Turkish Journal of Electrical Engineering & Computer Sciences

http://journals.tubitak.gov.tr/elektrik/

Research Article

Turk J Elec Eng & Comp Sci
(2017) 25: 2809 – 2819

doi:10.3906/elk-1512-271

Evaluation of distance education websites: a hybrid multicriteria approach

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Received: 27.12.2015 • **Accepted/Published Online:** 01.11.2016 • **Final Version:** 30.07.2017

Abstract: This study provides an evaluation model that prioritizes the relative weights of various distance education websites. The proposed approach consists of four sequential steps. In the first step, 25 different subcriteria under 4 major criteria are gathered from the existing literature. Identified criteria are weighted by stakeholders of distance education websites using the analytic network process outlined in the second step. In the third step, the technique for order preference by similarity to ideal solution method is applied in order to rank the 15 different Turkish distance education website alternatives. Finally, in the fourth step, different scenario analyses are applied to ascertain the influence of criteria groups (generated according to their qualitative and quantitative characteristics) on the selection of the best website.

Key words: ANP, distance education, multicriteria decision making, TOPSIS, website evaluation

1. Introduction

A distance education website, one of the most important tools in online education programs, can be considered an ambassador between instructors and students. Distance education management systems provide online learning materials to supplement traditional classroom instruction. However, the development, management, and continuous improvement of distance education websites are quite challenging for all stakeholders [1]. Additionally, the impact of a distance education website on system success cannot be fully understood without an evaluation of the website [1]. To do so, developing an evaluation framework for a distance education website has become an essential requirement of a feedback loop for continuous improvement. In spite of a considerable amount of research having already been carried out on website evaluation of various sectors such as e-business [2], hotels [3], online shopping [4], local governments [5], Internet banking [6], social networks [7], academic institutions [8,9], and tourism [10], there is still a gap to be filled regarding the evaluation of distance education or e-learning websites. Several references to the relevant literature are given below. Chiu et al. [11] proposed a "decomposed expectancy disconfirmation theory model" in order to examine the cognitive emotions that impact and influence learners' decision-making processes in the context of selecting a distance education program. The results suggest that a user's continuance intention is determined by satisfaction, which in turn is jointly determined by perceived usability, perceived quality, perceived value, and usability disconfirmation. Later, Lee et al. [12] investigated students' adoption of an Internet-based learning model. According to their study, usefulness, ease of use, and enjoyment/motivators were captured for use in explaining the students' intention.

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Then Pituch and Lee [13] proposed alternative models that strive to explain students' purpose in using an e-learning system when the system is used as an auxiliary learning tool within a traditional class versus a stand-alone distance education method. They identified how such system factors impact e-learning system use for both supplementary learning and distance education purposes. Later on, Roca et al. [14] proposed a decomposed technology acceptance model in the context of an e-learning service. The results suggest that users' continuance intention was determined by satisfaction, which in turn is jointly determined by perceived usefulness, information quality, confirmation, service quality, system quality, perceived ease of use, and cognitive absorption. Lin [15] used the updated DeLone and McLean information system success model to investigate the determinants for successful use of e-learning systems based on a survey of 232 undergraduate students. The results showed that system quality, information quality, and service quality had a significant effect on online learning systems. Tzeng et al. [16] proposed an evaluation model for distance education programs, with 58 criteria that fit with user's perception patterns. Tung and Chang [17] explored the important factors in motivating students to use online courses. They found out that computer self-efficacy, compatibility, perceived usefulness, perceived ease of use, and perceived information quality had a positive effect on the behavioral intention to use online courses. Lin [1] developed an evolution model that combines analytic hierarchy processes and triangular fuzzy numbers to propose a fuzzy evaluation model that prioritized the relative weights of distance education website quality factors. This result provided further support for the idea that information quality has a strong and significant influence on user satisfaction and behavioral intention to use course websites. Alenezi et al. [18] extended the technology acceptance model to examine the role of enjoyment, computer anxiety, computer self-efficacy, and Internet experience in influencing users' intentions regarding distance education program selection. The results indicated that computer anxiety, computer self-efficacy, and enjoyment significantly influenced students' intention to use e-learning systems. Additively, Büyüközkan et al. [19] adopted an axiomatic design-based approach for fuzzy group decision-making to evaluate the quality of e-learning websites. Zhang and Cheng [20] constructed a four-phase evaluation model for e-learning courses, which includes planning, development, process, and product evaluation model. Silambannan and Srinath [21] evolved a framework used to construct an e-learning website. Quality-based construction and evaluation of the website is the main goal of the proposed work. Results of the study indicated that navigation, browser independence, uniqueness, and information clarity criteria have significant impacts on e-learning websites. Nye [22] examined the development of a multilayered portal from the initial stages of planning to the indicators of strong engagement taken up by students, eventually leading to the creation of similar portals across the university. This research highlighted the shared desire by distance education students and academics for authentic and personal higher education participation regardless of the students' location. Beccaria et al. [23] examined the role of health-promoting behavior (nutrition, physical activity, stress management, spiritual growth, interpersonal relationships, and health responsibility) in student stress, strain, and coping for on-campus and distance education students. The findings of this research indicated that there is strong theoretical support for the targeting of health-promoting behaviors as an important component of student coping.

