

# Identification and prioritizing the key factors contributing to the success of E-learning using fuzzy TOPSIS technique

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## ABSTRACT

The current study aimed at identifying and prioritizing the success key factors of e-learning using the fuzzy TOPSIS method. This study's population comprised 16000 e-learning participants in Bushehr province, Iran, the members of which were selected using a simple cluster-stratified sampling method in Jam and Riz, Bushehr province. According to Morgan's table, the sample size was 375 people. Considering the literature review and expert's opinions in Jam and after consulting a group of professors, 60 success key factors were identified and divided into 8 categories, and 5 criteria were also selected. The eight alternatives included "1. Technical quality of the system, 2. Information quality, 3. Service quality, 4. Support quality, 5. Education quality, 6. Trainer quality, 7. Learner quality, 8. Exploitation intention", and the criteria covered "1. Costs, 2. Scalability, 3. Flexibility, 4. User satisfaction, 5. Profitability". The fuzzy TOPSIS questionnaires were distributed among three classes of sample individuals, to which 364 people responded. The results of prioritizing key factors of success of e-learning based on the fuzzy TOPSIS technique indicated that the alternative system support quality, technical quality, trainer quality, education quality, learner quality, information quality, exploitation intention, and service quality were ranked the first to the eighth priorities, respectively.

**Keywords:** Success key factors, E-Learning, Prioritizing, Fuzzy TOPSIS

## Introduction

Nowadays, man has entered a new era of civilization through his acquaintance with virtual networks – a result of information and communication technology. By this, the existence of an educational system is an essential demand in each nation, and in line with the advancements in information technology, all organizations including the educational system are rapidly keeping up with this type of evolution. Due to its drawbacks, the educational system, therefore, was one of the first organizations that utilized the achievements of information technology, networking, and the internet in line with the improvements of novel technologies. In the current era, the virtual world, as a development of the internet, has motivated universities to invest in electronic learning and make attempts to succeed in utilizing electronic learning and evaluating their success in using these systems (Ghalian, Shahrazad; Zalpour, Amir, 2019).

Voogt and Knezek (2008) argue that electronic learning is of strategic significance and that it is an effective method of learning

that needs to be mixed with the learning combination of schools. As technology is being developed in no time, teachers and students must develop technical skills. Teachers' perceptions and attitudes toward electronic learning play a vital role in it (Gordon O. Ouma et al. 2013).

The new economy with the industrial transformation, globalization, and the huge increase in competition, sharing and transfer of knowledge, information technology novelties, and the failure in supplying the new needs of life are clarified in the new learning world. Learning changes its core from the teacher to the student. Meanwhile, it presents an unbelievable possibility of knowledge accessibility and interaction in each corner of the globe (Wilmar Audye Cidral et al. 2018).

The success and effectiveness of e-learning to be utilized must be evaluated with credible methods. Although there are a great number of studies on the success of e-learning systems, a small portion of these studies have dealt with measuring its success in the central educational organization.

Even though the quality of the system has not been directly effective in prediction, its impact is indirect. The quality of the

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system and information have positive impacts on user satisfaction. In addition, the quality of information has positive impacts on system use, which in turn helps improve user satisfaction. All variables, therefore, have either direct or indirect positive impacts on electronic learning results. The quality of the system and information are the requirements of electronic learning (Lengyel, P. et al (2017).

Ghalian et al. (2019) presented four effective factors in executing electronic learning, including the quality of the services and units, the quality of information, online interaction, and the quality of the system and infrastructures. Ardakani et al. (2018) shed light on eleven factors effective in electronic learning, including technical infrastructures, clear educational purposes, educational and research incentives, teacher awareness and skill, educational executive structures, innovative management, and supportive managers. Golband et al. (2013) stated that content and teachers greatly impact the success of electronic learning and that virtual media and the student have a high impact. The results of the study conducted by Hosseini Seno et. al (2015) on how students recognize the priorities of effective educational and technological factors in electronic learning indicated that the two factors of the quality of evaluation and the content presented suitable to the learner's level are of higher significance in comparison with other educational factors.

