DESICION SUPPORT SYSTEM USING TOPSIS METHOD FOR SMARTPHONE SELECTION

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Abstract

Nowadays smartphone has developed rapidly, within days and months, they will build many smartphones and with so many differences feature such as more powerful processors, wider screen, more powerful front and back camera etc. Sometimes buyer has difficulties in determining which smartphone that most suitable with their needs. In this research, we implement TOPSIS method to support buyer in choosing the most appropriate smartphone, based on its feature and brands. TOPSIS, stand for Technique for Order of Preference by Similarity to Ideal Solution, is one of Decision support method based on calculation of positive ideal distance solution and negative ideal distance solution. Final output of TOPSIS calculation is order of priority of recommended smartphone's brand. TOPSIS was also applied in Decision Support System, where the output of this application was compared with the result of manual TOPSIS calculation.

Keywords TOPSIS, positive ideal distance solution, negative ideal distance solution weighted normalized decision matrix

1. Introduction

Decision Support system is Based Computer system used to make decision for organization. Decision Support Systems can be either fully computerized or human powered or combination of both. Decision Support System are used as a support tools for users or managers to solve specific problems. Database of the decision support system can be used to generate periodically reports, or to produce information as result of simulation of one or more components.[6][7]

One of the technics that's is used for simulation of decision support system models Multi-criteria Decision Making Methods. . The development of computer technology is very beneficial for the development of MCDM science. The development of MCDM is closely related to the development of computer technology. With advanced computer technology, it is very helpful in conducting systematic analysis of complex MCDM problems.[3]

One method of MCDM is TOPSIS Method, TOPSIS is stand for Technique for Order Preference by Similarity to Ideal Solution. The TOPSIS method was first introduced by Yoon and Hwang in 1981. This method is one method that is widely used to resolve practical decision making. TOPSIS has a concept where the chosen alternative is the best alternative that has the shortest distance from the ideal positive solution and the farthest distance from the negative ideal solution.[2][4] The more factors that must be considered in the decision-making process, the more difficult it is to take.

According to [Petr Průša, Stefan Jovčić] "Alternatives of TOPSIS methods are evaluated based on their distance in relation to the ideal and anti-ideal solution. The alternative is considered best if there is a minimum distance in relation to the ideal solution and the greatest distance from the anti-ideal solution''.

Nowadays, many brands of smartphones with various specifications sold in the market. This situation makes it difficult for users to make choices according to their wishes and budget. The rapid development and sales of smartphones on the market are increasing within short time. With all kinds of features available and with so many prices, consumers are often faced problems of difficulties in choosing a smartphone.

Related to these problems, a decision support system is built to help consumers to determine a type of smartphone are most appropriate based on their needs, features, and budget. Hopefully, this TOPSIS method in the decision support system can help customers to solve their problems.

2. **Methodology**

Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) is a multi-criteria decision-making method. First introduced by Yoon and Hwang in 1981 [10]. TOPSIS uses the principle that the chosen alternative must have the closest distance from the positive ideal solution and the longest distance from the negative ideal solution to determine the relative proximity of an alternative with the optimal solution [11][12]. The TOPSIS method is based on the concept that the best-chosen alternative not only has the shortest distance from the positive ideal solution, but also has the longest distance from the negative ideal solution

TOPSIS methods consists of these steps:

Step 1. Let us consider the decision matrix *D*, which consists of a*lternatives* and *criteria*, described by:

$$D = \begin{array}{c} \\ A_1 \\ \vdots \\ A_m \end{array} \begin{array}{c} C_1 \;\dots\dots\; C_n \\ \begin{pmatrix} x11 & \cdots & x1n \\ \vdots & \ddots & \vdots \\ xm1 & & xmn \end{pmatrix} \end{array} \qquad (1)$$

Where A1 , A_2 , ... ,A_m are alternatives and C_1 , ... , C_n are criteria. In our case study, A_i are brands of smart phone , and C_i are features of each brands. x_{ij} are value of criteria C_j of alternatives A_i which are given by survey. Each criteria C_j it's weight value W_j which statisfy :

$$\sum_{j=1}^{n} W_j = 1 \qquad (2)$$

In general, the criteria is classified into two types, those are Benefits and Costs. Benefit criterion means, the higher value the better , while Cost criterion means the opposite.

