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MULTI-CRITERIA DECISION MAKING FOR SMARTPHONE SELECTION USING THE TOPSIS METHOD

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ABSTRACT

In today's competitive consumer electronics market, selecting an optimal smartphone involves evaluating multiple conflicting criteria, such as price, performance, and features. This paper presents a structured decision-making approach using the TOPSIS (Technique for Order Preference by Similarity to Ideal Solution) method to rank and select the most suitable smartphone among several alternatives. Five key criteria – price, battery life, camera quality, storage capacity, and weight – were identified and weighted based on their relevance to user preferences. The decision matrix was normalized, weighted, and analyzed to determine the ideal and anti-ideal solutions.

The analysis revealed that Smartphone D was the most preferred option, having the highest closeness coefficient, thereby demonstrating its relative superiority. The results validate the effectiveness of TOPSIS in facilitating transparent and rational decision-making in complex multi-criteria environments. This research highlights the practical utility of TOPSIS in consumer product evaluation and paves the way for its application in broader decision-support systems.

1. INTRODUCTION

In an era of rapid technological advancement and intense competition in consumer electronics, selecting the most suitable smartphone has become a complex multi-criteria decision problem. Consumers often need to consider conflicting factors—such as price versus performance—while also accounting for subjective preferences. Multi-criteria decision making (MCDM) methods provide structured tools to support rational and reproducible choice decisions in such environments (Taherdoost & Madanchian, 2024; Hwang & Yoon, 1981). Among various MCDM techniques, the Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) has gained widespread acceptance owing to its intuitive geometric formulation and compensatory nature (Hwang & Yoon, 1981; Taherdoost & Madanchian, 2024). Several studies have applied TOPSIS directly to smartphone and mobile phone evaluation. Rakshit and Dey (2024) utilized TOPSIS to select the best smartphone based on criteria such as price, battery life, camera, and storage, illustrating the standard normalization, weighting, and ranking process.

Ncibi and Ayadi (2024) proposed an entropy-weighted variation of TOPSIS to reflect customer preferences more precisely in mobile phone selection. Hybrid MCDM frameworks, integrating TOPSIS with AHP or fuzzy logic, have been employed to model uncertainty and enhance decision robustness. Büyüközkan and Güleryüz (2016) introduced an intuitionistic fuzzy TOPSIS (IF-TOPSIS) model for group-based smartphone selection, handling ambiguous evaluations via fuzzy sets.

Another study integrated AHP and TOPSIS to derive weights via pairwise comparisons before ranking smartphones—demonstrating improved alignment with expert judgments (Author, 2021). Broader surveys on TOPSIS highlight its strengths and limitations, and how it compares to other MCDM methods such as VIKOR, PROMETHEE, and CoCoSo (Taherdoost & Madanchian, 2024; Rasoanaivo et al., 2024). Rasoanaivo and colleagues (2024) compared CoCoSo with TOPSIS in real case studies, identifying contexts in which TOPSIS may be preferable or augmented. Recent methodological work has addressed statistical dependency among criteria by combining independent component analysis (ICA) with TOPSIS to avoid biased rankings when criteria are correlated (Dean Pelegrina et al., 2020). Other scholarship explored alternative normalization schemes or distance metrics to enhance flexibility in TOPSIS applications (Taherdoost & Madanchian, 2024; systematic reviews). Although the focus here is smartphone choice, TOPSIS and its extensions have been widely applied in supplier evaluation, facility location, and technology forecasting (Şahin & Yiğider, 2014; Ayhan, 2013; Boran et al., 2009). Despite substantial literature on TOPSIS and its hybrid variants in consumer product evaluations, there remains a need for coherent, transparent frameworks that integrate standard TOPSIS with adjustable weighting schemes for smartphone decision-making contexts. Building on prior work, our study applies classic TOPSIS (without fuzzy or entropy enhancements) to rank smartphone alternatives based on user-centric criteria—demonstrating its practicality as a straightforward decision-support tool.

The novelty of this research lies in its practical and transparent application of the classical TOPSIS method for smartphone selection using real-world criteria relevant to modern consumer preferences, such as price, battery life, camera quality, storage, and weight. Unlike prior studies that rely heavily on fuzzy logic, entropy weighting, or hybrid MCDM approaches, this study demonstrates that standard TOPSIS, when applied with realistic and balanced weights, can yield accurate and actionable results without added complexity. By presenting a step-by-step methodology that is both replicable and easy to understand, the paper bridges the gap between theoretical decision-making tools and practical consumer applications, offering a robust baseline model for future comparative research in multi-criteria decision analysis.

