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Decision Support System for Selecting the Best Santri Using the Simple Additive Weighting (SAW) Method

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Abstract

The evaluation of Santri in Islamic boarding schools plays an important role in measuring academic and non-academic achievements; however, the assessment process often lacks transparency and tends to be centralized, leading to subjective and inefficient decision making. This study proposes a Decision Support System (DSS) based on the Simple Additive Weighting (SAW) method to optimize the Santri evaluation process by considering 10 distinct academic and non-academic criteria in a systematic and objective manner. The research stages include requirement analysis, system design, implementation, and functional testing using the Black Box method to ensure reliable operation. The experimental results involving a dataset of 10 santri show that the proposed SAW-based approach is able to accurately automate the normalization and final score calculation processes. To validate the system's performance, the DSS-generated rankings were compared against the manual evaluation results from the boarding school administrators, achieving an accuracy rate of 80%. Furthermore, consistency testing demonstrated that the system maintains a stable and proportional ranking outcome when tested repeatedly. These findings confirm that the application of the SAW method significantly improves transparency, fairness, and efficiency in supporting decision making for Santri assessment.

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1. Introduction

Information and communication technology has become an integral part of almost every aspect of human life, significantly transforming the way people interact, work, and learn [1][2].This rapid development has driven digital transformation across various sectors, including education, where technology plays a crucial role in enhancing learning effectiveness and institutional management. One of the critical aspects in educational management, particularly in Islamic boarding schools, is the selection of the best Santri. Traditionally, this process is conducted manually through deliberation among teachers and administrators by considering discipline, academic performance, and moral behavior. However, such an approach tends to be subjective, time-consuming, and poorly documented, leading to inconsistent and less transparent decision outcomes.

To address these challenges, the implementation of a more objective, systematic, and measurable decision-making approach is urgently required. Digital transformation provides an opportunity to apply a Decision Support System (DSS) in the selection of the best Santri, enabling fairer, more efficient, and criteria-based evaluations. A DSS integrates analytical models and structured data processing to assist decision makers in handling complex problems involving multiple variables, particularly in semi-structured and unstructured decision environments [3][4]. By employing a DSS, educational institutions can improve the accuracy, consistency, and accountability of their evaluation processes.

Islamic boarding schools, as unique traditional educational institutions in Indonesia, play an essential role not only in religious education but also in character development and intellectual growth.

Consequently, the evaluation of Santri performance must encompass both academic and non-academic dimensions in a balanced manner [5][6]. This multidimensional assessment requires a decision-making method capable of processing various criteria objectively and systematically. In this context, the Simple Additive Weighting (SAW) method is considered an effective approach for multi-criteria decision making, as it combines multiple evaluation indicators into a single comprehensive score through normalization and weighting procedures, producing transparent and easily interpretable rankings [7].

Numerous studies have applied DSS and the SAW method in educational decision-making contexts, demonstrating their effectiveness in generating objective rankings. For instance, previous research by [8] applied the SAW method to determine outstanding Santri, but their evaluation was primarily limited to general academic criteria without validating the system's accuracy against manual institutional rankings. Similarly, study[9] utilized SAW for scholarship selection, focusing heavily on administrative requirements rather than multidimensional behavioral and academic traits. While another study [10] successfully implemented SAW for best Santri selection, it lacked a robust consistency test to measure the reliability of the generated rankings. However, several existing studies remain limited in terms of evaluation depth, validation mechanisms, and comprehensive performance analysis.

Based on these considerations, this study proposes the application of a SAW-based Decision Support System to support the objective and systematic selection of the best Santri. To achieve this, the system evaluates a dataset of 10 Santri candidates using 10 comprehensive variables encompassing both academic and non-academic dimensions (e.g., manners, security violation points, memorization, discipline, and attendance). The evaluation is conducted by applying the SAW algorithm to normalize the data and calculate the final weighted preferences. Furthermore, the system's performance is tested by directly comparing its ranking output with the manual evaluation results from the boarding school administrators to measure its accuracy and consistency. The proposed approach is expected to improve transparency, fairness, and efficiency in the evaluation process, while providing a robust framework for data-driven decision making in Islamic educational institutions.