As given above, a large effort has been made regarding the evaluation of distance education websites; however, a generalized quantitative evaluation model based on multicriteria decision-making is still lacking. Determining the most important factors of a distance education website is crucial and helps system designers focus on factors with the highest weight and identify the best policy to improve website effectiveness [1]. To do so, in order to evaluate the relative importance of these factors, a multicriteria decision-making approach is essential [24]. Consequently, this study proposes a model that hybridizes the analytic network process (ANP)

and the technique for order preference by similarity to ideal solution (TOPSIS) in order to provide an evaluation model that prioritizes the relative weights of distance education websites. The intended contributions of this paper to current literature are: (i) to determine and evaluate the most relevant criteria for a distance education website; (ii) to apply a hybrid multicriteria decision model based on ANP and TOPSIS methodology; (iii) to present results of scenario analyses that capture the effects of different criteria groups generated according to their qualitative and quantitative characteristics on the ranking of the best websites.

The remainder of the paper is organized as follows. In the next section (Section 2), criteria considered for evaluation are provided. In Section 3, ANP and TOPSIS methods are given briefly. The proposed hybrid multicriteria decision-making model is presented in Section 4. Evaluation of Turkish distance education websites as a case study is given in Section 5, along with a scenario to demonstrate the applicability of the proposed model. Concluding remarks and future directions are given in Section 6.

2. Distance education website evaluation

From authors' perspectives and related literature, the criteria of a distance education website can be addressed via four main dimensions (Figure 1): system quality, information quality, service quality, and attractiveness [1].

