PARADIGMA

Implementation of Simple Additive Weighting Method To Analyze The Selection of The Laptop

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ARTICLE INFORMATION	ABSTRACT
	The existence of the laptop currently has been a basic need to help in completing work or daily activities. the many options of laptop types with different specifications are currently, creating some problems such as difficulty or confused when determining the laptop options to purchase. These problems are also found at the office of Satker PJN 1 Banten which is still done by considering only on laptop trends or only from specific advantages but not according to the existing needs and budget. The purpose of this research is to provide solutions to the problems by making a decision-making information system in analyzing the selection of the laptop at the office of Satker PJN 1 Banten. The proposed method is implementing the Simple Additive Weighting (SAW) method implemented by using a web-based application for the decision-making system in the selection of the laptop. The Simple Additive Weighting (SAW) method is a method used to produce the best alternative ranking value from some alternatives based on the weight of each criterion obtained from the result of the questionnaire data processing questionnaire. the results obtained from the selection of the laptop using the Simple Additive Weighting (SAW) method based on this web-based that can analyze the selection of the laptop objectively according to the ranking results of the calculations of the saw method, so the selection of the laptop is objective.

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INTRODUCTION

Decision making is a process to choose the right alternative, with many and varied parameters or variables being one of the factors that make it difficult to form a decision, coupled with the possibility of conflicts in decision making (Hadikurniawati et al., 2021). Problems that occur in decision making can occur in various aspects, one of which is in the selection of laptops. Because the existence of laptops today has become a fundamental need to help in completing a job or daily activity. This is supported by data that laptop users for work activities reached 67.08%, for learning reached 34.16% and for entertainment reached 36.84% (Khasanah & Setiyadi, 2019).

This problem can also be seen in previous research which explained that the large number of laptop products circulating today with the support of the latest technology and also affordable prices makes it confusing to choose it, so for that a decision-making system is needed that is expected to help in choosing a laptop that suits your needs (Sunarsa & Handayani, 2016).

The National Road Implementation Task Force (Satker PJN) Region I of Banten Province is a unit tasked with the implementation of the construction and handling

of national roads located in the Banten Province area. The decision-making system in the selection of laptop procurement at the PJN I Banten Satker Office is currently still carried out subjectively, namely such as the process of analyzing laptop selection which is carried out still by considering only in terms of current laptop trends or only from the advantages of certain specifications. With the current system, several problems arise, such as difficulties or confusion when determining the choice of a laptop that suits your needs. And also, the lack of understanding of laptop specifications that are tailored to existing needs and budgets, thus allowing for an excess of the budget spent

Based on the above problems, a computerized decision support information system is needed, to overcome current decision making due to difficulties or confusion in determining the laptop that suits your needs and existing budget. One of the methods that can be applied in the process of making a decision-making information system is the Simple Additive Weight (SAW), this method is used to determine an alternative choice based on weights and criteria that have been determined (Yustriandi & Elisabet Y. A, 2017).

The Simple Additive Weight (SAW) method applied to the web-based laptop selection decision support system is useful in maximizing the decisions to be taken (Hastuti & Wismarini, 2019). The results of the application of the SAW method can also help and make it easier to consider the selection of a laptop that suits your wants and needs based on predetermined criteria (Syahril & Suharjo, 2021).

Therefore, by applying the Simple Additive Weighting (SAW) method to a web-based decision-making information system, it is hoped that it can create efficiency and effectiveness in analyzing the selection of laptops at the PJN I Banten Task Force Office to make decisions correctly and accurately.

RESEARCH METHODE

The research methods applied in this research process are as follows:

Research Instruments

The research materials and equipment used are the dissemination of questionnaires. Questionnaires are a number of written questions that are used to obtain information from Respondents, questionnaires can also be used as research instruments (Tersiana, 2018). The questionnaires made must pay attention to the data that supports the process of processing research data which can then be applied with the Simple Additive Weighting (SAW) method. This questionnaire data was processed by several Respondents at the PJN I Banten Task Force Office, and then the results of the questionnaire were processed into information that could be used in this research process, such as criteria data, weight of each criterion and alternative data.

