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Implementation of a Web-Based Decision Support System Using Simple Additive Weighting (SAW) For Assessment Of "*Siswa Berprestasi*" In Sumenep High Schools

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A B S T R A C T

The assessment of student achievement in schools is a crucial aspect of determining educational success. This research developed a web-based Decision Support System (DSS) utilizing the Simple Additive Weighting (SAW) method to evaluate outstanding students, known as "Siswa Berprestasi," in several high schools in the Sumenep region. Data were collected from 30 respondents via online questionnaires. The validity and reliability of the data collection instruments were tested using construct validity and Cronbach's Alpha reliability tests. The results indicate that the SAW method effectively assesses student performance by considering academic, non-academic, and extracurricular criteria. The DSS implemented in case studies across five high schools in Sumenep showed significant improvements in assessment transparency and accuracy. The findings suggest the SAW-based DSS enhances the quality of student evaluations and is recommended for broader adoption in schools across the region.

Keywords: Decision Support System (DSS), Simple Additive Weighting (SAW), Student Assessment, Siswa Berprestasi.

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1. Introduction

A Decision Support System (DSS) is an essential tool for evaluating and determining outstanding students, or *siswa berprestasi*, within a school. In many educational institutions, the assessment of student achievement is not based on a single criterion but involves multiple aspects. These aspects may include academic performance (report card grades), behavior and participation, attendance, and achievements in extracurricular activities. A comprehensive evaluation of students often requires a holistic approach that takes all these factors into account.

However, the assessment process can often be subjective, as teachers or assessment committees must consider various aspects before assigning final scores or grades to students. This subjectivity can lead to inconsistencies and potential biases in the evaluation process. Therefore, a DSS can serve as an effective solution to manage the complexity of student assessments by providing a structured and objective approach.

Specifically, this study focuses on the use of a DSS to identify *siswa berprestasi* selected within a single school based on their overall performance. The DSS assists decision-makers (such as teachers, committees, or school boards) in: (1) collecting relevant data and information from various sources (such as report card grades, behavior records, attendance records, and extracurricular achievements); (2) analyzing and processing this data to generate more objective assessments based on predetermined criteria; (3) providing recommendations or decisions based on the data analysis, which can serve as a foundation for final decision-making regarding the selection of *siswa berprestasi* in schools.

With the implementation of a DSS, the process of identifying "siswa berprestasi" is expected to be fairer, more consistent, and transparent, ultimately leading to more accurate decisions that support the holistic development of students. This study focuses on applying a web-based DSS using the Simple Additive Weighting (SAW) method to assess student achievement in several high schools in Sumenep, East Java, Indonesia. The research collected data from 30 respondents via online questionnaires, ensuring a focused and relevant dataset. By incorporating a diverse set of criteria and employing rigorous validity and reliability testing, this study aims to enhance the reliability and scientific rigor of the assessment process.

2. Materials

2.1. *Siswa Berprestasi* (High-Achieving Students)

Assessing high-achieving students or *Siswa Berprestasi* involves a complex, multi-dimensional process that considers various aspects of student performance and development. Generally, high-achieving students are defined as those who demonstrate exceptional capabilities in both academic and non-academic areas of school life. Determining high-achieving students typically involves several key criteria, including cognitive abilities, attitudes, attendance, and participation in extracurricular activities.

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Cognitive abilities are a primary criterion used to assess student achievement. The average report card grades, which reflect a student's academic performance, are a direct indicator of their cognitive abilities. According to Gagne [1] and Sternberg [2], academic achievement is a crucial factor in assessing high-achieving students because report card grades provide an objective measure of a student's intellectual capacity and overall learning quality. This research selects average report card grades as a criterion because they offer an objective view of academic performance, which is a key indicator of academic success.

Attitude is another important component in evaluating student achievement. Renzulli [3] and Petersen [4] highlight that positive attitudes, motivation, and work ethic significantly contribute to academic success and personal development. Attitude assessment includes aspects such as classroom participation, compliance, and engagement. Since a positive attitude can impact academic results and student involvement, this criterion is chosen to ensure a comprehensive and fair evaluation of student performance.

Attendance Information is also a crucial factor in assessing high-achieving students. Brown [5] indicates that consistent attendance is closely related to active involvement in learning and academic achievement. Low absenteeism often reflects a student's commitment and participation in the learning process, making this criterion relevant for assessment.

