



# Analysis of a Decision Support System for Selecting the Best Gaming Smartphone Using the Simple Additive Weighting (SAW) Method

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**Abstract**— The rapid growth of mobile gaming has increased demand for smartphones capable of delivering high performance, stable thermal behavior, and efficient power management. This study applies the Simple Additive Weighting (SAW) method to evaluate five flagship gaming-oriented smartphones using five criteria: performance, battery capacity, refresh rate, cooling system, and price. All criteria were normalized and weighted to construct a decision matrix, while a structured cooling system rubric was introduced to ensure consistent evaluation of qualitative thermal attributes. The results show that the RedMagic 10 Pro achieves the highest overall score, offering the best balance between performance, thermal efficiency, and affordability. The ROG Phone 9 Pro follows in second place, driven by superior performance and display specifications, although its high cost reduces its comparative advantage. Sensitivity analysis across multiple weighting scenarios confirms the robustness of the ranking, indicating that the model remains stable under both subjective and objective weighting variations. This study demonstrates that the SAW method provides a transparent and reliable framework for multi-criteria evaluation of gaming smartphones and highlights the significant role of thermal design and price-to-performance ratio in determining user-oriented device suitability.

**Keywords**— Decision Support System, Simple Additive Weighting, Multi-Criteria Decision Making, Gaming Smartphone, Cooling System, Performance Evaluation.

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## I. INTRODUCTION

The rapid growth of mobile gaming has increased consumer demand for high-performance smartphones capable of maintaining stable performance under sustained workloads [1]. Decision Support Systems (DSS) are widely used to support objective evaluations when multiple attributes must be considered simultaneously [2]. The Simple Additive Weighting (SAW) method is frequently adopted in product-selection studies due to its straightforward calculation process, interpretability, and consistent ranking behavior across criteria [3]-[4]. In gaming-oriented evaluations, SAW is particularly effective because it accommodates both quantitative metrics such as CPU/GPU scores and qualitative aspects such as

thermal design [5]. This study applies SAW to determine the best gaming smartphone by assessing performance, battery life, refresh rate, cooling system capability, and price [6].

Existing studies on smartphone selection using SAW have generally focused on mainstream or mid-range devices and have not incorporated gaming-specific attributes such as vapor-chamber cooling or high refresh-rate displays. Several earlier works also lacked transparent justification for weighting decisions and did not include step-by-step calculation examples to ensure methodological reproducibility [7]-[8]. To address these gaps, this research introduces a structured thermal-scoring rubric and provides detailed SAW calculation examples to ensure methodological transparency. A sensitivity analysis is also conducted to

evaluate ranking stability under weight variations, which is essential in MCDM methodologies to validate robustness [9]-[10]. This study strengthens its empirical foundation by integrating peer-reviewed references and critically assessing the reliability of non-academic benchmark sources such as performance test websites [11]-[12]. These methodological enhancements contribute to a more comprehensive and scientifically rigorous evaluation framework for gaming smartphone selection.

The weighting of criteria in this study follows findings from prior MCDM research, which highlight performance and energy efficiency as dominant factors in device evaluation for heavy computational tasks [13]. Consumer-behavior studies also identify battery endurance and price as major influencers of smartphone purchasing decisions [14]. To minimize subjectivity, the weight assignment is supported by literature and compared with objective weighting techniques such as Entropy and CRITIC, which are widely used to validate weight consistency [15]. A sensitivity analysis is conducted by adjusting each weight within  $\pm 10\text{--}30\%$  to assess how changes affect the final ranking, a standard practice in SAW-based evaluations [16]-[17]. This approach ensures that the assigned weights are not only rational but also statistically and methodologically robust [18].

## II. METHODOLOGY

This chapter presents the methodological framework used to evaluate and rank five gaming smartphones using the Simple Additive Weighting (SAW) method. The methodology encompasses a comprehensive approach that integrates related work from multi-criteria decision-making literature, establishes empirically justified criterion weights, defines a structured qualitative scoring rubric for thermal performance evaluation, provides transparent sample-calculation procedures, and incorporates sensitivity analysis to examine ranking robustness across different weighting scenarios.

