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Decision support system for selecting outstanding students using simple addictive weighting (SAW) and rank order centroid (ROC) methods

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ABSTRACT

Selecting outstanding students is essential in fostering appreciation and motivation within the school environment. Nevertheless, many educational institutions continue to use manual assessment methods, which are often subjective and inefficient. This research focuses on the development of a web-based decision support system designed to assist in the selection process at a in Indonesia. The system integrates the Simple Additive Weighting (SAW) technique to generate student rankings based on preference scores, while the Rank Order Centroid (ROC) method is applied to assign weight values to the evaluation criteria, including academic performance, attendance, behavior, and extracurricular involvement. Data for this study were collected through interviews, direct observation, and student records. The application was developed using PHP for the backend, MySQL for database handling, and Bootstrap for the user interface design. The system's functionality was verified using black box testing, which confirmed that all features operated correctly. Additionally, the system was evaluated against the manual selection process conducted by the school, and the results showed an accuracy level of 80% in matching student rankings. This system proves to be a practical and structured solution for enhancing the transparency and objectivity of student achievement evaluations.

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1. INTRODUCTION

The selection of outstanding students is an important activity aimed at recognizing learners who have achieved excellence in both academic and non-academic aspects. This recognition is expected to motivate other students to study harder and participate more actively in various school activities [1]. However, in practice, the selection process in many schools—including at vocational high school in Indonesia is still carried out

manually. This process not only consumes time and energy but is also highly prone to subjectivity due to the absence of a standardized assessment system [2]–[5].

To address this issue, a Decision Support System (DSS) is required to help schools objectively and systematically select outstanding students. A DSS is an interactive computer-based system that supports decision-makers by utilizing data and specific decision models [6], [7]. One popular method used in decision-making is the Simple Additive Weighting (SAW) method, which enables multi-criteria evaluation by summing the weighted values of each alternative across the selected criteria [8]. The Simple Additive Weighting (SAW) method was selected due to its straightforwardness and effectiveness in addressing multi-criteria decision-making problems [9]. the result. It is easy to implement and interpret, making it a common choice in educational and organizational decision support applications [10], [11]. Nonetheless, SAW has a drawback in that it is sensitive to the data scale, requiring appropriate normalization to maintain fairness in evaluation [12], [13]. On the other hand, the Rank Order Centroid (ROC) method was chosen for weight determination because it offers a simple yet reliable approach to assign weights based on ranked preferences without the need for complex pairwise comparisons, which is particularly useful when subjective judgment is involved [14].

Previous research has shown that the combination of Simple Addictive Weighthing (SAW) and Rank Order Centroid (ROC) methods has been effectively applied in various contexts, such as the selection of the best employees, scholarship recipients [8], and student performance evaluations [16], as well as in outstanding student selection using other MCDM methods. However, the application of SAW and ROC in a web-based decision support system for selecting outstanding students in vocational schools—especially at a vocational high school in Indonesia is still rarely found. Therefore, the development of a web-based system is necessary to accelerate and streamline the selection process with more objective and structured results [2].

Based on the above background, the objectives of this research are:

(1) to design and develop a web-based decision support system for selecting outstanding students at a vocational high school in Indonesia.

(2) to apply the Simple Addictive Weighthing (SAW) method to calculate students' final scores and the Rank Order Centroid (ROC) method to determine the criteria weights, including report card grades, attendance, behavior, and extracurricular involvement.

2. METHOD

This research adopts a software engineering approach using the System Development Life Cycle (SDLC) with the Waterfall model, which consists of the stages of requirements analysis, system design, implementation, testing, and maintenance [15]. This model was chosen because it is suitable for structured system development with well-defined requirements. See Figure 1.