Extracurricular Activity Involvement plays a significant role in a student's overall development. Williams [6] underscores that participation in extracurricular activities can enhance students' social skills, leadership, and creativity. Therefore, involvement in extracurricular activities is chosen as a criterion because it provides additional insight into a student's contributions outside the academic environment, supporting a more holistic assessment of achievement.

By selecting these criteria—average report card grades (as representative of cognitive ability), attitude, attendance, and extracurricular activity involvement—this research aims to create a more comprehensive and objective assessment of student performance. Each criterion is chosen based on its relevance in representing various dimensions of student achievement, enabling a fairer and more accurate evaluation.

2.2. Decision Support System (DSS)

A Decision Support System (DSS) is a computer-based tool that assists in decision-making under semi-structured or unstructured conditions. According to Man and Watson [7], DSS facilitates decision-making by integrating diverse data sources, utilizing analytical models, and generating objective recommendations. This is particularly valuable in educational settings where complex evaluations, such as identifying high-achieving students, require consideration of multiple criteria.

In the context of assessing high-achieving students, a DSS can process and analyze data on academic performance, attendance, behavior, and extracurricular activities. This comprehensive approach enables more objective evaluations by reducing subjectivity and providing standardized assessments. Turban et al. [8] emphasize that DSS applications improve the accuracy and reliability of decisions by leveraging data-driven insights and minimizing human biases.

By implementing a DSS, educational institutions can ensure a fair and consistent evaluation process for high-achieving students. The system's ability to integrate and analyze various performance metrics supports informed decision-making, as demonstrated by Zhang et al. [9]. This leads to more accurate assessments and helps in recognizing students based on a holistic view of their achievements.

2.3. Simple Additive Weighting (SAW) Method

The Simple Additive Weighting (SAW) method is a widely-used technique in Multiple Attribute Decision Making (MADM) for evaluating alternatives based on multiple criteria. The fundamental principle of SAW is to aggregate the weighted values of each criterion to determine the overall score of each alternative after normalizing the data. This method's simplicity and straightforward calculation make it effective for generating objective evaluations, which is essential for assessing high-achieving students based on diverse performance metrics.

In the context of evaluating high-achieving students (*Siswa Berprestasi*), the SAW method can be applied to integrate various criteria such as academic performance, behavior, attendance, and extracurricular involvement. By assigning weights to these criteria according to their significance, SAW enables a balanced and objective assessment of students' achievements. The method's ability to process and rank alternatives based on weighted criteria aligns with the goals of Decision Support Systems (DSS) in providing structured and data-driven decision outcomes [10].

The application of SAW in educational settings helps to standardize the evaluation process, reducing subjectivity and improving consistency in identifying high-achieving students. As supported by Saaty [11], SAW's effectiveness in handling multiple criteria and its straightforward approach contribute to more accurate and reliable decision-making. This method's use of normalization and weighting ensures that all relevant aspects of student performance are considered in the final assessment.

2.4. Steps in the SAW Method

The Simple Additive Weighting (SAW) method involves several key steps, each crucial for evaluating alternatives based on multiple criteria. The process begins with identifying the criteria and alternatives, followed by normalizing the decision matrix to ensure comparability across all criteria.

Normalization is a critical step in SAW, as it transforms the raw data into a common scale. This step is essential for ensuring that the criteria can be compared directly, regardless of their original units or scales. There are two types of criteria: benefit and cost.

(a) **Benefit Criteria**: These are attributes where higher values are preferred (e.g., academic performance).

(b) **Cost Criteria**: These are attributes where lower values are preferred (e.g., absence).

if benefit criteria, then	if cost criteria, then
$r_{ij} = \frac{x_{ij} - x_j^{\min}}{x_j^{\max} - x_j^{\min}}$	$r_{ij} = \frac{x_j^{\max} - x_{ij}}{x_j^{\max} - x_j^{\min}}$

Figure 1. SAW Normalization Formula

The normalization formula for benefit and cost criteria is explained in Figure 1, where r_{ij} is the normalized value of alternative *i* for criterion *j*, x_{ij} is the original value, x_j^{min} and x_j^{max} are the minimum and maximum values for criterion *j*, respectively. In cost criteria, the formula is adjusted to reflect that lower values are more desirable.

After normalization, criteria are weighted according to their importance. The final preference value for each alternative is computed by summing the weighted normalized values as explained by Figure 2, where V_i is the final score for alternative i, w_j is the weight of criterion j, and r_{ij} is the normalized score.

