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Decision Support System for Gaming Laptop Selection Using AHP

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Abstract: This study aims to provide recommendations for gaming laptops using the AHP method with criteria for Hardware used, Graphics Card, Design, Cooling System, Reliability, Connectivity, Price, so that it becomes a solution for gamers in choosing the right laptop for gaming. The decision support system for gaming laptop selection recommendations developed is implemented using the Analytical Hierarchy Process (AHP) method. Where the AHP method can describe complex multi-factor or multi-criteria problems into a hierarchy, then the importance of each variable is given a subjective numerical value to be compared with other variables through a paired comparison matrix. Based on the assessment results using the AHP method, a recommendation for choosing the first gaming laptop by Dell Gaming G15 with a value of 0.806, the second model recommendation was obtained by Acer Nitro with a value of 0.5745, the third model recommendation was obtained by MSI Bravo 15 B5DD with a value of 0.524.
Keywords: AHP; Criteria; Decision Support System; Laptop Gaming; Recommendation

1. INTRODUCING

Gaming laptop is a laptop specifically designed to provide high performance in running computer games that require higher processing power and graphics. Unlike regular laptops, gaming laptops are equipped with more powerful hardware components, such as faster processors, more powerful graphics cards, more RAM, and faster storage. Gaming laptops generally have attractive and aggressive designs, with striking LED lighting and special features such as macro keys or mechanical keyboards. They also often come with high-quality screens, high resolutions, fast refresh rates, and support for graphics technologies such as G-Sync or Free-Sync. The selection of a gaming laptop must consider hardware specifications, graphics card, screen, design, cooling system, reliability, connectivity, and price. It is important to identify your needs and find a laptop that fits your budget and preferences.

Decision Support System (DSS) is a description of a system created to help decision making in an organization or complex situation[1]. The main purpose of DSS is to provide relevant information, analysis, and modeling to help make better and effective decisions[2]–[4]. DSS is a system that helps decision making by providing relevant information, analysis, and modeling. The goal is to assist decision makers in evaluating various alternatives and selecting the best one based on specified criteria[5]–[7].

Analytical Hierarchy Process (AHP) is a decision model used in making a decision to assist decision making in complex situations and involves various interrelated criteria or

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factors[8]–[11]. AHP was developed by Thomas L. Saaty and has become one of the popular methods in the field of decision making. AHP is a method in decision support systems used to assist decision making in complex situations and involving many criteria or factors. The AHP method allows decision makers to compare and assess these criteria relatively to obtain the right priority or weight. The use of the AHP method as a decision maker can obtain more structured information and support in making more rational and objective decisions. This method has been widely used in various fields, including business, management, finance, engineering, and environment.

Some previous research that has been done is laptop selection research using the AHP method. The result of the Analytical Hierarchy Process method in this study is the Lenovo Ideapad 310 laptop as the best laptop according to the right price criteria with specifications not much different from the Asus A456UF laptop because it is done through a systematic completion process with real data so that this system will provide information precisely and correctly[12]. This study uses the AHP method to conduct an analysis of existing alternatives based on priority weight, comparison between criteria with other criteria, and alternatives with other alternatives based on existing criteria. The results of this study show that the criteria of price, processor, RAM are three important criteria that determine the selection of laptops[13].

This study aims to provide recommendations for gaming laptops using the AHP method with criteria used Hardware, Graphics Card, Design, Cooling System, Reliability, Connectivity, Price, so it becomes a solution for gamers in choosing the right laptop for playing games.

2. RESEARCH METHOD

Research stages refer to the steps taken in the research process to achieve the set research objectives. These stages help guide researchers in planning, implementing, and analyzing research systematically[14], [15]. The stages of research conducted in this study will be shown in Figure 1 below.

