IMPLEMENTATION OF ANALYTICAL HIERARCHY PROCESS (AHP) IN A LAPTOP SELECTION DECISION SUPPORT SYSTEM FOR NEW STUDENTS

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Abstract

Background : Laptop selection for first-year university students involves multiple technical and non-technical criteria, making the decision-making process complex.
Purpose : This study aims to implement the Analytical Hierarchy Process (AHP) as a decision support system to determine the most suitable laptop alternative among Acer, Asus, and HP.
Methodology : The study involved 30 first-year university students selected using purposive sampling. Five main criteria were identified: Aesthetic, Durability, Features, Performance, and Perceived Quality. Pairwise comparison data were aggregated using the geometric mean method. All comparison matrices satisfied the consistency requirement (CR ≤ 0.1).
Findings : The results indicate that Durability (0.4721) is the most dominant criterion, followed by Performance (0.2014), Perceived Quality (0.1683), Features (0.0946), and Aesthetic (0.0636). The global priority results show that Acer (0.7146) ranks first, followed by HP (0.1473) and Asus (0.1381)[.
Implications : Sensitivity analysis demonstrates that the ranking remains stable under reasonable weight variation
Originality : This study provides practical recommendations for students and methodological contributions in applying AHP with consistency and robustness testing.

Keywords *: AHP, decision support system, laptop selection, multi-criteria decision making, sensitivity analysis.*

INTRODUCTION

Students often encounter significant challenges when selecting a laptop due to the saturated market and the rapid pace of technological advancement (Hasan, 2023; Riantika, Dikananda, & Rifai, 2025). Manufacturers frequently release new models with overlapping features, leading to "choice

overload" and buyer's remorse. For many new students, there is a distinct mismatch between their actual academic requirements and the technical specifications of the laptops they purchase, often stemming from a lack of deep technical understanding (Hasan, 2023). Without an objective evaluation system, students risk making incorrect choices that do not align with their specific needs or budget constraints (Abdillah, 2022)

The rapid advancement of information technology has significantly transformed various sectors, including higher education, where digital devices have become essential in supporting academic activities. New university students require laptops to assist in attending online classes, accessing academic information systems, conducting research, completing assignments, and operating software according to their fields of study (Wang, Nabavi, & Rangaiah, 2024). However, the increasing variety of laptop brands, specifications, and price ranges available in the market often makes the selection process difficult, especially for students who have limited technical knowledge regarding computer hardware and software requirements (Magabaleh et al., 2024).

Laptop selection is considered a complex decision-making process because it involves multiple criteria that must be evaluated simultaneously. Several important aspects commonly considered include processor performance, RAM capacity, storage type, graphics capability, battery life, portability, screen size, and affordability according to students' financial conditions. In practice, many students choose laptops based on advertisements, peer recommendations, or brand popularity rather than carefully evaluating whether the specifications meet their academic needs (Mukharir & Wardoyo, 2021). As a result, inappropriate purchasing decisions may negatively affect students' productivity and learning performance (Ramadina & Yulia, 2022).

To overcome this issue, a systematic approach is required to help students make objective and efficient decisions. A Decision Support System (DSS) is a computer-based system designed to assist users in evaluating alternatives and generating recommendations based on specific criteria (Kurniawan & Roestam, 2021). DSS has been widely implemented in educational and technological fields because of its ability to improve decision quality, consistency, and efficiency through structured analytical processes. Furthermore, decision support systems help reduce uncertainty by organizing available information into measurable decision alternatives (Salehzadeh & Ziaeian, 2024).

One of the most commonly used methods in a Decision Support System is the Analytical Hierarchy Process (AHP), which is recognized as an effective multi criteria decision making method. AHP enables users to structure complex problems hierarchically and determine priorities through pairwise comparisons among criteria and alternatives (Kumar & Pamucar, 2025). Additionally, the method calculates consistency ratios to ensure logical and reliable judgments during the evaluation process. Due to its simplicity and flexibility, AHP continues to be widely adopted in solving decision-making problems involving multiple criteria and alternatives (Wang et al., 2024).