Step 2, Since the data comes from differences resources, it is necessary to normalize it in order to transform it into a dimensionless matrix. The normalized decision matrix can be determined as follows:

$$r_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^{m} x_{ij}^2}} \quad \text{with i=1..m, j=1...n} \qquad (3)$$

Thus, normalized desicion matrix can be represented as r = [rij]mxn with i=1..m, and j=1...n

Step 3, After normalization, we calculate the weighted normalized decision matrix R =$[b_{ij}]_{mxn}$ with i= 1..m, j=1..n by multiplying the normalized decision matrix by its associated weights (w_i , i=1..n) . The weighted normalized value b_{ij} can be calculated as

$$y_{ij} = w_i \cdot r_{ij} \quad i=1..m, i=1..n \qquad (4)$$

Step 4, calculate the positive ideal solution A^+ and Negative ideal solution A^- as follows:

$$A^+ = (Y_1^+ , Y_2^+ , ... ,Y_m^+) \qquad (5)$$

$$A^- = (Y_1^- , Y_2^- , ... , Y_m^-) \qquad (6)$$

Where

$$Y_j^+ = (\max_i y_{ij} , j \in J_1 \colon \min_i y_{ij}, j \in J_2) \qquad Y_j^- = (\min_i y_{ij} , j \in J_1 \colon \max_i y_{ij}, j \in J_2)$$

Step 5, calculate Euclidean distance from positive ideal Solution (A^+) to each value A_i , and Euclidean distance from negative ideal Solution (A^-) to each A_i follows:

$$d_i^+ = \sqrt{(Y_i^+ - y_{ij})^2} \qquad (7)$$

$$d_i^- = \sqrt{(Y_i^- - y_{ij})^2} \qquad (8)$$

where:

- Y_i^+ is value of ideal positive solution of A^+, with i=1,... m

- Y_i^- is value of ideal negative solution of A^-, with i=1,... m
- y_{ij} is value of weighted normalized matrix, with i=1,...m, j=1,...n

Step 6, Calculate the relative closeness V_i for each alternative A_i , with respect to positive ideal solution as given by:

$$V_i = \frac{d_i^-}{d_i^+ + d_i^-} \quad \text{with i= 1,...m} \tag{9}$$

3. Case study

In our case study, several brands smartphones were chosen, those are ASUS Zenfone MAX PRO M1, Xiaomi Redmi Note 5A, Samsung Galaxy J, Oppo A3s and Vivo Y69. Each of alternatives has its own criteria, those are prosessor, RAM , internal memory, Camera, screen size and battery capacity. Those datas were input in the DSS. Input table can be seen in the table 1, as follows:

Table 1:Input table

Alternatif/ Kriteria	**ASUS Zenfone MAX PRO M1**	**Xiaomi Redmi Note 5A**	**Samsung Galaxy J6**	**Oppo A3s**	**Vivo Y69**
Prosesor	Qualcomm SDM636 Snapdragon 636	Qualcomm Snapdragon 435	Exynos 7870 Octa	Qualcomm SDM450 Snapdragon 450	Mediatek MT6750
RAM	3 gb	3 gb	3 gb	3 gb	3 gb
Internal Memory	32 gb	32 gb	32 gb	32 gb	32 gb
Camera	Primary Dual: 13 MP (f/2.2, 1.12m) + 5 MP (f/2.4, 1.12m),	Primary camera 13 MP, f/2.2	Primary 13 MP (f/1.9, 28mm)	Primary Dual: 13 MP, f/2.2, AF, 2 MP, f/2.4	Primary 13 MP, AF, f/2.2
Screen size	5.99 inches, 93.1 cm2 (~77.0% screen-to-body ratio)	5.5 inches (~71.5% screen-tobody ratio)	5.6 inches, 80.1 cm^2 (~76.5% screen-to-body ratio)	6.2 inches, 95.9 cm^2 (~81.2% screen-to-body ratio)	5.5 inches, 83.4 cm^2 (~71.4% screen-to-body ratio)
Bateray capacity	5000 mah	3080 mah	3000mah	4230 mah	3000mah

One person as a decision maker was asked to determine the decision value of all criteria from each alternative. Based on that decision value matrix is obtained. Entry of decision value matrix considered as x_{ij}, where i is equal to index of criteria, and j is equal to index of alternatives. The decision value matrix can be seen in the table 2 bellows.