Shakhawat Hossain, Gazi Md., et al. (2020) performed a study aiming to evaluate the vital factors of success in examining e-learning facilities using the Dimtel method in Bangladesh. The results of this study demonstrated that the technology dimension holds the highest and organizational provisions have the lowest significance. Celikbilek, Y. et al. (2019) investigated 19 components based on technology education and electronic learning. The results suggest that technology-based components are of the highest significance. Al-Habib et al. (2018) argue that students and staff members have different attitudes. Commonalities between the two groups include student characteristics, trainer qualities, ease of access, support, and education.

Considering the importance of learning and the urge for electronic learning in Bushehr province, Iran, numerous factors come into play in the acceptance and achievements of such a system. These factors include information technology infrastructures, system quality, the quality of information and content, service quality, system ease of use for the user, supplying all the user's needs, appropriate visual design of the system, educational content and material development, supporting management, etc.

Needless to say, a great step can be taken in improving the effectiveness of such kind of learning, hence individual knowledge, by recognizing and improving the above-said factors. The current study aims at recognizing the factors effective on electronic learning acceptance in the schools of Bushehr province, Iran to reach a higher acceptance of this type of learning.

## REVIEW OF LITERATURE

### *History of e-learning*

#### *World history of e-learning*

Along with the evolution and advancements of media, electronic learning, and e-learning institutions were developed not only in the UK and the US but also in other European and Asian countries in 1960. With the emergence of the internet, the New Jersey Institute of Technology presented an entire M.Sc. course online in

1984. The first online courses were presented by Phoenix University in 1989, and the Online University of California was established with a coalition of 100 colleges and universities presenting over 1500 lessons. The prevalence of utilizing digital communications has provided endless e-learning opportunities for every person at any given time and place across the globe. New technology e.g. animation and video combined at different levels with older forms of online media has given the chance to teachers to deliver successful bidirectional courses.

During such courses, students should be able to have simultaneous or non-simultaneous choices in the educational environment. The question, however, is "What is going to happen in the future?" It can be certainly stated that as long as people need education, electronic learning, in the new pattern, will move forward in a highly dynamic era (Ebadi, 2004).

Learning grounds, in turn, led to the acceptance of electronic learning platforms among students. Institutions and educational systems in the UAE can gain the maximum advantages and attraction to the e-learning user interfaces (Alghizzawi et al. 2019).

Electronic learning is referred to as an interactive form of learning in which online learning content and feedback are automatically provided for students. This form of learning may include online communication with real individuals or there might be no interaction among real people; however, the focus of electronic learning regarding the communication between students and professors is mostly on the learning content (Paulsen, 2002).

### *Types of electronic learning*

#### *Blend learning*

Blend learning is a mixed method that combines traditional face-to-face sessions and asynchronous long-distance ones. Otherwise, the created information is interactively accessible in online learning environments (Whaymand, 2004 stated by Fersen, 2005).

#### *Open learning*

In this method, the learners have a certain level of free learning in input, time, pace, and location criteria. Using open learning applications, the learners can work on their own and select their proper learning style (Race, 1989 stated by Fersen, 2005).

#### *Computer-based education*

Computer-based education is referred to as using a personal computer or a computer connected to a network (internet or intranet), managing and having access to a mass of ready and new information (Volery & Lord, 2000 stated by Fersen, 2005).

#### **Online /web-based learning**

Online or web-based learning is the process of using the internet and the worldwide web to distribute learning experiences interactively among students at different times and places which includes both synchronous and asynchronous interaction styles (Fersen, 2005).

#### *TOPSIS technique*

We experience numerous instances of decision-making in real life. Making decisions is easy at many times, but it can be difficult at many others especially when we have to make decisions in the presence of various and opposing criteria. It can be stated that a large number of decisions are complicated. Despite the vast range of multiple criteria decision-making (MCDM) practices in the real world, there are limitations and challenges to it. MCDM is regarded as a research technique in operations. It includes many methods, but it can be divided into two important segments:

1. Multiple object decision-making (MODM), which is used in a consistent environment 2. Multiple attribute decision making (MADM), which is used in an extended environment.

