An Integrated Multi-Criteria Decision Making Approach for Tablet Computer Selection

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Abstract

Today, educational institutions follow modern technology and use technological products such as smart board and tablet computer widely as education tools owing to the rapidly developing technology. The lessons supported by these technologies, make learning more effective by influencing student motivation positively. In that scope, the discussed developing technology and its innovative tools will help to improve the quality of education in the long term and contribute to the development of the different skills of the students. In this study, tablet computer selection problem of a high school located in Denizli, Turkey will be analyzed deeply. That determined high school decided to use tablet computers in the lessons as an education tool and the school management aimed to select the most suitable tablet computer to give their students. In this context, tablet computer alternatives have been assessed by an integrated approach based on the combined use of two MCDM (**M**ulti **C**riteria **D**ecision **M**aking) methods; AHP (**A**nalytic **H**ierarchy **P**rocess) and OCRA (**O**perational **C**ompetitiveness **RA**ting). The weights of the criteria were determined with AHP method, then OCRA method was used to rank tablet computer alternatives. The school management has been guided in the selection process of the most suitable tablet computer for their students. They found the search results satisfactory and decided to buy the selected tablet computer by the integrated MCDM method proposed in this study.

Keywords: MCDM, AHP, OCRA, tablet computer selection

Introduction

In recent years, due to the developments in electronic and information technologies, technologic devices that have internet connection like tablet computers and smart interactive boards have been widely used in the education. Many studies in the literature even indicate the usage of tablet computers in education would enable largely improved teaching quality (Wang et al., 2013; Anderson et al., 2006; Lomas and Rauch, 2003). On the other hand, lessons have become more interactive and engaging with the help of tablet computers. Also students become living higly informed by using of electronic technology products such as tablet computers, e-books and smart phones.

Tablet computer market has been developed vigorously in recent years and there are various alternatives and different brands in the marketplace. Also there are a lot of criteria to be considered while determining the most appropriate tablet computer. To select the most ideal tablet computer is a crucial decision for institutions and at the same time it is costly and time consuming. For this reason, in this study an integrated MCDM method is proposed for tablet computer selection. This integrated approach is based on AHP and OCRA methods. After determining the selection criteria, their weights are determined by using AHP method. Later tablet computer alternatives are evaluated and the best one is determined with the help of OCRA method.

In the literature there are studies that considers the importance of tablet computer in education or try to determine the criteria to select the best tablet computer. Anderson et al. (2006), applied UTAUT (Unified Theory of Acceptance and Use of Technology) to asses the user acceptance of tablet computers by the faculty of a College of Business at a large university in the United States. Huan et al. (2011), proposed DEMATEL based network process and Structural Equation Modeling

(SEM) for deriving factors influencing the acceptance of tablet personal computers. El-Gayar et al. (2011) developed a model to understand college students' acceptance of tablet computer as a means to forecast, explain, and improve their usage pattern in education. Wang et al. (2013), analyzed the key factors of consumer groups for tablet computer purchasing by using the combination of fuzzy AHP and MDS (Multidimensional Scaling) methods. Tsai and Chang (2013), compared the Apple iPad and non-Apple tablet computers with different multicriteria decision making methods. They used four MCDM methods, namely GRA (Grey Relational Analysis), VIKOR (Vise Kriterijumska Optimizacija I Kompromisno Resenje), TOPSIS (Technique for Order Preference by Similarity to Ideal Solution) and AHP to evaluate and select the tablet computers' rankings and then constructed a tablet computer evaluation performance model. Çetin and Demir (2015), determined the importance level of main and sub-criteria in selection of tablet computer by using fuzzy AHP. Raji and Zualkernan (2016), developed a decision tool for selecting the most sustainable learning tool intervention for a developing country with the help of MCDM approach based on the combination of ANP (Analytic Network Process) and Future Search Conference technique.

The difference of this study from others in the literature, AHP and OCRA methods are applied together to the tablet computer selection problem. The criteria weights are determined with AHP method and tablet alternatives are evaluated and the best one is determined by OCRA method.