Table 2 : Decision value Matrix

Kode	K1	K2	K3	K4	K5	K6
A1	4	4	3	3	4	5
A2	2	3	3	3	4	3
A3	3	3	3	4	3	3
A4	2	3	3	4	5	5
A5	2	3	3	3	4	3

Weight values of all alternatives were obtained from a survey. Weight value of criteria, that is w1, w2,, w3,..,w6, can be seen in table 3 bellows. As can be seen, the attributes of all criteria, considered as benefit.

Table 3: Weight criteria value Matrix

code	Name	Attribute	weight
K1	Processor	Benefit	5
K2	RAM	Benefit	3
K3	Memory Internal	Benefit	4
K4	Camera	Benefit	4
K5	screen size	Benefit	4
K6	Battery capacity	Benefit	5

Step 1, the normalized decision value is calculated, based on equation (3), and we have matrix of normalizes decision value Entry of this matrix is considered as r_{ij}, where i is index of alternative, and j is index of criteria.

Step 2, the normalized decision value is multiply by weight criteria value, based on equation (5). We have matrix of weight normalizes decision value,.Entry of this matrix is considered as y_{ij}, where i is index of alternative, and j is index of criteria.

Step 3, Determine positive (A^+) ideal solution and negative ideal solution (A^-) .Since all weight criteria is considered as benefit, thus equation of positive ideal solution is described in the equation 10:

$A^+ = (y_1^+ , y_2^+, y_3^+, ..., y_5^+)$, where y_i = max (y_{ij}) , i is index of alternative , and j is index of criteria............(10)
Equation of negative ideal solution is described in the equation 11:

$A^- = (y_1^- , y_2^-, y_3^-, ..., y_5^-)$, where y_i = min (y_{ij}) , i is index of alternative , and j is index of criteria............(11)

Step 4, Determine Euclidean distance of negative ideal solution (D^-) and positive ideal solution (D^+) based on equation (7) and (8). .

Step 5.determine preference value v_i based on equation (9). This V_i = (V1, $V_{2...}$ $V_{6)}$ was sorted descendant. If Vi has biggest value , then alternative of brand of smartphone is the best choice according to the individual decision maker. The rank of Vi is $V_1 > V_4 > V_3 > V_2 > V_5$. Those values can be seen in the table 5 bellows:

Tabel 4. Preference value of each alternative

Alternative	Preference value	Ranking
A_1	0.754	1
A_4	0.475	2
A_3	0.363	3
A_5	0.170	4
A_2	0.170	5

4. Decision Support System using TOPSIS method

Criteria form is displayed and the user can enter criterion data. as can be seen in the figure 1.

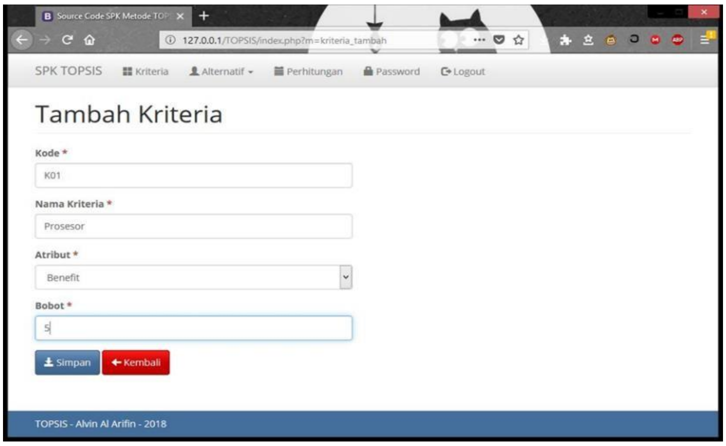


Fig. 1: form input of criteria's data

After user finish input criteria, then alternative form is displayed as can be seen in the figure 2.

