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Analysis of the Best Laptop Selection System Using Simple Additive Weighting (SAW) Method and Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) Method

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Abstract: Every laptop has different specifications, and of course, the differences in specifications will affect the performance of the laptop when in use. The need to choose the right laptop depends on your needs. Therefore, we need an appropriate laptop recommendation system for prospective buyers. Choosing the optimal laptop according to your needs can be solved with a Decision Support System (DSS). The DSS has a mathematical model that can be used as a solution to these problems. There are several methods commonly used in solving problems, including the Simple Additive Weighting Method (SAW), Weighted Product (WP), and Technique for Order Preference by Similarity to Ideal Solution (TOPSIS). In this study, the SAW and TOPSIS methods were used, then the results were compared to those of the previous studies by using the WP method with the same data and criteria. The results of this study indicate that differences in laptop recommendations are only found in the second and third order. When using the SAW method, the second and third recommended laptops in a row are A6 (HP 14-G1024 U) and A3 (Acer Aspire E5-551). When using the TOPSIS method, the second and third recommendations for laptops in a row are A3 (Acer Aspire E5-551) and A6 (HP 14-G1024 U). The results of this study indicate that the SAW method gives the same laptop recommendation results as the WP method.

Keywords: *selection; laptop; TOPSIS; SAW; WP.*

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1 Introduction

Each laptop has different specifications, of course, and the differences in specifications surely affect the performance of the laptop when you use it. Currently, the main needs of the average student are limited to office applications and taking online courses, merely requiring middle to lower class laptops. However, those who work as graphic designers or gamers require devices with high specifications to meet their needs. A frequent problem occurring is buying a laptop whose specifications do not meet your needs. Lack of understanding by the user of laptop specifications makes the purchase not optimal. This can be minimized by contacting the store directly, but is limited to the store staff's knowledge or available inventory. There are several features that serve as benchmarks for choosing a laptop, that is, the Central Processing Unit (CPU), Graphics Processing Unit (GPU), Random Access Memory (RAM), storage, display, and price. Some of these features result in laptop buying recommendations.

Therefore, a system that recommends the right laptop for you is needed so that the purchase of a laptop will meet your needs optimally for home use. Choosing the optimal laptop according to your needs can be effectively done by using a Decision Support System (DSS), a discipline of operations research that can be utilized for decision making support in the form of mathematical models. DSS is an interactive software-based system designed to help decision makers collect, analyze, and process information from raw data, documents, frameworks, and business models to identify problems, solve them, and make decisions. SPK is computer software used in specific situations to analyze and present business data to help users make business decisions.

DSS has a mathematical model used as a solution to the problems. The model is Multi Criteria Decision-Making (MCDM). MCDM is one of the methods developed and used to help decision makers choose out of several decision options to take by several criteria to be considered to make the right and optimal decision [6]. Fuzzy MCDM is a decision support method whose purpose is to determine predicted alternatives out of several alternatives based on certain criteria used in the Fuzzy Multi Criteria decision method [7].

In terms of usefulness, MCDM is grouped into two models. They are Multi Objective Decision Making (MODM) used to solve problems in continuous space and Multi Attribute Decision Making (MADM) used to solve problems in discrete space. And the method used in this study is MADM.

There are several methods commonly employed in solving MADM problems, that is, the Simple Additive Weighting Method (SAW), Weighted Product (WP), and Technique for Order Preference by Similarity to Ideal Solution (TOPSIS). These three methods are used in helping decision making for laptop selection.

The previous research conducted by [11] contributed results able to help make laptop selection decisions employing the WP method. And in this study, the researchers used the SAW and TOPSIS methods by using the same data and criteria as those the previous research used [11]. The researchers compare the results obtained by both methods to those obtained by the WP method.

2 Research Method

2.1 Research method

The Simple Additive Weighting (SAW) method and the Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) can assist for laptop selection decision making. The basic concept of the SAW method is to find out the weighted sum of the performance ratings for each alternative on all attributes. The SAW method requires a process of normalizing the decision matrix (X) to a scale that can be compared to all existing alternative ratings.

$$r_{ij} = \begin{cases} \frac{x_{ij}}{Max\ x_{ij}} \ if\ j : atribute\ of\ benefit, \\ \frac{Min\ x_{ij}}{x_{ij}} \ if\ j : atribute\ of\ cost, \end{cases} \tag{1}$$

where r_{ij} is the normalized performance rating of alternative A_i on attribute $C_i; i = 1, 2, \ldots, m$ and $j = 1, 2, \ldots, n$. The preference value for each alternative (V_i) is given as

$$V_i = \sum_{j=1}^{n} w_j r_{ij}, \tag{2}$$

where the greater value of V_i indicates that alternative A_i is preferred or more frequently chosen.