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

Figure 2. Final Score Formula of SAW

In the context of evaluating high-achieving students, all criteria used—academic performance, behavior, attendance, and extracurricular involvement—are considered **benefit criteria**. Therefore, the normalization process focuses on maximizing scores in these areas. The use of SAW ensures that each criterion's contribution to the final decision is measured objectively and consistently, aligning with the principles of Decision Support Systems (DSS) by providing a structured approach to evaluating complex multi-criteria problems.

2.5. Development if Web-Based DSS Application

The development of a web-based Decision Support System (DSS) application is a complex process involving several critical stages: requirement analysis, system design, coding, testing, and implementation. Requirement analysis involves understanding the needs of users and defining the necessary features and functionalities of the system. System design then translates these requirements into a detailed blueprint for the system's architecture. Coding follows, where developers build the system based on the design specifications. Testing is conducted to ensure the system functions correctly and meets all requirements, while implementation involves deploying the system for use.

In this research, a web-based DSS application is developed to facilitate the evaluation of high-achieving students using the Simple Additive Weighting (SAW) method. The web-based approach offers several advantages: it provides broader access, as users can interact with the system from various locations, and it allows for efficient data collection through online questionnaires. This is particularly relevant in educational settings where collecting data from a large number of students and educators can be challenging. The application streamlines the evaluation process, making it more accessible and efficient, aligning with the principles of DSS that emphasize improving decision-making processes by leveraging technology.

Previous research supports the effectiveness of web-based DSS applications in similar contexts. Sholihat and Gustian (2021) applied the SAW method to select high-achieving students, showcasing the method's versatility in educational environments [12]. Additionally, Subagio, Abdullah, and Jaenudin (2017) used SAW in a scholarship decision support system, further illustrating the method's utility in decision-making [13].

2.6. Reliability Testing with Cronbach's Alpha

Cronbach's Alpha is a statistical measure used to assess the internal consistency or reliability of a set of survey or test items. It evaluates how closely related a set of items are as a group, essentially measuring the degree to which items in a scale or questionnaire measure the same underlying construct [14].

$$\alpha = \frac{k}{k-1}\left(1 - \frac{\sum_{i=1}^{k} \sigma_i^2}{\sigma_T^2}\right)$$

Where:

- k = number of items
- σ_i^2 = variance of item i
- σ_T^2 = variance of the total score

Figure 3. Cronbach's Alpha Formula

Cronbach's Alpha is defined by the formula mentioned in Figure 3. The value of Cronbach's Alpha ranges from 0 to 1:

- 0.9 to 1.0: Excellent
- 0.8 to 0.9: Good
- 0.7 to 0.8: Acceptable
- 0.6 to 0.7: Questionable
- 0.5 to 0.6: Poor
- Below 0.5: Unacceptable

A higher Cronbach's Alpha value indicates a higher level of internal consistency among the items. Generally, a Cronbach's Alpha of 0.7 or higher is considered acceptable for most research purposes [15].

Cronbach's Alpha is used to ensure that the questionnaire or survey items are consistently measuring the same construct. In the context of your research, it verifies whether the items related to evaluating the usability and appropriateness of the Decision Support System (DSS) are reliable and accurately reflect the underlying constructs of ease of use and system suitability [16].

3. System Design

The design of the web-based Decision Support System (DSS) for evaluating high-achieving students is central to this research. This section elaborates on the key components of the system design, namely the use case diagram and the overall flow of the DSS.

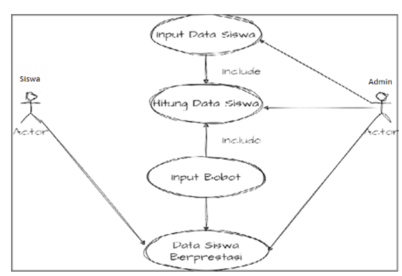

Figure 4. Use Case Diagram

In the use case diagram for the web-based Decision Support System (DSS) that explained in Figure 4, there are two primary actors: Students (Siswa) and Admin. The Admin role, which can also be held by a teacher, has the authority to manage and operate the system comprehensively. The admin can perform several tasks including inputting student data (Input Data Siswa), setting the weights for different criteria (Input Bobot), executing the calculations to determine high-achieving students (Hitung Data Siswa), and reviewing the final results (Data Siswa Berprestasi).

On the other hand, Students have a more limited interaction with the system. Their primary role is to view the final results of the DSS, specifically the list of high-achieving students. This function allows students to see where they stand relative to their peers based on the criteria set by the admin.