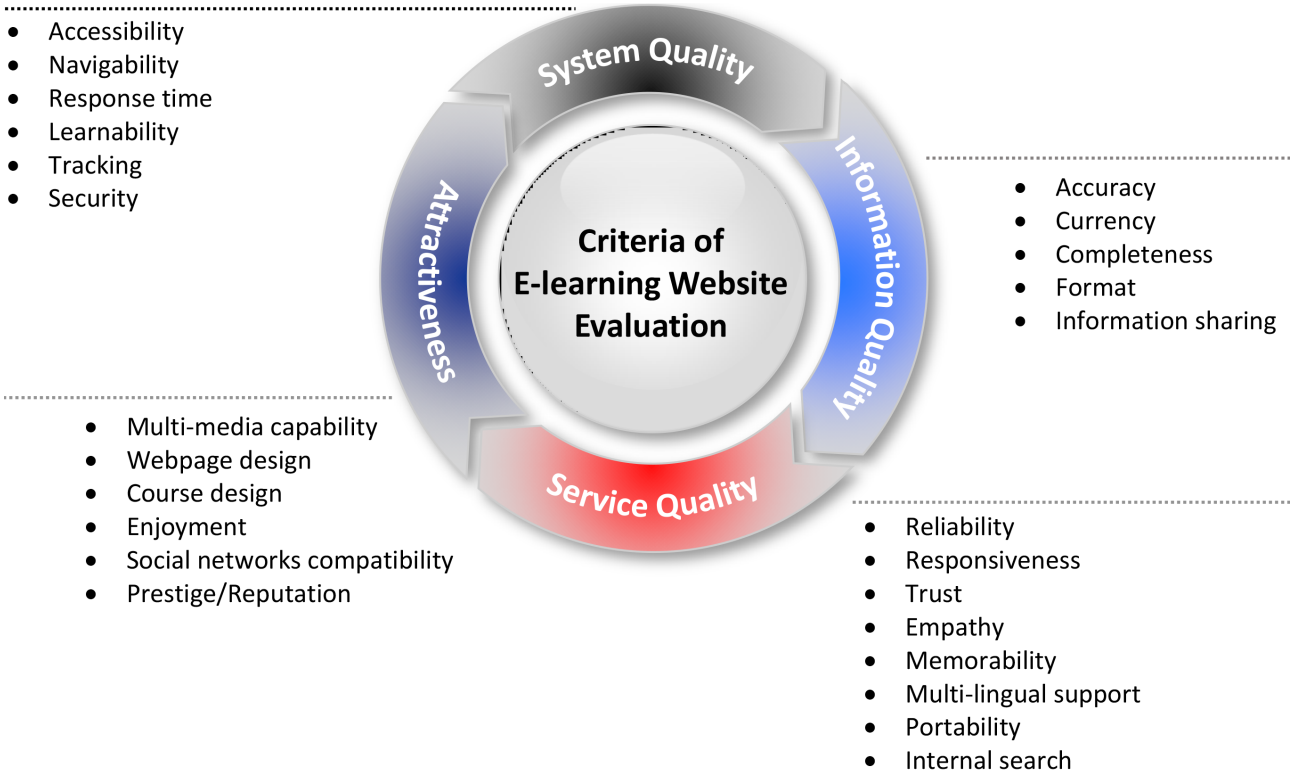

Figure 1. The four main dimensions in the study.

2.1. System quality

System quality cites the perceived ability of a distance education website to provide suitable functions in relation to user control [1]. In other words, the first dimension identifies the effect of system quality on the

learner's perceived satisfaction. This dimension includes accessibility [3], navigability [4,21], response time [16], learnability [2], tracking (proposed by Taiwan e-Learning & Digital Archives Program), and security [25].

2.2. Information quality

Information quality refers to the quality of the information provided by the online services. The most fundamental capability of a course website is the presentation of information regarding learning content, subjects, and items [15]. In this paper, information quality has been associated with five characteristics, namely, (i) accuracy, (ii) currency, (iii) completeness, (iv) format, and (v) information sharing to cope with the aforementioned problems [1,15].

2.3. Service quality

Service quality measures the overall support delivered by the website and consists of reliability [26], responsiveness [27], trust [28], empathy [29], memorability [1], multilingual support [21], portability [30], and internal search [6]. The nature of online interaction, without the cues provided by face-to-face contact, may require high-quality services to enhance user satisfaction with the website [1].

2.4. Attractiveness

Website visual attractiveness refers to the degree of user belief that the web pages are enjoyable to read and visually pleasing. If learners perceive the course website as aesthetically pleasing, well-organized, and attractive, they are more likely to pursue online learning. This study considers that attractiveness includes six dimensions [1]: multimedia capability [13], webpage design [31], course design [16], enjoyment [32], social network compatibility [33], and prestige/reputation [4].

3. Evaluation methods of distance education websites

This section presents brief information on the ANP method, followed by the same for the TOPSIS method.

3.1. The ANP method

ANP is a practical multicriteria decision making method introduced by Saaty [24] and is used to calculate weights/priorities. ANP is capable of handling interdependence between the decision levels and attributes by obtaining the composite weights through the development of a "supermatrix." The supermatrix is actually a partitioned matrix, where each matrix segment represents a relationship between two components or clusters in a system [24]. Matrix operations can be used to calculate the weights of criteria, especially where the numbers of criteria/elements in the model are relatively few. There are 25 criteria and 15 alternatives in the proposed model. That is why the "Super Decisions" software was used in the calculation of the weights of criteria by ANP. There are many studies in the available literature using ANP to solve different decision-making problems [34,35]. ANP is also utilized in a few studies on education, distance education, and website analysis. Readers can find details about the steps of ANP in various papers [36] and download free and open source software from www.superdecisions.com.

3.2. The TOPSIS method

The TOPSIS method, developed by Hwang and Yoon [37], has been demonstrated to be one of most effective multicriteria decision-making techniques. TOPSIS is based on the concept that the alternative that is closest

to the positive ideal solution and also farthest from the negative ideal solution is selected as the most preferred one [37]. The positive ideal solution is the solution that maximizes all the benefit criteria and minimizes all the cost criteria, while the negative ideal solution maximizes the cost criteria and minimizes the benefit criteria in the decision problem. The TOPSIS concept is fairly simple and comprehensible. The method is efficient in computations and determines the relative performance of the alternatives in simple mathematical formulas. Due to these characteristics, it is preferred by a substantial number of researchers for solving decision problems [38, 39]. A detailed application of TOPSIS can be easily found in Wang and Lee [40].