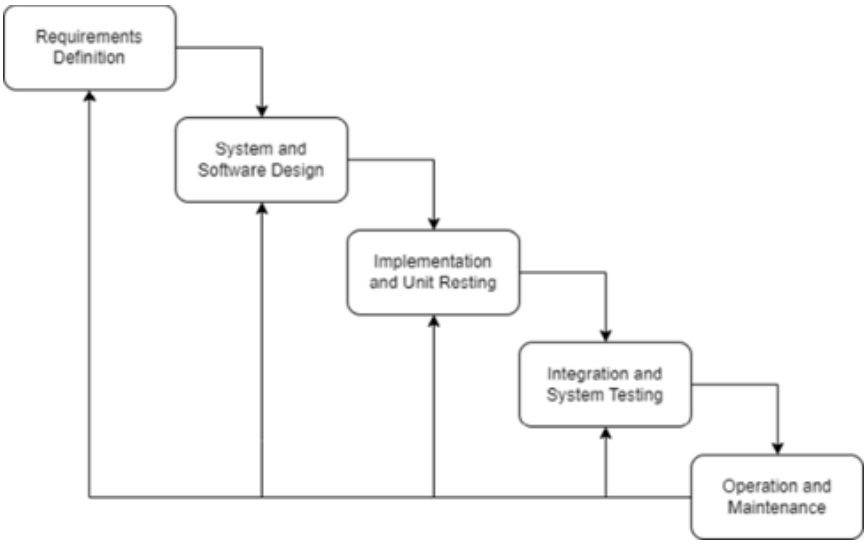

Figure 1. Waterfall model

Data Collection Techniques
The data in this study were obtained through the following methods:

- Direct observation at a vocatinal high school in Indonesia
- Interviews with school staff
- Documentation, including students' academic records, attendance, behavior, and extracurricular activities

Criteria and Evaluation Data
This system uses four main criteria in the selection process of outstanding students:

- Report Card Average (C1)
- Attendance (C2)
- Behavior (C3)
- Extracurricular Activities (C4)

All criteria are of the benefit type, meaning the higher the value, the better the result.

Table 1. Criteria and attributes

Criteria Code	Criteria Name	Attribute
C1	Report Card Average	Benefit
C2	Attendance	Benefit
C3	Behavior	Benefit
C4	Extracurricular	Benefit

The data were collected from students in grades X to XII across four different majors. Evaluations were carried out by homeroom teachers and system administrators through a web-based form.

Data Processing Methods
The data processing stage consists of two main steps:

Weighting criteria using rank order centroid (ROC)
Weights are calculated based on the priority order determined by the school. The formula used to calculate weights is shown in Equation (1):

$$W_m = \frac{1}{m}\sum_{i=1}^{m}\left(\frac{1}{i}\right) \quad (1)$$

Where:

- Wi: weight of the i-th criterion
- m: total number of criteria
- i: position in the priority ranking

The Rank Order Centroid (ROC) method is a widely used technique for determining weights in multi-criteria decision-making when only the ranking of criteria is known. Instead of assigning precise numerical values, decision-makers simply rank the criteria in order of importance. ROC then translates this ranking into fractional weights using a mathematical formula. The method assumes that the relative importance decreases progressively from the highest-ranked to the lowest-ranked criterion. ROC is especially useful in educational decision support systems where subjective weight assignment must be minimized, and consistency across evaluators is required [2], [9].

Final score calculation using simple additive weighting (SAW)
The SAW method calculates the final score by summing the normalized values of each alternative multiplied by the respective criterion weights [16]. This process follows Equations (2) and (3) and is illustrated in Figure 2.

$$\begin{cases} \frac{xij}{max\ xij}, j\ a\ atribut\ benefit \\ \frac{min\ xij}{xij},\ \ j\ a\ atribut\ cost \end{cases} \quad (2)$$

Where:

- rij: normalized rating
- xij: value in the i-th row and j-th column
- maxxij, minxij: the maximum/minimum value in each column

$$V_i = \sum_{j=1}^{n} w_j r_{ij} \quad (3)$$

Where:

- Vi: final score of alternative i
- wj: weight of criterion j
- rij: normalized rating
- n: number of criteria

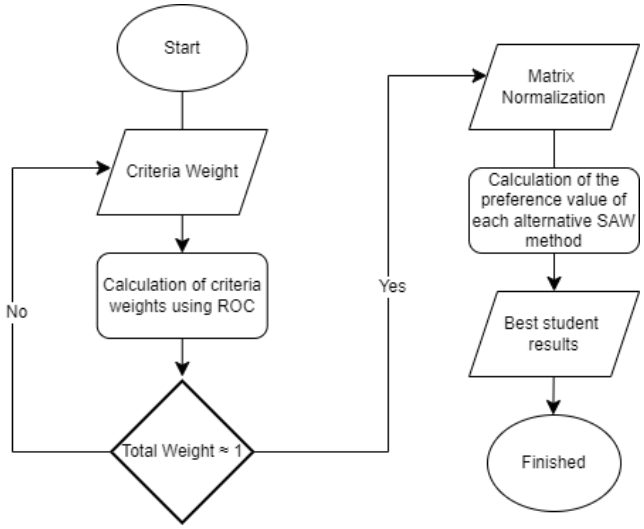

Figure 2. SAW method flowchart

Implementation and Testing

The system was built using PHP for the backend, MySQL for the database, and Bootstrap for the user interface design. After implementation, the system was tested using the Black Box Testing method, which focuses on functional testing. All core features—such as login, data input, score calculation, and report generation—were tested based on user scenarios.