Data Collection

The data collection process carried out in this study was by making observations, interviews and also distributing questionnaires by determining the number of samples and population first.

Populations are people who are the subject of research or people whose characteristics are to be studied (Roflin et al., 2021). The sample is part of the number and characteristics that the population has. The sample is considered to be a representative of a population whose results represent the overall symptoms that have been studied or observed (Sudarmanto et al., 2021).

Determination of the number of research samples can be carried out using the Slovin method. The Slovin method is a method of determining the number of samples (data) which is carried out using a formula to determine the number of populations and determine errors (margin of error) (Riyanto & Hatmawan, 2020).
In this case, to obtain the number of samples representing from the population at the PJN I Banten Task Force Office which amounted to 32 employees, this study used the Slovin method formula with an error tolerance rate of 5% or 0.05 as follows:

$$n = \frac{N}{1+Ne^2} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$
$$n = \frac{32}{1 + (32 \times 0,05^2)}$$
$$n = \frac{32}{1 + (32 \times 0,0025)}$$
$$n = \frac{32}{1 + 0,08}$$
$$n = \frac{32}{1,08}$$
$$n = 29,62$$

From the calculation results using the equation above, the number of samples representing the existing population was 29.62 or rounded up to 30 Respondents to fill out the questionnaire.

Data Analysis

In this process, data analysis has been carried out that has been collected and processed to determine the weight of each criterion and then the data is applied using the Simple Additive Weighting (SAW) method.

The SAW (Simple Additive Weighting) method is a method used to analyze the best alternatives from several alternatives with certain criteria. The essence of SAW is to determine the weight value for each attribute, then continue with the ranking process that will select the alternatives that have been given (Sari, 2018).

RESULTS AND DISCUSSION

The results and discussion of this research process consist of a discussion of the results of data analysis that has been processed using the Simple

Additive Weighting (SAW) method, discussion of the results of system analysis and discussion of the results of the implementation of the laptop selection application with the web-based Simple Additive Weighting (SAW) method.

Analysis Results Using the SAW Method

The method applied in this research process uses the Simple Additive Weighting (SAW) method. Here are the steps in applying the SAW method (Wanto et al., 2020), which are as follows:

1. Setting Criteria Data (Cj)

Table 1. is the criteria (Cj) that have been determined from the results of interviews with the Head of the Banten I PJN Satker Office:

Table 1. Criteria Data

Criterion	Descriptiion
C1	Price
C2	Processor
C3	RAM
C4	Screen Size
C5	Storage

Source: (Research Results, 2022)

2. Give the Value of Weight or Importance of Each Criterion (Wj)

Table 2. is the weighting of each criterion obtained from the results of distributing questionnaires to 30 employee respondents, which can be shown in the table below:

Table 2. Questionnaire Result Data

Respondents	Criteria				
	Price	Processor	RAM	Screen Size	Storage
R.1	5	5	3	3	5
R.2	5	5	5	3	3
R.3	5	5	5	4	3
R.4	5	5	5	3	3
R.5	5	5	5	4	3
R.6	5	5	5	4	5
R.7	5	5	5	4	5
R.8	5	5	5	4	3
R.9	5	5	5	4	5
R.10	5	5	5	4	3
R.11	5	5	3	4	3
R.12	5	5	4	4	3
R.13	5	5	5	4	3
R.14	5	5	5	4	4
R.15	5	5	5	3	4
R.16	5	5	5	4	4
R.17	5	5	5	4	5
R.18	5	5	5	4	4
R.19	5	5	5	4	4
R.20	5	5	5	4	5
R.21	5	5	4	3	4
R.22	5	5	5	3	4
R.23	5	5	5	3	4
R.24	5	5	4	3	3
R.25	5	5	3	3	4
R.26	5	5	4	4	4
R.27	5	5	5	3	3
R.28	5	5	5	3	4
R.29	5	5	5	3	4
R.30	5	5	5	4	4
Skor	150	150	140	108	115
Total Skor	150+150+140+108+115 = 663				