The TOPSIS concept is based on the concept that the best selected alternative has not only the shortest distance from the positive ideal solution but also the longest distance from the negative ideal solution. This concept is frequently used to solve decision making problems in several MADM models because the concept is simple and easy to understand, computationally efficient and has the ability to measure the relative performance of decision alternatives in a simple mathematical form.

TOPSIS requires the performance rating of each alternative A_i on each normalized criterion C_j, that is,

$$r_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^{m} x_{ij}^2}}. \tag{3}$$

The positive ideal solution A^+ and the negative ideal solution A^- can be determined based on the normalized weight rating (y_{ij}) as follows:

$$y_{ij} = w_i r_{ij}, \tag{4}$$

$i = 1, 2, \ldots, m$ and $j = 1, 2, \ldots, n$.

$$A^+ = \left(y_1^+, y_2^+, \ldots, y_n^+\right), \tag{5}$$

$$A^- = \left(y_1^-, y_2^-, \ldots, y_n^-\right) \tag{6}$$

with

$$y_j^+ = \begin{cases} max\ y_{ij}; if\ j : atribute\ of\ benefit, \\ min\ y_{ij}; if\ j : atribute\ of\ cost, \end{cases}$$

$$y_j^- = \begin{cases} max\ y_{ij}; if\ j : atribute\ of\ benefit, \\ min\ y_{ij}; if\ j : atribute\ of\ cost. \end{cases}$$

The distance between the alternative A_i and the positive ideal solution is formulated as follows:

$$D_i^+ = \sqrt{\sum_{j=1}^{n} \left(y_i^+ - y_{ij}\right)^2}; i = 1, 2, \ldots, m. \tag{7}$$

The distance between the alternative A_i and the negative ideal solution is formulated as follows:

$$D_i^- = \sqrt{\sum_{j=1}^{n} \left(y_{ij} - y_i^-\right)^2}; i = 1, 2, \ldots, m. \tag{8}$$

The preference value of each alternative (V_i) is given as

$$V_i = \frac{D_i^-}{D_i^- + D_i^+}; i = 1, 2, \ldots, m. \tag{9}$$

The higher value of V_i indicates that A_i is the preferred value.

2.2 Research material

The data and weighting used in this study are the same as those in the previous research [11]. The data in question can be seen in Table 1.

No	Alternative	Criteria				
		C_1	C_2	C_3	C_4	C_5
1	Axioo Neon TNW C825	Intel Celeron N2940	2 GB	500 GB	Intel HD Family	4.100.000
2	Axioo Neon TNN C825	Intel Celeron Quad Core N2920	2 GB	500 GB	Intel HD Family	4.000.000
3	Acer Aspire E5-551	AMD A10-7300	4 GB	1 TB	AMD Raden R7 M265	6.699.000
4	Lenovo Ideapad 100	Intel Core i3-5005U	2 GB	500 GB	NVIDIA GeForce 920A DDR3L 2 GB	5.399.000
5	Toshiba S40 A	Intel Core i3-3227u	2 GB	500 GB	NVIDIA GoForce GT 740 M	6.200.000
6	HP 14- U G1024 U	AMD A4-500	2 GB	500 GB	AMD Radeon HD 833	3.830.000

Table 1: Criteria.

From Table 1, coding is made as shown in Table 2.

In solving the selection of the best laptop by the SAW and TOPSIS methods, criteria and weights are required to perform calculations so that the best alternative will be obtained. The following are the criteria for decision making, based on the parameters in determining the best laptop at SMK Mandiri Bekasi as in Table 3.

In these criteria, a level of importance of the criteria is determined based on the predetermined weight value. The rating of each alternative on each criterion can be seen in Table 4.

Based on the criteria from the rating of each alternative (L_i) on each criterion (K_i) already determined, the weight of each criterion (K_i) is then determined.

No	Codes	Alternatives
1	A_1	Axioo Neon TNW C825
2	A_2	Axioo Neon TNN C825
3	A_3	Acer Aspire E5-551
4	A_4	Lenovo Ideapad 100
5	A_5	Toshiba S40 A
6	A_6	HP 14-G1024 U

Table 2: Alternative Codes.