3. RESULTS AND DISCUSSIONS

Results

This research resulted in a web-based decision support system designed to evaluate and determine outstanding students at a vocational high school in Indonesia. The system supports an objective selection process based on four main criteria: average academic score, attendance, attitude, and extracurricular activities.

The system development began with a user requirement analysis. The analysis showed that the previous selection process was done manually, time-consuming, and highly subjective. The developed system provides interfaces for administrators and homeroom teachers to manage student data, input assessments, compute weights and rankings, and generate selection reports.

Criteria and Weighting

The criteria used were agreed upon by the school and consist of four benefit-type elements. See Table 1 for the criteria. The weights for each criterion were calculated using the Rank Order Centroid (ROC) method, as shown in Equation 1. The final weights are presented in Table 2.

The Rank Order Centroid (ROC) weight calculations are as follows:

$$W_1 = \frac{1}{4}\left(\frac{1}{1} + \frac{1}{2} + \frac{1}{3} + \frac{1}{4}\right) = 0{,}5208$$
$$W_2 = \frac{1}{4}\left(\frac{1}{2} + \frac{1}{3} + \frac{1}{4}\right) = 0{,}2708$$
$$W_3 = \frac{1}{4}\left(\frac{1}{3} + \frac{1}{4}\right) = 0{,}1458 \quad (1)$$
$$W_4 = \frac{1}{4}\left(\frac{1}{4}\right) = 0{,}0625$$
$$\text{Total W} = 0{,}9999$$

Table 2. Criteria weights

Code	Criteria Name	Attribute	Weight
C1	Average Academic Score	Benefit	0.5208
C2	Attendance	Benefit	0.2708
C3	Attitude	Benefit	0.1458
C4	Extracurricular	Benefit	0.0625

Student Score Calculation

After determining the weights, the student alternatives were evaluated using the Simple Additive Weighting (SAW) method. Each criterion score was first normalized using Equation (2). The raw scores are shown in Table 3, and the normalized scores are presented in Table 4.

Table 3. Raw data of alternatives and criteria

No.	Alternative Name	C1	C2	C3	C4
1	Alfionita Eka Firnanda	50	75	75	25
2	Azkiyah Ayu Lestari	50	75	75	25
3	Dona Andriliawati	75	75	75	50
4	Eva Lutfianah	50	75	50	25
5	Lailatul Magfiroh	75	75	75	25
6	Melati Nurroswandini	75	100	75	25
7	Putri Mandala Cirani Adipranoto	75	75	75	25
8	Ririn Duwi Lestari	75	75	75	25
9	Rosa Amaliyah	75	100	100	50
10	Sifa Nur Imamatul Choiriyah	75	100	75	50
11	Vina Oktavia Badriyyatul Millah	75	100	100	50
12	Lintang Dwi Aura Kasih	75	100	50	50
13	Divna Mega Aurelya	75	75	100	50
14	Aura Aprilliya Sudewi	75	100	75	25
15	Ayu StyO Ningrum	75	100	50	25

Normalization is performed using the following equetion 4:

$$rij = \begin{cases} \dfrac{xij}{max\ xij}, & j\ a\ atribut\ benefit \\ \dfrac{min\ xij}{xij}, & j\ a\ atribut\ cost \end{cases} \quad (4)$$

Sample normalization calculation:

a. Alfionita Eka Firnanda

$$C_1 = \frac{50}{75} = 0.666666667$$

$$C_2 = \frac{75}{100} = 0.75$$

$$C_3 = \frac{75}{100} = 0.75$$

$$C_4 = \frac{25}{50} = 0.5$$

b. Azkiyah Ayu Lestari

$$C_1 = \frac{50}{75} = 0.666666667$$

$$C_2 = \frac{75}{100} = 0.75$$

$$C_3 = \frac{75}{100} = 0.75$$

$$C_4 = \frac{25}{50} = 0.5$$

c. Dona Andriliawati

$$C_1 = \frac{75}{75} = 1$$

$$C_2 = \frac{75}{100} = 0.75$$

$$C_3 = \frac{75}{100} = 0.75$$

$$C_4 = \frac{50}{50} = 1$$

Table 4. Normalized scores of student alternatives (SAW matrix)