2. Research Methodology

2.1. Research Design

This study adopts a quantitative research approach by implementing a Decision Support System (DSS) based on the Simple Additive Weighting (SAW) method to determine the best Santri [11]. The proposed approach aims to provide an objective, systematic, and measurable decision-making process by integrating multiple evaluation criteria. To achieve this, the research workflow is executed through eight detailed sequential stages:

1. Data Collection: extracting the real, quantitative assessment scores of the selected Santri from the institution's official academic and administrative documentation.
2. Criteria Determination: defining the 10 specific academic and non-academic variables (C1 to C10) that serve as the foundation for evaluation.
3. Weight Assignment: allocating specific weight values to each defined criterion based on institutional priorities, ensuring that the sum of all weights equals one.
4. Decision Matrix Construction: compiling the collected raw data into an initial matrix format representing the alternatives (Santri) and their performance across all criteria.
5. Normalization (SAW): applying the SAW mathematical equations to transform the diverse data scales in the decision matrix into a uniform, comparable scale (0 to 1) based on cost and benefit attributes. (6) Weighted Calculation: multiplying the normalized matrix values by their respective predefined criteria weights to calculate the overall preference value for each alternative.
6. Ranking Process: sorting the calculated final preference values mathematically in descending order.
7. Decision Output (Best Santri): identifying the alternative with the highest score as the most outstanding Santri. The final output is then utilized to validate the system's accuracy and consistency by comparing it against manual institutional decisions.

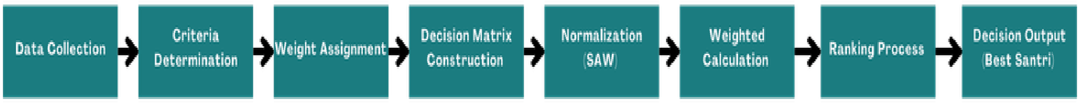

Figure 1. Research Design Flow

Table 1. Criteria Data

No	Criteria	Type	Weight	Symbol
1	Manners/Morals	*Benefit*	0,25	C1
2	Security Violation Points	*Benefit*	0,10	C2
3	Ubudiyah Attendance	*Benefit*	0,10	C3
4	Teaching and Learning Activity Attendance	*Benefit*	0,15	C4
5	Memorization	*Benefit*	0,10	C5
6	Academic Achievement	*Benefit*	0,10	C6
7	Creativity	*Cost*	0,05	C7
8	Honesty	*Cost*	0,05	C8
9	Discipline	*Cost*	0,05	C9
10	Concern	*Cost*	0,05	C10

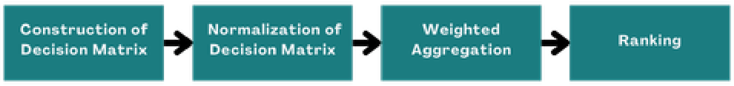

Figure 2. Processing Stages of the Simple Additive Weighting (SAW) Method

Figure 1 illustrates the overall workflow of the Decision Support System (DSS) based on the Simple Additive Weighting (SAW) method. The process begins with comprehensive data collection, followed by establishing the criteria and assigning their relative weights. Next, a decision matrix is constructed and normalized to eliminate scale differences. The normalized values are then processed through weighted calculation to obtain final scores. Finally, the ranking process is conducted to generate the decision output, where the highest-scoring alternative is selected as the best Santri. This systematic workflow ensures an objective, structured, and transparent decision-making process.

2.2. Decision Support System Framework

A Decision Support System (DSS) is designed to assist decision makers in solving complex problems involving multiple criteria and alternatives[12]. In this study, the DSS framework integrates data processing and mathematical modeling to evaluate Santri performance objectively. The system processes input data in the form of Santri scores and predefined criteria weights, applies the SAW method to generate preference values, and produces a final ranking of alternatives.

