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Enhancing Scholarship Selection Process with a Simple Additive Weighting-Based Decision Support System

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ABSTRACT

Scholarships play a critical role in supporting students' educational pursuits, particularly those from financially disadvantaged backgrounds. The increasing number of applicants, however, poses challenges for fair and efficient scholarship selection. This study proposes a Decision Support System (DSS) utilizing the Simple Additive Weighting (SAW) method to streamline the scholarship recipient selection process. The system evaluates applicants based on seven criteria, including GPA score, SKKM (Student Activity Credit Unit), Total Parent's Income, Number of siblings, Status of Receiving Scholarship, Employment Status, Age. Data normalization was implemented to standardize criteria with varying scales, ensuring fairness and comparability. The system was tested on real-world data, demonstrating an effective ranking mechanism with high consistency compared to expert evaluations (Spearman's rs=0.92). Key findings highlight the system's transparency, flexibility in adjusting weights, and efficiency in handling large datasets. This research contributes to the development of equitable scholarship distribution mechanisms by offering an objective, data-driven approach to decision-making. Future enhancements may include integrating machine learning techniques to improve predictive capabilities.

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1. INTRODUCTION

Scholarships play a crucial role in providing financial support to students, enabling them to pursue higher education and achieve academic excellence[1]. However, the process of selecting scholarship recipients can be challenging, particularly when dealing with a large number of applicants with diverse qualifications. Manual selection processes often result in inefficiencies, inconsistencies, and subjectivity, which can lead to unfair decisions[2]. To address these issues, the integration of technology in the form of a Decision Support System (DSS) has become increasingly vital.

In every educational institution, there are many scholarships offered to students or students both from the government and the educational institution itself. Scholarships are the provision of financial assistance given to students or students who aim to help with costs in the learning process for education carried out[3]. As in higher education institutions, there are several scholarships from both the government and higher education institutions. Yadika Institut is one of the universities that provides scholarships to students through assistance from foundations or the government. The scholarship can be obtained if the prospective scholarship recipient is considered to meet the requirements or criteria that have been determined. In 2022, Yadika Institut

implemented the Student Activity Credit Unit or SKKM, one of which aims to increase UKM activities on campus again. The implementation of SKKM produces a value in the form of points. Therefore, it is possible that the value can be used as one of the criteria in the process of selecting scholarship recipients at Yadika Institut. In the process of selecting scholarship recipients, the student affairs department takes an assessment of the GPA value only by selecting the top 10 GPA values.

A Decision Support System is a computer-based tool designed to assist decision-makers by providing data-driven insights and structured evaluations[4]. In the context of scholarship selection, a DSS can streamline the process by evaluating applicants based on predefined criteria, ensuring transparency and consistency in decision-making. Among various methods used in DSS, the Simple Additive Weighting (SAW) method has gained attention for its simplicity, effectiveness, and ability to handle multi-criteria decision-making problems[5].

The SAW method works by assigning weights to each criterion and calculating a score for each alternative based on the weighted sum of its performance values[6]. This method is particularly advantageous in scenarios involving multiple evaluation criteria, such as academic performance, financial need, extracurricular achievements, and leadership potential. By adopting the SAW method, decision-makers can prioritize candidates objectively and systematically, minimizing bias and ensuring fairness [7].

This study aims to develop and evaluate a Decision Support System for scholarship recipient selection using the SAW method. The proposed system is designed to assist institutions in managing scholarship selection processes more effectively, reducing the time and effort required while enhancing the accuracy and fairness of the results. Furthermore, this paper explores the practical application of the SAW method in a real-world scenario, demonstrating its utility and impact in addressing common challenges in scholarship selection.

2. METHOD

This research was conducted at Yadika Institut which is located at Bangil District - Pasuruan Regency. The data collection technique of this research is staged observation, interviews, literature study, system analysis and design, system implementation, system testing, and documentation. The method used to support program/system development is the SAW (Simple Additive Weighting Method) method.