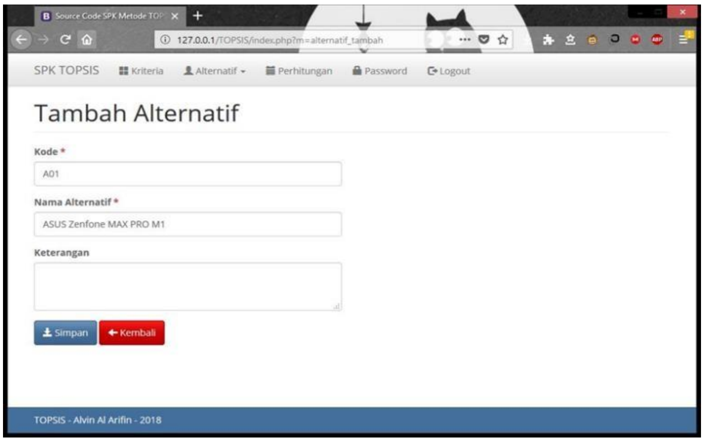
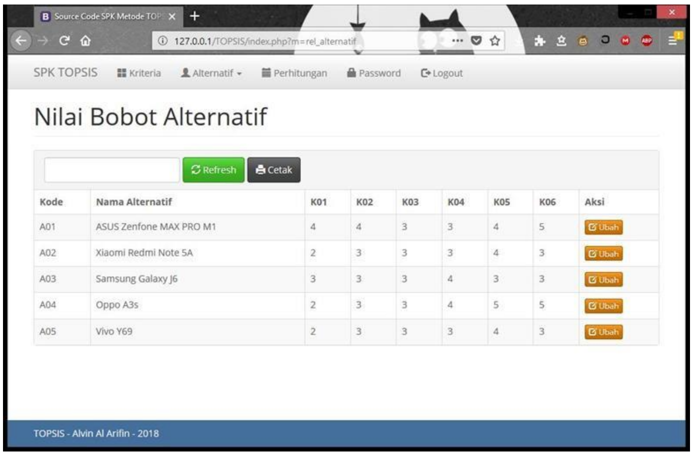


Fig. 2: form input of alternative's data

A decision maker can input all entry of decision value of all alternative and criteria, later on known as decision value matrix (Xij). The matrix of decision value in DSS can be seen in the figure 3

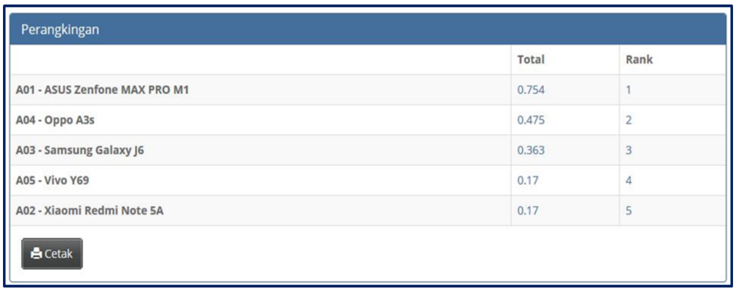


Kode	Nama Alternatif	K01	K02	K03	K04	K05	K06	Aksi
A01	ASUS Zenfone MAX PRO M1	4	4	3	3	4	5	Ubah
A02	Xiaomi Redmi Note 5A	2	3	3	3	4	3	Ubah
A03	Samsung Galaxy J6	3	3	3	4	3	3	Ubah
A04	Oppo A3s	2	3	3	4	5	5	Ubah
A05	Vivo Y69	2	3	3	3	4	3	Ubah

Fig. 3: Matrix of decision value , xij

Equation 3,4,5 until equation 9 is implemented in the system. Final result of DSS are preferences values, Vi, where i is equal 1 to 6. All Value of Vi will be displayed in descendant order. The alternative with the highest value of Vi, is the best choice. Rank of Vi as output of DSS, can be seen in figure 4:

5



	Total	Rank
A01 - ASUS Zenfone MAX PRO M1	0.754	1
A04 - Oppo A3s	0.475	2
A03 - Samsung Galaxy J6	0.363	3
A05 - Vivo Y69	0.17	4
A02 - Xiaomi Redmi Note 5A	0.17	5

Fig. 4: preferences value or relative closeness value

The result of the system is exactly the same as result value in the table 9.

5. Conclusion

Based on research conducted, a decision support system using the TOPSIS method has been successfully created and can provide recommendations for smartphone brand selection based on selected criteria, namely processor, ram, internal memory, camera, screen size, and battery capacity. In the final stage, the calculation of preference value is conducted and those value are ranked. Those rank of preference value are Asus Zenfone Max Pro M1 (0.753764224), A2 - Xiaomi Redmi Note 5A (0.170158058), A3 - Samsung Galaxy J6 (0.362518271), A4 - Oppo A3s (0.474802777), A5 - Vivo Y69 (0.170158058).

This Decision Support System can be developed to be Group DSS in the future.

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