2. TOPSIS METHOD: STEP-BY-STEP PROCEDURE

TOPSIS (Technique for Order Preference by Similarity to Ideal Solution) is a widely used multi-criteria decision-making (MCDM) method. It ranks alternatives based on their relative closeness to an ideal best and an ideal worst solution. Below is the step-by-step procedure.

Step 1: Construct the Decision Matrix
List all alternatives and criteria in a matrix form:

$$D = [x_{ij}]$$

Step 2: Normalize the Decision Matrix
Use vector normalization to eliminate scale differences:

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

Step 3: Construct the Weighted Normalized Decision Matrix
Multiply each normalized value by its criterion weight:

$$v_{ij} = w_j \cdot r_{ij}$$

Step 4: Determine the Ideal Best (A^+) and Ideal Worst (A^-) Solutions

$$A^+ = \{\max(v_{ij}) \text{ if benefit, } \min(v_{ij}) \text{ if cost}\}$$
$$A^- = \{\min(v_{ij}) \text{ if benefit, } \max(v_{ij}) \text{ if cost}\}$$

Step 5: Calculate the Separation Measures
Calculate the distance from the ideal best and ideal worst:

$$S_i^+ = \sqrt{\sum_{j=1}^{n} (v_{ij} - A_j^+)^2} \quad \text{(Distance from ideal best)}$$

$$S_i^- = \sqrt{\sum_{j=1}^{n} (v_{ij} - A_j^-)^2} \quad \text{(Distance from ideal worst)}$$

Step 6: Calculate the Relative Closeness to the Ideal Solution

$$C_i = \frac{S_i^-}{S_i^+ + S_i^-}$$

where $0 \le C_i \le 1$

Step 7: Rank the Alternatives
Rank alternatives in descending order of C_i. The higher the C_i, the better the alternative.

3. STEP-BY-STEP SOLUTION OF THE MODEL

Table 1: Decision Matrix

Smartphone	Price	Battery Life	Camera Quality	Storage	Weight
A	50	20	48	128	180
B	45	18	64	256	200
C	55	22	50	128	170
D	60	24	108	512	220

Table 2: Normalized Decision Matrix

Smartphone	Price	Battery Life	Camera Quality	Storage	Weight
A	0.4735	0.4735	0.3347	0.2132	0.4652
B	0.4262	0.4262	0.4463	0.4264	0.5169
C	0.5209	0.5209	0.3487	0.2132	0.4394
D	0.5682	0.5682	0.7531	0.8528	0.5686

Table 3: Weighted Normalized Matrix

Smartphone	Price	Battery Life	Camera Quality	Storage	Weight
A	0.118378	0.094703	0.083681	0.031980	0.069784
B	0.106541	0.085232	0.111575	0.063960	0.077537
C	0.130216	0.104173	0.087168	0.031980	0.065907
D	0.142054	0.113643	0.188283	0.127920	0.085291

Table 4: Ideal Best (A^+) and Ideal Worst (A^-)

Type	Price	Battery Life	Camera Quality	Storage	Weight
Ideal Best (A^+)	0.106541	0.113643	0.188283	0.127920	0.065907
Ideal Worst (A^-)	0.142054	0.085232	0.083681	0.031980	0.085291

Table 5: Separation Measures (S^+ and S^-)

Smartphone	S^+ (to A^+)	S^- (to A^-)
A	0.143736	0.029845
B	0.104486	0.055876
C	0.141700	0.029779
D	0.040459	0.144752

Table 6: Closeness Coefficient and Ranking

Smartphone	Closeness (C_i)	Rank
D	0.781550	1.0
B	0.348435	2.0
C	0.173659	3.0
A	0.171936	4.0

4. CONCLUSION

In this study, the TOPSIS (Technique for Order Preference by Similarity to Ideal Solution) method was applied to evaluate and rank multiple smartphone alternatives based on five critical criteria: price, battery life, camera quality, storage capacity, and weight. The analysis incorporated both benefit and cost criteria with assigned weights to reflect user preferences. The results demonstrated that Smartphone D ranked highest with a closeness coefficient of 0.7816, indicating its strong proximity to the ideal solution and overall superiority among the options considered. This was followed by Smartphones B, C, and A, in decreasing order of preference. The TOPSIS approach proved to be an effective and objective decision-making tool, capable of handling multi-criteria evaluation with both qualitative and quantitative factors. This method not only supports better consumer choices but also offers valuable insights for manufacturers and marketers aiming to align product features with customer priorities. Future research could explore more dynamic criteria, real-time user feedback integration, or a hybrid MCDM framework to further enhance decision accuracy.

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