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DECISION SUPPORT SYSTEM TO CHOOSE SMARTPHONE USING TOPSIS METHOD

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Abstract

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Technology has developed very rapidly nowadays, especially on smartphones. Nowadays smartphone is an item that is in great demand by everyone. smartphone is a mobile phone that has a function like a computer and also called mini computer. There are people who find it difficult to choose a smartphone with various advanced features available. Therefore, a decision support system was made using the TOPSIS method to select the smartphone that suits your needs. TOPSIS (Technique for order prefrence by similarity to ideal solution) is one of the multi-criteria decision making methods to find preference values based on criteria and alternatives. A total of 7 criteria chosen by the author that are: price, brand, ram, battery, front camera, rear camera and display. Therefore, the alternatives used are Samsung A20, Xiaomi Mi A1, Realme C2, Asus Zenfone Max M2 and Oppo F5 Youth. The data is then calculated using the TOPSIS method based on the stages. So that we can get the preferences value and the rank of the smartphone we wanted which is then implemented into a web-based application.

Keywords : Smartphone, TOPSIS, DSS

1. Introduction

Smartphone is a mobile phone that has the ability to use and function like a computer. There is no factory standard that defines the meaning of a smartphone. For some, a smartphone is a phone that runs on all operating system software that provides a standard and basic relationship for application developers. For others, a smartphone is simply a phone that provides advanced features such as e-mail (electronic mail), internet and the ability to read e-books (e-books) or includes a keyboard (either as built in or plugged in). In other words, a smartphone is a small computer that has the capabilities of a telephone (Intan Trivena Maria Daeng, 2017).

Currently, the use of cellular phones in Indonesia is progressing very rapidly, especially cellular phones that have social media chat facilities. Many types and types of smartphones are offered in the market with various brands, such as: Samsung, Sony, Oppo, Lenovo, Asus, and others. Of all the smartphone brands marketed, each has different advantages and disadvantages, for example in terms of shape or design, quality and price. Therefore, consumers have many choices of types of smartphones to

own. However, not a few ordinary consumers have difficulty in determining smartphones due to the many new features with various specifications which then utilize more than one information media to support the process of finding the type of smartphone that best suits the needs and criteria desired by consumers.

For that, we need a computerized system that can help consumers get a good decision in choosing a smartphone that suits their wants and needs. The system uses the Multi Criteria Decision Making method, especially the TOPSIS method. Previously, there was a decision support system research written by Harsiti and Henri Aprianti entitled "Smartphone Selection Decision Support System by Applying the Simple Additive Weighting (SAW) Method" in the Journal of Information Systems, Serang Raya University Vol.4 2017, pp. 19-24. The research uses the same object and applies a different method to that which the author applies. This research uses 5 criteria and smartphones released in 2017 and below. For this reason, the author wants to develop this research by adding criteria and the latest smartphone using a different method, namely TOPSIS

2. Method

2.1 TOPSIS *(*Technique For Order Preference By Similarity To Ideal Solution)

TOPSIS is a multi-criteria decision-making method introduced by Yoon and Hwang (1981). TOPSIS uses the principle that the chosen alternative must have the closest distance from the positive ideal solution and the farthest distance from the negative ideal solution from a geometric point of view by using Euclidean distance to determine the relative closeness of an alternative to the optimal solution. The positive ideal solution is defined as the sum of all the best achievable values for each attribute, while the negative ideal solution consists of all the worst achievable values for each attribute. The positive ideal solution is defined as the sum of all the best attainable values for each attribute, while the ideal negative solution consists of all the worst values achieved for each attribute. TOPSIS considers both the distance to the positive ideal solution and the negative ideal solution by taking relative proximity to the positive ideal solution. Based on the comparison to the relative distance, an alternative priority arrangement can be achieved

Steps to solve the problem using the TOPSIS method :

1. Describing alternatives (m) and criteria (n) into a matrix, where Xij is a measurement of choice from the i-th alternative and the j-th criteria

$$D = \begin{bmatrix} X_{11} & X_{12} & X_{13} \\ X_{21} & X_{22} & X_{23} \\ X_{i1} & X_{i2} & X_{i3} \end{bmatrix}$$

2. Create a normalized decision matrix.

TOPSIS requires the performance ranking of each alternative Ai on each normalized Cj criteria

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

3. Create a weighted normalized decision matrix.

The value of each normalized data (R) is then multiplied by the weight (W) to obtain a weighted normalized decision matrix (Y)**.**

$$y_{ij} = w_j . r_{ij}$$

4. Determine the positive ideal solution matrix and the negative ideal solution matrix.

The positive ideal solution A+ and the negative ideal solution A- can be determined based on the normalized weight ranking (yij).