4. The proposed hybrid multicriteria decision-making approach

Before the proposed approach application, the decision-making team (stakeholders of the distance education websites), who will evaluate criteria and alternatives, is formed. Three members of the team are students who participate in distance education and the remainders are the authors of this paper. Selection and evaluation decisions of criteria and alternatives are based on consensus. Geometric means of values are found to obtain the pairwise compassion matrix, on which there is a consensus. The proposed hybrid model is applied in three basic stages. First, evaluation criteria are determined and the model is formed. Criteria weights are calculated via ANP in the second stage. Linguistic terms are used to evaluate criteria weights. Finally, the performance of 15 alternative websites is evaluated and ranked using TOPSIS. The linguistic ratings used to present seven situations of performance are very poor (VP = 0), poor (P = 1), medium poor (MP = 3), fair (F = 5), medium good (MG = 7), good (G = 9), and very good (VG = 10) [40]. A schematic diagram of the proposed model for distance education websites' evaluation is shown in Figure 2.

5. Case study: evaluation of Turkish distance education websites

In our study, we try to describe the needed website's criteria depending on the literature and expert opinions. After that, we propose a hybrid approach to determine criteria weights and evaluate 15 universities' distance education websites.

5.1. Identification of the necessary criteria and calculation the weights of criteria

The four main dimensions' criteria and the subcriteria are shown in Figure 1, and their definitions are explained in Section 2. Eight subcriteria (C13, C22, C33, C36, C38, C44, C45, and C46) are quantitative and alternatives are evaluated by certain numbers, not linguistic variables according to these criteria. There is another group that consists of C12, C13, C14, C16, C37, and C42. In this group, anybody can easily access the alternative websites and evaluate the distance education websites according to these criteria. The remaining number must sign up for the university's own system or as a member of the university. It is not possible for the decision-making team to sign up or be a member of all alternatives simultaneously.

ANP allows for complex interrelationships among attributes and uses pairwise comparisons to determine criteria weights. Main criteria under the goal are paired and the following question is asked to the decision-making team: "Which criterion is more important to have an ideal/optimum distance education webpage?" The decision-making team selects one criterion and then determines the degree. The same process is applied for subcriteria in each cluster. After that, the decision-making team must notice the arrows within the network. A one-sided arrow indicates a criterion affected by the other criteria, while a two-sided arrow between two criteria shows that the two criteria affect each other. For instance, the criterion C16: Security is affected by C12: Navigability, C25: Information sharing, C31: Reliability, C35: Memorability, and C37: Portability. Loop