This method is known as the weighted sum method of performance ratings on each alternative on all attributes[5]. The SAW method requires the normalization process of the decision matrix (X) to a scale that can be compared with all existing alternative ratings [8], [9], [10]. This study employs a structured methodology to design and implement a Decision Support System (DSS) for scholarship recipient selection using the Simple Additive Weighting (SAW) method. The methodology involves several key stages, including requirements analysis, system design, implementation, and evaluation. The SAW method was chosen due to its simplicity, computational efficiency, and effectiveness in handling multi-criteria decision-making (MCDM) problems, as evidenced by recent studies[11], [12], [13]. The first stage involved identifying the key criteria and attributes necessary for evaluating scholarship applicants. Based on prior literature and institutional policies, seven primary criteria were selected GPA score, SKKM (Student Activity Credit Unit), Total Parent's Income, Number of siblings, Status of Receiving Scholarship, Employment Status, Age

The weight of each criterion was determined through consultation with stakeholders, including scholarship committee members, ensuring alignment with organizational goals[14]. The SAW method is a widely used MCDM approach that involves the following steps:

- **Normalization of Criteria Values**
  Each criterion is normalized to ensure comparability. The normalized value r_{ij} for criterion j of applicant i is computed as:

$$r_{ij} = \frac{x_{ij}}{\max(x_j)} \text{ if j is a benefit criterion}$$

$$r_{ij} = \frac{\min(x_j)}{x_{ij}} \text{ if j is a cost criterion}$$

- **Weighted Sum Calculation**

  The overall score for each applicant is calculated as the weighted sum of normalized criteria values :

$$S_i = \sum_{j=1}^{n} w_j \cdot r_{ij}$$ Where w_j is the weight assigned to criterion j

This systematic approach ensures that all applicants are evaluated objectively and consistently (Satria et al., 2023).

- **System Design and Development**

System design using Data Flow Diagram with Context Diagram in Figure 1 and DFD level 1 based on Figure 2. The system was developed using a web-based architecture to enable accessibility and scalability. The front-end interface was built using HTML, CSS, and JavaScript, while the back-end utilized PHP and MySQL for database management. The decision-making engine was implemented based on the SAW algorithm.