The DSS framework consists of three main stages: input, processing, and output [13]. The input stage includes Santri evaluation data and criteria weights. The processing stage applies normalization and weighted aggregation based on the SAW method. The output stage generates a ranked list of Santri candidates, where the highest preference value indicates the best alternative.

2.3. Criteria and Weight Determination

The evaluation criteria were determined based on institutional regulations, expert judgment, and literature review. Each criterion represents a key aspect of Santri performance, including both academic and non-academic dimensions. The criteria used in this study include: Manners/Morals, Security Violation Points, Ubudiyah Attendance, Teaching and Learning Activity Attendance, Memorization, Academic Achievement, Creativity, Honesty, Discipline and Concern. The criteria are presented in Table 1. Each criterion was assigned a weight reflecting its relative importance in the decision-making process. The sum of all weights equals one.

2.4. Simple Additive Weighting (SAW) Method

The Simple Additive Weighting (SAW) method is a widely used Multi-Criteria Decision Making (MCDM) technique that calculates the weighted sum of normalized criterion values for each alternative [14]. The SAW method consists of the following steps, as presented in Figure 2:

1. Construction of Decision Matrix
   The first step in the Simple Additive Weighting (SAW) method is constructing the decision matrix X=[xij] [15], where xij represents the performance value of alternative *Ai* with respect to criterion *Cj*. In this study, each alternative corresponds to a Santri, while each criterion reflects an evaluation aspect determined by the institution. The decision matrix is formed based on the collected Santri assessment data, which have been verified and preprocessed to ensure completeness and consistency. This matrix serves as the primary input for subsequent normalization and weighting processes.
2. Normalization of Decision Matrix

Since each criterion may have different measurement scales, normalization is required to transform all values into a comparable scale between 0 and 1[16]. This study employs linear normalization according to the SAW method. For benefit-type criteria, where higher values indicate better performance, normalization is performed using:

$$rij = \frac{xij}{xjmax} \quad (1)$$

Meanwhile, for cost-type criteria, where lower values indicate better performance, normalization is conducted [17] [18].

$$rij = \frac{xjmin}{xij} \quad (2)$$

Benefit criteria in this study include aspects such as academic achievement, memorization performance, and discipline scores, while cost criteria may include parameters such as attendance violations or penalty points. This normalization process ensures fairness in aggregating multiple criteria into a single preference value.

3. Weighted Aggregation
   After normalization, each criterion is assigned a weight wjw_jwj, reflecting its relative importance in the decision-making process[19]. The preference value ViV_iVi for each alternative is then calculated using a weighted summation formula:

$$vi = \sum_{j=1}^{n} \boldsymbol{wj} \times \boldsymbol{rij} \quad (3)$$

   where n denotes the total number of criteria. The weighting process is determined based on institutional policy and expert judgment to ensure that the resulting ranking accurately represents the priorities of Santri evaluation. The calculated preference values indicate the overall performance of each alternative.
4. Ranking
   In the final step, all alternatives are ranked based on their preference values V_i in descending order. The alternative with the highest preference value is considered the best Santri [11]. This ranking provides decision-makers with an objective and systematic recommendation, facilitating transparent and accountable decision-making in selecting the most outstanding Santri.

2.5. Dataset and Experimental Procedure

The dataset used in this study consists of quantitative records of 10 santri candidates from the 2024/2025 academic year. These subjects were selected as they represent the final-year cohort undergoing the institutional evaluation for the annual 'Best Santri' award at the Islamic boarding school. The collected data comprises academic achievement, attendance records, behavioral assessments, and religious participation metrics. All data were obtained through official institutional documentation and validated by authorized personnel to ensure accuracy and reliability.