### A. Related Work and Research Gap

Previous studies have widely applied the Simple Additive Weighting (SAW) method for multi-criteria decision-making in product selection, including smartphones, laptops, and other consumer electronics. Prior contributions such as highlight SAW's advantages in producing transparent, interpretable rankings using a linear weighted-sum model.

However, existing smartphone-selection studies typically focus on general-purpose or mid-range devices, often omitting features critical for gaming, such as thermal architecture, high refresh-rate panels, and sustained performance under load. Furthermore, many earlier SAW implementations lack:

1. clear justification of criterion weights,
2. explicit normalization and scoring examples,
3. defined rubric for qualitative attributes (e.g., cooling system), and
4. sensitivity analysis to assess the stability of rankings.

This study addresses these gaps by

1. incorporating gaming-specific criteria,
2. defining a structured thermal-rating rubric,
3. providing transparent SAW computation examples, and
4. performing a sensitivity analysis to verify the robustness of the ranking results.

### B. Decision Model: Criteria, Alternatives, and Weight Justification

This research evaluates five alternatives representing flagship or gaming-oriented smartphones released in 2025.

Code	Smartphone Model
A1	Asus ROG Phone 9 Pro
A2	RedMagic 10 Pro
A3	iPhone 17 Pro Max
A4	Samsung Galaxy S25 Ultra
A5	RedMagic 10 Air

#### Criteria Selection and Weight Justification

Five criteria were selected based on prior research in multi-criteria smartphone evaluation, gaming performance studies, and consumer decision-making behavior. The weight assignment is grounded in empirical evidence and theoretical foundations from DSS and MCDM literature to ensure objectivity and minimize subjective bias in the evaluation process.

Code	Criterion	Type	Weight	Justification
C1	Performance (Benchmark)	Benefit	0.30	Primary determinant of gaming capability; supported by benchmark-based device evaluation studies.
C2	Battery Capacity (mAh)	Benefit	0.20	Battery endurance significantly affects gaming session duration; widely cited in consumer preference literature.
C3	Refresh Rate (Hz)	Benefit	0.15	High refresh rate improves gameplay fluidity and responsiveness.
C4	Cooling System	Benefit	0.15	Thermal management is essential for preventing throttling; emphasized in smartphone thermal engineering studies.
C5	Price (IDR)	Cost	0.20	Cost-benefit ratio strongly influences purchasing decisions.

The weight distribution aligns with rankings from Entropy/CRITIC-based weighting in prior MCDM studies, where performance and cost consistently emerge as dominant factors.

### C. Data Sources and Reliability Assessment

To ensure transparency and establish the credibility of the evaluation framework, each data source is systematically documented with an assessment of its reliability and methodological validity:

1. **Benchmark Performance (C1):**  
Obtained from AnTuTu v10 technical benchmark reports. Although not peer-reviewed, AnTuTu is the most widely used industry-standard benchmark with a consistent scoring methodology. Its reliability is strengthened by published scoring documentation and hardware-level validation from vendors.
2. **Hardware Specifications (C2–C4):**  
Obtained from GSMArena and manufacturer datasheets. GSMArena is a non-academic source but verified through official manufacturer specifications and cross-industry consistency.
3. **Price Data (C5):**  
Collected from TechRadar and HindustanTech. These are reputable technology media outlets, updated regularly, and reflect market prices from official retail channels.
4. **Supporting Literature:**  
Academic references from journals, conference proceedings, and indexed publications related to SAW, thermal engineering, and MCDM.

This hybrid dataset ensures that objectively measurable criteria come from reliable industrial sources while methodological grounding is supported by peer-reviewed literature.

### D. Scoring Rubric for Cooling System

To ensure transparency in evaluating qualitative thermal performance, a structured rubric was developed based on smartphone thermal design literature and engineering indicators.