No.	Name	C1	C2	C3	C4
1	Alfionita Eka Firnanda	0.6667	0.75	0.75	0.5
2	Azkiyah Ayu Lestari	0.6667	0.75	0.75	0.5
3	Dona Andriliawati	1.0000	0.75	0.75	1.0
4	Eva Lutfianah	0.6667	0.75	0.5	0.5
5	Lailatul Magfiroh	1.0000	0.75	0.75	0.5
6	Melati Nurroswandini	1.0000	1.0	0.75	0.5
7	Putri Mandala Cirani Adipranoto	1.0000	0.75	0.75	0.5

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No.	Name	C1	C2	C3	C4
8	Ririn Duwi Lestari	1.0000	0.75	0.75	0.5
9	Rosa Amaliyah	1.0000	1.0	1.0	1.0
10	Sifa Nur Imamatul Choiriyah	1.0000	1.0	0.75	1.0
11	Vina Oktavia Badriyyatul Millah	1.0000	1.0	1.0	1.0
12	Lintang Dwi Aura Kasih	1.0000	1.0	0.5	1.0
13	Divna Mega Aurelya	1.0000	0.75	1.0	1.0
14	Aura Aprilliya Sudewi	1.0000	1.0	0.75	0.5
15	Ayu StyO Ningrum	1.0000	1.0	0.5	0.5

The final preference value for each student was obtained using Equation (5):

$$V_i = \sum_{j=1}^{n} w_j r_{ij} \quad (5)$$

Sample calculations

a. Alfionita Eka Firnanda

(0.520833x0.66666666666667) (0.270833x0.75) (0.145833x0.75) (0.0625x0.5)

= 0.6909715

b. Azkiyah Ayu Lestari

(0.520833x0.66666666666667) (0.270833x0.75) (0.145833x0.75) (0.0625x0.5)

= 0.6909715

c. Dona Andriliawati

(0.520833x1) (0.270833x0.75) (0.145833x0.75) (0.0625x1)

= 0.8958325

The overall preference score results are presented in Table 5.

Table 5. Preference values of student alternatives

No.	Name	Value
1	Alfionita Eka Firnanda	0.690971
2	Azkiyah Ayu Lestari	0.690971
3	Dona Andriliawati	0.895833
4	Eva Lutfianah	0.654513
5	Lailatul Magfiroh	0.864583
6	Melati Nurroswandini	0.932291
7	Putri Mandala Cirani Adipranoto	0.864583
8	Ririn Duwi Lestari	0.864583
9	Rosa Amaliyah	1.000000
10	Sifa Nur Imamatul Choiriyah	0.963541
11	Vina Oktavia Badriyyatul Millah	1.000000
12	Lintang Dwi Aura Kasih	0.927083
13	Divna Mega Aurelya	0.932291
14	Aura Aprilliya Sudewi	0.932291
15	Ayu StyO Ningrum	0.895833

The final ranking results are shown in Table 6.

Table 6. Ranking results

No	Student	Class	Departemen	Value	Rank
1	Vina Oktavia Badriyyatul Millah	X	ASKEP	0.999999	1
2	Rosa Amaliyah	X	ASKEP	0.999999	2
3	Sifa Nur Imamatul Choiriyah	X	ASKEP	0.963541	3
4	Aura Aprilliya Sudewi	X	ASKEP	0.932291	4
5	Divna Mega Aurelya	X	ASKEP	0.932291	5
6	Melati Nurroswandini	X	ASKEP	0.932291	6
7	Lintang Dwi Aura Kasih	X	ASKEP	0.927082	7
8	Ayu StyO Ningrum	X	ASKEP	0.895832	8
9	Dona Andriliawati	X	ASKEP	0.895832	9
10	Ririn Duwi Lestari	X	ASKEP	0.864582	10
11	Putri Mandala Cirani Adipranoto	X	ASKEP	0.864582	11
12	Lailatul Magfiroh	X	ASKEP	0.864582	12
13	Azkiyah Ayu Lestari	X	ASKEP	0.690971	13
14	Alfionita Eka Firnanda	X	ASKEP	0.690971	14
15	Eva Lutfianah	X	ASKEP	0.654513	15