Source: (Research Results, 2022)

From the results of the distribution of the questionnaire, a calculation is then carried out to determine the weight value on each criterion (Wj) obtained from the results of the questionnaire score of each criterion divided by the total score, as shown in the following calculation:

$$\text{Price Criteria Weight} = \frac{\text{Price Criteria Score}}{\text{Total Score}} = \frac{150}{663} = 0{,}23$$

$$\text{Process Criteria Weight} = \frac{\text{Process Criteria Score}}{\text{Total Score}} = \frac{150}{663} = 0{,}23$$

$$\text{RAM Criterion Weight} = \frac{\text{RAM Criterion Score}}{\text{Total Score}} = \frac{140}{663} = 0{,}21$$

$$\text{Screen Size Criteria Weight} = \frac{\text{Screen Size Criteria Score}}{\text{Total Score}} = \frac{108}{663} = 0{,}16$$

$$\text{Storage Criteria Weight} = \frac{\text{Storage Criteria Score}}{\text{Total Score}} = \frac{115}{663} = 0{,}17$$

Based on the calculation results above, for more details, it can be seen in table 3 below:

Table 3. Calculation Results to Determine the Weight Value of Criteria

Criteria	Description	Questionnaire Score	Weight Value (W)
C1	Price	150	0,23
C2	Processor	150	0,23
C3	RAM	140	0,21
C4	Screen Size	108	0,16
C5	Storage	115	0,17
	Total	663	1,00

Source: (Research Results, 2022)

Based on the results of these calculations, the following is the criteria data (Cj) and the weight value of each criterion (Wj), namely in table 4:

Table 4. Weight Criteria

Criteria	Description	Weight (W)	Percentage (%)
C1	Price	0,23	23
C2	Processor	0,23	23
C3	RAM	0,21	21
C4	Screen Size	0,16	16
C5	Storage	0,17	17
	Total	1,00	100

Source: (Research Results, 2022)

Based on the Criteria data, the value of the importance level for each type of choice is determined, namely in table 5:

Table 5. Value Importance Criteria

Criteria	Choice Type or Sub Criteria	Value
Price (C1)	> 11 Juta	5
	9 - 11 Juta	4
	7 - 9 Juta	3
	5 - 7 Juta	2
	3 - 5 Juta	1
Processor (C2)	> Intel Core i7	5
	Intel Core i7 atau AMD Ryzen 7	4
	Intel Core i5 atau AMD Ryzen 5	3
	Intel Core i3 atau AMD Ryzen 3	2
	< Intel Core i3	1
RAM (C3)	> 16 GB	5
	16 GB	4
	8 GB	3
	4 GB	2
	2 GB	1
Screen Size (C4)	> 16 Inch	5
	15 – 15,9 Inch	4
	14 – 14,9 Inch	3
	13 – 13,9 Inch	2
	< 13 Inch	1
Storage (C5)	1 TB SSD	5
	512 GB SSD	4
	256 GB SSD	3
	128 GB SSD	2
	< 128 GB SSD	1

Source: (Research Results, 2022)

3. Defining Alternative Data (Ai)

Table 6. is alternative data (Ai) which has been determined from the results of data processing carried out, namely as follows:

Table 6. Alternative Data

No	Alternative	Price	Processor	RAM	Screen Size	Storage
A1	Msi Modern 14 B5M - 068ID	Rp. 10.299.000	AMD Ryzen 7	8GB	14 Inch	512 GB SSD
A2	Asus Vivobook A516JPO	Rp. 8.925,000	Intel Core i5	8GB	15,6 Inch	512 GB SSD
A3	Acer Aspire 3 Slim A314-35-C80W	Rp. 4.599.000	Intel Celeron	4GB	14 Inch	256 GB SSD
A4	Dell Vostro 14-3401	Rp. 5.799.000	Intel Core i3	4GB	14 Inch	256 GB SSD
A5	Apple MacBook Air 2020	Rp. 19.849.000	Intel Core i5	8GB	13 Inch	512 GB SSD

Source: (Research Results, 2022)

4. Determining the Match Rating of Each Alternative in Each Criterion

Based on alternative data in table 6, the next step is to determine the rating value of each suitable alternative for each criterion, namely in table 7:

Table 7. Value Rating Matches Every Alternative on Every Criteria

No	Alternative	Criteria				
		Price C1	Processor C2	RAM C3	Screen Size C4	Storage C5
A1	Msi Modern 14 B5M - 068ID	4	4	3	3	4
A2	Asus Vivobook A516JPO	3	3	3	4	4
A3	Acer Aspire 3 Slim A314-35-C80W	1	1	2	3	3
A4	Dell Vostro 14-3401	2	2	2	3	3
A5	Apple MacBook Air 2020	5	3	3	2	4

Source: (Research Results, 2022)

5. Making a Decision Matrix (X)

Create a decision matrix (X) formed from the match rating table. The Value X of each Alternative (Ai) in each Criteria (Cj) has been determined. The resulting matrix is as follows:

$$X = \begin{bmatrix} 4 & 4 & 3 & 3 & 4 \\ 3 & 3 & 3 & 4 & 4 \\ 1 & 1 & 2 & 3 & 3 \\ 2 & 2 & 2 & 3 & 3 \\ 5 & 3 & 3 & 2 & 4 \end{bmatrix}$$

6. Normalizing the Decision Matrix

Normalizing the decision matrix X by calculating the normalized performance rating value (rij) of alternative (Ai) on criteria (Cj), using the formula in the equation below, which is as follows:

$$r_{ij} = \begin{cases} \dfrac{X_{ij}}{Max_i\, X_{ij}} \\ \\ \dfrac{Min_i\, X_{ij}}{X_{ij}} \end{cases}$$

Before normalization is carried out, the criteria attribute grouping consists of costs and benefits. The following is the grouping in the table 8:

Table 8. Criteria Attribute Grouping

Criteria	Description	Cost	Benefit
C1	Price	✓	

C2	Processor	✓	
C3	RAM	✓	
C4	Screen Size	✓	
C5	Storage	✓	

Source: (Research Results, 2022)

From the grouping of attributes in the table above, the calculation of the normalization of the decision matrix is then carried out. Here are the normalization results on each Criterion, which are as follows:

a. Normalization for Criteria Price (*Cost*)

$$r_{11} = \frac{\min(4; 3; 1; 2; 5)}{4} = \frac{1}{4} = 0,25$$

$$r_{21} = \frac{\min(4; 3; 1; 2; 5)}{3} = \frac{1}{3} = 0,33$$

$$r_{31} = \frac{\min(4; 3; 1; 2; 5)}{1} = \frac{1}{1} = 1$$

$$r_{41} = \frac{\min(4; 3; 1; 2; 5)}{2} = \frac{1}{2} = 0,50$$

$$r_{51} = \frac{\min(4; 3; 1; 2; 5)}{5} = \frac{1}{5} = 0,20$$

b. Normalization for Criteria *Processor* (*Benefit*)

$$r_{12} = \frac{4}{\max(4; 3; 1; 2; 3)} = \frac{4}{4} = 1$$

$$r_{22} = \frac{3}{\max(4; 3; 1; 2; 3)} = \frac{3}{4} = 0,75$$

$$r_{32} = \frac{1}{\max(4; 3; 1; 2; 3)} = \frac{1}{4} = 0,25$$

$$r_{42} = \frac{2}{\max(4; 3; 1; 2; 3)} = \frac{2}{4} = 0,50$$

$$r_{52} = \frac{3}{\max(4; 3; 1; 2; 3)} = \frac{3}{4} = 0,75$$

c. Normalization for Criteria RAM (*Benefit*)