The rest of this study is organised as follow. After the introduction section, AHP is explained in the second section. In the third section, OCRA method is introduced and the steps of the method is given. Application of tablet computer selection is presented in the fourth section. Finally conclusion of the study and suggestions for future studies are given in the last section.

Analytic Hierarch Process

Analytic **H**ierarchy **P**rocess (AHP) is a structured technique for organizing and analyzing complex decisions. It was developed by Saaty (1980) and owing to its simplicity, it has been widely used as an efficient MCDM method for ranking alternatives and determining the criteria weights. AHP can be defined as a process of hierarchizing a system in order to carry out a wide-ranging evaluation and final selection of one of the alternative solutions to a particular problem. The method can also be understood more broadly as a theory of measurement using quantitative and/or qualitative data (Cabała, 2010).

In the literature, AHP method has been applied to different fields such as strategic planning (Arbel and Orger, 1990), evaluation of advanced construction technology (Skibniewski and Chao, 1992), warehouse site selection (Korpela and Tuominen, 1996), strategic investment analysis (Angels and Lee, 1996), facility location selection (Yang and Lee, 1997), project management (Al Harbi, 2001), software selection (Lai et al., 2002; Karaarslan and Gundogar, 2009), managing risk in supplay chain (Gaudenzi and Borghesi, 2006), selection process for a project variant (Cabała, 2010), supplier selection (Bruno et al., 2012), inventory classification (Lolli et al., 2014), energy management (Jovanovic´ et al., 2015), identifying the factors affecting on labor productivity of construction projects (Sherekar and Tatikonda, 2016), risk evaualtion (Zeng and Xu, 2017), assessing renewable energy sources (Nasirov et al., 2017). In addition, AHP method has been also used in the literature to determine the weights of the criteria in MCDM problems. For instance, Macharis et al. (2004) integrated useful AHP feautures into PROMETHEE (Preference Ranking Organization METHod for Enrichment of Evaluations) method such as the design of the decision-making hierarchy and the determination of the weights. Önüt and Soner deterimined the weights of the criteria in transshipment site selection with AHP method. Dağdeviren et al. (2009) used AHP method to determine the weights of the criteria in weapon selection problem. Amiri (2010) proposed to use AHP method to determine the weights of the criteria in the project selection for oil-fields development. Kaya and Kahraman determined the weights of the criteria in multicriteria renewable energy planning by using AHP methodology. Demircanlı and Kundakcı (2015), determined the criteria weights in the evaluation of the performance of football players by using AHP method. Sarıçalı and Kundakcı (2016), used AHP method to determine the criteria weights in the evaluation of hotel alternatives. In this study, AHP method is also used while determining the weights of the criteria in tablet computer selection problem. By this way AHP method is integrated with OCRA method.

The steps of the AHP can be summarized as:

Step 1: Firstly, evaluation criteria and alternatives of the problem are clarified. Then the problem is constructed as a hierarchy of goal, criteria, if exists sub-criteria, and alternatives. The goal of the decision making problem is placed to the highest level and the alternatives are placed to the lowest level. Then, criteria and sub-criteria are placed between them (Wang et al, 2007).

Step 2: In the second step, decision makers make pairwise comparisons. Firstly they compare the relative importance of criteria by using Saaty's 1-9 scale given in Table 1. Then, pairwise comparison of alternatives under each criterion are made and pairwise comparison matrices are obtained. n x n pairwise comparison matrix A based on the decision maker's judgments can be given as in Equation (1) (Kundakcı et al., 2015).

$$A=\left[a_{ij}\right]=\begin{bmatrix} 1 & a_{12} & \cdots & a_{1n} \\ a_{21} & 1 & \cdots & a_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ a_{n1} & 1/a_{2n} & \cdots & 1 \end{bmatrix} \quad (i,j = 1,2,\ldots,n) \quad (1)$$

Here, a_{ij} indicates the decision maker's evaluation of relative importance of criterion i respect to criterion j and $a_{ij}>0$, $a_{ji}=1/a_{ij}$, $a_{ii}=1$ (Caputo et al, 2008).