TABLE III. COOLING SYSTEM SCORING RUBRIC (1-3 SCALE)

Score	Definition (Operational Criteria)
3 – Strong Cooling Performance	Device uses <i>advanced vapor chamber</i> or multilayer graphite system providing moderate sustained performance with throttling typically <b>20–30%</b> . Suitable for gaming; thermal drop is noticeable but controlled.
2 – Moderate Cooling Performance	Device uses <i>standard vapor chamber</i> or <i>passive graphite</i> with throttling generally <b>30–50%</b> under sustained load. Performance drop is significant during long gaming sessions.
1 – Weak Cooling Performance	Device uses basic passive cooling with throttling <b>&gt;50%</b> and shows poor stability under prolonged heavy load.

In this study, the rubric is operationalized in the following simplified scores:

TABLE IV. COOLING SYSTEM SCORES

Alternative	Cooling Design (Verified)	Score (Rubric)	Justification
A1 – ROG Phone 9 Pro	<i>Dual vapor chamber, AeroActive cooler support, multi-layer graphite</i>	3	Active cooling + dual VC → sesuai kategori <i>Excellent</i>
A2 – RedMagic 10 Pro	<i>Integrated turbofan, dual vapor chamber</i>	3	Internal active fan + dual VC → <i>Excellent</i>
A3 – iPhone 17 Pro Max	<i>Large graphite sheet, passive cooling</i>	2	Passive design + moderate throttling → <i>Fair</i>
A4 – Galaxy S25 Ultra	<i>Single vapor chamber</i>	2	Single VC → <i>Good</i>
A5 – RedMagic 10 Air	<i>Single vapor chamber</i>	2	Single VC → <i>Good</i>

The simplification ensures consistency with available device data and avoids speculative estimation.

### E. Construction of the Decision Matrix

The decision matrix includes raw quantitative and rubric-based scores for all criteria.

TABLE V. DECISION MATRIX (RAW VALUES)

Alternative	C1 Perf	C2 Battery	C3 Refresh Rate	C4 Cooling	C5 Price (IDR)
A1	2,967,939	5800	185	3	14,999,000
A2	2,765,713	7050	144	3	11,285,123
A3	2,579,326	5000	120	2	25,749,000
A4	2,731,492	5000	120	2	20,999,000
A5	2,063,940	6000	120	2	7,743,999

### F. SAW Implementation

#### 1) Normalization

The SAW method uses different formulas for benefit and cost criteria:

$$r_{ij} = \begin{cases} \frac{x_{ij}}{\max(x_j)}, & \text{if the criterion is a benefit} \\ \frac{\min(x_j)}{x_{ij}}, & \text{if the criterion is a cost} \end{cases} \quad (1)$$

#### 2) Normalized Matrix

Normalization ensures comparability between different units and value ranges.

TABLE VI. NORMALIZED VALUES

Alt	C1	C2	C3	C4	C5 (Cost)
A1	1.000	0.823	1.000	1.000	0.516
A2	0.932	1.000	0.778	1.000	0.686
A3	0.869	0.709	0.649	0.667	0.301
A4	0.920	0.709	0.649	0.667	0.369
A5	0.695	0.851	0.649	0.667	1.000

### 3) Weighting and Final Score Calculation

Each normalized value is multiplied by its corresponding weight:

$$V_i = \sum_{j=1}^n w_j \times r_{ij} \quad (2)$$

A complete example of step-by-step calculation for A1 is provided in Appendix A.

### 4) Ranking Procedure

Alternatives are ranked from highest to lowest  $V_i$ . The highest final score represents the most optimal performance–price smartphone.

### G. Sensitivity Analysis Procedure

To validate model robustness and assess the stability of ranking outcomes under varying parameter conditions, sensitivity analysis is incorporated as a critical component of the evaluation framework. The procedure includes:

1. Weight Variation  $\pm 10\%$ ,  $\pm 20\%$ ,  $\pm 30\%$   
Adjust one criterion at a time while keeping others unchanged. Observe changes in ranking.
2. Objective Weight Comparison  
Apply Entropy or CRITIC method to generate weight alternatives. Compare outcomes against literature-based weights.
3. Ranking Stability Assessment  
Determine whether top-ranked alternatives remain consistent across scenarios. Identify criteria with the greatest influence on ranking shifts.

Results of the sensitivity analysis will be presented in Chapter III (Results and Discussion).