Criteria	Description
K_1	Prosesor
K_2	RAM
K_3	Harddisk
K_4	VGA
K_5	Harga

Table 3: Atribute Codes.

Value	Alternative
1	Very low
2	Low
3	Fair
4	High
5	Very High

Table 4: Alternative Rating.

a) Processor Weight Value (K_1).
The weight value (W) of each processor criterion has been determined by the

Processor	Very low	1
	Low	2
	Fair	3
	High	4
	Very High	5

Table 5: Processor Criteria.

SMK Mandiri Bekasi school.

b) RAM Weight Criteria (K_2).
The weight value (W) of each RAM criterion has been determined by the SMK Mandiri Bekasi school.

RAM Capacity	1 GB	1
	RAM Weight Criteria	2
	RAM Weight Criteria	3
	8 GB	4
	16 GB	5

Table 6: RAM Criteria.

c) Harddisk weight criteria (K_3).
The weight value (W) of each Harddisk criterion has been determined by the SMK

Harddisk Capacity	250 GB	1
	320 GB	2
	500 GB	3
	750 GB	4
	>750 GB	5

Table 7: Harddisk Criteria.

Mandiri Bekasi school.

d) VGA Weight Criteria (K_4).

Processor	Very low	1
	Low	2
	Fair	3
	High	4
	Very High	5

Table 8: VGA Criteria.

e) Price Weight Criteria (K_5).

Price capacity	$3-4\ M$	1
	$4-6\ M$	2
	$6-8\ M$	3
	$8-15\ M$	4
	$\geq 15\ M$	5

Table 9: Price Criteria.

f) Weight Value Criteria.

W_1	Processor	5
W_2	RAM	4
W_3	Harddisk	3
W_4	VGA	5
W_5	Price	3

Table 10: Weight Criteria.

3 Results and Discussion

3.1 Solving by SAW method

To determine the normalization matrix, the elements can first be determined using equation (1) or (2):

$$
\begin{aligned}
r_{11} &= \frac{2}{\max\{\ 2 \quad 4 \quad 1 \quad 4 \quad 4 \quad 4\ \}} = \frac{2}{4} = 0.5,\\
r_{21} &= \frac{4}{\max\{\ 2 \quad 4 \quad 1 \quad 4 \quad 4 \quad 4\ \}} = \frac{4}{4} = 1,\\
r_{31} &= \frac{1}{\max\{\ 2 \quad 4 \quad 1 \quad 4 \quad 4 \quad 4\ \}} = \frac{1}{4} = 0.25,\\
\vdots &= \vdots\\
r_{12} &= \frac{1}{\max\{\ 1 \quad 4 \quad 3 \quad 1 \quad 1 \quad 1\ \}} = \frac{1}{4} = 0.25,\\
r_{22} &= \frac{4}{\max\{\ 1 \quad 4 \quad 3 \quad 1 \quad 1 \quad 1\ \}} = \frac{4}{4} = 1\\
\vdots &= \vdots
\end{aligned}
$$

and so on. Based on the results obtained, a matrix is formed as displayed in Table 11.

No	Alternative	Criteria				
		K_1	K_2	K_3	K_4	K_5
1	A_1	0.5	0.25	0.75	0.4	0.2
2	A_2	1	1	0.75	0.4	0.5
3	A_3	0.25	0.75	1	1	0.25
4	A_4	1	0.25	0.75	0.4	0.2
5	A_5	1	0.25	0.75	0.4	0.25
6	A_6	1	0.25	0.75	0.4	1

Table 11: Calculation of Matrix Normalization.

Then each element of the normalization matrix and weight criteria are substituted in

equation (3).

$$\begin{aligned} V_1 &= 5(0.5) + 4(0.25) + 3(0.75) + 5(0.4) + 3(0.2) = 8.35, \\ V_2 &= 5(1) + 4(1) + 3(0.75) + 5(0.4) + 3(0.5) = 14.75, \\ V_3 &= 5(0.25) + 4(0.75) + 3(1) + 5(1) + 3(0.25) = 13, \\ V_4 &= 5(1) + 4(0.25) + 3(0.75) + 5(0.4) + 3(0.2) = 10.85, \\ V_5 &= 5(1) + 4(0.25) + 3(0.75) + 5(0.4) + 3(0.25) = 11, \\ V_6 &= 5(1) + 4(0.25) + 3(0.75) + 5(0.4) + 3(1) = 13.25. \end{aligned}$$

The V value shows the order of laptop recommendations ranging from the largest to smallest. Based on the Simple Additive Weighting (SAW) method applied, the results and order of selection priorities are as displayed in Table 12. Table 12 shows that the priority order of the first laptop selection is A_2 (Axioo Neon TNN C825), that of the second laptop selection is A_6 (HP 14-G1024 U), and so on.

