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AN APPROACH FOR E-LEARNING COURSES EVALUATION BASED ON THE EDAS METHOD

Abstract

The development and increasing use of information and communication technology and the Internet as well, have facilitated access to educational materials and increased the popularity of e-learning courses. The increase in the number of e-learning courses imposes the need for evaluating their quality. As a result, the criteria and procedures for evaluating the quality of e-courses are becoming increasingly important. Therefore, the use of the EDAS method for evaluating the quality of e-courses is discussed in this paper. The four e-courses are assessed against the seven evaluation criteria obtained on the basis of the literature review. The evaluation process is performed in the group decision-making environment with the aim of obtaining more reliable results.

Keywords: EDAS, MCDM, group decision-making, e-learning, content, quality

JEL classification: *C44, I29, M15*

ПРИСТУП ЕВАЛУАЦИЈИ КУРСЕВА ДАЉИНСКОГ УЧЕЊА ЗАСНОВАН НА ЕДАС МЕТОДИ

Апатракт

Развој и раст примене информационо-комуникационих технологија, као и Интернета, је олакшао приступ образовним материјалима и утицао на пораст популарности курсева за даљинско учење. Пораст броја наведених курсева довео је и до потребе за оцењивањем њиховог квалитета. Као резултат тога, критеријуми и процедуре за евалуацију електронских курсева су постали изузетно важни. Из тог разлога, у овом раду је приказана примена ЕДАС методе за евалуацију квалитета електронских курсева. Извршена је оцена четири електронска курса заснована на седам критеријума дефинисаних на основу прегледа литературе.

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Процес евалуације је изведен у условима ѓруѓноѓ одлучивања у циљу добијања шшо релеванѓнијих резулѓаѓа.

Кључне речи: *ЕДАС, ВКО, ѓруѓно одлучивање, елекѓронско учење, садржај, квалиѓеѓ*

Introduction

The development of the Internet has seriously changed the industrial and business activity in the world. Additionally, Internet caused the revolution in education by introducing the learning based on the Internet technology. The use of this technology accelerates exchanging of information and facilitates the education management and performing the given tasks (Tzeng et al., 2007). In that way, the learning process is not connected to the particular place or period of time. Now, a student could choose when and where he/she will perform the studying.

Designing an e-learning course is not easy task for a faculty or other type of educational institution. The e-learning course could not be developed independently from the environment. In other words, the student needs and expectations should be considered before and during the realization of the online course. So, the technical functionality of the online course is as much important as its capacity for adaptation to the changes of the environment (Graf & List, 2005).

Assessment of the usability and quality of the online course is not an easy task. Besides, identifying the users of the online course as well as the tasks in an online context are the aditional obstacle (Zaharias & Poylymenakou, 2009). The convenient tool for the assessment of the online courses could be the Multiple Criteria Decision Making (MCDM) methods. The MCDM can be described as the process of selecting the most appropriate from a set of available alternatives. However, MCDM can be defined as a process of ranking and prioritizing alternatives.

In addition to many known MCDM methods, such as: SAW (MacCrimmon, 1968), AHP (Saaty, 1980), TOPSIS (Hwang and Yoon, 1981), PROMETHEE (Brans and Vickine, 1985), ELECTRE (Roy, 1991), VIKOR (Opricovic, 1998), some new MCDM methods have been proposed, such as: COPRAS (Zavadskas et al., 1994), ARAS (Zavadskas and Turskis, 2010), EADS (Keshavarz Ghorabaee et al., 2015). Until now, the MCDM methods have been used for the facilitation of decision-making process in many business fields such as: hotel and tourism industry (Stanujkic et al., 2017a; Karabašević et al., 2019; Popovic et al., 2019a; Popovic et al., 2019b), IT industry (Karabasevic et al., 2018), negotiation (Stanujkic et al., 2017b), household issues (Hassanpour & Pamucar, 2019), transport (Çam & Sezen, 2020), etc.

The evaluation of the e-learning websites occupied significant research attention which proves a number of papers that elaborate the mentioned topic, only to mention some of them, Garg and Jain (2017) proposed the application of the FAHP, COPRAS, VIKOR and WDBA methods in the case of the e-learning website selection, while Khan et al. (2019) applied the PIV method for the same purpose. The analysis of the components of e-learning systems and its prioritization is, also, performed by using the MCDM methods (Çelikbilek &Adıgüzel Tüylü, 2019).