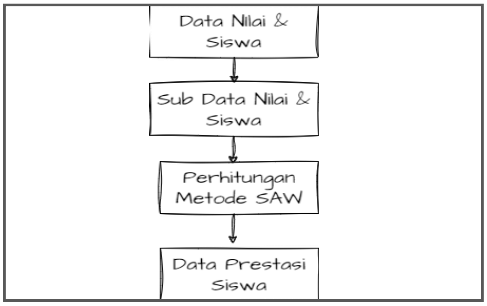

Figure 5. Base Step of Calculation

The base step of calculation is explained in the Figure 5. In this web-based Decision Support System (DSS) designed for evaluating high-achieving students, the calculation process follows a specific sequence. The first step involves the admin inputting student data and their respective scores into the system. This is followed by the detailed entry of sub-data related to each student's scores, ensuring all relevant criteria are accounted for. It is assumed that the weights for each criterion have been predetermined and set separately within the system.

Once the data and weights are in place, the system proceeds to perform the calculations using the Simple Additive Weighting (SAW) method. This method enables the system to objectively assess each student based on the weighted criteria. After the calculations are completed, the system displays the final results, showcasing the data of high-achieving students according to the defined criteria and the SAW method's output.

4. Result

In this section, the author delves into the detailed calculation process of the Simple Additive Weighting (SAW) method, the setting of weights, and the application of these processes in a sample case within the Decision Support System (DSS). Additionally, this section explains how the results from the DSS are presented through various user interface pages that facilitate the understanding of the SAW calculations and outcomes.

The Simple Additive Weighting (SAW) calculation begins with the creation of a rating table to display the weights assigned to each criterion. This is followed by calculating the total score for each alternative based on the pre-determined weights.

4.1. Rating Model

In this study, the rating model consists of four criteria, with the decision-maker assigning weights to each criterion as explained in Table 1.

Table 1. Criteria and Weight

Criteria	Weight
Rata-Rata Rapot	0.5
Sikap	0.4
Absensi	0.3
Ekstrakurikuler	0.2

Criteria explained in Bahasa Indonesia, there are *Rata-Rata Rapot* (Grade Point Average), *Sikap* (Attitude), *Absensi* that represent the attendance of student, and Ekstrakurikuler (Extracurricular).

4.2. SAW Calculation

Based on Table 1, an example assessment table is generated as shown in Table 2 that explains 4 alternatives of High-Achieving Students.

Table 2. Assessment of High-Achieving Students

Alternatives	Criteria			
	Rata2 Rapot	Sikap	Absensi	Ekstrakurikuler
Hairul	72,60	4	3	4
Imam	80,90	3	2	4
Nurul	50,60	3	4	2
Ica	63,70	2	3	3

The calculation to obtain the normalized matrix value uses the formula that explained in Figure 6.

$$r_{11} = \frac{72.60}{\max\{72.60, 80.90, 50.60, 63.70\}} = \frac{72.60}{80.90} = 0.897$$

$$R = \begin{pmatrix} 0.897 & 1 & 0.75 & 1 \\ 1 & 0.75 & 0.5 & 1 \\ 0.625 & 0.75 & 1 & 0.5 \\ 0.787 & 0.5 & 0.75 & 0.75 \end{pmatrix}$$

Figure 6. Calculation of normalized matrix R

The next step is ranking the alternatives using the weights assigned by the decision-maker: W = [0.5,0.4,0.3,0.2] following Table 1. The results are obtained as explained in Figure 7.

$$V_1 = (0.5 \times 0.897) + (0.4 \times 1) + (0.3 \times 0.75) + (0.2 \times 1) = 1.273$$

$$V_2 = (0.5 \times 1) + (0.4 \times 0.75) + (0.3 \times 0.5) + (0.2 \times 1) = 1.15$$

$$V_3 = (0.5 \times 0.625) + (0.4 \times 0.75) + (0.3 \times 1) + (0.2 \times 0.5) = 1.012$$

$$V_4 = (0.5 \times 0.787) + (0.4 \times 0.5) + (0.3 \times 0.75) + (0.2 \times 0.75) = 0.968$$

Figure 7. Calculation result of each alternatives preference score.

As explained in Figure 6, the highest score is found at V_1, indicating that the student with the highest value is the top-performing student based on the selected criteria. In the other word, Hairul as the 1st alternative is selected become the top High-Achieving Student.