$$r_{13} = \frac{3}{\max(3; 3; 2; 2; 3)} = \frac{3}{3} = 1$$

$$r_{23} = \frac{3}{\max(3; 3; 2; 2; 3)} = \frac{3}{3} = 1$$

$$r_{33} = \frac{2}{\max(3; 3; 2; 2; 3)} = \frac{2}{3} = 0,67$$

$$r_{43} = \frac{2}{\max(3; 3; 2; 2; 3)} = \frac{2}{3} = 0,67$$

$$r_{53} = \frac{3}{\max(3; 3; 2; 2; 3)} = \frac{3}{3} = 1$$

d. Normalization for Criteria Screen Size (*Benefit*)

$$r_{14} = \frac{3}{\max(3; 4; 3; 3; 2)} = \frac{3}{4} = 0,75$$

$$r_{24} = \frac{4}{\max(3; 4; 3; 3; 2)} = \frac{4}{4} = 1$$

$$r_{34} = \frac{3}{\max(3; 4; 3; 3; 2)} = \frac{3}{4} = 0,75$$

$$r_{44} = \frac{3}{\max(3; 4; 3; 3; 2)} = \frac{3}{4} = 0,75$$

$$r_{54} = \frac{2}{\max(3; 4; 3; 3; 2)} = \frac{2}{4} = 0,50$$

e. Normalization for Criteria *Storage* (*Benefit*)

$$r_{15} = \frac{4}{\max(4; 4; 3; 3; 4)} = \frac{4}{4} = 1$$

$$r_{25} = \frac{4}{\max(4; 4; 3; 3; 4)} = \frac{4}{4} = 1$$

$$r_{35} = \frac{4}{\max(4; 4; 3; 3; 4)} = \frac{3}{4} = 0,75$$

$$r_{45} = \frac{3}{\max(4; 4; 3; 3; 4)} = \frac{3}{4} = 0,75$$

$$r_{55} = \frac{4}{\max(4; 4; 3; 3; 4)} = \frac{4}{4} = 1$$

7. Forming a Normalized Matrix (R)

The results of the normalized performance value rating (rij) form a normalized matrix as follows:

$$R = \begin{bmatrix} 0,25 & 1 & 1 & 0,75 & 1 \\ 0,33 & 0,75 & 1 & 1 & 1 \\ 1 & 0,25 & 0,67 & 0,75 & 0,75 \\ 0,50 & 0,50 & 0,67 & 0,75 & 0,75 \\ 0,20 & 0,75 & 1 & 0,50 & 1 \end{bmatrix}$$

8. Conducting the Ranking Process

Furthermore, calculating the Value of preferences is obtained from the summation for each normalized matrix multiplication with the preference Weight corresponding to the matrix column element. In the equation below looking for the Value preference for each Alternative (Vi), it is as follows:

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

Here is the calculation process:

$$\begin{aligned} V_1 &= (23 \times 0,25) + (23 \times 1) + (21 \times 1) \\ &\quad + (16 \times 0,75) + (17 \times 1) \\ &= 5,75 + 23 + 21 + 12 + 17 \\ &= 78,75 \end{aligned}$$

$$\begin{aligned} V_2 &= (23 \times 0,33) + (23 \times 0,75) + (21 \times 1) \\ &\quad + (16 \times 1) + (17 \times 1) \\ &= 7,67 + 17,25 + 21 + 16 + 17 \\ &= 78,92 \end{aligned}$$

$$\begin{aligned} V_3 &= (23 \times 1) + (23 \times 0,25) + (21 \times 0,67) \\ &\quad + (16 \times 0,75) + (17 \times 0,75) \\ &= 23 + 5,75 + 14 + 12 + 12,75 \\ &= 67,50 \end{aligned}$$