For the purpose of this paper, the application of the EDAS method is proposed. The reason for the proposing mentioned method reflects thorough the fact that it is simple, understandable, and convenient for facilitation the business problems. Therefore, the remaining part of the paper is organized as follows: In the second section, the EDAS method is presented and in the third section a numerical illustration is considered. Finally, the conclusions are given.

The EDAS method

As previously mentioned, the EDAS has been introduced by Keshavarz Ghorabaee et al. (2015). Similar to the very popular TOPSIS method, the EDAS method uses two distance measures to select the most appropriate alternative, but the calculation procedures are quite different. The EDAS method use two distance measures, namely the Positive Distance from Average (PDA) and the Negative Distance from Average (NDA), and that the most appropriate alternative is the alternative that has higher value of PDA and lower value of NDA.

The computational procedure of the EDAS method, for decision-making problem with m criteria and n alternatives, can be precisely presented as follows (Stanujkic et al., 2017c):

Step 1. Select the available alternatives, the most important criteria that describe alternatives, and rank alternatives in order to selected criteria. As a result, a decision matrix has been formed.

Step 2. Determine the average solution according to all criteria, shown as follows:

$$\varkappa_j = (x_1, x_2, \cdots, x_n), \tag{1}$$

with:

$$\varkappa_j = \frac{\sum_{i=1}^{m} x_j}{m}. \tag{2}$$

where x_{ij} denotes the rating of the alternative i in the relation of the criterion j.

Step 3. Calculate the positive distance from average d_j^- and the negative distance from average d_j^- according to the type of criteria (beneficial and non-beneficial) as follows:

$$d_j^+ = \begin{cases} \dfrac{\max(0,(x_j - \varkappa_j))}{\varkappa_j}; & j \in \Omega_{\max} \\ \dfrac{\max(0,(\varkappa_j - x_j))}{\varkappa_j}; & j \in \Omega_{\min} \end{cases}, \tag{3}$$

$$d_j^- = \begin{cases} \dfrac{\max(0,(\varkappa_j - x_j))}{\varkappa_j}; & j \in \Omega_{\max} \\ \dfrac{\max(0,(x_j - \varkappa_j))}{\varkappa_j}; & j \in \Omega_{\min} \end{cases}, \tag{4}$$

where: Ω_{max} and Ω_{min} denotes the set of beneficial and non-beneficial criteria, respectively.

For a decision-making problem involving only the beneficial criteria d_{ij}^{+} d_{ij}^{-} can be determined as follows:

$$d_{ij}^{+} = \frac{\max(0,(x_{ij} - \bar{x}_{j})}{\bar{x}_{j}}, \tag{5}$$

$$d_{ij}^{-} = \frac{\max(0,(\bar{x}_{j} - x_{ij})}{\bar{x}_{j}} . \tag{6}$$

Step 4. Determine the weighted sum of PDA, Q_{i}^{+}, and weighted sum of NDS, Q_{i}^{-}, for all alternatives, as follows:

$$Q_{i}^{+} = \sum_{j=1}^{n} w_{j} d_{ij}^{+} , \tag{7}$$

$$Q_{i}^{-} = \sum_{j=1}^{n} w_{j} d_{ij}^{-} . \tag{8}$$

Step 5. Normalize the values of weighted sum of PDA and weighted sum of NDA for all alternatives, as follows:

$$S_{i}^{+} = \frac{Q_{i}^{+}}{\max_{i} S_{i}^{+}} , \tag{9}$$

$$S_{i}^{-} = 1 - \frac{Q_{i}^{-}}{\max_{i} S_{i}^{-}} , \tag{10}$$

where S_{i}^{+} and S_{i}^{-} denote the normalized weighted sum of PDA and NDA, respectively.

Step 6. Calculate the appraisal score S_{i} for all alternatives, as follows:

$$S_{i} = \frac{1}{2}(S_{i}^{+} + S_{i}^{-}) . \tag{11}$$

Step 7. Rank the alternatives according to the decreasing values of the appraisal score. The alternative with the highest S_{i} is the best choice among the candidate alternatives.

