an alternative.

Setting The Preference Weight (W)

Table 7. Weighting Criteria

Criterion	Contents	Weight
C1	Tuition Fees	0,3
C2	Accreditation	0,2
C3	Number of lecturers and staff	0,2
C4	Job opportunities	0,3
Total		1

Table 7. outlines the four main criteria considered, along with the relative weight of each in the overall assessment. The tuition fee criterion (Weight: 0.3) represents 30% of the total assessment. It shows that the cost of education is considered a very important factor in decision-making. The accreditation criteria (Weight: 0.2) represent 20% of the total assessment. Reflects the importance of the accreditation status of the institution or program in the evaluation. The criteria for the number of lecturers and staff (Weight: 0.2) also represents 20% of the total assessment. It shows that institutional human resources are considered a fairly important factor. Job Opportunity Criteria (Weight: 0.3) Represents 30% of the total assessment. Signifying that the graduate's career prospects are considered to be as important as the cost of tuition. The sum of the entire weight is 1 (or 100%), which is standard in the weighting method to ensure proper normalization.

Create A Decision Matrix

The following is displayed the decision matrix that has been made using the results of the calculation of the criteria weights listed in Table 6.

$$X = \begin{bmatrix} 0,5 & 0,75 & 0,5 & 4 \\ 0,75 & 0,75 & 0,5 & 4 \\ 0,5 & 0,75 & 0,5 & 3 \\ 0,75 & 0,75 & 0,5 & 3 \\ 0,5 & 0,75 & 0,5 & 4 \end{bmatrix}$$

Matrix Normalization

In this case example, the tuition fee criterion will be the cost criterion. Meanwhile, accreditation criteria, the number of lecturers and staff, and job opportunities will be benefit criteria. Here is the formula to be used and the calculation for the normalization of the criteria;

$$rij = \begin{cases} \frac{x_{ij}}{\max x_{ij}} \\ \frac{\min x_{ij}}{x_{ij}} \end{cases}$$

Normalization value of spp (cost)

$$R11 = \frac{\min \{0,5; 0,75; 0,5; 0,75; 0,5\}}{0,5} = \frac{0,5}{0,5} = 1$$

$$R21 = \frac{\min \{0,5; 0,75; 0,5; 0,75; 0,5\}}{0,75} = \frac{0,5}{0,75} = 0,66$$

$$R31 = \frac{\min \{0,5; 0,75; 0,5; 0,75; 0,5\}}{0,5} = \frac{0,5}{0,5} = 1$$

$$R41 = \frac{\min \{0,5; 0,75; 0,5; 0,75; 0,5\}}{0,75} = \frac{0,5}{0,75} = 0,66$$

$$R51 = \frac{\min \{0,5; 0,75; 0,5; 0,75; 0,5\}}{0,5} = \frac{0,5}{0,5} = 1$$

Normalization value of accreditation (benefit)

$$R12 = \frac{0,75}{\max \{0,75; 0,75; 0,75; 0,75; 0,75\}} = \frac{0,75}{0,75} = 1$$

$$R22 = \frac{0,75}{\max \{0,75; 0,75; 0,75; 0,75; 0,75\}} = \frac{0,75}{0,75} = 1$$

$$R32 = \frac{0,75}{\max \{0,75; 0,75; 0,75; 0,75; 0,75\}} = \frac{0,75}{0,75} = 1$$

$$R42 = \frac{0,75}{\max \{ 0,75; 0,75; 0,75; 0,75; 0,75 \}} = \frac{0,75}{0,75} = 1$$

$$R52 = \frac{0,75}{\max \{ 0,75; 0,75; 0,75; 0,75; 0,75 \}} = \frac{0,75}{0,75} = 1$$

The value of normalizing the number of lecturers and staff (benefits)

$$R13 = \frac{0,5}{\max \{ 0,5; 0,5; 0,5; 0,5; 0,5 \}} = \frac{0,5}{0,5} = 1$$

$$R23 = \frac{0,5}{\max \{ 0,5; 0,5; 0,5; 0,5; 0,5 \}} = \frac{0,5}{0,5} = 1$$

$$R33 = \frac{0,5}{\max \{ 0,5; 0,5; 0,5; 0,5; 0,5 \}} = \frac{0,5}{0,5} = 1$$

$$R43 = \frac{0,5}{\max \{ 0,5; 0,5; 0,5; 0,5; 0,5 \}} = \frac{0,5}{0,5} = 1$$

$$R53 = \frac{0,5}{\max \{ 0,5; 0,5; 0,5; 0,5; 0,5 \}} = \frac{0,5}{0,5} = 1$$

The value of normalization of job opportunities (benefits)

