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Implementation of the Simple Additive Weighting (SAW) Method in a Decision Support System for the Most Popular Course Interests at Labuhanbatu University

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Abstract−Labuhanbatu University (ULB), one of the private universities in Labuhanbatu Regency, North Sumatra, admits new students every academic year across various study programs under four faculties. To date, the determination of the study program with the highest student interest has been carried out manually by summarizing the number of applicants without considering other supporting factors such as applicant quality, program capacity, and student satisfaction. Consequently, the analysis results tend to be less objective and less reliable as a basis for academic planning. This study aims to design and implement a Decision Support System (DSS) using the Simple Additive Weighting (SAW) method to assist the academic management in identifying the study program with the highest student interest based on five criteria: the number of applicants, the average entrance examination score, the on-time graduation rate, study program capacity, and student satisfaction level. This research employed an applied research approach using a case study method, which included problem identification, data collection, determination of criteria and weights, decision matrix normalization, preference value calculation, web-based system development, and system testing using the black-box testing method. The results demonstrate that the SAW method is capable of producing consistent and objective rankings of study programs based on the highest preference values. Based on the sample data, the Information Technology Study Program achieved the highest preference value of 0.9817, making it the study program with the highest student interest, followed by Management, Information Systems, Accounting, Mathematics Education, and Agrotechnology. The developed system can serve as an effective decision-support tool for university administrators in planning admission quotas and developing study programs.

Keywords: Simple Additive Weighting (SAW); Decision Support System; Study Program Preference; Labuhanbatu University; Multi-Criteria Decision Making

1. INTRODUCTION

Higher education plays a strategic role in developing competitive human resources amid the rapid advancement of science and technology. Labuhanbatu University (ULB), established in 2019 through the merger of several higher education institutions in Labuhanbatu Regency, has experienced a steady increase in the number of new student applicants each academic year across various study programs offered by its four faculties: the Faculty of Economics and Business, the Faculty of Science and Technology, the Faculty of Teacher Training and Education, and the Faculty of Law. The wide range of study programs offered requires the university administration to accurately identify which study programs attract the greatest interest from prospective students during each admission period.

In practice, the determination of the study program with the highest level of student interest is still conducted using a simple approach by comparing the number of applicants for each study program without considering other important factors, such as the academic quality of prospective students, available program capacity, graduation rates, and student satisfaction with the selected study programs. This approach may lead to less objective conclusions because a high number of applicants does not necessarily reflect the quality of incoming students or the sustainability of student interest in a particular study program. Therefore, there is a need for a system capable of supporting a more structured and measurable decision-making process.

A Decision Support System (DSS) is a computer-based system designed to assist decision-makers in solving semi-structured problems by utilizing relevant data and analytical models. Various Multi-Criteria Decision Making (MCDM) methods have been applied in previous studies to support selection and ranking processes, including the Weighted Product (WP) method for study program selection [1], the Multi-Factor Evaluation Process (MFEP) for selecting academic majors at the secondary school level [7], and the MOORA method for selecting workgroup leaders [8]. Furthermore, comparative studies evaluating the accuracy of the SAW and TOPSIS methods for proposal assessment [2] have shown that weighted-summation-based approaches remain competitive with other, more sophisticated MCDM techniques.

Among the various MCDM methods, the Simple Additive Weighting (SAW) method has been widely adopted because its computational procedure is relatively simple, easy to understand, and requires less complex normalization than methods such as the Analytic Hierarchy Process (AHP) and ELECTRE. Previous studies have demonstrated the effectiveness of SAW in various application domains, including teacher recruitment [4], [5], new student admission [10], [11], outstanding student selection [13], [15], social assistance beneficiary selection [14], website-based study program selection [16], university major recommendation systems [17], campus ambassador finalist selection [19], and improving the efficiency of outstanding student selection [20]. Several studies have also integrated SAW with the Weighted Product (WP) method to improve the validity and reliability of ranking results [12], [16].

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Based on the foregoing discussion, this study aims to design and implement a Decision Support System using the Simple Additive Weighting (SAW) method to objectively determine the study program with the highest student interest at Labuhanbatu University based on multiple relevant criteria. The results of this study are expected to serve as an evaluation tool for university administrators in planning admission quotas, allocating institutional resources, and developing strategies for the improvement and promotion of study programs in future student admission periods..

2. RESEARCH METHODS

2.1 Research Type and Approach

This study employed applied research using a case study approach at Labuhanbatu University. The research was conducted to develop a Decision Support System (DSS) that can be practically implemented by the academic administration to determine the study program with the highest student interest.