$$\begin{aligned} V_4 &= (23 \times 0,50) + (23 \times 0,50) + (21 \times 0,67) \\ &\quad + (16 \times 0,75) + (17 \times 0,75) \\ &= 11,50 + 11,50 + 14 + 12 + 12,75 \\ &= 61,75 \end{aligned}$$

$$\begin{aligned} V_5 &= (23 \times 0,20) + (23 \times 0,75) + (21 \times 1) \\ &\quad + (16 \times 0,50) + (17 \times 1) \\ &= 4,60 + 17,25 + 21 + 8 + 17 \\ &= 67,85 \end{aligned}$$

Based on the calculation results above, the ranking results are obtained in table 9:

Table 9. Ranking Results

No	Alternative	Hasil Akhir	Rangking

| V1 | Msi Modern 14 B5M - 068ID | 78,75 | 2 |
V2	Asus Vivobook A516JPO	78,92	1
V3	Acer Aspire 3 Slim A314-35-C80W	67,50	4
V4	Dell Vostro 14-3401	61,75	5
V5	Apple MacBook Air 2020	67,85	3

Source: (Research Results, 2022)

System Analysis Results

At this stage, the results of the analysis of the system made in this study use the Unified Modeling Language (UML) which is one of the standard modeling tools consisting of a series of integrated diagrams used for system development and object-oriented software development. The purpose of UML itself is to visualize, build, and document the architecture of software systems (Aprilian & Saputra, 2020).

1. Use Case Diagram

Use Case is a modeling for the behavior of the information system to be created (Sukamto & Salahuddin, 2018).
The interaction between the admin and the system which is described using a use case diagram can be seen in Figure 1:
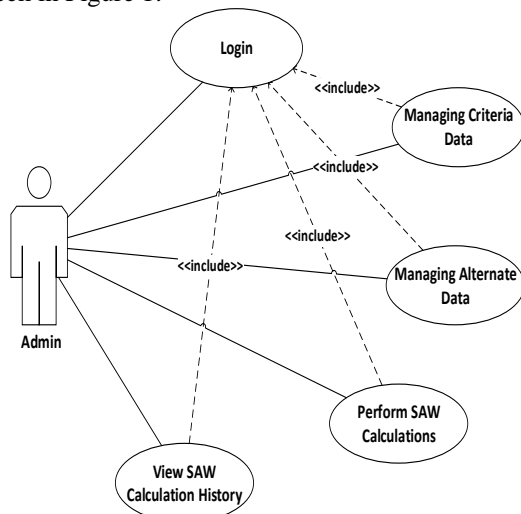
Source: (Research Results, 2022)
Figure 1. *Use Case Diagram*