4.3. Web-Based DSS User Interfaces

The website design illustrates the interface used within the system as a medium of communication between the user and the system.

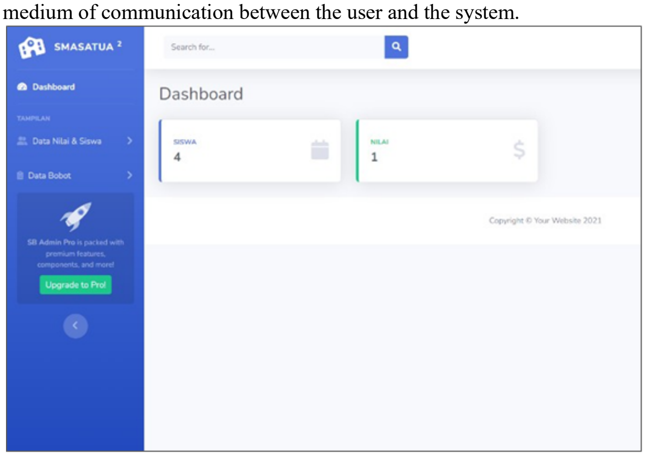

Figure 8. Dashboard Page

The Dashboard or home page that described in Figure 8 is the main page that appears every time a user accesses the website after logging in. This page includes the main menu, which consists of dashboard, student data and grades, weight data, logout, and achievement data.

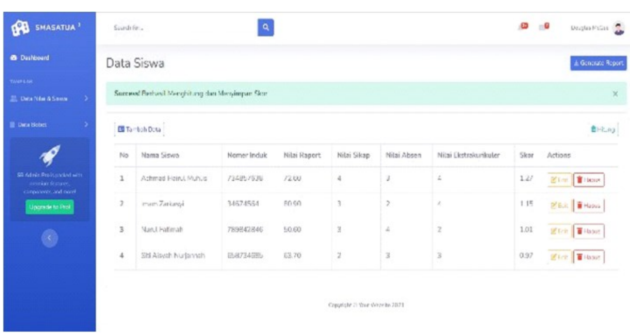

Figure 9. Student Data Page

The Student Data page is shown in Figure 9. It used to input student data, which includes assessment columns such as report card grades, attitude scores, attendance scores, and extracurricular activity scores.

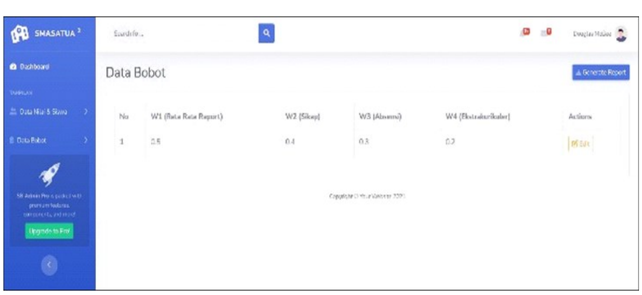

Figure 10. Weight Data Page

On weight data page, users will enter the weights according to their needs, as shown in Figure 10.

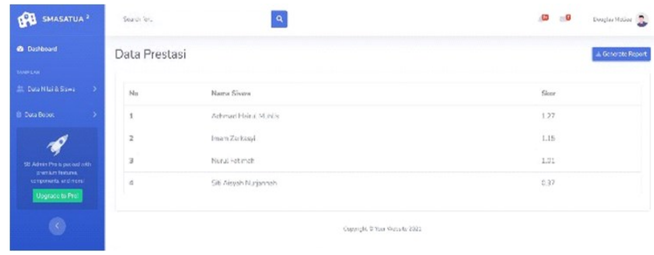

Figure 11. Achievement Data Page (Result Page)

4.4. Validity and Testing of the Web-Based Decision Support System (DSS)

The focus of the testing involves evaluating two key questions: (1) "Is the website easy to use for students and teachers?"; (2) "Does the DSS meet the needs for assessing high-achieving students?". The answer of the question will focus on Website Usability and DSS Effectiveness. Based on that focus, the author made a questionnaire that have main structure explained in Figure 12.

1. Website Usability:
   "The website is easy to navigate and use for the tasks I need to complete."
   - Strongly Disagree (1)
   - Disagree (2)
   - Neutral (3)
   - Agree (4)
   - Strongly Agree (5)
2. DSS Effectiveness:
   "The DSS effectively supports the evaluation and identification of outstanding students based on the relevant criteria."
   - Strongly Disagree (1)
   - Disagree (2)
   - Neutral (3)
   - Agree (4)
   - Strongly Agree (5)

Figure 12. Main structure of questionnaire

From 30 respondents, the result of this questionnaire is explained in Table 3.