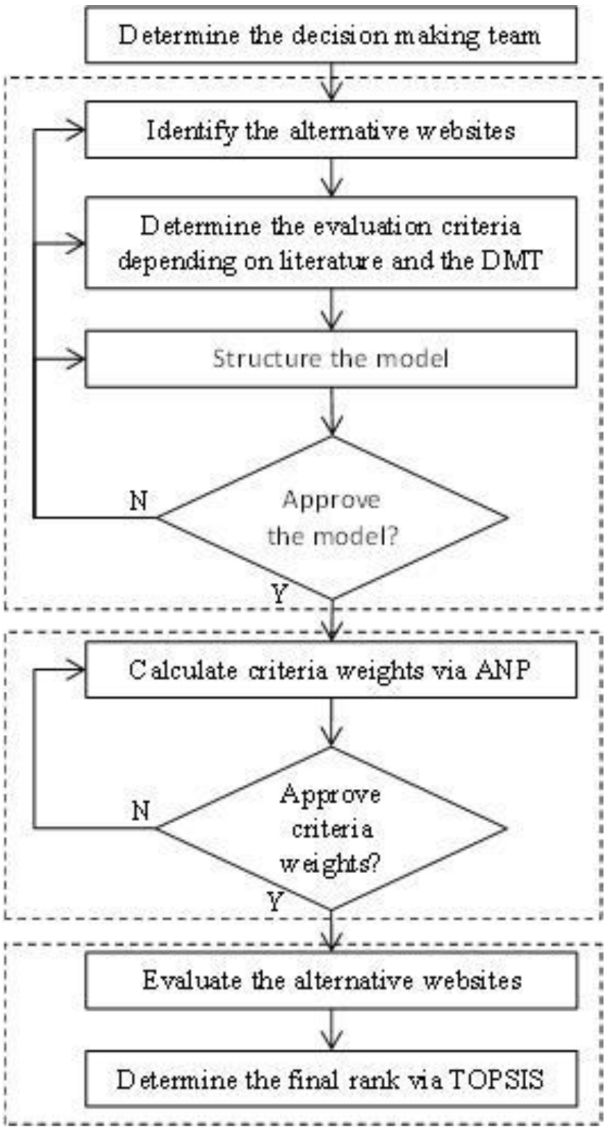

Figure 2. Schematic diagram of the proposed model.

shows that subcriteria within the cluster affect each other (Figure 3). At the last step, a super matrix, which is actually a partitioned matrix, is formed and criteria weights are calculated by obtaining a limit matrix. The software "Super Decisions" directs users to solicit evaluations, then applies these steps automatically and makes the process easier for users. ANP requires the inconsistency ratio (CR) to be smaller than 0.1; this means the user makes the evaluations consistently. CRs of all the pairwise comparison matrixes in the model are smaller than 0.1. Evaluations are then completed and the criteria priorities are calculated, as given in Table 1. The three most important criteria are C25, C16, and C45, in descending order.

5.2. Evaluation of alternatives and determine the final rank

After the criteria weights are approved by the decision-making team, 15 alternative web pages are then evaluated according to 25 subcriteria. The criteria C13, C22, and C46 are the cost criteria, in which low grades are preferred. The others are the benefit criteria, in which high grades are preferred. The criteria C13,

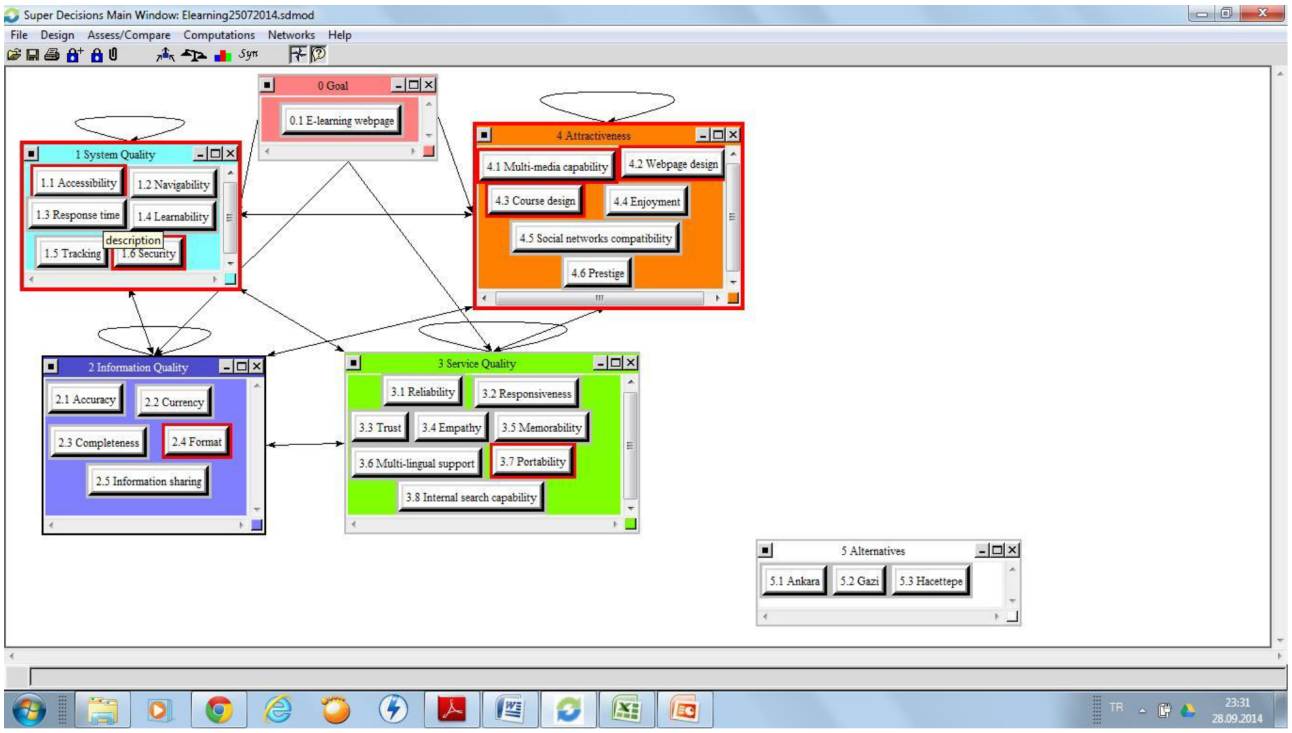

Figure 3. The network structure of the criteria evaluation.