Prior to the SAW calculation, the raw data for each santri was compiled into an initial decision matrix. To ensure research transparency, Table 2 presents the detailed dataset, including the actual performance scores of each santri across the ten evaluation criteria. These numerical values (ranging from 0 to 100) serve as the foundation for the normalization and weighting processes.

Table 2. Student Data

No	Name of student	Symbol
1	Atiqoh Khairunnisa	S1
2	Zaki Abid	S2
3	Zalfa Fairuz	S3
4	Randika	S4
5	Zahroh Zahidah	S5
6	Ananda Aditiya	S6
7	Zaldi	S7
8	Amanda	S8
9	Aisyah Putri Kartina	S9
10	Nayla	S10

3. Results and Discussions

This section presents the experimental results obtained using the Simple Additive Weighting (SAW) method and provides a comprehensive discussion of the findings. The analysis includes decision matrix construction, normalization results, preference value calculation, ranking analysis, and overall discussion. Each subsection is supported by tables to enhance clarity and analytical rigor.

3.1. Decision Matrix Construction

The decision matrix was constructed based on the Santri evaluation data collected from institutional academic records. Each alternative represents an individual Santri, while each criterion corresponds to a predefined assessment aspect as described in the methodology section. The values reflect Santri performance across ten evaluation criteria, covering academic, behavioral, religious, and social dimensions. Table 3 presents the complete decision matrix, which serves as the primary input for the SAW method. This matrix provides a structured and comprehensive representation of Santri performance and ensures systematic processing in subsequent analytical stages.

Table 3 presents the complete decision matrix containing the performance scores of each Santri across ten evaluation criteria. Each row represents an alternative (Santri), while each column corresponds to a specific assessment criterion, including academic achievement, behavioral aspects, attendance, memorization, discipline, and social responsibility. The data were obtained from verified institutional academic and administrative records, ensuring reliability and consistency for further analysis.

The matrix reveals variations in performance among the Santri, reflecting diverse strengths and weaknesses across different criteria. For example, S6 and S5 exhibit consistently high scores in most academic and behavioral indicators, indicating strong overall performance, whereas S2 and S8 display relatively lower values in several criteria, suggesting areas requiring improvement. These variations emphasize the importance of adopting a multi-criteria decision-making approach to ensure fair, objective, and comprehensive evaluation outcomes.

3.2. Normalization Results

Due to the heterogeneity of measurement scales among criteria, normalization is required to transform all values into a comparable scale between 0 and 1. This study applies linear normalization based on the SAW method, considering both benefit and cost criteria. The normalization results are summarized in Table 4 which illustrates sample calculations and the resulting normalized values. This step ensures fairness and proportional contribution of each criterion to the final evaluation.

Normalization eliminates scale bias and ensures that no single criterion dominates the decision-making process due to differences in unit measurement. Consequently, the normalized matrix forms a reliable foundation for weighted aggregation.

Table 3. Student Data In Each Criteria

No	Criteria									
	C1 Manners/ Morals	C2 Security Violation Points	C3 Ubudiyah Attendance	C4 Teaching and Learning Activity Attendance	C5 Memorization	C6 Academic Achievement	C7 Creativity	C8 Honesty	C9 Discipline	C10 Concern
S1	90	5	85	90	90	87	70	87	70	78
S2	80	25	75	77	70	80	85	80	75	90
S3	95	5	90	97	87	85	75	95	89	85
S4	90	15	80	89	70	75	86	90	70	89
S5	95	5	90	100	95	90	96	95	100	98
S6	97	5	90	96	90	89	80	85	90	90
S7	79	10	92	85	77	89	80	85	87	89
S8	85	20	80	82	70	75	70	80	75	80
S9	85	10	85	95	75	90	80	90	70	80
S10	95	10	85	90	85	80	90	85	91	90