Table 1. Saaty's 1-9 scale (Saaty, 1987)

Intensity of importance	Definition	Explanation
1	Equal importance	Two activities contribute equally to the objective
3	Moderate importance of one over another	Experience and judgement slightly favor one activity over another
5	Essential or strong importance	Experience and judgement strongly favor one activity over another
7	Very strong importance	An activity is strongly favor one activity over another
9	Extreme importance	The evidence favoring one activity over another is of the highest possible order of affirmation.
2, 4, 6, 8	Intermediate values between two adjacent judgements	When compromise is needed

Step 3: The principal eigenvalue and the corresponding normalized right eigenvector of the comparison matrix give the relative importance of the various criteria being compared. The elements of the normalized eigenvector are termed weights with respect to the criteria or sub-criteria and ratings with respect to the alternatives (Bhushan and Rai, 2004) and this weight vector can be given as in Equation (2).

$W = [w_1, w_2, \ldots, w_n]^T$ $i=1,2,\ldots,n$ (2)

The elements of the weight vector are computed as the average value of the rows in the normalized pairwise comparison matrix A, as seen in Equation (3) (Caputo et al, 2013):

$$w_i=\frac{1}{n}\sum_j\left(\frac{a_{ij}}{\sum_i a_{ij}}\right) \quad i,j = 1,2,\ldots,n \quad (3)$$

Step 4: In this step, the consistency of the comparison matrices are evaluated and if they are inconsistent, decision makers re-examine their pair-wise comparisons. To search for consistency, firstly consistency index (*CI*) is calculated as in Equation (4):

$$CI = (\lambda_{max} - n)/(n-1) \quad (4)$$

here λ_{max} is the maximum eigenvalue of matrix *A*. Then the consistency ratio (*CR*) is calculated by using Equation (5):

$$CR = CI / RI \quad (5)$$

RI values are the average value of *CI* for random matrices and obtained using the Saaty scale and given in Table 2. The comparison matrix is accepted as consistent if $CR < 0.10$.

Table 2. *RI* values (Saaty, 1987; 2013)

n	1	2	3	4	5	6	7	8	9	10	11	12
RI	0	0	0.58	0.90	1.12	1.24	1.32	1.41	1.45	1.49	1.51	1.48

Step 5: A normalized relative rating b_{ij} is computed for each i^{th} alternative respect to any criterion C_j, in comparison with the other alternatives (Caputo et al, 2013).

Step 6: The rating of each alternative is multiplied by the weights of the sub-criteria and aggregated to get local ratings with respect to each criterion. Then, the local ratings are multiplied by the weights of the criteria and aggregated to get global ratings (Bhushan and Rai, 2004). A ranking score R_i is obtained for the i^{th} alternative as given in Equation (6);

$$R_i = \sum_j b_{ij} w_j \quad (6)$$

The final ranking of the alternatives are determined based on these ranking scores. Alternatives are ranked in descending order of their scores.

OCRA Method

The OCRA (**O**perational **C**ompetitiveness **RA**ting) method is a relative performance measurement approach based on a nonparametric model. OCRA is firstly developed by Parkan in 1994 and it is a very useful and simple method for analyzing different sectors and comparing different decision units. In addition, the ability to compare and monitor the performance of a decision unit over time is another important feature of this method.