Table 1. The criteria priorities obtained via ANP.

	Criteria	Priorities		Criteria	Priorities
C1	System Quality	–	C32	Responsiveness	0.23193
C11	Accessibility	0.02193	C33	Trust	0.02031
C12	Navigability	0.19275	C34	Empathy	0.16543
C13	Response time	0.07730	C35	Memorability	0.05869
C14	Learnability	0.19582	C36	Multilingual support	0.12472
C15	Tracking	0.14057	C37	Portability	0.22896
C16	Security	0.37163	C38	Internal search capability	0.14109
C2	Information Quality	–	C4	Attractiveness	–
C21	Accuracy	0.08528	C41	Multimedia capability	0.12527
C22	Currency	0.20529	C42	Webpage design	0.23340
C23	Completeness	0.17583	C43	Course design	0.16917
C24	Format	0.13256	C44	Enjoyment	0.04482
C25	Information sharing	0.40103	C45	Social networks compatibility	0.31594
C3	Service Quality	–	C46	Prestige	0.11139
C31	Reliability	0.02886			

C22, C33, C36, C38, C44, C45, and C46 are quantitative. The Pingdom Website Speed Test (loading time) (http://tools.pingdom.com/fpt/) is used to measure the response time (C13) of alternatives. The alternative websites were visited on 15 December 2015 and their last updated dates were checked. The values for criterion C22 are the duration of time that passed since the last update date. The performance values of the alternatives for the criterion C33 are trust flow values, which are taken from a website (https://www.majesticseo.com/). The criterion C36 describes multilinguistic support. If the website supports only the Turkish language, its

value is fair (F), while a website that is partially supported in English receives a grade of "medium good" (MG). Sites that support 2 and 3 or more different foreign languages received a grade of "good" (G) and very good (VG), respectively. Multilingual support is important because there were 72,020 foreign students in Turkish universities in the 2014–2015 academic year, according to the Higher Education Council of Turkey. The websites often offer options for an internal search and frequently asked questions (FAQ) on the main menu (home page) or on other pages. This option is related to criterion C38 in the model here. The alternatives that offer just FAQ on the back page receive a grade MP, while the ones that offer just FAQ on the home page receive a grade F. Web pages that support an internal search in the back page or in the home page are graded as MG and G, respectively. Finally, web pages that support a detailed internal search receive a grade of VG. The values of the criterion C44 mean daily page views per visitor, which can be extrapolated from Alexa (http://www.alexa.com/). A higher number indicates that the user is spending more time to visit more pages within the site; the authors here consider the number of visited pages as an indicator of enjoyment. The criterion C45 refers to social network compatibility. There are numerous publicly available social media tools, such as Facebook, Twitter, and LinkedIn. Web pages that use one, two, three, four, and five links or more to social network sites are graded as MP, F, MG, G, and VG, respectively. The same web page (http://www.alexa.com/) provides a global rank and a domestic rank (i.e. in Turkey) for the websites. The rank in Turkey is used for criterion C46. Finally, the decision-making team evaluated the alternatives under the criteria C12, C13, C14, C16, C37, and C42 by using linguistic ratings. The final rankings are given in Table 2. According to Table 2, the best distance education website is A14 and the worst one is A4.

Table 2. Final ranking for alternative websites.