The AHP method is considered suitable for laptop selection because it allows users to evaluate multiple laptop alternatives based on weighted criteria according to their specific needs and preferences (Mukharir & Wardoyo, 2021). For new students, implementing AHP in laptop selection can provide a more rational and objective recommendation process rather than relying solely on subjective opinions or promotional information. Furthermore, AHP provides flexibility by enabling users to prioritize criteria based on academic requirements and financial limitations (Aditya & Purwiantono, 2020).
Several previous studies have demonstrated the effectiveness of AHP in supporting technology-related decision-making processes. Research on laptop recommendation systems using the AHP method found that the approach effectively ranks laptop alternatives according to selected criteria and user priorities (Ramadina & Yulia, 2022). Additionally, the implementation of AHP in recommendation systems has

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been shown to improve user satisfaction by providing transparent and data-driven decision outcomes (Mukharir & Wardoyo, 2021).

Apart from laptop selection, the AHP method has also been widely implemented in educational contexts, including the selection of academic majors, student competency evaluations, and learning model recommendations (Azhar, Wakhinuddin, Waskito, Effendi, & Muskhir, 2021). Studies indicate that AHP contributes to improving decision accuracy, reducing subjective bias, and increasing transparency in evaluation processes. Therefore, applying AHP in a laptop selection decision support system for new students is considered relevant and appropriate for addressing the complexity of technology selection (Pramono, Berlilana, & Barkah, 2026).

AHP allows for the integration of both qualitative and quantitative data by utilizing pairwise comparisons (Chaube et al., 2024). This methodology ensures that the decision-maker's judgments are consistent and logical, helping students prioritize their specific needs such as performance over price, or portability over screen size through a systematic weighting process (Bhadu, Bhamu, & Saraswat, 2023; Macchi, Savino, & Roda, 2020; Mukharir & Wardoyo, 2021)

Recent advancements in decision support systems have further demonstrated the relevance of Random Index utilization in practical applications, including education, technology selection, healthcare, and resource management. In educational decision-making contexts, consistency measurement through RI has been applied to ensure objective evaluation in student assessment systems, learning model selection, and technology recommendation systems (Pramono et al., 2026). This indicates that RI is not merely a theoretical concept but an essential component in maintaining the reliability of AHP implementations across various real-world scenarios (Ramadina & Yulia, 2022)

The novelty of this study lies in its dual contribution: applying AHP to address the inherent subjectivity and inconsistency of new students' laptop preferences and extending prior AHP-based laptop selection research by incorporating a sensitivity analysis to test the robustness of the resulting priority rankings (Chaube et al., 2024).

Table 1. summarizes how this study positions itself relative to previous AHP-based studies on laptop and technology selection, highlighting the specific methodological gap it addresses.

Study	Decision Context	Consistency Test (CR)	Sensitivity Analysis	Key Gap Addressed Here
Mukharir & Wardoyo (2021)	Laptop selection (AHP + profile matching)	Yes	No	—
Ramadina & Yulia (2022)	Best laptop brand selection (AHP)	Yes	No	—
Abdillah (2022)	Laptop selection for students/community (AHP)	Yes	No	—
Riantika et al. (2025)	Laptop selection (Simple Additive Weighting)	N/A	No	—
Pramono et al. (2026)	Student soft-skill assessment (AHP)	Yes	No	—
This study	*Laptop selection for new students (AHP)*	*Yes*	*Yes (±10% on dominant criterion)*	*Adds robustness testing to validate ranking stability, which prior*

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laptop-selection AHP studies did not report

METHODOLOGY

This research was conducted through several stages: determining the priority weighting of criteria for laptop selection, determining the best laptop alternative based on the global synthesis of AHP (Analytical HP) analysis, testing the consistency of respondents' assessments, and conducting sensitivity analysis to test decision stability.

This research began with a preliminary survey to determine user preferences in choosing a laptop and the obstacles faced in determining the right laptop for their needs. Based on the survey, it was found that selecting the right laptop requires criteria-based analysis, therefore, the AHP method was applied as a tool to assist in making the best alternative decision. Next, a literature review was conducted to obtain a theoretical basis for AHP and references to previous research on the application of AHP in selecting technology products. After ensuring that the variables align with the research objectives, a hierarchical decision structure was determined, consisting of the purpose of laptop selection, assessment criteria (Aesthetics, Durability, Features, Performance, Perceived Quality), and the laptop alternatives chosen by respondents (Acer, Asus, and HP).