In general, we can categorize these methods based on their purpose:

##### **A) Assigning weight and ranking the factors**

Methods whose purpose is assigning weight to criteria, sub-criteria, and ranking the alternatives fall in this category.

##### **B) Ranking the alternatives**

Methods whose only purpose is ranking the research alternatives fall in this category. These methods are known as aid methods, for they are not used as a single method and are used in combination with and helping the methods falling in the first category. Criterion weight is needed for these methods to rank the research alternatives; this weight can be given both by the respondent and be calculated through the first-category methods and then enter these methods as input. One of these methods is called TOPSIS.

The TOPSIS technique is suited to obtain experts' and masters' opinions; however, a drawback in absolute environments is that this method does not correctly reflect human thinking because a responding expert must explain his opinion in exact numerals. This is while binary comparisons are fuzzy and the expert naturally tends to announce a range instead of a constant and absolute number in his judgments. The fuzzy theory was introduced against absolute (white) theory to eliminate and nullify verbal ambiguities. The fuzzy TOPSIS, introduced by Chin, 1992, is one of these fuzzy methods used in ranking alternatives. In this mode, the elements of the decision-making matrix, or the weights of attributes are explained in a fuzzy mode or fuzzy numerals about or both of them.

The criteria are considered as the means of judgment. Criteria must be always taken into account in making decisions.

An alternative is what we try to make a selection among others. In the current study, we tried to rank the alternatives considering the criteria after identifying success key factors and then determining the alternatives and criteria based on experts' and masters' opinions, using the fuzzy TOPSIS method.

The theoretical framework of the e-learning systems includes three main components in information systems which include people, technologies, and services (Epricio et al 2016).

### *DETERMINING THE CRITERIA AND SUB-CRITERIA OF SUCCESS KEY FACTORS OF ELEARNING*

#### *Criteria*

##### *Flexibility of the e-learning system*

The flexibility of an e-learning system is described by considering several factors; for example, when a system user will not be able to delete the account or what has been assigned to retired teachers, some exiting user, or a graduate student.

##### *Scalability of the e-learning system (High capability)*

The limitations about the number of learners will be eliminated in e-learning. A large number of interested learners can be taught unlimitedly within an e-learning system.

##### *Costs:*

Our major purpose in running e-learning is certainly to reduce costs and reach the highest efficiency. In this regard, we need to calculate the costs of a virtual education system, technical support, and other related expenses. Taking income and expenses for courses in person into account, we are required to estimate a suitable virtual education system.

##### *Profitability:*

It was indicated in a vast number of studies that the effectiveness and quick performance of a platform lead to a higher tendency of users to use that platform. This connection has been proved in numerous studies.

##### *Satisfaction:*

Undoubtedly, user satisfaction has proven credibility and trustworthiness as the major success evaluation factor of e-learning systems. The users will find the system satisfactory if they perceive the adaptability of their needs and demands and the e-learning system.

*Sub-criteria*

*Information quality:*

Information quality or the quality of the educational system revolves around properties including communicational components, the evaluation cases of the evaluative factors, and the variability of learning styles (Dima Al-Farhit et al. 2020).

*Technical quality of the system:*

The technical quality of the system is linked to some factors, e.g. reliability, accessibility, ease of use, etc. (Dima Al-Farhit et al. 2020).

*Support quality:*

The quality of support is to support issues in electronic learning systems, such as ethics and legal problems of support in upgrading electronic learning systems (Dima Al-Farhit et al. 2020).

*Service quality:*

The quality of services embraces the responsiveness and availability of employees in addition to their ability to give directions and instructions on platform use.

*Trainer quality:*

The trainer’s attitude, enthusiasm, knowledge, and communicational capacity are of great importance.

*Learner quality:*

This includes the learner’s previous experiences of using e-learning systems, their attitude and worries, and also their self-efficacy.

*Information quality (content):*

This covers the availability, comprehensibility, usability, and consistency of the subjects. Besides, the information needs to be up-to-date.