2.2 Research Stages

This study was conducted through eight stages: (1) identifying problems related to the manual process of determining the study program with the highest student interest; (2) reviewing previous literature relevant to Decision Support Systems (DSS) and the Simple Additive Weighting (SAW) method; (3) collecting data through observations, interviews with the academic administration, and documentation of new student admission data; (4) determining the research alternatives and evaluation criteria; (5) assigning weights to each criterion based on expert judgment from the academic administration; (6) applying the SAW algorithm to obtain the preference value of each alternative; (7) designing and implementing a web-based system; and (8) testing the system using the black-box testing method.

2.3 Research Alternatives and Criteria

The alternatives evaluated in this study consisted of six study programs at Labuhanbatu University: Management (A1), Accounting (A2), Information Technology (A3), Information Systems (A4), Mathematics Education (A5), and Agrotechnology (A6). The evaluation criteria and their corresponding weights were determined through discussions with the academic administration and are presented in Table 1.

Table 1. Evaluation Criteria and Weights

Code	Criterion	Weight (W)	Attribute
C1	Number of Applicants	0.30	Benefit
C2	Average Entrance Examination Score	0.25	Benefit
C3	On-Time Graduation Rate	0.15	Benefit
C4	Study Program Capacity	0.15	Benefit
C5	Student Satisfaction Level	0.15	Benefit

All criteria in this study are classified as benefit attributes, meaning that a higher value for a criterion indicates better performance of an alternative. The total weight of all five criteria is 1.00, in accordance with the weighting requirements of the SAW method.

2.4 Simple Additive Weighting Algorithm

The SAW method assigns weights to each criterion and subsequently performs a ranking process to identify the best alternative among all available alternatives. The implementation steps of the SAW algorithm in this study are as follows:

a. Determine the decision criteria, namely C1 through C5.
b. Assign suitability ratings for each alternative with respect to every criterion to form the decision matrix X.
c. Normalize the decision matrix X into the normalized matrix R using Equation (1) for benefit attributes:

$$rij=max(xij)xij \quad (1)$$

where (r_{ij}) is the normalized performance rating, (x_{ij}) is the value of alternative *i* on criterion *j*, and (\max(x_{ij})) is the maximum value for criterion *j*.

d. Calculate the preference value by multiplying each normalized value by its corresponding criterion weight and summing the results according to Equation (2):

$$Vi=\sum(Wj\times rij) \quad (2)$$

where (V_i) is the final preference value of alternative *i*, (W_j) is the weight assigned to criterion *j*, and (r_{ij}) is the normalized performance rating.

e. The alternative with the highest (V_i) value is considered the most recommended alternative, which in the context of this study represents the study program with the highest student interest.

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2.5 Research Data

The data used to demonstrate the SAW algorithm in this study consist of sample data representing the general pattern of new student admissions during one admission period. The dataset includes the number of applicants, average entrance examination scores, on-time graduation rates, study program capacities, and student satisfaction survey results for each study program. These data were used to illustrate the complete workflow of the system before its implementation using actual admission data in future enrollment periods.

3. RESULTS AND DISCUSSION

3.1 Decision Matrix

Based on the data for each alternative across the five evaluation criteria, the decision matrix **X** was constructed as presented in Table 2**.**

Table 2. Decision Matrix (Raw Data)

Alternative (Study Program)	C1	C2	C3	C4	C5
A1 – Management	420	72	78	300	4.0
A2 – Accounting	310	75	82	250	4.1
A3 – Information Technology	480	80	85	280	4.5
A4 – Information Systems	390	78	80	260	4.3
A5 – Mathematics Education	260	70	88	200	3.9
A6 – Agrotechnology	180	68	90	220	3.8

3.2 Decision Matrix Normalization

Each value in Table 2 was normalized using Equation (1) because all criteria are benefit attributes. This normalization process was performed by dividing each alternative's value for a criterion by the maximum value of that criterion. For example, the normalized value (r_31) for the Information Technology study program on criterion C1 is calculated as 480/480 = 1.0000, since Information Technology has the highest number of applicants. The complete normalized decision matrix is presented in Table 3**.**

Table 3. Normalized Decision Matrix (R)

Alternative (Study Program)	r1	r2	r3	r4	r5
A1 – Management	0.8750	0.9000	0.8667	1.0000	0.8889
A2 – Accounting	0.6458	0.9375	0.9111	0.8333	0.9111
A3 – Information Technology	1.0000	1.0000	0.9444	0.9333	1.0000
A4 – Information Systems	0.8125	0.9750	0.8889	0.8667	0.9556
A5 – Mathematics Education	0.5417	0.8750	0.9778	0.6667	0.8667
A6 – Agrotechnology	0.3750	0.8500	1.0000	0.7333	0.8444

3.3 Preference Value Calculation

The preference value ((V_i)) for each alternative was calculated by multiplying each value in the normalized matrix R by its corresponding criterion weight and then summing the weighted values according to Equation (2). As an example, the calculation for Alternative A3 (Information Technology**)** is presented as follows:

$$V3 = (0{,}30\times1{,}0000) + (0{,}25\times1{,}0000) + (0{,}15\times0{,}9444) + (0{,}15\times0{,}9333) + (0{,}15\times1{,}0000)$$

$$V3 = 0{,}3000 + 0{,}2500 + 0{,}1417 + 0{,}1400 + 0{,}1500 = 0{,}9817$$

The same calculation was applied to all alternatives, resulting in the preference values and final rankings presented in Table 4.