Table 3. Questionnaire Result

Respondent ID	Website Usability (Q1)	DSS Effectiveness (Q2)	Respondent ID	Website Usability (Q1)	DSS Effectiveness (Q2)
1	4	5	16	3	4
2	3	4	17	5	5
3	5	5	18	4	4
4	4	3	19	3	3
5	2	4	20	5	5
6	5	5	21	4	4
7	3	4	22	2	4
8	4	3	23	4	3
9	5	5	24	5	5
10	4	4	25	3	4
11	3	3	26	4	5
12	4	5	27	5	4
13	5	4	28	2	3
14	2	3	29	4	5
15	4	5	30	3	4

Based on the questionnaire result, varians of Q1 and Q2 can be calculated as explained in Figure 13.

- Website Usability (Q1)

  Data Q1: [4, 3, 5, 4, 2, 5, 3, 4, 5, 4, 3, 4, 5, 2, 4, 3, 5, 4, 3, 5, 4, 2, 4, 5, 3, 4, 5, 2, 4, 3]

  Rata-rata Q1 $\bar{Q}1$ = 3.9

  Varians Q1 $\mathrm{Var}(Q1)$:

$$\mathrm{Var}(Q1) = \frac{1}{29}\sum_{i=1}^{30}(Q1_i - 3.9)^2 \approx 0.79$$

- DSS Effectiveness (Q2)

  Data Q2: [5, 4, 5, 3, 4, 5, 4, 3, 5, 4, 3, 5, 4, 3, 5, 4, 5, 4, 3, 5, 4, 4, 3, 5, 4, 5, 4, 3, 5, 4]

  Rata-rata Q2 $\bar{Q}2$ = 4.2

  Varians Q2 $\mathrm{Var}(Q2)$:

$$\mathrm{Var}(Q2) = \frac{1}{29}\sum_{i=1}^{30}(Q2_i - 4.2)^2 \approx 0.71$$

Figure 13. Varians Calculation

After determining varians, covarian also can be calculated based on the questionnaire result as explained in Figure 14.

$$\mathrm{Cov}(Q1, Q2) = \frac{1}{29}\sum_{i=1}^{30}(Q1_i - 3.9)\cdot(Q2_i - 4.2) \approx 0.60$$

Figure 14. Covarian Calculation

Given $N = 2$ (the number of items), covarian is 0.60, and average of varians is 0.75, it can determine the result of Cronbach's Alpha that explained in Figure 15.

$$\alpha = \frac{2\cdot 0.60}{0.75 + (2-1)\cdot 0.60} = \frac{1.20}{0.75 + 0.60} = \frac{1.20}{1.35} \approx 0.89$$

Figure 15. Cronbach's Alpha Calculation

Based on Figure 15, The Cronbach's Alpha for this case is approximately 0.89, indicating that the data collection instrument (questionnaire) has good internal consistency. A value above 0.7 is generally considered acceptable, so this result demonstrates that both questions in the questionnaire have good reliability.

5. Conclusion

This study presents the development and application of a web-based Decision Support System (DSS) utilizing the Simple Additive Weighting (SAW) method to evaluate high-achieving students (Siswa Berprestasi) across several high schools in Sumenep. The DSS aims to provide a structured and objective approach to student assessment by integrating multiple criteria, including academic performance, attitude, attendance, and extracurricular involvement. The system features user-friendly interfaces for data input, weight assignment, and result display, streamlining the evaluation process for both students and administrators.

The SAW method was effectively applied, ensuring a balanced and objective assessment of student performance through straightforward calculations and a clear ranking system. This approach guarantees that the assessment is both fair and transparent. Reliability testing of the data collection instrument using Cronbach's Alpha resulted in a high value of approximately 0.89, indicating strong internal consistency and reliable measurement of the questionnaire's constructs.

In conclusion, the developed DSS provides a robust tool for evaluating high-achieving students, integrating multiple performance metrics while ensuring a fair and consistent assessment process. The successful implementation of the SAW method, along with high reliability as confirmed by Cronbach's Alpha, highlights the effectiveness of this approach. The DSS not only improves the accuracy of student evaluations but also enhances transparency and equity in recognizing outstanding students.

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