OCRA is a non-parametric efficiency measurement technique and firstly it was proposed for solving performance measurement and productivity analysis problems. Later this method has been also used to solve various MCDM problems. In the literature there are studies that apply OCRA method to different fields. Parkan (1996a) evaluated the operational competitiveness profile of the hotels with OCRA method. Parkan (1996b) used OCRA method to measure the service performance of a subway system. Parkan and Wu (1996) used TOPSIS and OCRA methods to help a semiconductor manufacturer for selecting a process among four alternatives based on their operational benefits. Jayanthi et al. (1996, 1999) proposed an approach based on OCRA method for competitive analysis of manufacturing plants in the U.S. food processing industry. Parkan et al. (1997), proposed to use OCRA method to measure the operational performance of the application software development teams of a large bank in Hong Kong. Parkan and Wu (1998) solved a process selection problem in a manufacturing sector with TOPSIS and OCRA methods. Parkan and Wu (1999a) analyzed the relative operational performance of Hong Kong's manufacturing industries period from 1987 to 1993 with OCRA method. Parkan and Wu (1999b) used TOPSIS and OCRA methods for robot selection problem. Parkan and Wu (1999c) constructed performance profile of a bank with OCRA method and compared the obtained results with the results of Data Envelopment Analysis (DEA). Parkan and Wu (2000) applied OCRA method to process selection problem and also compared the obtained results with the results of AHP and DEA to understand their similarities and differences. Parkan (2002) evaluate the performance of a public transport company with OCRA method. Parkan (2003) measured the relative performances of the drugstores by using OCRA method and analyzed whether the drugstore operations improved significantly after the deployment of a new electronic point of sale system. Tóth (2005) used OCRA method to analyze the performance of the Hungarian food industry. Parkan (2005) compared the operational performance of two hotels located in a large city by using OCRA method. Bakucs et al. (2011) obtained technical efficiency scores of farms in Bulgaria, Estonia and Hungary with Stochastic Frontier Analysis (SFA), DEA and OCRA, based on the data of national Farm Accountancy Data Network (FADN). Chatterjee and Chakraborty (2012) applied four preference ranking-based MCDM methods for solving a gear material selection problem. These methods are EXPROM2 (Extended PROMETHEE 2), COPRAS-G (Complex Proportional Assessment), ORESTE (Organization, Rangement Et Synthese De Donnes Relationnelles) and OCRA methods. They also compared the ranking performance of these methods with the results of the past researchers. Chakraborty et al. (2013) solved facility location selection problem with grey relation analysis, MOORA (Multi Objective Optimization on the basis of Ratio Analysis), ELECTRE II (ELimination Et Choix Traduisant la REalité) and OCRA methods and obtained a final ranking with REGIME method to resolve disagreement in the ranks obtained by the four different MCDM methods. Chatterjee (2013) proposed to use eight preference ranking-based methods for decision-making in manufacturing applications.These methods are EVAMIX (Evaluation of Mixed Data), COPRAS, COPRAS-G, EXPROM2, ORESTE, OCRA, ARAS (Additive Ratio Assessment) and PSI (Parameter Space Investigation). Chatterjee and Chakraborty (2014) selected flexible manufacturing system by using six different preference ranking methods; Evaluation of Mixed Data (EVAMIX), COPRAS, EXPROM2, ORESTE, OCRA and ARAS. They also compared the obtained results. Darji and Rao (2014) proposed to use four MCDM methods for material selection in sugar industry. They compared the results obtained with extended TODIM (an acronym in Portuguese of Interactive and Multicriteria Decision Making), ARAS, OCRA, EVAMIX methods. Gbegnin and Gürbüz (2014) compared OCRA with operating margin. Madić et al. (2015) selected the most suitable nonconventional machining process for a given machining application with OCRA method. Özbek (2015a) measured the performances of foreign-capital banks by SAW (Simpel Additive Weighting), MOORA and OCRA methods according to six criteria; deposits, capital, labour, loans, interest income and non-interest income. Özbek (2015b) combined AHP and OCRA methods to evaulate the performance of public banks in Turkey. Özbek (2015c) used SAW, MOORA and OCRA methods to measure the performances of foreign-capital banks. Tuş Işık and Aytaç Adalı (2016) proposed an integrated approach based on SWARA (Step-wise Weight Assessment Ratio Analysis Method) and OCRA methods to evaluate the hotel alternatives and select the best one.