Alternative	Results	Ranking
A_1	8.35	6
A_2	14.75	1
A_3	13	3
A_4	10.85	5
A_5	11	4
A_6	13.25	2

Table 12: Alternative Priority.

3.2 Solving by TOPSIS Mehod

By using equation (4), the normalized matrix is obtained as in Table 13 below.

No	Alternative	Criteria				
		K_1	K_2	K_3	K_4	K_5
1	A_1	0.2408	0.1857	0.3841	0.2981	0.5361
2	A_2	0.4815	0.7428	0.3841	0.2981	0.2144
3	A_3	0.1204	0.5571	0.5121	0.7454	0.4288
4	A_4	0.4815	0.1857	0.3841	0.2981	0.5361
5	A_5	0.4815	0.1857	0.3841	0.2981	0.4288
6	A_6	0.4815	0.1857	0.3841	0.2981	0.1072

Table 13: Calculation of Matrix Normalization.

Then, from the normalized matrix, the weighted matrix is obtained as in Table 14.

Table 14 is obtained by multiplying the elements of each row in Table 13 by the corresponding weight criteria.

The positive and negative ideal solution matrix is obtained from equation (5) or (6). In the positive ideal solution, the largest value is selected for the profit attribute and the smallest value for the cost attribute. Meanwhile in the negative ideal solution, it applies vice versa. Then by using equations (7) and (8), the results are obtained as in Table 16.

Alternative	Criteria				
	K_1	K_2	K_3	K_4	K_5
A_1	1.204	0.7428	1.1523	1.4905	1.6083
A_2	2.4075	2.9712	1.1523	1.4905	0.6432
A_3	0.602	2.2284	1.5363	3.727	1.2864
A_4	2.4075	0.7428	1.1523	1.4905	1.6083
A_5	2.4075	0.7428	1.9205	1.4905	1.2864
A_6	2.4075	0.7428	1.1523	1.4905	0.3216

Table 14: Calculation of Weighted Matrix Normalization.

Alternative	Criteria				
	K_1	K_2	K_3	K_4	K_5
$A(+)$	2.075	2.9712	1.9205	3.727	0.3216
$A(-)$	0.602	0.7428	1.1523	1.4905	1.6083

Table 15: Calculation of Positive and Negative Ideal Matrix.

Alternative	Ideal Solution Distance	
	$D(+)$	$D(-)$
A_1	3.696193	0.602
A_2	2.386523	3.026056
A_3	2.211341	2.731303
A_4	3.494771	1.8055
A_5	3.301293	1.988361
A_6	3.249281	2.217076

Table 16: Calculation of Alternative Distance Matrix to Positive and Negative Ideal Solutions.

By using the Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) method, the results and order of selection priorities are as in Table 17.

Alternative	Results	Ranking
A_1	0.140059	6
A_2	0.559078	1
A_3	0.5526	2
A_4	0.340643	5
A_5	0.375896	4
A_6	0.405586	3

Table 17: Alternative Priority.

Based on Table 17, it can be seen that the order of priority for choosing the first laptop is A_2 (Axioo Neon TNN C825), and that for choosing the second laptop is A_3 (Acer Aspire E5-551), and so on.

4 Conclusion

The application of SAW and TOPSIS methods provides different priority orders for the second and third laptop recommendations. By using the SAW method, the second and third laptop recommendations are A_6 (HP 14-G1024 U) and A_3 (Acer Aspire E5-551). At the same time, when using the TOPSIS method, the second and third laptop recommendations are A_3 (Acer Aspire E5-551) and A_6 (HP 14-G1024 U). When compared to the results of the previous studies, it can be seen that the SAW method provides the same laptop recommendation sequence results as the WP method, that is, A_6 (HP 14-G1024 U) and A_3 (Acer Aspire E5-551). Meanwhile the TOPSIS method gives different results in the order of recommendations for the second and third laptops, that is, A_6 (HP 14-G1024 U) and A_3 (Acer Aspire E5-551) by the WP method and A_3 (Acer Aspire E5-551) and A_6 (HP 14-G1024 U) by the TOPSIS method. The difference occurs due to differences in calculation methods among SAW, WP, and TOPSIS.

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