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Sustainable Way of Choosing Effective Electronic Devices Using Fuzzy TOPSIS Method

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Abstract

Choosing sustainable electronic device is a growing concern among the peoples of Bangladesh. A perfect choice can reduce the Cost as well as sufferings. In this paper, we have considered four smart phone manufacturing company corresponding four major features such as Android version, Battery power, RAM and Cost which is characterized by weighted value under fuzzy consideration to find a sustainable device. This selection is illustrated by modified TOPSIS (Technique for Order Preference by Similarity to Ideal Solution) method for normalizing the given data. TOPSIS is one of the numerical methods of the multi-criteria decisions making (MCDM), which is a broadly applicable method with a simple mathematical model. Furthermore, the numerical analysis suggests that, modified TOPSIS method could be very effective to find a sustainable device which can also be cost effective for the peoples of Bangladesh.

Keywords: Sustainable Device; TOPSIS Method; MCDM; Android Version; Cost Effective.

1. Introduction

The user-oriented design is the most important issue in today's Smartphone market in Bangladesh. In recent years, usability of effective design has become expected, particularly different features of Smartphone. Usability considers soaring user happiness in juxtaposition with user performance [5].

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To the peoples of Bangladesh usability includes three main concepts: effectiveness, efficiency, and user happiness. User assessment of the usability dealings affects purchasing of the creation [6].It could be said that the last quarter of the 20th century and the beginning of new millennium have flourished in different studies and researches aiming to expand the decision-making systems in situations in which dealings within the system and the environment are becoming ever more convoluted and more active and when the reaction time to actual or understood dysfunctions becomes a substantial aspect of achievement [2].

Since manufactures have provided different types of Smart phones in the market, the daily usage of Smart phones have created a decision making problem for buyers/users nowadays which are varies in features. Though there is argument that the price of Smart phones determines the quality of Smart phones but that is not true since our lifestyle are getting sophisticated and consumers are ready to pay any amount of money to purchase high quality Smart phones. So how can a Smart phones user buy the best Smart phones from the market? This paper aims to answer the stated question perspective of Bangladesh by modified TOPSIS method.

Considering overall user of Smartphone we have modified TOPSIS method [14] to make best option. In the proposed method ,we considered four smart phone manufacturing company Samsung, Symphony, Walton, Micromax corresponding four major features such as Android version, Battery power, RAM and Cost to identify perfect device. The objective of this study is to design a methodology for evaluation of best devices for the customers. Most of the people of Bangladesh are interested to emphasize on price for buying any kinds of Smartphone. The methodology will serve tool for decision making in purchasing Smartphone; we modified the method for the Smartphone users of Bangladesh not only cost effective but also effective viability and well features. Basically we make small data analysis to choose best feature of Smartphone from 100 students at BRAC University. This analysis helps to give weighted value for specific features. This Section dealing with effective purchasing will become a part of the whole decision making chain where the return on investment and the expected usability of the device must also be considered. This study, how- ever, addresses solely the issues of the choice of a suitable device, not the issue of their deployment. We have applied proposed method [15] for best device selection by proper modification.

2. Statistics smart phone users in bangladesh

According to latest reports, there are 106,000,000 active mobile phone subscribers in Bangladesh, and roughly 95% of them are prepaid connection users. However, there is no official statistic for Smartphone owners. The proliferation of local, low cost smart phones has changed the handset user dynamics over the last few years. Whereas Nokia had 80% market share even a few years ago, nowadays most new handset sale is going to Symphony, a local brand that gets handsets made and branded in China; closely followed by Samsung, Maximus, Micromax, Walton (another local brand) and a few other minor players. Apple and Nokia are here, but their contribution is very low.