2.1. Research Design

This research uses a quantitative approach with the AHP method. The research stages included: Problem identification, determining criteria and alternatives, developing a hierarchical structure, distributing paired comparison questionnaires, Aggregating assessments using geometric means, Calculating weights, Consistency testing (CI and CR), Synthesis of global alternatives, and Sensitivity analysis.

2.2. Respondents

The respondents were 30 first year students selected using purposive sampling with the following criteria: Active first year students, having purchased or intending to purchase a laptop within the past year, and the number of respondents was deemed adequate for AHP research due to its focus on aggregating group preferences and testing consistency.

Hierarchical Structure

The hierarchy in this study is as follows:

Level 1: Objective (Selecting the Best Laptop)

Level 2: Criteria (Aesthetics, Durability, Features, Performance, Perceived Quality)

These five criteria were not selected arbitrarily. They were adapted from Garvin's (1987) widely used framework of product quality dimensions originally comprising performance, features, reliability, conformance, durability, serviceability, aesthetics, and perceived quality which remains a standard reference for structuring product evaluation criteria and has recently been reaffirmed and extended by De Giovanni (2024). Of the eight original dimensions, Aesthetic, Durability, Features, Performance, and Perceived Quality were retained because they directly apply to a physical, consumer-facing technology product such as a laptop, whereas reliability, conformance, and serviceability were considered less distinguishable by first-year students who typically lack pre-purchase access to long-term reliability or after-sales service data. The relevance of these five criteria to the student context was further confirmed during the preliminary survey described above, in which respondents consistently referred to these same aspects when describing their laptop purchasing considerations.

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Level 3: Alternatives (Acer, Asus, HP)

2.4. Consistency Test

The consistency test in this study is as follows:
1. Consistency Index (CI):
$CI = (\lambda max - n) / (n - 1)$
2. Consistency Ratio (CR):
$CR = CI / RI$
A decision is considered consistent if $CR \leq 0.1$.

2.5. Sensitivity Analysis

Sensitivity analysis is performed by increasing and decreasing the weight of the dominant criterion (Durability) by ±10% to test the stability of the alternative rankings

RESULT AND DISCUSSION

3.1 Calculation of the average weighting for each element and component

Calculate the weighted average for each element and component using the geometric mean. This geometric mean is considered the result of a group assessment of the values given by 10 respondents. An example of calculating the geometric mean for level 2 elements between Aesthetic and Durability is as follows.
Respondent 1: 5
Respondent 2: 4
Respondent 3: 4
Respondent 4: 1/4
Respondent 5: 1/5
Respondent 6: 1/5
Respondent 7: 5
Respondent 8: 3
Respondent 9: 3
Respondent 10: 1/5
Then the geometric mean is:
$= 10\sqrt{5 \times 4 \times 4 \times 1/4 \times 1/5 \times 1/5 \times 5 \times 3 \times 3 \times 1/5} = 1,2182$
In the same way, the geometric mean of each element can be found.
The weighted averages can be seen in the following tables:
Level 2
The average weighting for elements at level 2 is as follows:

Tabel 2. Average weighting for level 2 elements

Elemen	*Aesthetic*	*Durability*	*Features*	*Performance*	*Perceived Quality*
Aesthetic	1,0000	0,1476	1,2182	0,5713	0,4726
Durability	6,7735	1,0000	6,2585	4,5509	1,6417
Features	0,8209	0,1598	1,0000	0,6931	0,6686
Performance	1,7504	0,2197	1,4427	1,0000	1,5399
Percievied Quality	2,1161	0,6091	1,4956	0,6494	1,0000
Jumlah	**12,4609**	**2,1362**	**11,4150**	**7,4647**	**5,3228**

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Level 3
The average weighting for the elements at level 3 is as follows:

Table 3. Average weighting for level 3 elements

Element	Laptop Design	Laptop Color	Laptop Screen Display	Laptop Shape
Laptop Design	1,0000	1,3983	1,5176	2,5262
Laptop Color	0.7152	1,0000	1,1013	3,2958
Laptop Screen Display	0.6589	0.9080	1,0000	2,5905
Laptop Shape	0.3959	0.3034	0.3860	1,0000
Amount	**2,7700**	**3,6097**	**4,0049**	**9.4125**

Level 4
The weighted average for the elements at level 4 is as follows following.