The use of EDAS method for group decision-making

Solving complex decision-making problems require the involvement of a number of respondents. In such cases, personal attitudes have to be transformed into the

group attitudes. For a team consisting of K respondents the individual attitudes can be transformed into a group as follows:

$$x_{ij} = \frac{1}{K}\sum_{k=1}^{K} x_j^k \ ,$$

(12)

where x_{ij}^k denotes attitude of alternative i in relation to criterion j obtained from decision-maker k, and x_{ij} denotes the rating of the alternative i in the relation of the criterion j.

A Numerical Illustration

In this case study, four e-learning courses, designated as A_1, A_2, A_3, and A_4, have been evaluated on the basis of seven criteria by twenty-four respondents. The criteria used for the evaluation, as well as their weights, are shown in Table 1.

The responses, computational details, and weight obtained from the first of three randomly selected respondents are shown in *Tables 1*, *2*, and *3*.

Table 1: The criteria and weights of criteria

Criteria		w_j
C_1	Level of content	0.14
C_2	Presentation method	0.14
C_3	Teaching method	0.13
C_4	e-learning environment	0.14
C_5	Learning materials	0.15
C_6	Quality of multimedia content	0.14
C_7	Group work and interactivity	0.15

The ratings obtained from three to twenty-four respondents are shown in *Tables 2* to *4* and on *Figures 1* to *3*.

Table 2: The ratings obtained from the fist of twenty-four respondents

Criteria	C_1	C_2	C_3	C_4	C_5	C_6	C_7
C_1	4	3	3	4	2	4	5
C_2	3	5	2	4	4	4	4
C_3	5	5	4	5	3	3	2
C_4	4	5	5	4	4	4	4

Figure 1: The ratings obtained from the fist of twenty-four respondents

Table 3: The ratings obtained from the second of twenty-four respondents

Criteria	C_1	C_2	C_3	C_4	C_5	C_6	C_7
C_1	2	3	5	5	2	3	2
C_2	4	5	4	5	4	4	5
C_3	5	4	4	5	5	5	3
C_4	3	5	3	4	4	5	4

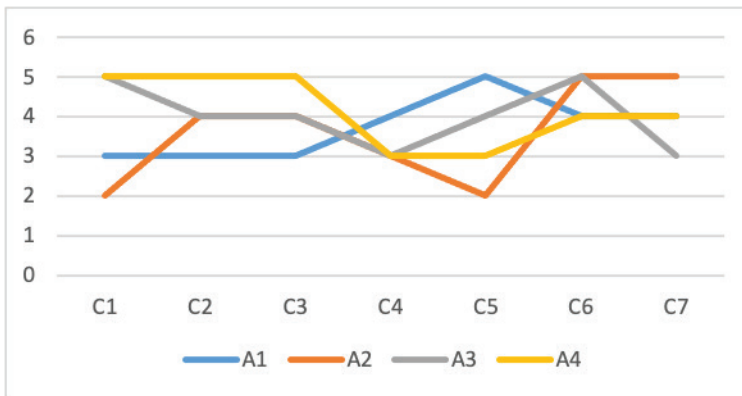*Figure 2: The ratings obtained from the second of twenty-four respondents*

Table 4: The ratings obtained from the third of twenty-four respondents

Criteria	C_1	C_2	C_3	C_4	C_5	C_6	C_7
C_1	3	3	3	4	5	4	4
C_2	2	4	4	3	2	5	5
C_3	5	4	4	3	4	5	3
C_4	5	5	5	3	3	4	4

Figure 3: The ratings obtained from the third of twenty-four respondents

The ratings of the alternative A_1 obtained from all respondents are shown in *Table 5*. At the end of this table, the group ratings are also shown.

Table 5: The ratings and group ratings of alternative A_1

	C_1	C_2	C_3	C_4	C_5	C_6	C_7
R_1	4	3	3	4	2	4	5
R_2	2	3	5	5	2	3	2
R_3	3	3	3	4	5	4	4
R_4	4	3	3	4	2	4	5
R_5	3	4	5	4	3	2	2
R_6	4	4	2	4	5	4	4
R_7	3	5	4	4	4	5	5
R_9	4	4	4	5	4	5	4
R_{10}	3	3	5	3	3	1	2
R_{11}	4	5	4	5	5	4	3
R_{12}	3	5	4	4	4	4	4
R_{13}	2	2	3	2	1	2	3
R_{14}	3	4	3	2	4	2	4
R_{15}	4	2	2	3	4	5	3
R_{16}	3	4	5	4	3	2	2
R_{17}	2	3	3	2	3	2	3
R_{18}	2	2	2	1	2	2	1
R_{19}	5	4	4	5	4	3	2
R_{20}	1	3	3	1	2	1	2
R_{21}	4	3	3	4	2	4	5
R_{22}	2	2	3	3	2	2	2
R_{23}	3	5	4	2	3	4	2
R_{24}	5	4	5	4	3	2	3
Avg.	3.25	3.50	3.63	3.46	3.13	3.04	3.13