System Implementation

The system was developed using the PHP programming language, MySQL as the database, and the Bootstrap for the user interface. The main interface of the system consists of the following components:

- Login page (see Figure 3)
- Admin dashboard (see Figure 4)
- Assessment data entry (see Figure 5)
- Calculation process page (see Figure 6)
- Final result page (see Figure 7)

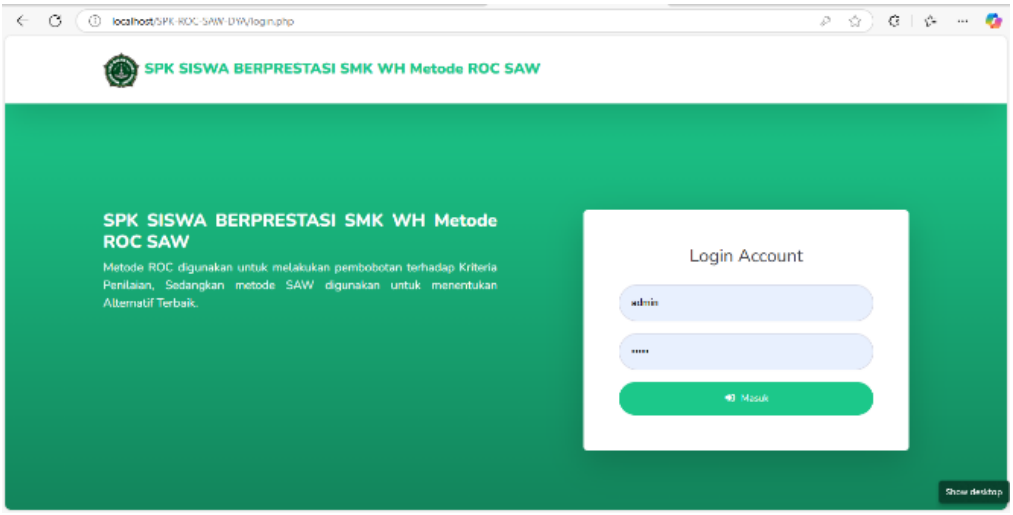

Figure 3. Login page

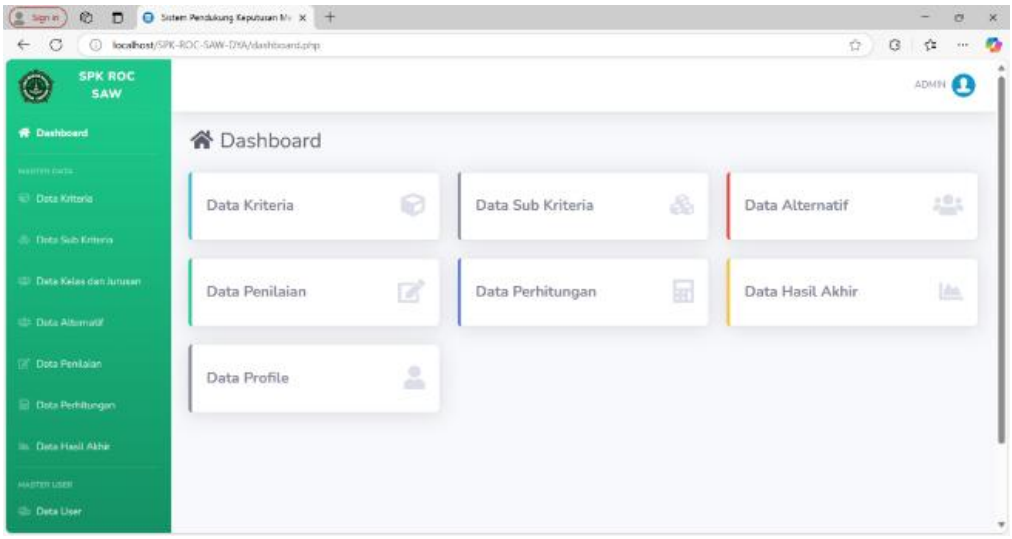