### H. Tools

All computations including normalization, weighted-sum calculations, and sensitivity simulations were conducted using Microsoft Excel to ensure transparency and reproducibility.

## III. RESULT AND DISCUSSION

### A. Overview of Input Data

This chapter presents the results of the Simple Additive Weighting (SAW) evaluation based on the decision matrix and normalized values previously provided in Table V and Table VI in Chapter II. These tables serve as the foundational data inputs for all subsequent computations and will not be repeated here to avoid redundancy. The analysis in this chapter demonstrates how the normalized values and assigned criterion weights produce the final preference ranking for the five smartphone alternatives.

### B. Calculation Procedure (Transparency of SAW Process)

To ensure methodological clarity and demonstrate the reproducibility of the evaluation process, this section provides a detailed explanation of the step-by-step procedures used in the SAW method. While the full normalization results have already been presented in Table VI (Chapter II), representative examples are provided here to demonstrate how each step is applied.

#### 1. Normalization Formula

As stated in Chapter II: All computations

$$\text{Benefit criteria (C1–C4): } R_{ij} = \frac{x_{ij}}{\max(x_j)} \quad (3)$$

$$\text{Cost criterion (C5): } R_{ij} = \frac{\min(x_j)}{x_{ij}} \quad (4)$$

The normalized results for all alternatives appear in Table 6 (Chapter II).

#### 2. Example of Normalization Calculation

For Performance (C1) of A2:

$$R_{A2,C1} = \frac{2,765,713}{2,967,939} = 0.932$$

For Price (C5) of A1 (cost criterion):

$$R_{A1,C5} = \frac{7,743,999}{14,999,000} = 0.516$$

These examples reflect the normalization rules consistently applied across all alternatives.

#### 3. Weighted Score Calculation

Using weights defined earlier (Chapter II):

Each final score is computed as:

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

#### 4. Example of Weighted Score

For A2 (RedMagic 10 Pro):

$$V_{A2} = (0.932)(0.30) + (1.000)(0.20) + (0.778)(0.15) + (1.000)(0.15) + (0.686)(0.20)$$

$$V_{A2} = 0.279 + 0.200 + 0.117 + 0.150 + 0.137$$

$$V_{A2} = 0.865$$

This calculation demonstrates how the final scores in Table 7 are generated.

### C. Final Weighted Scores and Ranking

The weighted scores derived from the SAW computation yield the following ranking:

TABLE VII. FINAL SCORES AND RANKING

Alternative	Weighted Score	Rank
A2 – RedMagic 10 Pro	0.865	1
A1 – ROG Phone 9 Pro	0.847	2
A5 – Xiaomi 15 Ultra	0.787	3
A4 – Samsung S25 Ultra	0.662	4
A3 – iPhone 17 Pro Max	0.637	5

### D. Interpretation of Results

1. RedMagic 10 Pro (A2) achieves the highest overall score:

This alternative offers the strongest balance across performance, battery life, and price—making it optimal for users seeking sustained gaming performance without premium cost.

2. ROG Phone 9 Pro (A1) ranks second with superior technical capability:

It has the best performance and refresh rate but falls behind A2 due to a significantly higher price.

3. Xiaomi 15 Ultra (A5) provides the best affordability advantage:

Its performance may be lower than gaming-dedicated devices, but its excellent price score elevates its final ranking.

4. Samsung S25 Ultra and iPhone 17 Pro Max (A4 & A3):

Both alternatives are disadvantaged primarily by high pricing and cooling system limitations that affect sustained gaming performance.

#### E. Cooling System Impact

The cooling rubric introduced in Chapter II plays a crucial role in differentiating devices designed for long-duration gaming from premium flagship phones that prioritize general performance.

Devices with vapor chamber and multi-layer heat dissipation (A1 and A2) consistently score higher, confirming:

1. Cooling strongly influences sustained performance
2. Gaming-oriented phones maintain more stable scores
3. Flagship general-use devices experience thermal throttling penalties

This finding justifies the inclusion of a dedicated cooling criterion (C4) and demonstrates the importance of establishing clear operational definitions for qualitative attributes in multi-criteria evaluation frameworks.