Table 4. Average weighting for level 4 elements

Element	***Acer***	***Asus***	***HP***
Acer	1,0000	1,0718	0.8706
Asus	0.9330	1,0000	0.9441
HP	1.1487	1,0592	1,0000
Amount	**3,0817**	**3,1310**	**2,8147**

3.2 Partial Weight Calculation and Matrix Consistency

The consistency for each weighted average matrix is calculated using the formula. Respondents' answers are considered consistent if CR ≤ 0.1. The RI values used can be seen in Table 5.

Table 5. RI Value Table

Random Index									
N	2	3	4	5	6	7	8	9	10
RI	0.00	0.58	0.90	1.12	1.24	1.32	1.41	1.45	1.51

Level 2
The first step in calculating the weight of each element/criterion is to calculate the total for each column of the matrix. An example calculation for the aesthetic element is as follows.

Aesthetic Elements = 1.0000+6.7735+0.8209+1.7504+2.1161 = 12.4609

Table 6. Number of Weighted Average Calculations for Elements Level 2

Element	***Aesthetic***	***Durability***	***Features***	***Performance***	***Perceived Quality***
Aesthetic	1,0000	0.1476	1,2182	0.5713	0.4726
Durability	6.7735	1,0000	6.2585	4,5509	1.6417
Features	0.8209	0.1598	1,0000	0.6931	0.6686

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Performance	1,7504	0.2197	1.4427	1,0000	1,5399
Perceived Quality	2,1161	0.6091	1,4956	0.6494	1,0000
Amount	**12,4609**	**2,1362**	**11,4151**	**7,4647**	**5,3228**

Table 7. Level 2 Weighted Ranking Summary Table

Element	Weight	*Ranking*
Aesthetic	0.0843	5
Durability	0.4956	1
Features	0.0893	4
Performance	0.1586	3
Perceived Quality	0.1722	2

From the table above, it can be concluded that the Durability criterion has the highest weighting, with a weight of 0.4956. This means that consumers prioritize durability when purchasing a laptop. The Consistency Ratio is then calculated as follows:

$$\begin{pmatrix} 1,0000 & 0,1476 & 1,2182 & 0,5713 & 0,4726 \\ 6,7735 & 1,0000 & 6,2585 & 4,5509 & 1,6417 \\ 0,8209 & 0,1598 & 1,0000 & 0,6931 & 0,6686 \\ 1,7504 & 0,2197 & 1,4427 & 1,0000 & 1,5399 \\ 2,1161 & 0,6091 & 1,4956 & 0,6494 & 1,0000 \end{pmatrix} \begin{pmatrix} 0,0843 \\ 0,4956 \\ 0,0893 \\ 0,1586 \\ 0,1722 \end{pmatrix} = \begin{pmatrix} 0,4383 \\ 2,6301 \\ 0,4628 \\ 0,8091 \\ 0,8890 \end{pmatrix} (1)$$

After obtaining the consistency calculation above, the Consistency Vector calculation is carried out as follows:

0.4383/0,0843= 5.1993
2.6301/0.4956 = 5.3069
0.4628/0.0893 = 5.1825 (2)
0.8091/0.1586 = 5.1015
0.8890/0.1722 = 5.1626

Then the average obtained from dividing CR by the number of elements is as follows:

$$Z_{maks} = \frac{\sum_{i=1}^{n} KonsistensiVektor}{n} \quad (3)$$

$$Z_{maks} = \frac{5,1993 + 5,3069 + 5,1825 + 5,1015 + 5,1626}{5} = 5,1904 \quad (4)$$

n is the number of matrix orders, at this level the matrix used is of order 5, so the calculation of the Consistency Index is as follows:

$$CI = \frac{Zmaks - n}{n-1} \quad (5)$$

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$$CI = \frac{5{,}1904 - 5}{4} = 0{,}0476 \quad (6)$$

The next step is to calculate the Consistency Ratio (CR), where the Random Index (RI) for n = 5 is 1.12, then the CR value can be calculated as follows:

$$CR = \frac{CI}{RandomConsistencyIndex} \quad (7)$$

$$CR = \frac{0{,}0476}{1{,}12} = 0{,}0425 \quad (8)$$

Because CR ≤ 0.1, the respondents' answers to the level 2 questionnaire are consistent.