Figure 4. Admin dashboard page

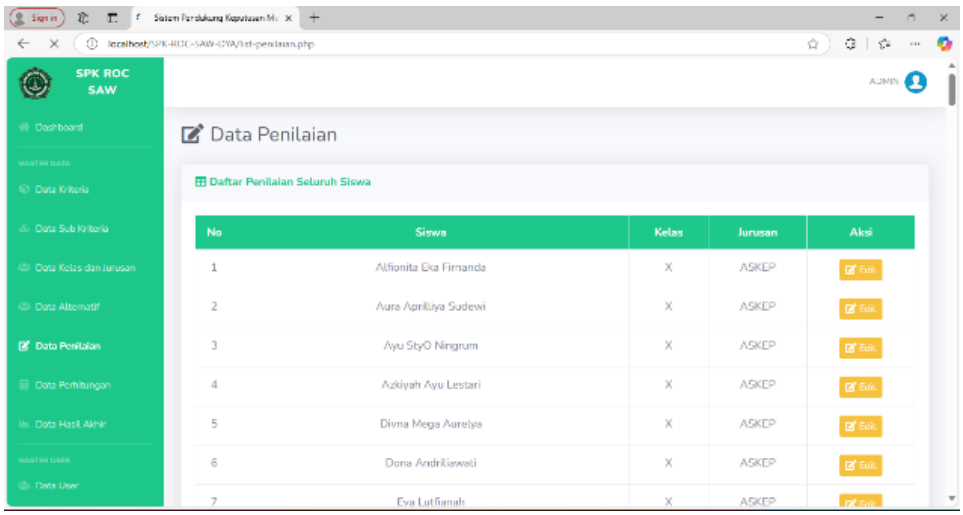

Figure 5. Assessment menu

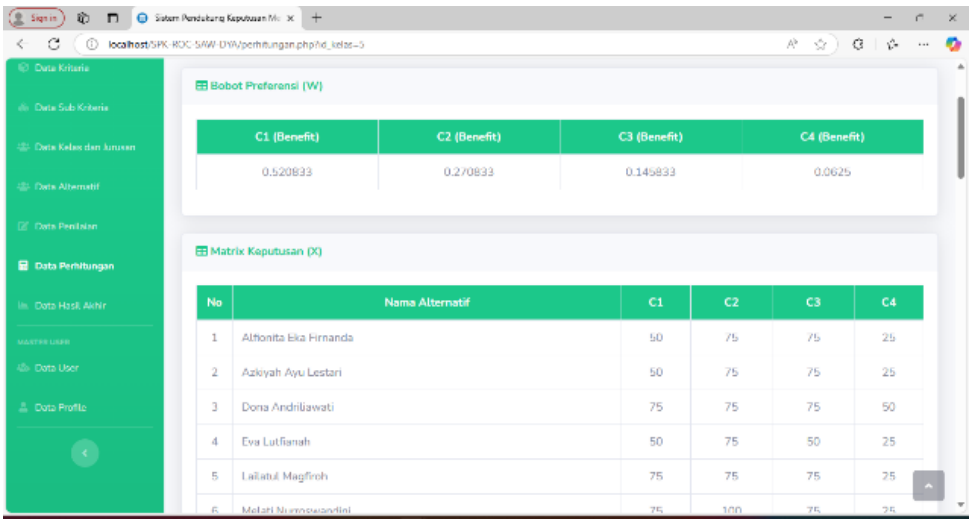

Figure 6. Calculation menu

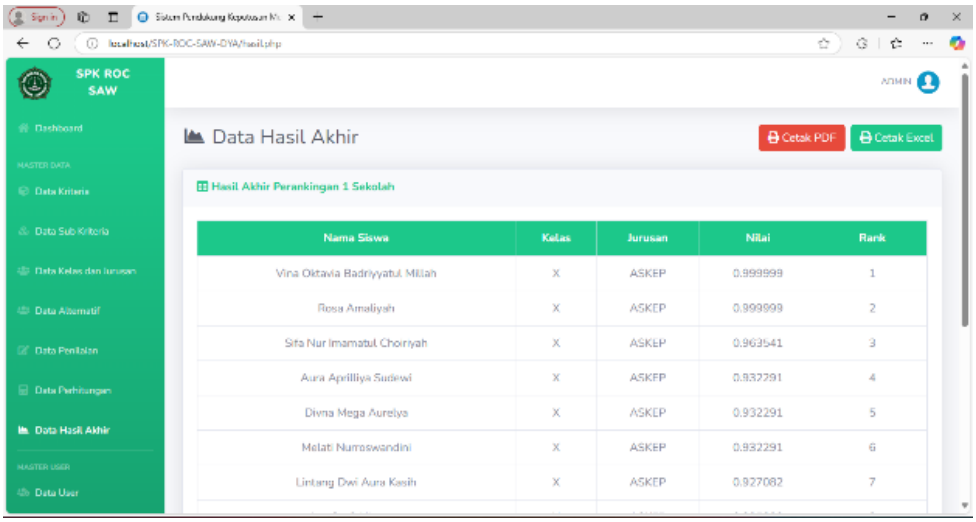

Figure 7. Final result menu

System Testing

System testing was conducted using the Black Box Testing method to ensure that all functions operated as intended. The test scenarios covered features such as login, data input, calculation process, and final result export. The test results are shown in Table 7.