As a rough estimate, we can assume that there are around 1 million Smartphone users in Bangladesh. The forecast illustrates the number of total mobile data subscriptions in Bangladesh from 2010 to 2015. The number of mobile data subscriptions is projected to amount to 102 millions, in 2015 [4]. Hence, from the statistics shows

the proper choice of electronic device especially Smartphone is major important for the Smartphone user. An overall mobile market in Bangladesh shown in below: As per latest research from the Smartphone sub-segment saw a strong 20% growth highlighting a rapid decline in feature phone demand (-10%) during the quarter. The smart phones as a share of total mobile phones is estimated to rise from 28% to almost 50% by the end of 2017[14]

Table 1: Bangladesh Smartphone Shipment share in 2016 [14]

Symphony mobile	45%
Samsung	15%
Huawei	9%
Walton	9%
Lava	8%
Others	14%
Total	100%

Table 2: Smartphone import growth in Bangladesh [14]

Year	Number of Smartphone (in $ millions)
2012	21
2013	118
2014	262
2015	316
2016	379
2017	421
2018	491

3. Data Analysis for weighted value

The study was the question to 100 students of BRAC university about the best feature of a modern Smartphone which is their priority to among the features Price, Cost, Android version, Ram,Screen size, Design, Camera. The overall data analysis is shows that most of the students priority is minimum cost and from the priority we choose the weighted value under fuzzy consideration. We characterized fuzzy value for four features Cost, Android version, Battery power and Ram that is w= [.1, .4, .2, .1]. Normally in Topsis method weighted value is characterized randomly, But in our proposed method weighted value given after analysis of small data.

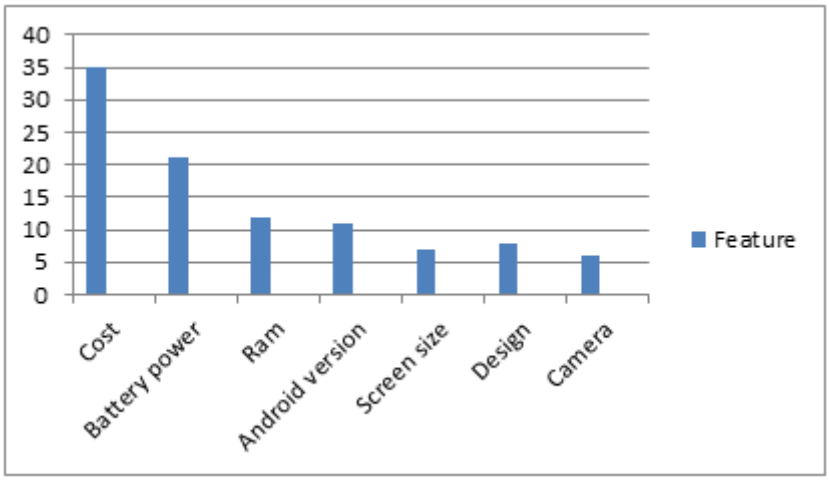

Figure 1: Data analysis of Smartphone

4. TOPSIS Method

TOPSIS (Technique for Order Preference by Similarity to Ideal Solution) is one of the numerical methods of the multi-criteria decision making. This is a broadly applicable method with a simple mathematical model. Furthermore, relying on computer support, it is very suitable practical method. The method is applied in the last three decades (on the history of TOPSIS see [9,8]), and there are many papers on its applications (see [13,10,11]).

Technique for order performance by similarity to ideal solution (TOPSIS), TOPSIS method is a technique for order preference by similarity to ideal solution that maximizes the benefit criteria/attributes and minimizes the cost criteria/attributes, whereas the negative ideal solution maximizes the cost criteria/attributes and minimizes the benefit criteria/attributes. A MADM problem can be concisely expressed in a matrix format, in which columns indicate attributes considered in a given problem; and in which rows list the competing alternatives. Specifically, a MADM problem with m alternatives (A_1, A_2,…, A_m) that are evaluated by n attributes (C_1, C_2,….., C_n) can be viewed as a geometric system with m points in n- dimensional space. An element X_{ij} of the matrix indicates the performance rating of the i^{th} alternative, A_i , with respect to the j^{th} attribute, C_j, as shown:

$$\begin{pmatrix} x_{11} & x_{12} & x_{13} & \cdots & x_{1n} \\ x_{21} & x_{22} & x_{23} & & \\ & \vdots & & \ddots & \vdots \\ x_{m1} & x_{m2} & x_{m3} & \cdots & x_{mn} \end{pmatrix}$$

Let W = $(w_1, w_2, w_3, \ldots \ldots w_n)$ be the relative weight vector about the criteria, satisfying. Then the procedure of TOPSIS can be expressed in a series of steps.