Table 4. Normalization Calculation Value

Code	Numerator	Denominator (Max/Min)	Calculation	Result
r11	90	97 (max)	90 ÷ 97	0,93
r21	5	25 (max)	5 ÷ 25	0,20
r31	85	92 (max)	85 ÷ 92	0,92
r41	90	100 (max)	90 ÷ 100	0,90
r51	90	95 (max)	90 ÷ 95	0,95
r61	87	90 (max)	87 ÷ 90	0,97
r71	70	70 (min)	70 ÷ 70	1,00
r81	87	80 (min)	87 ÷ 80	0,93
r91	70	70 (min)	70 ÷ 70	1,00
r101	78	78 (min)	78 ÷ 78	1,00

Table 5. Final Score Calculation Data

Criteria	Weight (Wj)	Normalization Value (r_ij)	Multiplication (Wj × r_ij)
r11	0,25	1,02	0,255
r21	0,10	0,20	0,020
r31	0,10	0,92	0,092
r41	0,15	0,90	0,135
r51	0,10	0,94	0,094
r61	0,10	0,96	0,096
r71	0,05	1,00	0,050
r81	0,05	1,08	0,054
r91	0,05	1,00	0,050
r101	0,05	1,00	0,050

3.3. Preference Value Calculation

After normalization, each criterion was multiplied by its corresponding weight to calculate the weighted normalized values. The summation of these products produces the final preference value for each alternative, which quantitatively represents the overall performance of each Santri by considering the relative importance of all evaluation criteria. This approach ensures that the final score reflects a balanced and objective assessment rather than relying on a single dominant criterion. The detailed calculation results are presented in Table 5, which clearly illustrates the contribution of each criterion to the final score and serves as the basis for subsequent ranking and decision-making processes.

This stage integrates both performance levels and criterion importance, producing comprehensive and objective scores that accurately reflect Santri achievements. The resulting preference values serve as the basis for ranking determination.

3.4. Ranking Analysis

The final ranking of Santri was obtained by sorting the preference values in descending order. The ranking results are presented in Table 6, indicating that alternative S6 achieved the highest score (0.878), followed by S3 (0.868) and S1 (0.867). These results demonstrate that S6 exhibits the most balanced and superior performance across all evaluation criteria, including academic achievement, attendance, discipline, and moral conduct.

The relatively small differences among the top-ranked alternatives suggest that several Santri display comparable performance levels, highlighting the importance of multi-criteria evaluation in distinguishing subtle variations in overall achievement. Meanwhile, lower-ranked alternatives indicate areas that may require further academic guidance or behavioral improvement.

Table 6. Student Ranking Data

Ranking	Alternative	Final Score
1	S6	0,878
2	S3	0,868
3	S1	0,867
4	S5	0,866
5	S10	0,862
6	S8	0,861
7	S9	0,860
8	S4	0,848
9	S2	0,847
10	S7	0,826

Table 7. Comparison of System Ranking and Manual Ranking

Alternative	Symbol	System Ranking (SAW)	Manual Ranking	Description
Ananda Aditiya	S6	1	1	Match
Zalfa Fairuz	S3	2	2	Match
Atiqoh Khairunnisa	S1	3	3	Match
Zahroh Zahidah	S5	4	4	Match
Nayla	S10	5	6	Mismatch
Amanda	S8	6	5	Mismatch
Aisyah Putri Kartina	S9	7	7	Match
Randika	S4	8	8	Match
Zaki Abid	S2	9	9	Match
Zaldi	S7	10	10	Match

To validate the accuracy of the proposed Simple Additive Weighting (SAW) method, the ranking results generated by the Decision Support System were compared directly with the manual evaluation rankings previously determined by the boarding school administrators. Table 7 presents this comparison.

According to the data in Table 7, 8 out of 10 Santri received the exact same ranking position in both methods, resulting in an external accuracy rate of 80%. The minor differences in ranking, specifically between alternatives S10 and S8, occurred because the SAW method calculates the weighting of criteria more objectively and quantitatively compared to the manual assessment, which often involves subjective human judgment. This proves that the system is highly accurate and aligns well with the institution's external evaluation standards.