2. Activity Diagram
Activity Diagram is a graphical representation of the workflow of incremental activities and actions with support for choice, iteration, and concurrency (Munawar, 2018).
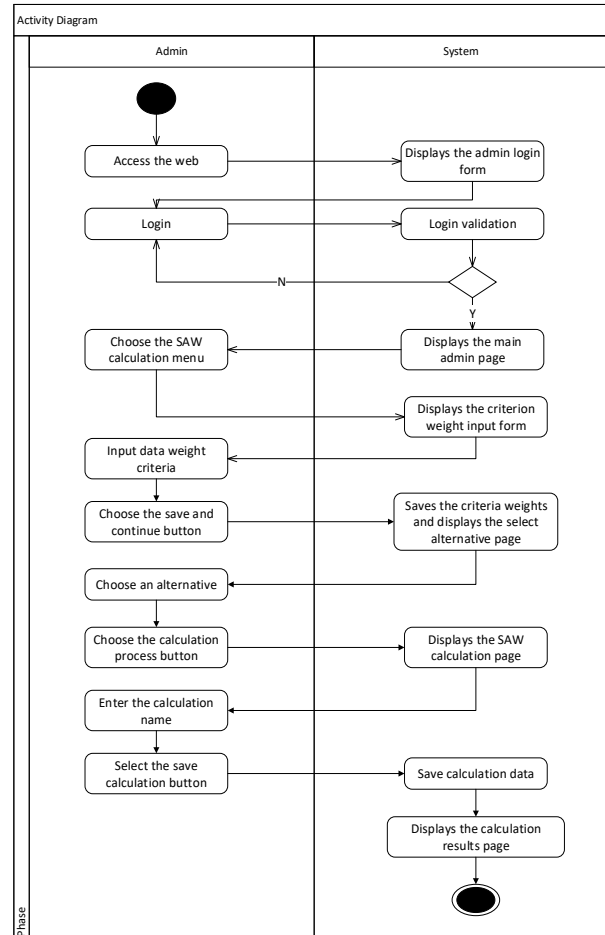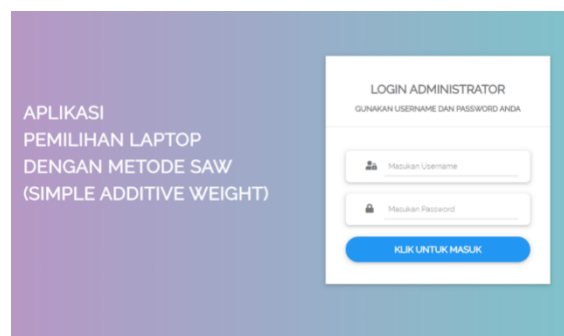

Source: (Research Results, 2022)
Figure 2. *Activity Diagram*

Implementation Results

The following are the results of the implementation of the interface design in the laptop selection application with the web-based Simple Additive Weighting (SAW) method, which consists of:
1. Admin Login Page

Figure 3 is a page that functions to validate users to enter the admin page, then the admin is required to log in first by filling in the username and password.
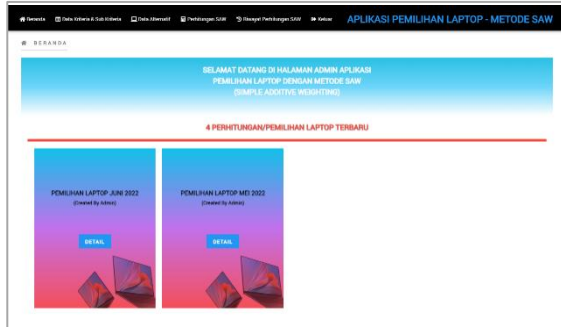

Source: (Research Results, 2022)

Figure 3. Admin Login Page
2. Admin Home

Figure 4 is the main admin page where the first page is displayed to the admin after logging in, on this page there is information on the history of SAW
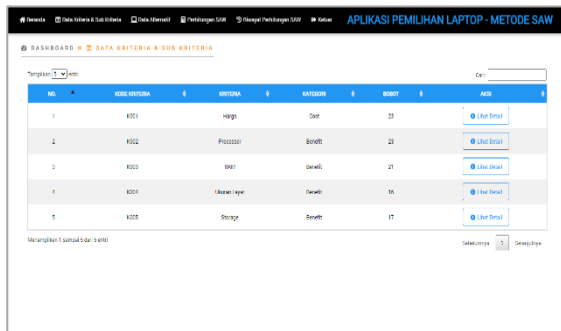
calculations and several menus such as Criteria data, Alternative data, SAW calculations, and the exit menu.

Source: (Research Results, 2022)
Figure 4. Admin Home

3. Data Criteria page

Figure 5. The criteria data page is a page for admins to view criteria data, such as a list of existing criteria data and details for each criterion.