The steps of the OCRA method can be summarized as follows (Parkan and Wu, 2000; Chatterjee and Chakraborty, 2012; Tuş Işık and Adalı Aytaç, 2016):

Step 1: Decision matrix *X* is formed as in Equation (7). In the rows of the decision matrix alternatives are placed, and in the columns the criteria are placed. In this matrix, x_{ij}, indicates the performance of alternative *i* under criterion *j.*

$$X = \left[x_{ij}\right]_{mxn} = \begin{bmatrix} x_{11} & x_{12} & \cdots & x_{1n} \\ x_{21} & x_{22} & \cdots & x_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ x_{m1} & x_{m2} & \cdots & x_{mn} \end{bmatrix} \qquad i = 1,\ldots,m \quad j = 1,2,\ldots,n \quad (7)$$

Step 2: In the second step, preference ratings with respect to non-beneficial criteria (cost criteria) are determined. Here, the performance values of the alternatives for the criterion to be minimized are calculated only and the beneficial criteria are not taken into consideration. The total performance of the alternative with respect to non-benefical criteria are calculated with the help of Equation (8):

$$\bar{l}_i = \sum_{j=1}^{g} w_j \frac{\max(x_{ij}) - x_{ij}}{\min(x_{ij})} \qquad (i = 1, 2, \ldots, m \quad j = 1, 2, \ldots, g) \qquad (8)$$

$\bar{l}_i$ indicates the relative performance of alternative *i* and x_{ij} is the performance value of alternative *i* under non-beneficial criterion *j*. Here *g* is the number of non-beneficial criteria (cost criteria) and w_j is the importance degree (weight) of criterion *j*. w_j is used to increase or decrease the impact of the difference on the rating (l_i) with respect to criterion *j*.

Step 3: In this step, linear preference rating of each alternative for non-beneficial criteria are calculated with the help of Equation (9).

$$\bar{\bar{l}}_i = \bar{l}_i - \min(\bar{l}_i) \quad (9)$$

Here, $\bar{\bar{l}}_i$ indicates the total preference rating of alternative *i* for non-beneficial criteria.

Step 4: In this step, preference ratings with respect to beneficial criteria (benefit criteria) are determined. For beneficial criteria the alternatives having higher value are more preferred. The total performance rating of alternative *i* for all beneficial criteria is calculated with Equation (10)

$$\bar{O}_i = \sum_{j=g+1}^{n} w_j \frac{x_{ij} - \min(x_{ij})}{\min(x_{ij})} \qquad (i = 1, 2, \ldots, m \quad j = g+1, g+2, \ldots., n) \qquad (10)$$

Here $(n-g)$ indicates the number of beneficial criteria and w_j is the importance weight of beneficial criterion *j*. $\sum_{j=1}^{g} w_j + \sum_{j=g+1}^{n} w_j = 1$ equality must be ensured. In other words, the sum of the weights of beneficial and non-beneficial criteria must equal to one.

Step 5: In this step, linear preference rating is calculated for beneficial criteria with the help of Equation (11).

$$\bar{\bar{O}}_i = \bar{O}_i - \min(\bar{O}_i) \quad (11)$$

Step 6: In the last step, the total preference value for each alternative is calculated by using Equation (12) and least preferable alternative will take the value of zero.

$$P_i = (\bar{\bar{l}}_i + \bar{\bar{O}}_i) - \min(\bar{\bar{l}} + \bar{\bar{O}}) \quad i = 1, 2, \ldots, m \quad (12)$$

Alternatives are ranked according to their total preference value. The alternative with the highest total performance value is in the first rank.

Application

A high school located in Denizli, Turkey, decided to use tablet computers in the lessons as an education tool and the school management aimed to determine the most suitable tablet computer to give their students. For this aim, firstly criteria for evaluating the tablet computers are determined by the decision makers from school management. These criteria are C_1 Screen Size, C_2 Storage Capacity, C_3 Memory (RAM), C_4 Processor Speed, C_5 Battery Capacity, C_6 Camera Resolution, C_7 Brand Reliability, C_8 Weight, and C_9 Price. Later, pair-wise comparisons are made for these criteria by the decision makers by using Saaty's 1-9 scale given in Table 1. These comparisons are given on Table 3. Then criteria weights are determined by using AHP method.