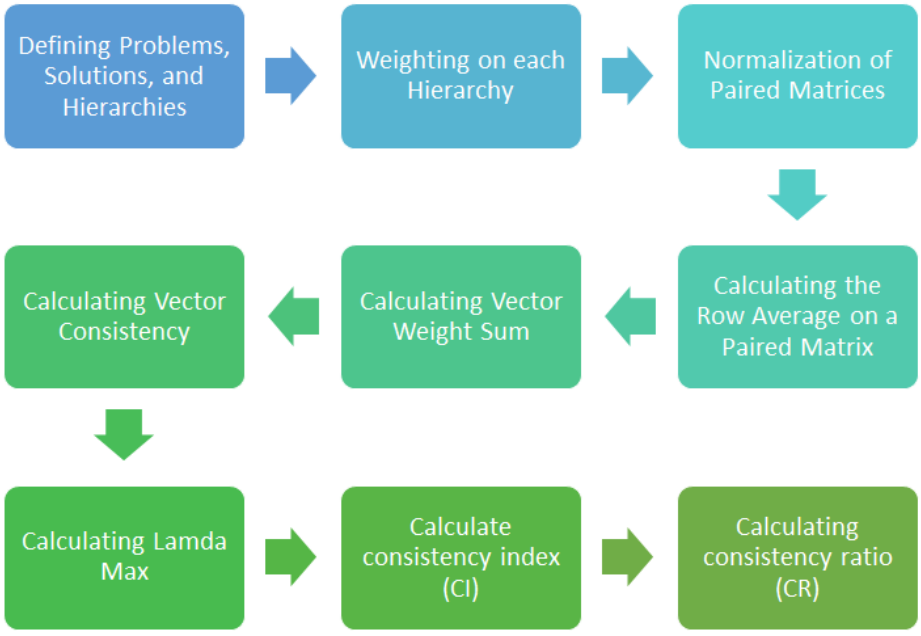

Figure 1. Stages of Gaming Laptop Selection Research

The explanation of the stages of research carried out will be described as follows.

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1. **Defining Problems, Solutions, and Hierarchies**
   In this stage we try to determine the problem we will solve in a clear, detailed and easy to understand. From the existing problems we try to determine solutions that may be suitable for the problem. We will develop the solution further in the next stage.
2. **Weighting on each Hierarchy**
   Assessment of criteria at each level of the hierarchy is given an assessment of the relative importance of one criterion to another. The level of hierarchy of each criterion is carried out in pairwise comparison, which compares each element with other elements. Each level of the hierarchy is paired so that the value of the importance of the element is obtained in qualitative form.

3. **Normalization of Paired Matrices**
   Normalize data on paired matrices between criteria by dividing the i column and j row by the sum in column i.

4. **Calculating the Row Average on a Paired Matrix**
   This step performs the summation of the values of the row and divides the result of the sum by the number of elements to get the average value/priority weight shown in the following equation

$$x = \frac{\sum i}{n} \quad (1)$$

5. **Calculating Vector Weight Sum**
   In this step, we multiply the initial matrix of comparison criteria by the Row Average.

6. **Calculating Vector Consistency**
   This step calculates the Vector Consistency obtained from the multiplication between the Weight Sum Vector and the Row Average.

7. **Calculating Lamda Max**
   This stage calculates the lamda max with the following formula.

$$\Lambda_{max} = \frac{\sum a}{n} \quad (2)$$

8. **Calculate consistency index (CI)**
   At this stage we calculate the consistency index value with the following equation.

$$CI = \frac{\sum \lambda - n}{n-1} \quad (3)$$

9. **Calculating consistency ratio (CR)**
   At this stage we calculate the consistency index value with the following equation.

$$CR = \frac{CI}{IR} \quad (4)$$

   Finally, check the CR value with the condition that if the value is more than 10%, then the judgment data assessment must be corrected. However, if the Consistency Ratio (CI / IR) ≤ 0.1, then the calculation results can be declared correct. If it is consistent, we can do calculations based on existing criteria so as to produce an alternative that becomes an option.

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3. RESULT AND DISCUSSIONS

Applying AHP approach in decision support systems, the selection of gaming laptops has criteria of Hardware, Graphics, Card Design, Cooling, System Reliability, Connectivity, and Price.

AHP Method Process in Gaming Laptop Selection

The stages of the AHP calculation process to see the consistency ratio value will be discussed as follows.

1. Defining Problems, Solutions, and Hierarchies
   The first stage will define the problem, namely the selection of a gaming laptop. The solution that will be produced is the determination of gaming laptop recommendations.
2. Weighting on each Hierarchy
   In the second step, we will make the weighting of each hierarchy and matrix paired from each criterion, as follows. The criteria used are Hardware (K1), Graphics Card (K2), Design (K3), Cooling System (K4), Reliability (K5), Connectivity (K6), Price (K7)

	K1	K2	K3	K4	K5	K6	K7
K1	1	0.333	5	7	5	3	3
K2	3	1	5	5	3	7	0.333
K3	0.2	0.2	1	3	0.333	0.2	5
K4	0.143	0.2	0.333	1	0.333	3	0.200
K5	0.2	0.333	3	3	1	0	0.143
K6	0.333	0.143	5	0.333	3	1	0.2
K7	0.333	3	0.2	5	7	5	1
SUM	5.210	5.210	19.533	24.333	19.667	19.533	9.876

3. Normalization of Paired Matrices
   In the third stage, we will calculate the normalization of the paired matrix of each criterion, as follows:

	K1	K2	K3	K4	K5	K6	K7
K1	0.192	0.064	0.256	0.288	0.254	0.154	0.304
K2	0.576	0.192	0.256	0.205	0.153	0.358	0.034
K3	0.038	0.038	0.051	0.123	0.017	0.010	0.506
K4	0.027	0.038	0.017	0.041	0.017	0.154	0.020
K5	0.038	0.064	0.154	0.123	0.051	0.017	0.014
K6	0.064	0.027	0.256	0.014	0.153	0.051	0.020
K7	0.064	0.576	0.010	0.205	0.356	0.256	0.101

4. Calculating the Row Average on a Paired Matrix
   In the fourth step, we will calculate the row average on the matrix in pairs, as follows

Criteria	Row Average
K1	0.216
K2	0.253
K3	0.112
K4	0.045
K5	0.066
K6	0.084
K7	0.224

5. Calculating Vector Weight Sum
   In the fourth step, we will calculate the row average on the matrix in pairs, as follows

0.192	0.064	0.256	0.288	0.254	0.154	0.304	X	0.216	=	0.197
0.576	0.192	0.256	0.205	0.153	0.358	0.034		0.253		0.259

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0.038	0.038	0.051	0.123	0.017	0.010	0.506	0.112	0.145
0.027	0.038	0.017	0.041	0.017	0.154	0.020	0.045	0.038
0.038	0.064	0.154	0.123	0.051	0.017	0.014	0.066	0.055
0.064	0.027	0.256	0.014	0.153	0.051	0.020	0.084	0.069
0.064	0.576	0.010	0.205	0.356	0.256	0.101	0.224	0.238

6. Calculating Vector Consistency
   In the sixth step, we will multiply the weight sum vector by the row average, as follows

0.197		0.216		0.042526
0.259		0.253		0.0655337
0.145		0.112		0.0162179
0.038	X	0.045	=	0.0017066
0.055		0.066		0.0036442
0.069		0.084		0.0057628
0.238		0.224		0.0532434

7. Calculating Lamda Max
   This step calculates the lamda max with formula (2) as follows

$$\Lambda_{max} = \frac{0.042526+0.0655337+0.0162179+0.0017066+0.0036442+0.0057628+0.0532434}{7} = 0.026947788$$

8. Calculate consistency index (CI)
   At this stage we calculate the consistency index value with the following equation.

$$CI = \frac{0.026947788 - 7}{7 - 1} = -1.162175369$$

9. Calculating consistency ratio (CR)
   At this stage we calculate the consistency index value with the following equation.

$$CR = \frac{-1.162175369}{1.32} = -0.880435885$$

   From the results of the CR value obtained shows that the CR value < 0.1 can be continued for alternative calculations.

Implementation of the AHP Method in Determining Gaming Laptop Recommendations

The decision support system for choosing gaming laptop recommendations uses 4 alternative gaming laptops, the alternatives used are Acer Nitro (A1), MSI Bravo 15 B5DD (A2), HP Victus Gaming laptop 15 (A3), Dell Gaming G15 (A4). The following is the comparative matrix value of each alternative based on existing criteria.
The first step is to make the assessment results of each alternative with existing criteria, the results of the comparative matrix assessment can be seen as follows. The results of the matrix comparison and matrix normalization for hardware criteria can be seen in table 1 below.

Table 1. Comparison Matrix and Hardware Criteria Normalization Results

Criteria K1				
Alternative	A1	A2	A3	A4
A1	1	0.2	3	3
A2	5	1	0.2	3
A3	0.333	5.	1	5
A4	0.333	0.333	0.2	1
Total	6.667	6.533	4.4	12
Normalization Results				
A1	0.150	0.031	0.682	0.25
A2	0.75	0.153	0.045	0.25

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A3	0.05	0.765	0.227	0.417
A4	0.05	0.051	0.045	0.083

The results of the matrix comparison and matrix normalization for graphics card criteria can be seen in table 2 below.

Table 2. Comparison Matrix and Graphics Card Criteria Normalization Results

Criteria K2				
Alternative	A1	A2	A3	A4
A1	1	3	5	0.333
A2	0.333	1	5	0.333
A3	0.2	0.2	1	3
A4	3	3	0.333	1
Total	4.533	7.2	11.333	4.667
Normalization Results				
A1	0.221	0.417	0.441	0.071
A2	0.074	0.139	0.441	0.071
A3	0.044	0.028	0.088	0.643
A4	0.662	0.417	0.029	0.214

The results of the matrix comparison and matrix normalization for design criteria can be seen in table 3 below.

Table 3. Comparison Matrix and Design Criteria Normalization Results

Criteria K3				
Alternative	A1	A2	A3	A4
A1	1	0.2	0.143	3
A2	5	1	5	3
A3	7	0.2	1	0.333
A4	0.333	0.333	3	1
Total	13.333	1.733	9.143	7.333
Normalization Results				
A1	0.075	0.115	0.016	0.409
A2	0.375	0.577	0.547	0.409
A3	0.525	0.115	0.109	0.045
A4	0.025	0.192	0.328	0.136

The results of the matrix comparison and matrix normalization for cooling system criteria can be seen in table 4 below.