$$R14 = \frac{4}{\max \{ 4; 4; 3; 3; 4 \}} = \frac{4}{4} = 1$$

$$R24 = \frac{4}{\max \{ 4; 4; 3; 3; 4 \}} = \frac{4}{4} = 1$$

$$R34 = \frac{3}{\max \{ 4; 4; 3; 3; 4 \}} = \frac{3}{4} = 0,75$$

$$R44 = \frac{3}{\max \{ 4; 4; 3; 3; 4 \}} = \frac{3}{4} = 0,75$$

$$R54 = \frac{4}{\max \{ 4; 4; 3; 3; 4 \}} = \frac{4}{4} = 1$$

Here are the results of the matrix normalization:

$$R = \begin{vmatrix} 1 & 1 & 1 & 1 \\ 0,66 & 1 & 1 & 1 \\ 1 & 1 & 1 & 0,75 \\ 0,66 & 1 & 1 & 0,75 \\ 1 & 1 & 1 & 1 \end{vmatrix}$$

Ranking

The next stage after obtaining the normalized value is the calculation of the preference value (V_i). To get the score V , the sum of the results of the multiplication of each normalized matrix row element (R) with the preference weight (W) corresponding to the matrix column element is performed (Sirait & Siregar, 2022).

$$V_i = \sum_{j=1}^n w_j . r_{ij}$$

$$V1 = (0,3*1) + (0,2*1) + (0,2*1) + (0,3*1) = 1$$

$$V2 = (0,3*0,66) + (0,2*1) + (0,2*1) + (0,3*1) = 0,90$$

$$V3 = (0,3*1) + (0,2*1) + (0,2*1) + (0,3*0,75) = 0,93$$

$$V4 = (0,3*0,66) + (0,2*1) + (0,2*1) + (0,3*0,75) = 0,82$$

$$V5 = (0,3*1) + (0,2*1) + (0,2*1) + (0,3*1) = 1$$

Referring to the rankings that have been compiled, the study program with the highest V grade is considered the choice that best meets the set criteria. The following table presents the ranking order based on the results of the final calculations that have been performed.

Table 8. Ranking Determination

No	Courses	Value	Ranking
1	Informatics Engineering (A1)	1	1
2	Computer Engineering (A2)	0,90	4
3	Electrical Engineering (A3)	0,93	3
4	Electrical Engineering (A4)	0,82	5
5	Civil Engineering (A5)	1	2

Referring to the information displayed in Table 8, it can be seen that the Informatics and Civil Engineering Study Program shows advantages over other study programs. These two study programs obtained the highest preference score and were the same (1). This advantage is mainly due to the combination of relatively low tuition fees (Rp 2,000,000) and great job opportunities. This shows that these two study programs offer excellent value for prospective students, with promising career prospects and more affordable education costs.

The S1 Electrical Engineering Study Program, even though it has moderate job opportunities, S1 Electrical Engineering remains ranked third with a preference value of 0.93, this is due to the relatively low tuition fee (Rp 2,000,000). Meanwhile, the Computer Engineering Study Program, which has a higher tuition fee (Rp 2,400,000), Computer Engineering is ranked fourth with a preference value of 0.90. This shows that great job opportunities are able to offset the higher cost of education. The D3 Electrical Engineering Study Program is ranked at the bottom mainly because of the job opportunities that are considered "moderate". This shows how important career prospects are in the overall assessment of a course of study, even when other factors such as the number of lecturers and staff are superior.

The difference in tuition fees clearly affects the ranking. Study programs with a tuition fee of Rp 2,400,000 (Computer Engineering and D3 Electrical Engineering) tend to be ranked lower compared to those that cost Rp 2,000,000, although they have other equivalent characteristics. The effect of minimal accreditation, all study programs have B accreditation, so this factor is not a differentiator in the analysis. However, it also shows an equal quality standard among all options. Although the S1 Electrical Engineering and D3 Electrical Engineering Study Program has a larger number of lecturers and staff (13 compared to 11), this is not enough to compensate for the weakness in terms of job opportunities and tuition fees.

CONCLUSION

Based on data analysis using the simple additive weighting (SAW) technique, the following conclusions can be drawn:

The best study program at the Faculty of Engineering, University of Papua is an alternative that is ranked 1st, namely the Informatics Engineering Study Program, even though the Informatics Engineering and Civil Engineering Study Program appears as the best choice with the highest preference value. Both courses offer an optimal combination of affordable education costs and promising career prospects. The selection of study programs should not only be based on the results of this SAW analysis, but also consider personal factors such as interests, talents, and long-term career goals of prospective students. Thus, prospective students are advised to consider Informatics Engineering as the primary choice, but still evaluate other options based on their match with their personal interests and goals.

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