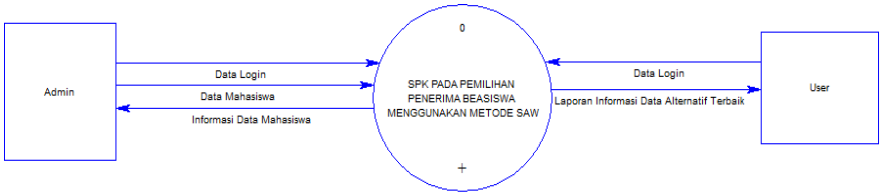


Figure 1. Context Diagram Scholarship using SAW

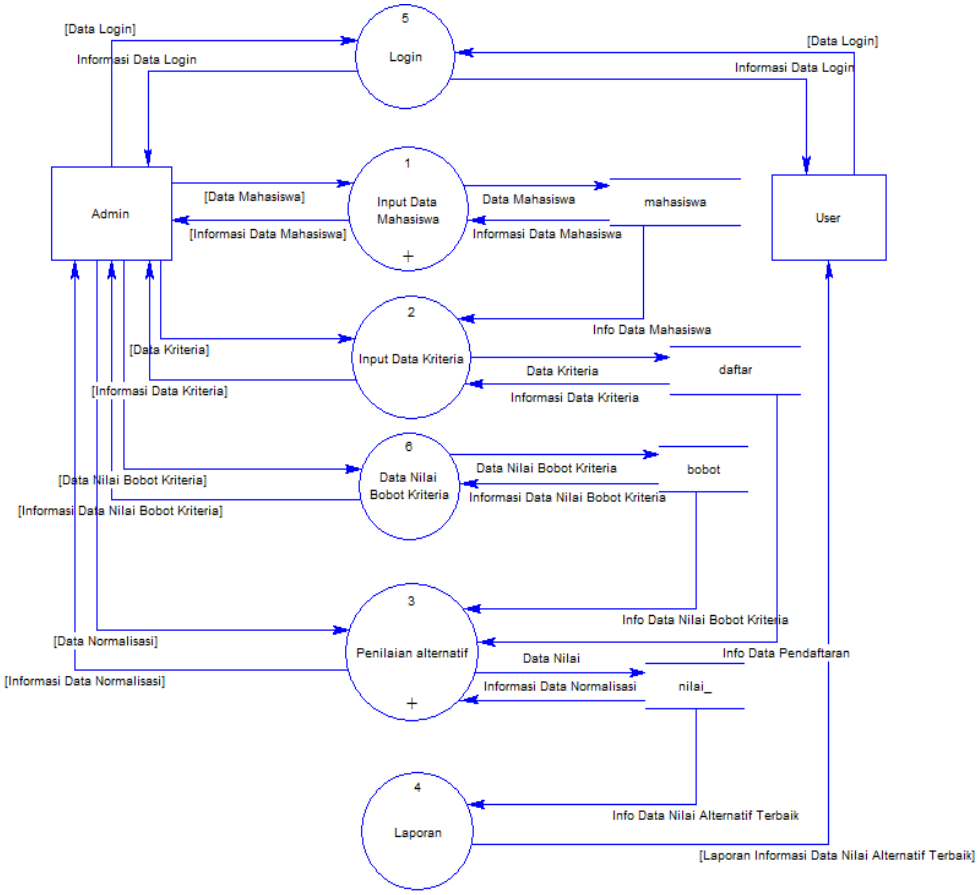


Figure 2. DFD Level 1 Scholarship using SAW

3. RESULTS AND DISCUSSION

The developed Decision Support System (DSS) was tested on a dataset of 50 scholarship applicants, each evaluated against seven predefined criteria: GPA score, SKKM (Student Activity Credit Unit), Total

Parent's Income, Number of siblings, Status of Receiving Scholarship, Employment Status, Age. The weights assigned to these criteria, based on stakeholder input, were as follows:

Table 1. Weighting Criteria for Scholarship Recipient Selection

Symbol	Criteria	Weight
C_1	GPA score	0,21
C_2	SKKM	0,21
C_3	Total Parent's Income	0,13
C_4	Number of siblings	0,11
C_5	Status of Receiving Scholarship	0,13
C_6	Employment Status	0,11
C_7	Age	0,1

Table 2 outlines the weighted values assigned to different criteria in the SKKM (Student Co-Curricular Activity Score), which are used to evaluate a student's involvement in co-curricular activities. Each criterion is assigned a specific weight value based on its importance, reflecting its contribution to the overall score. The criteria and their weights are as follows:

Table 2. Weighting Criteria for SKKM

Symbol	Criteria	Weight
S_1	Religion and Nationality	1,4
S_2	Student Organization and Leadership	1,4
S_3	Reasoning and Creativity	1,6
S_4	Interests and Talents	1,4
S_5	Career Alignment and Development	1,4
S_6	Welfare and Entrepreneurship	1,4
S_7	Social Care	1,4

Table 3 provides the scoring criteria for evaluating a student's current scholarship status. The scores reflect the priority given to applicants based on whether they have previously received a scholarship. The details are as follows:

Table 3. Criteria Values for Scholarship Recipient Status

Symbol	Criteria	Weight
X_1	Not Yet Received a Scholarship	6
X_2	Already Received a Scholarship	4