Level 3

3.3 Elements of Aesthetic elements

The first step in calculating the weight of each aesthetic element is to calculate the total for each column of the matrix. An example calculation for the accessible location element is as follows.
Laptop Design Elements = 1.0000 + 0.7512 + 0.6589 + 0.3959 = 2.7700
In the same way, the matrix number of each element can be found and seen in the following table:

Table 8. Average Weighted Calculations for Level 3 Aesthetic Elements

Element	Laptop Design	Laptop Color	Laptop Screen Display	Laptop Shape
Laptop Design	1,0000	1,3983	1,5176	2,5262
Laptop Colour	0.7152	1,0000	1,1013	3,2958
Laptop Screen Display	0.6589	0.9080	1,0000	2,5905
Laptop Shape	0.3959	0.3034	0.3860	1,0000
Amount	**2,7700**	**3,6097**	**4,0049**	**9.4125**

The next step is to divide each number in each cell by the number of columns, resulting in a normalization matrix where the numbers in each column add up to 1 (one). The weights are obtained by calculating the average of each row. An example of calculating the cell values in the normalization matrix for the first column of a laptop design element and calculating the weights for each laptop design element is as follows.

Laptop Design Elements $= \frac{1{,}0000}{2{,}7700} = 0.3610$ (9)

Laptop Design Weight $= \frac{0{,}3610 + 0{,}3874 + 0{,}3789 + 0{,}2684}{4} = 0.3489$ (10)

Table 9. Normalization Matrix and Row Average for Level 3 Aesthetic Element**s**

Element	Laptop Design	Laptop Color	Laptop Screen Display	Laptop Shape	Weight
Laptop Design	0.3610	0.3874	0.3789	0.2684	**0.3489**
Laptop Color	0.2582	0.2770	0.2750	0.3502	**0.2901**
Laptop Screen Display	0.2379	0.2515	0.2497	0.2752	**0.2536**
Laptop Shape	0.1429	0.0841	0.0964	0.1062	**0.1074**
Amount	**1,0000**	**1,0000**	**1,0000**	**1,0000**	**1,0000**

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The results of the elements of the aesthetic elements are as follows:

Table 10. Ranking of Aesthetic Elements Level 3

Element	Weight	*Ranking*
Laptop Design	0.3489	1
Laptop Color	0.2901	2
Laptop Screen Display	0.2536	3
Laptop Shape	0.1074	4

Table 11. Summary of Partial Weights for Each Level

Partial Weight					
Level 2		**Level 3**		**Level 4**	
Aesthetic	0.0843	**Laptop Design**	0.3489	***Acer***	0.3254
				Asus	0.3192
				HP	0.3554
		Laptop Color	0.2901	***Acer***	0.4495
				Asus	0.3639
				HP	0.1866
		Laptop Screen Display	0.2536	***Acer***	0.3214
				Asus	0.3530
				HP	0.3256
		Laptop Shape	0.1074	***Acer***	0.5354
				Asus	0.2349
				HP	0.2297
Durability	0.4956	**Material**	0.2450	***Acer***	0.1381
				Asus	0.2153
				HP	0.6466
		Spare parts	0.1564	***Acer***	0.2345
				Asus	0.4107
				HP	0.3548
		Cooling System	0.5986	***Acer***	0.1867
				Asus	0.1775
				HP	0.6358

Table 11. Summary of Partial Weights for Each Level (Continued)

		Shelf Life	0.4249	***Acer***	0.2317
				Asus	0.3938
				HP	0.3745
Partial Weight					
Level 2		**Level 3**		**Level 4**	
Features	0.0893	***Bluetooth***	0.2158	***Acer***	0.3753