The ratings obtained for alternatives A_2, A_3, and A_4 are similarly presented in *Tables 6, 7,* and *8.*

Table 6: The ratings and group ratings of alternative A_2

	C_1	C_2	C_3	C_4	C_5	C_6	C_7
R_1	3	5	2	4	4	4	4
R_2	4	5	4	5	4	4	5
R_3	2	4	4	3	2	5	5
R_4	4	3	4	4	4	4	4
R_5	3	3	4	4	4	4	4
R_6	5	3	5	4	4	4	4
R_7	5	3	5	4	4	4	4
R_9	2	5	4	4	4	5	4
R_{10}	3	5	5	5	4	5	5
R_{11}	3	5	2	4	4	4	4
R_{12}	3	4	4	4	5	5	2
R_{13}	2	3	2	2	1	4	2
R_{14}	3	2	2	2	3	2	3
R_{15}	3	3	3	3	4	4	3
R_{16}	3	3	4	4	4	4	4
R_{17}	2	3	3	3	3	2	3
R_{18}	3	3	2	2	3	2	1
R_{19}	5	4	3	5	4	4	5
R_{20}	3	5	2	4	4	4	4
R_{21}	4	5	4	4	3	4	2
R_{22}	3	3	4	3	2	2	3
R_{23}	2	3	3	2	4	3	4
R_{24}	4	3	4	2	2	2	4
Avg.	3.29	3.71	3.50	3.54	3.46	3.71	3.58

Table 7: The ratings and group ratings of alternative A_3

	C_1	C_2	C_3	C_4	C_5	C_6	C_7
R_1	5	5	4	5	3	3	2
R_2	5	4	4	5	5	5	3
R_3	5	4	4	3	4	5	3
R_4	5	3	4	5	4	4	5
R_5	3	5	3	3	4	5	2
R_6	5	3	3	5	3	3	3
R_7	3	4	3	3	3	4	4
R_9	3	5	5	5	5	3	5
R_{10}	4	3	2	5	3	4	3
R_{11}	3	4	5	3	3	5	4
R_{12}	3	3	4	4	5	4	5
R_{13}	3	2	1	1	3	5	3

	C_1	C_2	C_3	C_4	C_5	C_6	C_7
R_{14}	5	4	4	3	4	5	3
R_{15}	5	3	4	5	4	4	5
R_{16}	3	5	3	3	4	5	2
R_{17}	5	3	3	5	3	3	3
R_{18}	3	1	1	2	4	1	2
R_{19}	4	5	2	5	4	4	4
R_{20}	1	3	1	1	3	1	3
R_{21}	5	5	4	5	3	3	2
R_{22}	5	5	4	5	3	3	2
R_{23}	3	3	2	1	3	1	2
R_{24}	4	2	3	4	1	3	3
Avg.	3.92	3.71	3.17	3.79	3.54	3.63	3.13

Table 8: The ratings and group ratings of alternative A_4

	C_1	C_2	C_3	C_4	C_5	C_6	C_7
R_1	4	5	5	4	4	4	4
R_2	3	5	3	4	4	5	4
R_3	5	5	5	3	3	4	4
R_4	4	5	3	4	4	4	4
R_5	4	4	3	4	3	4	4
R_6	4	5	2	4	4	4	4
R_7	3	5	5	3	3	5	4
R_9	2	5	4	4	5	4	5
R_{10}	4	5	5	4	5	4	3
R_{11}	4	4	5	5	5	3	3
R_{12}	5	4	3	2	4	5	4
R_{13}	2	2	4	1	4	2	2
R_{14}	3	4	2	4	3	2	2
R_{15}	3	5	4	4	5	2	3
R_{16}	3	4	4	3	5	2	5
R_{17}	2	2	3	2	3	2	3
R_{18}	2	2	2	1	1	1	2
R_{19}	5	4	5	4	4	3	3
R_{20}	4	5	5	4	4	4	4
R_{21}	4	5	3	5	5	2	2
R_{22}	3	3	2	2	1	2	2
R_{23}	2	2	3	4	4	2	2
R_{24}	3	1	2	3	5	2	5
Avg.	3.46	4.00	3.63	3.38	3.79	3.13	3.38

Finally, the group rating of alternatives are shown in *Table 9*.