Positive ideal solution A+

The equation used to determine the positive ideal solution is:

$$A^+ = (y_1^+, y_2^+, y_3^+, \dots, y_n^+)$$

Negative ideal solution A-

The equation used to determine the negative ideal solution is:

$$A^- = (y_1^-, y_2^-, y_3^-, \dots, y_n^-)$$

5. Determine the distance between the value of each alternative with the positive ideal solution matrix (D+) and negative ideal solution matrix (D-).

Distance between Alternative Ai and Positive Ideal Solution (D+):

$$D_i^+ = \sqrt{\sum_{j=1}^{n} \left(y_i^+ - y_{ij}\right)^2}$$

Distance between Alternative Ai and Positive Ideal Solution (D-):

$$D_i^- = \sqrt{\sum_{j=1}^{n} \left(y_i^- - y_{ij}\right)^2}$$

6. Determine the preference value for each alternative.

The preference value is the proximity of an alternative to the ideal solution.

The preference value for each alternative (Vi) is given as :

$$V_i = \frac{D_i^-}{D_i^- + D_i^+}$$

A larger Vi value indicates that the alternative Ai is preferred. (Riandari et al., 2017)

3. Results and Discussion

3.1 Data requirements

Previously, we have determined the criteria to be carried out in this research and then give weights based on how important these factors are needed, then loaded into the following table.

The data used in the implementation of a priori algorithm are outlined in the following pattern:

Table 1. criteria value

Factor	value
Price	5
Brand	3
RAM/ROM	4
Front camera	4
Rear camera	2
Battery	3
Display	2

After that, the criteria variables for choosing a smartphone have been obtained. The following is a table of the specified criteria:

Table 2. data criteria

Criteria	Name	Range	Score
C1	Harga	≥ Rp. 3.000.000	5
		Rp. 2.500.000 – 2.999.999	4
		Rp. 2.000.000 – 2.499.999	3
		Rp. 1.500.000 – 1.999.999	2
		Rp. 1.000.000 – 1.499.999	1

Criteria	Name	Range	Score
C2	Brand	Very Popular	5
		Popular enough	4
		Popular	3
		Quiet Popular	2
		Not Popular	1
C3	RAM/ROM (GB)	≥ 4/64	5
		3/64	4
		3/32	3
		2/32	2
		2/16	1
C4	Battery	≥ 5000 mAh	5
		4500 - 4999 mAh	4
		4000 – 4499 mAh	3
		3500 – 3999 mAh	2
		3000 – 3499 mAh	1
C5	Rear camera	> 25 MP	5
		21 - 25 MP	4
		14 – 20 MP	3
		9 – 13 MP	2
		0 – 8 MP	1
C6	Front Camera	> 25 MP	5
		21 - 25 MP	4
		14 – 20 MP	3
		9 – 13 MP	2
		0 – 8 MP	1
C7	Display	Very attractive	5
		Attractive enough	4
		Attractive	3
		Quite attractive	2
		Not attractive	1

Table 3. smartphone brand classification

Smartphone Brand	classification
Samsung	Very Popular
Xiaomi	Very Popular
Oppo	Popular
Huawei	Popular
Realme	Popular
Asus	Popular enough
Vivo	Popular enough

Previously, we already had criteria data in the criteria table, then we created an alternative matrix and criteria using the alternatives in the database later. As an example, we will use several alternatives or types of smartphones and their specifications in the following table:

Table 4. data smartphone

Smartphone Name	Specification					
	Price	RAM/ROM	Rear Camera	Front Camera	Battery	*Display*
Samsung A20 (A1)	Rp 2.200.000	3/32 GB	13 MP	8 MP	4000 mAh	Very Attractive
Xiaomi Mi A1 (A2)	Rp 2.199.000	4/64 GB	12 MP	5 MP	3080 mAh	Very Attractive
Realme C2 (A3)	Rp 1.599.000	3/32 GB	13 MP	5 MP	4000 mAh	Very Attractive
Asus Zenfone Max M2 (A4)	Rp 1.799.000	3/32 GB	13 MP	8 MP	4000 mAh	Very Attractive
Oppo F5 Youth (A5)	Rp 3.299.000	3/32 GB	13 MP	16 MP	3200 mAh	Attractive

3.2 Topsis Method Calculation

The steps for completing the TOPSIS method are:

1. Create an alternative matrix and criteria.

Table 5. Alternative matrix towards criteria

Alternate	Criteria						
	C1	C2	C3	C4	C5	C6	C7
A1	3	5	3	3	3	3	5
A2	3	5	5	1	3	1	5
A3	5	3	3	3	3	1	5
A4	5	1	3	3	3	3	5
A5	1	3	3	1	3	5	3

2. Create a normalized decision matrix

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

|X1| = $\sqrt{3^2 + 3^2 + 2^2 + 2^2} + 5^2$ = 7,1414
$r_{11} = \frac{X_{11}}{X1} = \frac{3}{7,1414} = 0,42$
$r_{21} = 0,42$
$r_{31} = 0,28$
$r_{41} = 0,28$
$r_{51} = 0,7001$
|X2| = $\sqrt{5^2 + 5^2 + 4^2 + 3^2} + 3^2$ = 9,1651
$r_{12} = \frac{X_{12}}{X2} = \frac{5}{9,1651} = 0,5455$
$r_{22} = 0,5455$
$r_{32} = 0,4364$
$r_{42} = 0,3273$
$r_{52} = 0,3273$
|X3| = $\sqrt{3^2 + 5^2 + 3^2 + 3^2} + 3^2$ = 7,8102
$r_{13} = \frac{X_{13}}{X3} = \frac{3}{7,8102} = 0,3841$
$r_{23} = 0,6401$
$r_{33} = 0,3841$
$r_{43} = 0,3841$
$r_{53} = 0,3841$
|X4| = $\sqrt{3^2 + 1^2 + 3^2 + 3^2} + 1^2$ = 5,3851
$r_{14} = \frac{X_{14}}{X4} = \frac{3}{5,3851} = 0,5570$
$r_{24} = 0,1856$
$r_{34} = 0,5570$
$r_{44} = 0,5570$
$r_{54} = 0,1856$
|X5| = $\sqrt{2^2 + 2^2 + 2^2 + 2^2} + 2^2$ = 4,4721
$r_{15} = \frac{X_{15}}{X5} = \frac{2}{4,4721} = 0,4472$
$r_{25} = 0,4472$
$r_{35} = 0,4472$
$r_{45} = 0,4472$
$r_{55} = 0,4472$
|X6| = $\sqrt{1^2 + 1^2 + 1^2 + 1^2} + 3^2$ = 3,6055
$r_{16} = \frac{X_{16}}{X6} = \frac{1}{3,6055} = 0,2773$
$r_{26} = 0,2773$
$r_{36} = 0,2773$
$r_{46} = 0,2773$
$r_{56} = 0,832$
|X7| = $\sqrt{5^2 + 5^2 + 5^2 + 5^2} + 3^2$ = 10,4403
$r_{17} = \frac{X_{17}}{X7} = \frac{5}{10,4403} = 0,4789$
$r_{27} = 0,4789$
$r_{37} = 0,4789$

$r_{47} = 0{,}4789$
$r_{57} = 0{,}2873$

Table 6. normalized decision matrix

Alternate	C1	C2	C3	C4	C5	C6	C7
A1	0,42	0,5455	0,3841	0,5570	0,4472	0,2773	0,4789
A2	0,42	0,5455	0,6401	0,1856	0,4472	0,2773	0,4789
A3	0,28	0,4364	0,3841	0,5570	0,4472	0,2773	0,4789
A4	0,28	0,3273	0,3841	0,5570	0,4472	0,2773	0,4789
A5	0,7001	0,3273	0,3841	0,1856	0,4472	0,832	0,2873

3. Create a weighted normalized decision matrix
W = ((5), (3), (4), (3), (2), (4), (2))
Yij = wi.rij

Table 7. weighted normalized decision matrix

Alternatif	C1	C2	C3	C4	C5	C6	C7
A1	2,1	1,6365	1,5364	1,671	0,8944	1,1092	0,9578
A2	2,1	1,6365	2,5604	0,5568	0,8944	1,1092	0,9578
A3	1,4	1,3092	1,5364	1,671	0,8944	1,1092	0,9578
A4	1,4	0,9819	1,5364	1,671	0,8944	1,1092	0,9578
A5	3,5005	0,9819	1,5364	0,5568	0,8944	3,328	0,5746

4. Positive ideal solution A+ and negative ideal solution A-

Positive Ideal Solution A+

The equation used to determine the positive ideal solution is:

$A^+ = \{(\max y_{ij} \mid j \in J), (\min y_{ij} \mid j \in J'), i = 1,2,3,\dots,m\}$

y_1^+ = min(2,1, 2,1, 1,4, 1,4, 3,5005) = 1,4

y_2^+ = max(1,6365, 1,6365, 1,3092, 0,9819, 0,9819) = 1,6365

y_3^+ = max(1,5364, 2,5604, 1,5364, 1,5364, 1,5364) = 2,5604

y_4^+ = max(1,671, 0,5568, 1,671, 1,671, 0,5568) = 1,671

y_5^+ = max(0,8944, 0,8944, 0,8944, 0,8944, 0,8944) = 0,8944

y_6^+ = max(1,1092, 1,1092, 1,1092, 1,1092, 3,328) = 3,328

y_7^+ = max(0,9578, 0,9578, 0,9578, 0,9578, 0,5746) = 0,9578

A^+ = (1,4, 1,6365, 2,5604, 1,671, 0,8944, 3,328, 0,9578)

Negative Ideal Solution A-

The equation used to determine the negative ideal solution is:

$A^- = \{(\min y_{ij} \mid j \in J), (\max y_{ij} \mid j \in J'), i = 1,2,3,\dots,m\}$

y_1^- = max(2,1, 2,1, 1,4, 1,4, 3,5005) = 3,5005

y_2^- = min(1,6365, 1,6365, 1,3092, 0,9819, 0,9819) = 0,9819

y_3^- = min(1,5364, 2,5604, 1,5364, 1,5364, 1,5364) = 1,5364

y_4^- = min(1,671, 0,5568, 1,671, 1,671, 0,5568) = 0,5568

y_5^- = min(0,8944, 0,8944, 0,8944, 0,8944, 0,8944) = 0,8944

y_6^- = min(1,1092, 1,1092, 1,1092, 1,1092, 3,328) = 1,1092

y_7^- = min(0,9578, 0,9578, 0,9578, 0,9578, 0,5746) = 0,5746

A^- = (3,5005, 0,9819, 1,5364, 0,5568, 0,8944, 1,1092, 0,5746)

5. The distance between the weighted value of each alternative to the ideal solution positive D+ and negative D-

Distance between Alternative Ai and Positive Ideal Solution (D+) :

$$D_i^+ = \sqrt{\sum_{j=1}^{n} \left(y_i^+ - y_{ij}\right)^2}$$

$$D_1^+ = \sqrt{\begin{matrix}(1{,}4-2{,}1)^2+(1{,}6365-1{,}6365)^2+(2{,}5604-1{,}5364)^2+(1{,}671-1{,}671)^2 \\ +(0{,}8944-0{,}8944)^2+(3{,}328-1{,}1092)^2+(0{,}9578-0{,}9578)^2\end{matrix}}$$

D_1^+ = 2,5419

D_2^+ = 2,5796

D_3^+ = 2,4654

D_4^+ = 2,5298

D_5^+ = 2,6976

Distance between Alternative Ai and Negative Ideal Solution (D-) :

$$D_i^- = \sqrt{\sum_{j=1}^{n} \left(y_i^- - y_{ij}\right)^2}$$

D_1^- = 1,9437

D_2^- = 1,8936

D_3^- = 2,4302

D_4^- = 2,4081

D_5^- = 2,2187

Table 8. The value of D+ dan D-

D+	D-
2,5419	1,9437
2,5796	1,8936

2,4654	2,4302
2,5298	2,4081
2,6976	2,2187

6. Determine the preferences of each alternative

$$V_i = \frac{D_i^-}{D_i^- + D_i^+}$$

So that the preference value for each alternative is:

Table 9. Preference value

V
0,4333
0,4233
0,4964
0,4877
0,4513

From the preference values above, a ranking of results is obtained in the following table:

Table 10 TOPSIS calculation results ranking

Ranking	Nama	Nilai preferensi
1	Realme C2	0,4964
2	Asus Zenfone Max M2	0,4877
3	Oppo F5 Youth	0,4513
4	Samsung A20	0,4333
5	Xiaomi Mi A1	0,4233

4. Conclusions (time new Roman, bold, 11)

Based on the discussion in this smartphone selection DSS research, the following conclusions can be drawn:

1. With this research, it is hoped that it will make it easier for ordinary people to determine smartphones that fit the criteria.
2. TOPSIS method is a method that has many shortcomings but is feasible to use in a decision support system.
3. This decision support system uses 7 criteria and 5 alternatives.
4. TOPSIS SPK application performs calculations in accordance with TOPSIS calculations

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