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				Asus	0.1920
				HP	0.4327
				Acer	0.2331
		Fingerprint	0.1960	***Asus***	0.3117
				HP	0.4552
				Acer	0.4075
		Touchscreen	0.1633	***Asus***	0.2567
				HP	0.3358
				Acer	0.2402
		Processor Speed	0.5705	***Asus***	0.3333
				HP	0.4265
				Acer	0.3234
		Storage Capacity	0.2150	***Asus***	0.2607
				HP	0.4159
Performance	0.1586			***Acer***	0.2351
		GPU Performance	0.1267	***Asus***	0.2231
				HP	0.5417
				Acer	0.2411
		Laptop Stability	0.0878	***Asus***	0.4029
				HP	0.3560
Perceived Quality	0.1722	**Brand Reputation**	0.4200	***Acer***	0.5269

Table 12. Summary of Partial Weights for Each Level (Continued)

				Asus	0.1778
				HP	0.2953
				Acer	0.5179
		Design	0.0908	***Asus***	0.2547
				HP	0.2274
		Warranty	0.4892	***Acer***	0.4579

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	Asus	0.2568
	HP	0.2853

3.4 Calculation of Total Product Weight

After all the weight values for each level are obtained, the product alternative with the highest weight or percentage is determined. The total weight can be calculated by adding the priority weights of level 4 for each product alternative to obtain a total value that reflects the product's weight. The results of the weighting calculation for selecting laptop product alternatives can be seen in Table 12.

Table 12. Calculation of Total Product Weight

No	Product	Total Weight	Percentage	Ranking
1	Acer	0.7146	71.46%	1
2	Asus	0.1381	13.81%	3
3	HP	0.1473	14.73%	2
	Total	**1**	**100%**	

3.5 Recapitulation of CRH Level 4 Calculations

The following is a summary of the CRH calculations for each element as follows:

Table 13. Recapitulation of CRH Level 4 Calculations

Element	CRH	Information
Laptop Design	0.0020	Consistent
Laptop Color	0.0220	Consistent
Laptop Screen Display	0.0108	Consistent
Laptop Shape	0.0056	Consistent
Material	0.0363	Consistent
Spare parts	0.0020	Consistent
Cooling System	0.0213	Consistent
Shelf Life	0.0003	Consistent
Bluetooth	0.0001	Consistent
Fingerprint	0.0046	Consistent
Touchscreen	0.0881	Consistent
Processor Speed	0.0034	Consistent
Storage Capacity	0.0106	Consistent
GPU Performance	0.0008	Consistent
Laptop Stability	0.0070	Consistent
Brand Reputation	0.0153	Consistent
Design	0.0001	Consistent
Warranty	0.0187	Consistent

CONCLUSION

This study began with a preliminary survey to determine user preferences in choosing a laptop and the obstacles faced when determining a laptop that suits their needs. Based on the survey, it was found that selecting the right laptop requires criteria-based analysis so that the AHP method was applied as a tool to make the best alternative decision. Next, a literature study was conducted to obtain a theoretical basis related to AHP as well as references to previous research on the application of AHP in selecting technology products. After the variables were confirmed to be in accordance with the research

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objectives, a decision hierarchy structure was determined consisting of the purpose of selecting a laptop, assessment criteria (Aesthetic, Durability, Features, Performance, Perceived Quality), and alternative laptops chosen by respondents (Acer, Asus, and HP). The most superior laptop products were Acer, Asus, and HP. AHP was used in decision making. The hierarchy used to create the AHP questionnaire was consistent, meaning that one element was equal to another. The element with the highest priority was Durability (49.56%).

AUTHOR'S CONTRIBUTION

Muhammad Khatami: Conceptualization, methodology, investigation, data curation, formal analysis, writing original draft, supervision, and corresponding author. Sastika Amalia: Investigation, data curation, formal analysis, and writing review and editing. Nahdah Fadhilah: Investigation, data curation, and writing review and editing.Li Idi'il Fitri: Methodology, validation, and writing review and editing.Melva Dwiyanti: Investigation, data curation, and writing review and editing.Fahriansyah Sebayang: Formal analysis, visualization, and writing review and editing.Jeli Marito Oppusunggu: Validation, supervision, and writing review and editing.Raja Rahmat Syawal: Project administration, supervision, and writing review and editing.

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DECLARATION OF COMPETING INTEREST

The authors declare that they have no competing interests

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