Table 4. Preference Value Calculation Results and Ranking

Alternative (Study Program)	Preference Value (Vi)	Rank	Category
A3 – Information Technology	0.9817	1	Highest Student Interest
A1 – Management	0.9008	2	High
A4 – Information Systems	0.8942	3	High
A2 – Accounting	0.8264	4	Moderate
A5 – Mathematics Education	0.7579	5	Moderate
A6 – Agrotechnology	0.7117	6	Low

The results presented in Table 4 indicate that the Information Technology study program (A3) achieved the highest preference value of 0.9817, and was therefore identified as the study program with the highest student interest.

It was followed by Management (0.9008), Information Systems (0.8942), Accounting (0.8264), Mathematics Education (0.7579), and Agrotechnology (0.7117), which ranked last. The high preference value of the Information Technology study program was mainly attributed to its highest number of applicants and highest average entrance examination score, corresponding to criteria C1 and C2, respectively. Since these two criteria carry the greatest weights, they made the largest contribution to the final preference value.

3.4 System Implementation

The results of the SAW algorithm were subsequently implemented in a web-based system consisting of several main modules, including an administrator login module, modules for managing alternative data (study programs) and evaluation criteria, a criterion weight management module, an automatic SAW calculation module, and a reporting module that displays the ranking of study programs based on student interest. Academic administrators can update the data for each new student admission period, allowing the ranking results to always reflect the most recent data without requiring manual calculations.

3.5 System Testing

The system was tested using the black-box testing method to ensure that each function operated as expected without examining the internal structure of the program code. The results of several key testing scenarios are presented in Table 5.

Table 5. Black-Box Testing Results

Test Scenario	Expected Result	Test Result	Status
Administrator login	Access to the dashboard page	Dashboard displayed successfully	Valid
Input of alternative and criterion data	Data stored in the database	Data successfully stored and displayed	Valid
SAW calculation process	The system generates preference values (Vi) according to the formula	Preference values match manual calculations	Valid
Print ranking report	Ranking report can be downloaded	Report successfully downloaded in PDF format	Valid

Based on the testing results shown in Table 5, all testing scenarios were declared valid, indicating that the system successfully performs data entry, SAW calculations, and ranking report generation according to user requirements. These findings demonstrate that the developed system is suitable for supporting decision-making in determining the study program with the highest student interest at Labuhanbatu University.

3.6 Discussion

The implementation of the SAW method in this study demonstrates that determining the study program with the highest student interest should not be based solely on the number of applicants but should also consider other supporting criteria, such as applicant quality and student satisfaction. For example, although the Management study program has the largest admission capacity, its preference value remains lower than that of Information Technology because the latter performs better in terms of the average entrance examination score and student satisfaction level. These findings are consistent with those of previous studies, which have shown that the SAW method is effective for various selection and ranking problems due to its ability to objectively accommodate multiple evaluation criteria simultaneously [3], [6], [9], [18]. Therefore, the developed system provides more comprehensive recommendations than the manual tabulation method previously employed by the academic administration of Labuhanbatu University.

4. CONCLUSION

Based on the research findings and discussion, it can be concluded that the Simple Additive Weighting (SAW) method was successfully implemented in a Decision Support System (DSS) to determine the study program with the highest student interest at Labuhanbatu University by utilizing five evaluation criteria: the number of applicants, the average entrance examination score, the on-time graduation rate, study program capacity, and student satisfaction level. Testing using sample data showed that the Information Technology study program achieved the highest preference value of 0.9817, thereby being identified as the study program with the highest student interest. Furthermore, the results of the black-box testing confirmed that all system functions operated correctly and were declared valid. The developed system can serve as a decision-support tool for university administrators in planning student admission quotas and developing strategies for study program improvement in future admission periods. Future research is recommended to implement the system using actual student admission data collected over multiple admission periods, integrate the system with the university's Academic Information System (SIAKAD) in real time, and compare the performance of the SAW method with other Multi-Criteria Decision-Making (MCDM) methods, such as the Analytic Hierarchy Process (AHP), Technique for Order Preference by Similarity to Ideal Solution (TOPSIS), and the Weighted Product (WP) method, to evaluate the consistency of the ranking results.

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