Alternatives	Scenario 1			
	S_i^*	S_i^-	C_i	Rank
A1	0.0246	0.0772	0.7581	4
A2	0.0281	0.0886	0.7591	3
A3	0.0396	0.0714	0.6435	11
A4	0.0742	0.0550	0.4257	15
A5	0.0298	0.0780	0.7234	5
A6	0.0232	0.0800	0.7749	2
A7	0.0311	0.0688	0.6886	7
A8	0.0327	0.0689	0.6781	9
A9	0.0537	0.0602	0.5289	14
A10	0.0328	0.0700	0.6808	8
A11	0.0322	0.0677	0.6778	10
A12	0.0411	0.0732	0.6407	12
A13	0.0312	0.0767	0.7112	6
A14	0.0186	0.0912	0.8305	1
A15	0.0463	0.0589	0.5602	13

5.3. Scenario analyses

This section presents the results of additional computational experiments to gain a better sense of the potential and value of the evaluation model, and also to determine how the changes in the criteria affect the ranking. Each scenario is explained below:

Scenario 1: It is assumed that the evaluation model includes 14 criteria, which are C11, C12, C13, C14, C16, C22, C33, C36, C37, C38, C42, C44, C45, and C46. A common trait of these criteria is that they can

be evaluated by the users or learners without system knowledge. Scenario 2: It is assumed that the evaluation model includes 8 criteria, which are C13, C22, C33, C36, C38, C44, C45, and C46. These 8 criteria can be measured quantitatively. Scenario 3: It is assumed that all priorities or weights of all criteria (25 criteria) are equal to zero.

Preference orders for distance education websites in different scenarios are shown in Table 3. It comes as no surprise to the authors that the applied scenarios have produced rather different rankings and scores. The A14 website is the best choice among all solutions except in scenario 3. Comparably, the A4 alternative is the worst option in all solutions except in scenario 3. It is also striking to note that there are rather significant similarities in the priority scores of the alternatives A2, A3, A5, A10, and A15 produced by the four methods. Comparisons of the findings, however, should be made very carefully. As a remarkable outcome, observe the significant differences in the ranks of A6, A7, A8, and A9.

Table 3. Final ranking for initial solution and scenarios.

Alternatives	Initial solution		Scenario 1		Scenario 2		Scenario 3	
	C_i	Rank	C_i	Rank	C_i	Rank	C_i	Rank
A1	0.7581	4	0.7288	9	0.7805	6	0.7894	7
A2	0.7591	3	0.7253	10	0.8518	3	0.8472	3
A3	0.6435	11	0.6956	13	0.6874	14	0.5599	14
A4	0.4257	15	0.1950	15	0.1343	15	0.6164	13
A5	0.7234	5	0.7908	3	0.8412	4	0.8332	4
A6	0.7749	2	0.7392	7	0.7209	12	0.8877	1
A7	0.6886	7	0.7417	6	0.7282	10	0.8661	2
A8	0.6781	9	0.7135	12	0.7634	8	0.4267	15
A9	0.5289	14	0.7156	11	0.7500	9	0.8183	5
A10	0.6808	8	0.7888	4	0.7752	7	0.7799	8
A11	0.6778	10	0.7327	8	0.7247	11	0.8144	6
A12	0.6407	12	0.7685	5	0.8130	5	0.7588	10
A13	0.7112	6	0.7998	2	0.8583	2	0.7756	9
A14	0.8305	1	0.8816	1	0.9269	1	0.7434	11
A15	0.5602	13	0.6738	14	0.6991	13	0.7138	12

6. Conclusion and suggestions

This study combines the concepts of ANP and TOPSIS to evaluate and rank distance education websites. In addition to the initial solution, an additional three scenarios based on the number of weighted criteria are applied. Highlights of the study are summarized as follows: Information sharing, security, and social network compatibility are the most important factors for a distance education website. According to the considered criteria, the best distance education website is A14 and the worst one is A4. Ranking the websites with weighted criteria provides more realistic results than with unweighted criteria. Increasing the number of quantitative criteria leads to more robust results. Finally, course website practitioners and designers should improve technological infrastructure and provide an attractive learning scenario and interactive multimedia design, including flash presentations.

Outcomes of the results in this study can provide guidance to system designers in identifying the key factors facilitating distance education website development, and find the ideal policy for improving website effectiveness. Several limitations to this study, which lead to further examination and additional research, are as follows: (i) apart from students or users, opinions of system designers should be considered; (ii) apart from

applied crisp approaches, fuzzy multicriteria decision-making approaches (such as fuzzy TOPSIS and fuzzy ANP) should be adopted to cope with uncertainty in distance education website evaluation; (iii) apart from ANP and TOPSIS, other multicriteria decision-making methods, such as PROMETHEE and VIKOR, should be applied, and finally (iv) apart from considered quantitative criteria, more measurable criteria should be handled.

Acknowledgments

The authors express sincere appreciation to the area editor and anonymous reviewers for their efforts to improve the quality of this paper. The authors would also like to thank three students for their valuable contributions.

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