4.1. Objective of proposed TOPSIS method

1. To find a sustainable Smartphone which can be cost effective?

2. Improve quality and flexibility to meet end-customers' value and reduce lead time at different stages of the supply chain in the markets of Bangladesh.
3. Another important objective is Smartphone selection process is to reduce purchase risk, and develop closeness and long-term relationships between buyers and suppliers in Bangladesh.

4.2. Assumptions

We have considered four smart phone manufacturing company Samsung, Walton, Micromax, Symphony corresponding four major features such as Android version, Battery power, RAM and Cost. And our objective to find a sustainable device which is can be considered as a best option for the customer. Also we take fuzzy consideration for the weighted value according to the data in Figure 1where weighted value 'w_{ij}'belongs to between 0 and 1.

- m = Four alternatives (Smart phone models)
- n = 4 Four attributes/criteria
- x_{ij} = score of option i with respect to criterion j
- $\{x_{ij}\}$ 4×4 score matrix.
- J = set of benefit attributes: Cost, Android version, Ram, Battery power (more is better)
- J' = set of negative attributes: cost (less is better)

Also it must be noted that weighted value $w_{ij} \in [0,1]$

5. Steps of topsis method

Step 1:

Construct normalized decision matrix. This step transforms various attribute dimensions into non-dimensional attributes, which allows comparisons across criteria. Normalize scores or data as follows: $r_{ij} = \frac{x_{ij}}{\sum x_{ij}^2}$ for

$$i = 1, \dots, m; \text{ and } j = 1, \dots, n \qquad (1)$$

Step 2: Construct the weighted normalized decision matrix. Assume we have a set of Weights for each criteria

w_j for j = 1,…n. Multiply each column of the Normalized decision matrix by its associated weight. An element of the new matrix is: $v_{ij} = w_j r_{ij}$ (2)

Step 3: Determine the positive ideal and negative ideal solutions.

Positive Ideal solution. $A^* = \{v_1^*, \dots, v_n^*\}$, (3)

where $v_j^* = \{ \max(v_{ij}) \text{ if } j \in J ; \min(v_{ij}) \text{ if } j \in J'$ (4)

Negative ideal solution. $A' = \{ v_1', \dots, v_n' \}$, (5)

where v' = { min (v_{ij}) if j ∈ J ; max (v_{ij}) if j ∈ J' } (6)

Step 4:

Calculate the separation measures for each alternative:

The separation from the positive ideal alternative is:

$$S_i^* = [\Sigma (v_j^* - v_{ij})^2]^{1/2} \quad i = 1, \ldots, n. \tag{7}$$

The separation from the negative ideal alternative is:

$$S'_i = [\Sigma (v_j' - v_{ij})^2]^{1/2} \quad j = 1, \ldots, m \tag{8}$$

Step 5:

Calculate the relative closeness to the ideal solution

$$C_i^* = S'_i / (S_i^* + S'_i) \quad 0 < C_i^* < 1. \tag{9}$$

Step 6: Rank the preference order.

6. Numerical Illustration

Initially give classical range of four smart phone manufacturing company Samsung, Walton, Micromax, Symphony corresponding four major features.

The weighted value w_{ij} is under fuzzy consideration whose values is between 0 and 1 given below.

Table 3

Weight	0.1	0.4	0.2	0.1
	Android version	Cost	Battery power	Ram
Symphony	7	9	9	8
Samsung	8	7	8	7
Micromax	9	6	8	9
Walton	6	7	8	6

Steps of TOPSIS

Step 1(a): Calculate $\sqrt{\sum x_{ij}^2}$ for each column

Table 4

	Android version	Cost	Battery power	Ram
Symphony	49	81	81	64
Samsung	64	49	64	49
Micromax	81	36	64	81
Walton	36	49	64	36
$\sum x_{ij}^2$	230	215	273	230
$\sqrt{\sum x_{ij}^2}$	15.17	14.66	16.52	15.17

Step 1 (b): According to (1) normalized matrix r_{ij}

Table 5

Symphony	0.46	0.61	0.54	0.53
Samsung	0.53	0.48	0.48	0.46
Micromax	0.59	0.41	0.48	0.59
Walton	0.40	0.48	0.48	0.40

Step 2 (b): From (2) weighted normalized matrix v_{ij}

Table 6

Symphony	0.046	0.244	0.162	0.106
Samsung	0.053	0.192	0.144	0.092
Micromax	0.059	0.164	0.144	0.118
Walton	0.040	0.192	0.144	0.080

Step 3 (a): Determine ideal solution A*.