Table 4. Comparison Matrix and Cooling System Criteria Normalization Results

Criteria K4				
Alternative	A1	A2	A3	A4
A1	1	3	5	5
A2	0.333	1	3	7
A3	0.2	0.333	1	5
A4	0.2	0.143	0.2	1
Total	1.733	4.476	9.2	18
Normalization Results				
A1	0.577	0.670	0.543	0.278
A2	0.192	0.223	0.326	0.389

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A3	0.115	0.074	0.109	0.278
A4	0.115	0.032	0.022	0.056

The results of the matrix comparison and matrix normalization for reliability criteria can be seen in table 5 below.

Table 5. Comparison Matrix and Reliability Criteria Normalization Results

Criteria K5				
Alternative	A1	A2	A3	A4
A1	1	5	0.2	0.143
A2	0.2	1	3	0.143
A3	5	0.333	1	0.2
A4	7	7	5	1
Total	13.2	13.333	9.2	1.486
Normalization Results				
A1	0.076	0.375	0.022	0.096
A2	0.015	0.075	0.326	0.096
A3	0.379	0.025	0.109	0.135
A4	0.530	0.525	0.543	0.673

The results of the matrix comparison and matrix normalization for connectivity criteria can be seen in table 6 below.

Table 6. Comparison Matrix and Connectivity Criteria Normalization Results

Criteria K6				
Alternative	A1	A2	A3	A4
A1	1	5	0.143	0.333
A2	0.2	1	0.2	0.333
A3	7	5	1	0.333
A4	3	3	3	1
Total	11.2	14	4.343	2
Normalization Results				
A1	0.089	0.357	0.033	0.167
A2	0.018	0.071	0.046	0.167
A3	0.625	0.357	0.230	0.167
A4	0.268	0.214	0.691	0.500

The results of the matrix comparison and matrix normalization for priice criteria can be seen in table 7 below.

Table 7. Comparison Matrix and Price Criteria Normalization Results

Criteria K7				
Alternative	A1	A2	A3	A4
A1	1	3	3	0.2
A2	0.333	1	0.333	7
A3	0.333	3	1	0.333
A4	5	0.143	3	1
Total	6.667	7.143	7.333	8.533
Normalization Results				
A1	0.150	0.420	0.409	0.023
A2	0.050	0.140	0.045	0.820
A3	0.050	0.420	0.136	0.039

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A4	0.750	0.020	0.409	0.117

After the normalization results of each alternative are obtained, then determine the row average of each alternative with existing criteria. The results of the row average calculation can be seen in table 8 below.

Table 8. Row Average Alternative

	K1	K2	K3	K4	K5	K6	K7
A1	0.278	0.287	0.154	0.517	0.142	0.161	0.251
A2	0.300	0.181	0.477	0.283	0.128	0.076	0.264
A3	0.365	0.201	0.199	0.144	0.162	0.345	0.161
A4	0.057	0.331	0.170	0.056	0.568	0.418	0.324

After the row average value for each alternative is obtained, then multiply between the row average value of the criteria with the row average value of the alternatives to get the final value of each alternative. The final value of each alternative can be seen in table 9.

Table 9. Alternative Final Value and Alternative Ranking

Alternative	Total AHP Calculation Value	Alternative Ranking
A4	0.806	1
A1	0.574	2
A2	0.524	3
A3	0.371	4

The results of the assessment of gaming laptop selection recommendations are applied using the AHP method, so that it will make it easier for users to make decisions. The results of the assessment of the recommendation for choosing an Alternative 4 gaming laptop, namely Dell Gaming G15 ranked 1st, Alternative 1, namely Acer Nitro ranked 2nd. Alternative 2, namely MSI Bravo 15 B5DD ranked 3rd, and Alternative 3, namely HP Victus Gaming laptop 15 ranked 4th.

Based on the assessment results using the AHP method, a recommendation for choosing the first gaming laptop by Dell Gaming G15 with a value of 0.806, the second model recommendation was obtained by Acer Nitro with a value of 0.5745, the third model recommendation was obtained by MSI Bravo 15 B5DD with a value of 0.524.

4. CONCLUSION

The decision support system for gaming laptop selection recommendations developed is implemented using the Analytical Hierarchy Process (AHP) method. Where the AHP method can describe complex multi-factor or multi-criteria problems into a hierarchy, then the importance of each variable is given a subjective numerical value to be compared with other variables through a paired comparison matrix. In order for the resulting pairwise comparison matrix to be used as a reference, the determination of the quantitative scale at the importance of the criteria becomes an important factor.

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