Source: (Research Results, 2022)
Figure 5. Data Criteria Page

4. Alternative Data page

Figure 7. is an Alternative page, namely a page for admins to manage Alternative data, such as adding data, editing data, and deleting data.
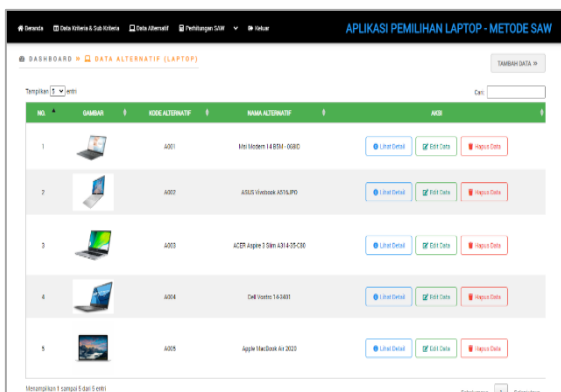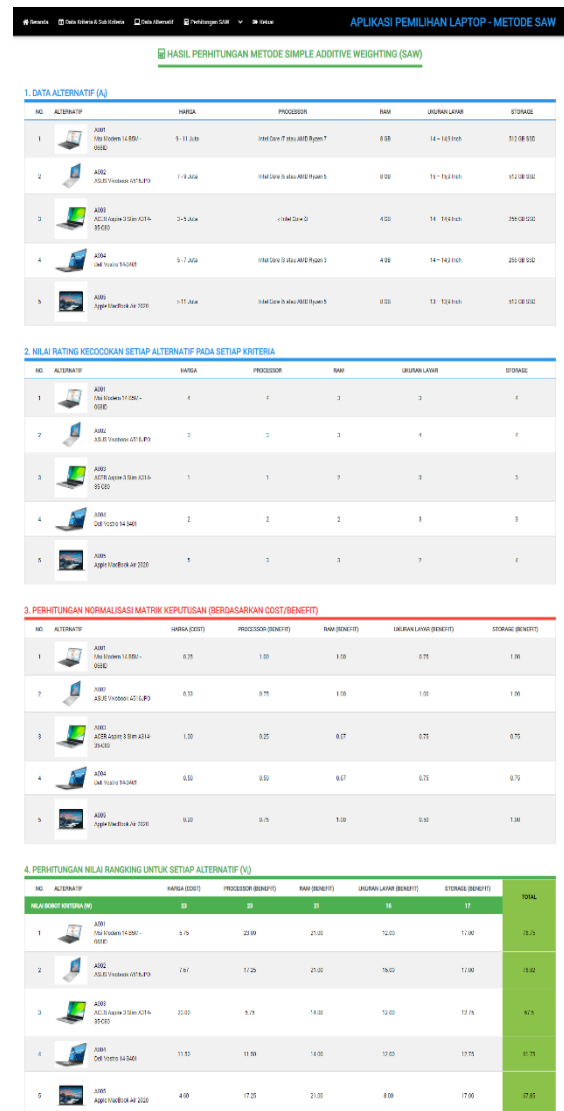

Source: (Research Results, 2022)
Figure 7. Alternative Data page

5. SAW Method Calculation Result Page

Figure 8. is the SAW method calculation result page, which is the admin page for performing

SAW calculations, and ranking results. The results of this calculation can also be saved by the admin to later be used as the history of SAW calculations.

Source: (Research Results, 2022)
Figure 8. SAW Method Calculation Result Page

CONCLUSION

Based on the results of the research that has been done, it can be concluded that choosing a laptop using the Simple Additive Weighting (SAW) method can make it easier for the PJN I Banten Task Force to analyze and choose a laptop that fits your needs and the existing budget. As well as being able to produce an objective laptop selection in accordance with the results of the SAW method ranking calculations. The results of ranking using the Simple Additive Weighting (SAW) method can be concluded that the largest value is in V2 with a result of 78.92. Alternative A2, namely the Asus Vivobook A516JPO, can be the best alternative choice for laptops at the PJN I Banten Working Unit Office.

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