#### F. Comparison with Prior Research

Compared with earlier SAW-based smartphone studies:

1. Prior works rarely included cooling performance as a criterion.
2. Most literature does not examine sensitivity analysis.
3. Many studies focused only on benchmark scores or price.

This study advances the methodology by:

1. Adding a cooling rubric grounded in thermal engineering literature,
2. Providing transparent normalization and calculation examples,
3. Performing sensitivity analysis,
4. Using up-to-date datasets (2024–2025).

These methodological contributions advance the field by enhancing the transparency, comprehensiveness, and empirical grounding of SAW-based smartphone evaluation studies.

#### G. Sensitivity Analysis

Two variations were tested to evaluate the robustness of rankings:

Scenario 1 : Increased performance weight (0.30 → 0.40)

A1 becomes Rank 1

A2 becomes Rank 2

Other rankings remain stable

Scenario 2 : Increased Price Weight (0.20 → 0.30)

A2 remains strong

A1 decreases slightly

A5 increases in ranking

Sensitivity Conclusion

Across all scenarios:

No major ranking instability occurred,

The top three (A2, A1, A5) remained consistent,

The SAW model demonstrates strong robustness.

#### H. Summary of Findings

1. RedMagic 10 Pro (A2) is the best overall gaming smartphone in this evaluation.
2. ROG Phone 9 Pro (A1) offers superior performance but is limited by price.
3. Xiaomi 15 Ultra (A5) is highly competitive due to affordability.
4. Cooling performance proves essential in determining gaming suitability.
5. The ranking is robust under weight variation scenarios, confirming the reliability of the decision model.

## IV. CONCLUSION

This study implemented the Simple Additive Weighting (SAW) method to evaluate five gaming-oriented smartphones using five criteria: performance, battery capacity, refresh rate, cooling system, and price. All criteria and normalized values were prepared in Chapter II, while the final weighted scores were calculated in Chapter III based on the SAW aggregation model.

The evaluation results demonstrate that Alternative A2 (RedMagic 10 Pro) achieved the highest final score, indicating the best balance across performance metrics, battery endurance, thermal management, and affordability. Alternative A1 (ROG Phone 9 Pro) ranked second, supported by superior performance and display characteristics but affected by its higher price. Alternative A5 (Xiaomi 15 Ultra) ranked third, showing strong overall value due to its relatively low price despite moderate specifications. Meanwhile, Alternative A4 (Samsung S25 Ultra) and Alternative A3 (iPhone 17 Pro Max) presented strong technical specifications but were less competitive in cost-effectiveness and cooling-based scoring. The results confirm that SAW provides a transparent and systematic decision-making approach for multi-criteria evaluation of gaming smartphones. The findings also highlight the importance of cooling performance and price-to-performance ratio as major determinants of gaming suitability. Sensitivity analysis conducted in Chapter III shows that ranking stability remains consistent under changes in weighting, indicating that the decision model is reliable.

The findings offer several practical implications: Manufacturers should focus not only on performance metrics but also on sustained thermal efficiency and price competitiveness; Consumers can use SAW-based evaluations to make more structured decisions in selecting devices tailored to gaming needs; Researchers may consider SAW as a reliable method for product evaluation where diverse quantitative and qualitative attributes coexist. Limitations of this study has several limitations: The cooling system scoring still partially depends on qualitative assessment due to limited publicly available sustained performance data; Battery endurance and thermal throttling results could vary based on test conditions

and methodologies employed by different testing laboratories and benchmarking platforms; Market prices fluctuate across regions and time, potentially affecting the price-based ranking. Recommendations for Future Research is: Integrating additional criteria such as charging efficiency, peak temperature under stress tests, or GPU-specific benchmarks; Applying objective weighting techniques (e.g., Entropy or CRITIC) directly into the decision model; Comparing SAW with other MCDM methods such as AHP, TOPSIS, MOORA, or PROMETHEE to test the robustness of results; Including real-world gaming endurance tests or laboratory-based thermal measurements to strengthen the accuracy of cooling assessments; Expanding the set of evaluated devices to include mid-range gaming smartphones or newly released models.

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