Table 3. The pairwise comparison matrix

	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8	C_9
C_1	1	5	1/2	1/2	2	7	4	6	3
C_2		1	1/6	1/6	1/4	3	1/2	2	1/3
C_3			1	1	3	8	5	7	4
C_4				1	3	8	5	7	4
C_5					1	6	3	5	2
C_6						1	1/4	1/2	1/5
C_7							1	3	1/2
C_8								1	1/4
C_9									1
CR	0,03								

Calculations are obtained with the help of Expert Choice software. Consistency ratio of the pairwise comparison matrix is calculated and it is less than 0.10. So the importance weights are accepted as consistent. The weights of the criteria obtained from the computations based on the pairwise comparison matrices are shown in the Table 4.

Table 4. Weights of the criteria

	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8	C_9
Weights	0.167	0.039	0.247	0.247	0.116	0.020	0.056	0.027	0.081

After determining the criteria weights with AHP method, tablet computer alternatives are evaluated with OCRA method. To form the decision matrix, firstly alternatives are determined by the decision makers of the school management. There are various tablet computers in the marketplace. After a preliminary investigation, they identified 10 alternatives that would best meet the demands of the school and the students. Then the decision matrix is formed as in Table 5. In the rows of this decision matrix 10 alternatives are placed, and in the columns 9 criteria are placed. In this decision matrix, the data for C_7 is qualitative data and the others are quantitative data. These quantitative data were obtained from the website of an electronic retailer. To obtain the qualitative data, decision maker evaluated the alternatives by using 5 point scale in which 5: Excellent, 4: Very good, 3: Good, 2: Fair, and 1: Poor. On the other hand, some of the criteria have to be maximized and the others minimized. As seen in Table 5, criteria between C_1-C_7 are maximization criteria (beneficial criteria) and criteria C_8, C_9 are minimization criteria (non-beneficial criteria).

Table 5. Decision Matrix

Optimization Direction	Max	Max	Max	Max	Max	Max	Max	Min	Min
Criteria / Alternatives	C_1 (Inch)	C_2 (GB)	C_3 (GB)	C_4 GHz	C_5 (mAH)	C_6 (MP)	C_7	C_8 (GR)	C_9 (Euro)
A_1	8	16	1.5	1.2	4200	5	5	314	185
A_2	8	16	1	1.3	4200	5	4	360	156
A_3	10.1	16	2	1.3	4060	5	3	503	160

A_4	10.1	8	1	1.5	5070	2	4	525	200
A_5	10	16	2	1.2	6350	5	3	560	190
A_6	10.1	16	1	1.2	5500	2	2	521	159
A_7	10.1	64	2	1.7	5240	5	3	770	199
A_8	7	32	1	1.8	3000	3	4	364	157
A_9	10.1	16	1	1.3	3540	5	3	510	171
A_{10}	9.7	16	2	1.83	7500	6	2	550	170

After forming the decision matrix, according to OCRA method the performance ratings $\bar{I}_i$ with respect to non-beneficial criteria (C_8, C_9) are calculated by using Equation (8). For instance $\bar{I}_1$ value for A_1 alternative is calculated as:

$$\bar{I}_1 = 0.027\left(\frac{770-314}{314}\right) + 0.081\left(\frac{200-185}{156}\right) = 0.0470$$

Then, linear preference ratings ($\bar{\bar{I}}_i$) of each alternative for non-beneficial criteria are calculated with Equation (9). For example, $\bar{\bar{I}}_1$ value for A_1 alternative is calculated as: $\bar{\bar{I}}_1 = 0.0470 - 0.0005 = 0.0465$. For other alternatives $\bar{I}_i$ and $\bar{\bar{I}}_i$ values are calculated and given in Table 6.