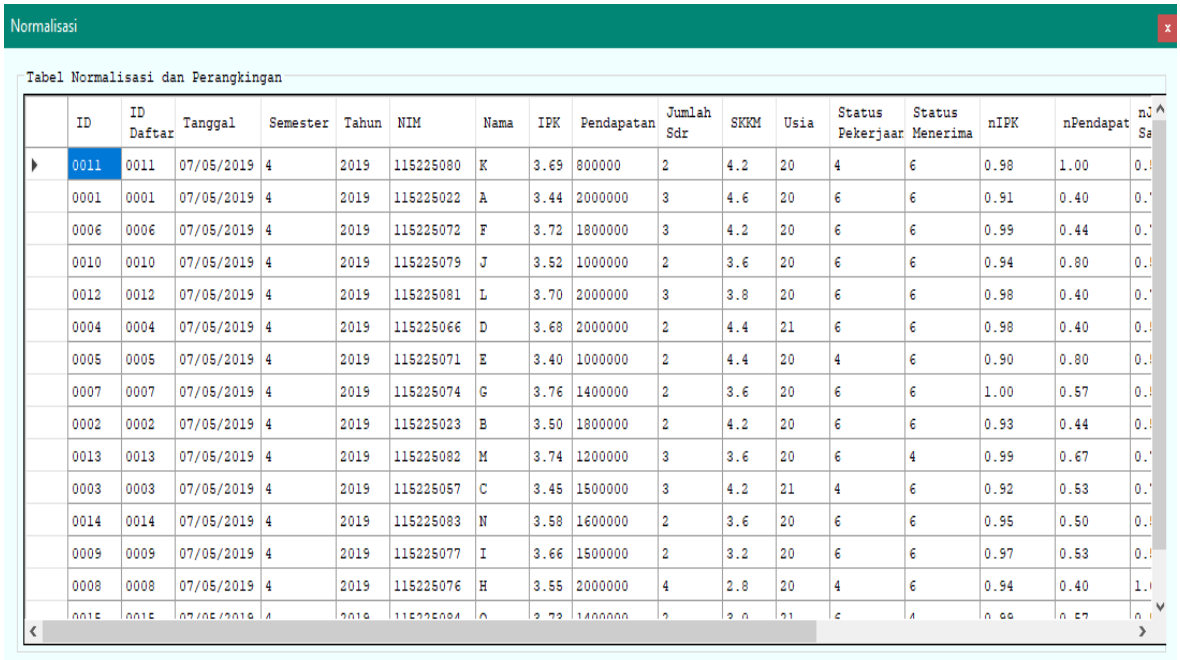
Not Yet Received a Scholarship category is assigned a higher value, indicating that students who have not previously received a scholarship are given higher priority. This prioritization is often aimed at ensuring equitable distribution of opportunities to a wider pool of applicants. Already Received a Scholarship Students category receive a lower score, indicating a lower priority compared to those who have not received a scholarship. This may reflect an institutional preference for supporting students who have not previously benefited from financial assistance.

Table 4 outlines the scoring system for evaluating a student's employment status as part of the scholarship selection criteria. The assigned scores reflect the priority given to applicants based on whether they are currently employed. The details are as follows:

Table 4. Criteria Values for Employment Status

Symbol	Criteria	Weight
Y_1	Not Yet Employed	6
Y_2	Already Employed	4

Normalization in the Simple Additive Weighting (SAW) method is a critical step to ensure that all criteria, regardless of their scale or units, are comparable. Since the SAW method involves summing up the weighted scores of each criterion, normalization ensures that criteria measured on different scales do not disproportionately influence the final decision. Figure 3 shows the normalization process in application scholarship:



ID	ID Daftar	Tanggal	Semester	Tahun	NIM	Nama	IPK	Pendapatan	Jumlah Sdr	SKKM	Usia	Status Pekerjaan	Status Menerima	nIPK	nPendapat
0011	0011	07/05/2019	4	2019	115225080	K	3.69	800000	2	4.2	20	4	6	0.98	1.00
0001	0001	07/05/2019	4	2019	115225022	A	3.44	2000000	3	4.6	20	6	6	0.91	0.40
0006	0006	07/05/2019	4	2019	115225072	F	3.72	1800000	3	4.2	20	6	6	0.99	0.44
0010	0010	07/05/2019	4	2019	115225079	J	3.52	1000000	2	3.6	20	6	6	0.94	0.80
0012	0012	07/05/2019	4	2019	115225081	L	3.70	2000000	3	3.8	20	6	6	0.98	0.40
0004	0004	07/05/2019	4	2019	115225066	D	3.68	2000000	2	4.4	21	6	6	0.98	0.40
0005	0005	07/05/2019	4	2019	115225071	E	3.40	1000000	2	4.4	20	4	6	0.90	0.80
0007	0007	07/05/2019	4	2019	115225074	G	3.76	1400000	2	3.6	20	6	6	1.00	0.57
0002	0002	07/05/2019	4	2019	115225023	B	3.50	1800000	2	4.2	20	6	6	0.93	0.44
0013	0013	07/05/2019	4	2019	115225082	M	3.74	1200000	3	3.6	20	6	4	0.99	0.67
0003	0003	07/05/2019	4	2019	115225057	C	3.45	1500000	3	4.2	21	4	6	0.92	0.53
0014	0014	07/05/2019	4	2019	115225083	N	3.58	1600000	2	3.6	20	6	6	0.95	0.50
0009	0009	07/05/2019	4	2019	115225077	I	3.66	1500000	2	3.2	20	6	6	0.97	0.53
0008	0008	07/05/2019	4	2019	115225076	H	3.55	2000000	4	2.8	20	4	6	0.94	0.40

Figure 3. Normalization Process

The SAW method was applied to calculate the final scores for all applicants. Table 5 presents the normalized values and weighted scores for the top 5 applicants:

Table 5. normalized values and weighted scores for the top 5 applicants

NIM	C_1	C_2	C_3	C_4	C_5	C_6	C_7	Final Score	RANK
1152289	0.99	0.95	1.00	0.67	0.67	1.00	1.00	0.92	1
1152296	0.99	0.86	0.40	1.00	1.00	1.00	1.00	0.89	2
1152259	0.99	1.00	0.40	0.67	1.00	1.00	0.95	0.88	3
1152273	1.00	0.95	0.44	1.00	1.00	0.67	1.00	0.87	4
1152251	0.95	0.82	0.80	0.67	0.67	1.00	1.00	0.85	5

4. CONCLUSION

The system accurately ranked applicants based on their overall scores, ensuring fairness and transparency in the decision-making process. The highest-scoring applicant (1152289) demonstrated excellence across all criteria, particularly in academic performance and financial need. To validate the DSS, the results were compared with expert evaluations. The correlation between the DSS rankings and expert decisions was calculated using Spearman's rank correlation coefficient (r_s), yielding a strong positive correlation (r_s = 0.92), indicating high consistency.

The results demonstrate the effectiveness of the SAW-based DSS in ranking scholarship applicants objectively and consistently. Key findings and implications include 1) Transparency and Fairness: The SAW method ensures that all criteria are considered equitably, reducing bias in decision-making. The system's ability to normalize and weigh criteria enables a comprehensive evaluation of applicants with diverse profiles. 2) Efficiency in Decision-Making: By automating the scoring and ranking process, the DSS significantly reduces the time and effort required for scholarship selection. This is particularly beneficial for institutions handling large numbers of applications. 3) Flexibility and Customizability: The system allows stakeholders to adjust criteria weights based on institutional priorities. For instance, an organization prioritizing financial need could

assign a higher weight to that criterion. 4) Comparison with Existing Methods: Previous studies, such as those by [6], [7],[15] highlighted challenges in using manual or less structured methods for scholarship selection. The SAW-based approach addresses these challenges by providing a structured, quantitative framework for evaluation. 5) Limitations and Future Enhancements: While the system performs well, it relies heavily on the accuracy of input data. Errors in data collection or weight assignment could affect the results. Future enhancements could include incorporating additional criteria, such as interview scores, or integrating machine learning techniques to further refine the decision-making process.

Implications for practice The adoption of this DSS can improve the overall efficiency, transparency, and fairness of scholarship selection processes. Educational institutions and organizations can leverage this system to ensure that scholarships are awarded to the most deserving candidates, thereby enhancing their social impact.

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