Table 7. Black box testing results

No	Tested Feature	Process	Test Input	Expected Output	Result
1	Login	User enters correct username and password	Username: admin, Password: ****	Successfully logged in and redirected to dashboard	Success
2	Login	User enters incorrect username or password	Username: wrong, Password: wrong	Error message: "Username or Password is incorrect!"	Success
3	Add Student Data	User adds a new student with complete data	Name, NISN, Class, Major	Student data successfully added and displayed in the list	Success
4	Add Student Data	Submit form without entering any data	All fields empty	Validation message: "please fill out this field"	Success
5	Edit Student Data	User edits student information	Edited student name	Data successfully updated in the list	Success
6	Delete Student Data	User deletes a student entry	Click trash icon next to the selected student	Student data successfully deleted	Success
7	Input Assessment	Admin inputs priority values for each student and criterion	Priority score per criterion	Score successfully saved	Success
8	Calculation (ROC + SAW)	System calculates weights using Rank Order Centroid (ROC), then ranks alternatives using Simle Addictive Wegthing (SAW)	Click "Generate Weight"	Displays weighting and ranking results	Success
9	View Final Results	User opens the “Final Result Data” menu	Click menu “Final Result Data”	Displays complete table with scores and rankings	Success
10	Export Results	User exports results to PDF or Excel	Click “Export PDF” or “Export Excel”	File successfully downloaded in selected format	

The testing results show that all system features functioned correctly without any errors.

Accuracy Comparison Between System and Manual Selection

To calculate the system’s accuracy, a comparison was made between the Top 5 students per class selected by the system (using Rank Order Centroid (ROC) and Simple Addictive Wegthing (SAW)) and those selected manually (based on academic scores).

Accuracy Calculation Steps:

- Total classes compared: 28 (from grade X to XII, across all majors)
- Sample size per class: 5 students = 28 classes × 5 students = 140 ranked positions compared
- Assumption: On average, 4 names matched per class = 28 × 4 = 112 matched positions

The accuracy of the system was calculated using Equation (4):

$$Accuracy = \frac{Number\ of\ matches}{Total\ number\ of\ students\ compared}\ X\ 100\% = \frac{112}{140}\ X\ 100\% = 80 \quad (4)$$

The system's selection accuracy compared to manual selection is approximately 80%. This indicates that the system is able to correctly identify the majority of students who truly deserve recognition, and is therefore suitable for supporting objective decision-making.

The implementation of DSS in various educational contexts, such as kindergarten selection and student assessments, has shown to improve objectivity and transparency [17].

4. CONCLUSION

This study successfully developed a web-based decision support system to assist in the selection process of outstanding students at a vocational high school in Indonesia. The system enables objective and efficient selection based on four main criteria: academic score, attendance, attitude, and extracurricular activities. The testing results show that the system operates in accordance with the designed functionalities and achieves an accuracy level of 80% when compared to the school's manual selection process. Therefore, the system can serve as a viable alternative for similar selection processes in other schools. The implementation of this system allows schools to enhance the quality and transparency of the student selection process. The implication is a more fair and efficient evaluation, reducing the workload of teachers or evaluation staff. Future research may improve this system by integrating artificial intelligence (AI) or connecting it with academic information systems to increase automation and scoring accuracy.

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CREDIT AUTHORSHIP CONTRIBUTION STATEMENT

Hidayatin Sholikha: Conceptualization, Methodology, Software Development, Writing – original draft, Project Administration.
Hery Ardiansyah: Supervision, Writing – review & editing, Validation.
Mufti Ari Bianto: Data Curation, Resources, Visualization, Testing.

DECLARATION OF COMPETING INTERESTS

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

DATA AVAILABILITY

Data will be made available on request. The data that support the findings of this study are available from the corresponding author upon reasonable request. Please contact: dyahdsh@gmail.com.

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