Table 6. Performance ratings for non-beneficial criteria

Alternatives	$\bar{I}_i$	$\bar{\bar{I}}_i$
A_1	0.0470	0.0465
A_2	0.0581	0.0576
A_3	0.0437	0.0432
A_4	0.0211	0.0205
A_5	0.0232	0.0227
A_6	0.0427	0.0422
A_7	0.0005	0.0000
A_8	0.0572	0.0567
A_9	0.0374	0.0369
A_{10}	0.0345	0.0340

Then, preference ratings with respect to beneficial criteria (benefit criteria) are determined by using Equation (10). For instance, $\bar{O}_1$ value of A_1 is calculated as:

$$\bar{O}_1 = 0.167\left(\frac{8-7}{7}\right) + 0.039\left(\frac{16-8}{8}\right) + 0.247\left(\frac{1.5-1}{1}\right) + 0.247\left(\frac{1.2-1.2}{1.2}\right) + 0.116\left(\frac{4200-3000}{3000}\right) + 0.020\left(\frac{5-2}{2}\right)$$
$$+ 0.056\left(\frac{5-2}{2}\right) = 0.3467$$

Then linear preference ranking is calculated for beneficial criteria with the help of Equation (11). For example, $\bar{\bar{O}}_1$ value for A_1 alternative is calculated as: $\bar{\bar{O}}_1 = 0.3467 - 0.2096 = 0.1371$. Later, for other alternatives $\bar{O}_i$ and $\bar{\bar{O}}_i$ values are calculated and given in Table 7.

Table 7. Performance ratings for beneficial criteria

Alternatives	$\overline{O}_i$	$\overline{\overline{O}}_i$
A_1	0.3467	0.1371
A_2	0.2158	0.0062
A_3	0.4795	0.2699
A_4	0.2717	0.0621
A_5	0.5451	0.3355
A_6	0.2096	0.0000
A_7	0.8415	0.6319
A_8	0.3065	0.0969
A_9	0.2124	0.0028
A_{10}	0.6941	0.4845

Lastly, the total preference value P_i for each alternative is calculated by using Equation (12) and least preferable alternative will take the value of zero.

For example, preference value for A_1 alternative is calculated as $P_1 = (0.0465 + 0.1371) - 0.0397 = 0.1439$. For other alternatives P_i values are calculated and presented in Table 8. Total preference values of alternatives are ranked in descending order. By this way the ranking of the alternatives is obtained as seen in Table 8. According to these values the best tablet computer alternative is A_7. It has been proposed to buy this tablet computer to the school management and they have found the results satisfactory and decided to buy A_7 alternative.

Table 8. Total preference values of alternatives

Alternatives	p_i	Ranking
A_1	0.1439	A_7
A_2	0.0241	A_{10}
A_3	0.2734	A_5
A_4	0.0430	A_3
A_5	0.3185	A_1
A_6	0.0025	A_8
A_7	0.5922	A_4
A_8	0.1139	A_2
A_9	0.0000	A_6
A_{10}	0.4787	A_9

Conclusions

Tablet computer selection is an important decision for the schools as it is costly and time consuming. In this study, to evaluate the tablet computer alternatives and select the best one for a high school, an integrated approach based on AHP and OCRA methods is proposed. After determining the criteria to be considered in the evaluation process, the criteria weights are calculated with the help of AHP method. Criteria weights are determined by using Expert Choice software, and “memory” and “processor speed” criteria have the highest importance degree with 0.247. They are followed by “screen size” with 0.167, “battery capacity” with 0.116, “price” with 0.081, “brand reliability” with 0.056, “storage capacity” with 0.039, “weight” with 0.027 and “camera resolution” with the lowest weight 0.020. After determining the criteria weights, tablet computer alternatives are evaluated with OCRA method and the ranking is obtained as $A_7 > A_{10} > A_5 > A_3 > A_1 > A_8 > A_4 > A_2 > A_6 > A_9$. As the best alternative is A_7, it is advised to the school management to purchase this tablet computer alternative for their students. By this way, the school management has been guided in this decision making process.

In OCRA method, different rankings can be obtained if the weights of the criteria vary or the performance values of the alternatives change. OCRA method does not contain complex calculations and it is easy to understand. So this method can be applied easily to different MCDM problems. In the future studies, the tablet computer selection problem can be solved with different MCDM methods and the results can be compared. In addition, criteria weights can be determined by different methods like MACBETH, SWARA and entropy weight rather than AHP. It is also possible to use proposed integrated method to solve other MCDM problems.

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