A* = {0.059, 0.244, 0.162, 0.080} using (3) and (4)

Step 3 (a): Find negative ideal solution A'.

A' = {0.040, 0.164, 0.144, 0.118} using (5) and (6)

Step 4 (a): using (7) Determine separation from ideal solution A* = {0.059, 0.244, 0.162, 0.080}

Table 7

Symphony	$(.046-.059)^2$	$(.244-.244)^2$	$(0)^2$	$(.026)^2$
Samsung	$(.053-.059)^2$	$(.192-.244)^2$	$(-.018)^2$	$(.012)^2$
Micromax	$(.053-.059)^2$	$(.164-.244)^2$	$(-.018)^2$	$(.038)^2$
Walton	$(.053-.059)^2$	$(.192-.244)^2$	$(-.018)^2$	$(.0)^2$

Step 4 (a): Separation from ideal solution S_i^*:

	$\Sigma(v_j^* - v_{ij})^2$	$S_i^* = [\Sigma (v_j^* - v_{ij})^2]$
Symphony	0.000845	0.029
Samsung	0.003208	0.057
Micromax	0.008186	0.090
Walton	0.003389	0.058

Step 4 (b): Using (8) find separation from negative ideal solution, A' = {0.040, 0.164, 0.144, 0.118}

Table 8

Symphony	$(.046-.040)^2$	$(.244-.164)^2$	$(.18)^2$	$(-.012)^2$
Samsung	$(.053-.040)^2$	$(.192-.164)^2$	$(0)^2$	$(-.026)^2$
Micromax	$(.053-.040)^2$	$(.164-.164)^2$	$(0)^2$	$(0)^2$
Walton	$(.053-.040)^2$	$(.192-.164)^2$	$(0)^2$	$(-.038)^2$

Step 4 (b): Determine separation from negative ideal solution S_i' :

Table 9

	$\Sigma(v_j' - v_{ij})^2$	$S_i' = [\Sigma (v_j' - v_{ij})^2]^{½}$
Symphony	0.006904	0.083
Samsung	0.001629	0.040
Micromax	0.000361	0.019
Walton	0.002228	0.047

Step 5: Calculate the relative closeness to the ideal solution using (9)

Table 10

	$S_i'/(S_i^*+S_i')$	C_i^*
Symphony	0.083/0.112	0.74
Samsung	0.040/0.097	0.41
Micromax	0.019/0.109	0.17
Walton	0.047/0.105	0.45

7. Result Discussion

Topsis method is an excellent effective method for decision making especially, it is a best technique for the customers to choose any product within specific criteria. And that opportunity is reflected by the proposed method which we see from steps 5 that our best option for a smart phone is Symphony. Though it depends on customers to classify best criteria which he prefer and it will numerically allocated by fuzzy set. According our data analysis Symphony is the most effective Smartphone for the customers of Bangladesh.

The overall ranking for decision making given below.

Symphony (0.74) ⇨ Walton (0.45) ⇨ Samsung (0.41) ⇨ Micromax (0.17)

8. Conclusion

The study discussed that how to select the effective Smartphone when decision makers set the target value of each criterion. The study proposed a method and a procedure to extend the TOPSIS method to solve the problem. The main advantages of using modified TOPSIS method is giving highest weighted value to a feature after proper analysis of customer satisfaction which done in our paper. The computation processes are straightforward. The concept permits the pursuit of best alternatives criterion depicted in a simple mathematical and data analysis for desired features of peoples. Acquired results from numerical example determine that this model could be used for decision making optimization in electronic device selection.

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