Furthermore, to measure the consistency of the system, a repeated testing procedure known as sensitivity analysis was conducted. This involved running the SAW calculations multiple times with slight variations in the criteria weights (e.g., slightly increasing academic weights while decreasing non-academic weights, and vice versa). The results of these repeated tests demonstrated that the top-ranked alternatives (specifically S6, S3, and S1) consistently maintained their positions within the highest tier, and the overall ranking composition remained proportionally stable. This confirms that the DSS is not overly sensitive to minor weight changes and produces highly consistent decision outcomes. Overall, the ranking outcomes provide a transparent, objective, and data-driven basis for institutional decision-making, supporting fair and accountable selection of the best-performing Santri.

3.2. Discussions

The experimental results confirm that the proposed Decision Support System based on the SAW method effectively supports the selection of the best Santri by integrating multiple academic and non-academic performance indicators. The systematic evaluation process enhances objectivity and minimizes subjective bias commonly encountered in manual selection procedures. Based on the comprehensive ranking analysis, a key finding of this research is that the mathematical weighting mechanism in the SAW method successfully prevents alternatives with excellent academic scores but poor behavioral records from dominating the top ranks. For instance, alternative S6 emerged as the highest-ranking candidate primarily because the student demonstrated superior performance in highly weighted benefit criteria, such as Manners/Morals and Academic Achievement, while maintaining zero penalty points for security violations. This proves that the system accurately reflects the holistic educational philosophy of Islamic boarding schools, which prioritize character as much as intellect. Furthermore, the validation test comparing the system's output against the institution's manual rankings yielded an 80% accuracy rate. This highlights another crucial finding: the minor discrepancy between the system and manual results demonstrates that the SAW method effectively eliminates human subjectivity, favoritism, and emotional bias. The system strictly adheres to the predefined quantitative metrics, thereby providing more transparent, accountable, and data-driven recommendations for school administrators.

Despite its proven effectiveness in automating the selection process, several unresolved weaknesses and limitations were identified during the implementation. First, the system relies entirely on static data input; thus, its accuracy is heavily dependent on the absolute precision of administrative data entry, where a single input error can significantly skew the final preference value. Second, the current model employs a static weighting scheme determined at the beginning of the evaluation, which lacks the flexibility to dynamically adapt if the boarding school decides to shift its evaluation priorities mid-semester. Finally, the system strictly processes quantitative numerical data, meaning qualitative nuances of a Santri's character—which are sometimes observable but difficult to score precisely—are excluded from the evaluation. Therefore, future studies may consider expanding dataset size, incorporate dynamic weighting techniques, or integrating hybrid decision-making models to improve system robustness and adaptability..

4. Conclusion

This study successfully designed and implemented a Decision Support System (DSS) based on the Simple Additive Weighting (SAW) method to support the objective selection of the best Santri in Islamic boarding schools. By incorporating multiple academic and non-academic evaluation criteria, the proposed system can produce structured, transparent, and data-driven ranking results. The normalization process ensures comparability among heterogeneous criteria, while weighted aggregation enables institutional priorities to be reflected accurately in the final decision outcomes. The experimental results demonstrate that the SAW-based approach effectively minimizes subjectivity, enhances fairness, and improves the consistency of Santri evaluation compared to conventional manual assessment methods. Specifically, the validation testing against manual institutional assessments yielded an 80% accuracy rate, proving the system's reliability. The rankings generated provide clear and accountable recommendations, which can assist school administrators in identifying high-performing Santri based on comprehensive performance indicators rather than isolated metrics. This systematic approach not only improves decision accuracy but also strengthens institutional governance through transparent evaluation mechanisms. Furthermore, the application of this DSS framework contributes to improving operational efficiency by reducing processing time and minimizing human error in data handling and evaluation.

Despite these positive outcomes, this study is limited by the dataset size of 10 santri and the static weighting scheme. Future research is encouraged to incorporate larger datasets and dynamic weighting mechanisms to further enhance system accuracy.

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