Table 9: The group ratings of considered alternatives, and the average solution

	C_1	C_2	C_3	C_4	C_5	C_6	C_7
A_1	3.25	3.50	3.63	3.46	3.13	3.04	3.13
A_2	3.29	3.71	3.50	3.54	3.46	3.71	3.58
A_3	3.92	3.71	3.17	3.79	3.54	3.63	3.13
A_4	3.46	4.00	3.63	3.38	3.79	3.13	3.38
x_j	3.48	3.73	3.48	3.54	3.48	3.38	3.30

The average solution, according to all criteria, obtained using Eqs. (1) and (2), is also shown in the last row on *Table 9.*

The positive distances from average, calculated using Eq. (5), and the negative distances from average, calculated using Eq. (6), are shown in *Table 10* and *Table 11*, respectively.

Table 10: The positive distances from average

	C_1	C_2	C_3	C_4	C_5	C_6	C_7
A_1	0.000	0.000	0.042	0.000	0.000	0.000	0.000
A_2	0.000	0.000	0.006	0.000	0.000	0.099	0.085
A_3	0.126	0.000	0.000	0.071	0.018	0.074	0.000
A_4	0.000	0.073	0.042	0.000	0.090	0.000	0.022

Table 11: The negative distances from average

	C_1	C_2	C_3	C_4	C_5	C_6	C_7
A_1	0.066	0.061	0.000	0.024	0.102	0.099	0.054
A_2	0.054	0.006	0.000	0.000	0.006	0.000	0.000
A_3	0.000	0.006	0.090	0.000	0.000	0.000	0.054
A_4	0.006	0.000	0.000	0.047	0.000	0.074	0.000

Weighted sum of PDA and NDA, obtained using Eq. (7) and Eq. (8), and normalized weighted sum of PDA and NDA, obtained using Eq. (9) and Eq. (10), are shown in *Table 12*.

Table 12: Calculation details obtained using EDAS method

	Q_i^-	Q_i^-	S_i^-	S_i^-	S_i	Rank
A_1	0.01	0.06	0.14	0.00	0.07	4
A_2	0.03	0.01	0.66	0.84	0.75	2
A_3	0.04	0.02	1.00	0.65	0.82	1
A_4	0.03	0.02	0.78	0.69	0.74	3
Σ	0.04	0.06				

The appraisal score S_i for each alternative, determined using Eq. (11) is also given in *Table 12.* On the basis of the appraisal score the alternative denotes as A_3 is selected as the most appropriate one.

Conclusion

Many faculties and institutions design and offer various online courses pointed to different topics. Every one of these institutions has certain advantages and disadvantages in conducting such type of education. The main goal is, certainly, obtaining the quality education and achievement of the desired goal without sacrificing the education standards.

In order to define the advantages and disadvantages of a certain online course, the MCDM techniques could be a very convenient way. The authors proposed different models for the assessment of the quality of the e-learning as well as for the prioritization of the e-learning websites. This paper presents an application of the EDAS method for e-learning courses evaluation. The evaluation was based on the seven criteria that rely on the views of twenty-four respondents.

The main reason for the application of the EDAS method is its simplicity and relevance. The obtained results clearly outlined what features of the online course should be improved, as well as how is it position relative to the competition. The simplicity of the presented method makes it suitable for application by the practitioners outside of the scientific field. By using this method, the practitioners, i. e. the educators that offer e-courses will easily determine what features of its course are good and what should be improved.

The proposed model is based on the application of the crisp numbers, which is the crucial deficiency of this paper. Because of that, the vagueness of the environment i.e. the indecision of the respondents, is not appreciated in the satisfying degree. This shortage could be overcome by using the proper extensions of the proposed method. Afterward, the applicability of the EDAS method certainly could not be denied.

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