The decision matrix is comprised of the alternatives and the criteria as the rows and columns of the matrix, respectively.

**RESEARCH MODEL**

After an initial study of a limited number of research papers regarding success factors of electronic learning and examining the presented models, the model suggested by Al-Farhait et. al (2020) (UK) was selected as the basis model of the current study. Based on the previous studies and according to the conclusion drawn from the four approaches of 1. DeLone and McLean model, 2. Technology Acceptance Model, 3. User satisfaction model, 4. Electronic learning quality models, the present multidimensional model of the evaluation of electronic learning system success (EESS) was suggested. This model is not based on the number of structures; instead, it presents a comprehensive image.

*Categorization of the Factors Present In The Selected Model*

Table 1 demonstrates the categorization of the factors existing in the relative categories of the presented model.

**Table 1. Categorization of the factors existing in the selected model**

	➤ System availability	➤ User needs	➤ Ease of learning	➤ Ease of use
System technical quality	➤ System Properties	➤ Security	➤ Achieving goals	➤ Personalization
	✓ Content availability	✓ Material development variability		✓ Conformation
Information quality	✓ Comprehensibility		✓ usability	✓ Being up-to-date
Service quality	➤ Directions and instructions		➤ Availability of staff	➤ Fair perception
	➤ Help			➤ Staff responsiveness
Educational quality of the system	✓ Interaction capacities	✓ Various learning styles	✓ Efficient communication	✓ Evaluation methods
Support quality	➤ Infrastructures	➤ Legal issues	➤ Improvement	➤ Ethics
Trainer quality	✓ Trainer motivation	✓ Trainer responsiveness		✓ Trainer attitude
	✓ Communication with the trainer			✓ Trainer knowledge
Learner quality	➤ Learner self-efficacy	➤ Learner experience	➤ Learner behavior	➤ Learner attitude
User satisfaction		✓ Enjoyment		➤ Satisfaction of system run
Profitability	➤ Efficiency and usefulness			➤ Quick performance
Use (exploitation)		✓ Use intention		✓ Regular use

## Materials and Methods

The researcher tries, in the current study, to identify and prioritize the key factors of e-learning success using the fuzzy TOPSIS method. In this practical study, the researcher gathered information to respond to the questions about the current status of the research topic. The present study was conducted using the fuzzy TOPSIS method, in which several qualitative evaluated parameters have been extracted under the supervision of experts and masters of the e-learning field. The rest of the study was conducted quantitatively. The current study is, therefore, a practical-developmental research in terms of research purpose; a descriptive study in terms of research problem; a survey cross-sectional study in terms of data collection; and a qualitative-quantitative study in terms of data nature.

### Measuring The Research Variables

The library method was used to gather information relative to the topic literature and its review to identify the evaluation criteria of knowledge management performance and a field study was conducted to collect information to find proper answers to the research questions. The questionnaire was used as the data collection tool in the current study.

### RESEARCH POPULATION, SAMPLE AND SAMPLING METHOD

The research population of this study is comprised of 16000 e-learning users of Bushehr province, Iran who have been selected using a simple cluster-stratified sampling method in Jam and Riz cities of the province. According to Morgan's table, the population volume was determined to be 375 participants.

Table 2. Descriptive statistics of the research participants

Variable	Frequency	Percentage
gender	male	40.93
	female	59.07
Description of position	student	62.64
	teacher	27.20
	School principal or headmaster	10.16
Age	10 to 20	52.75
	20 to 30	15.93
	30 to 40	15.38
	over 40	15.93

## DESCRIPTIVE FINDINGS

The significance and practicality of data analysis and statistics in research are so apparent that few cases try to investigate the data analysis and the techniques to exploit the findings in research methodology. Descriptive statistics is used to determine the population and sample characteristics. This part is devoted to the description of the properties of the question respondents.

## INFERENTIAL FINDINGS

### Identifying Final Attributes

The main criteria have been primarily studied and determined. Table 3 displays the research criteria. In addition, the research criteria and alternatives have been named by numerical indices in Table 3, so that they could be easily tracked and studied in the research.

Table 3. Main attributes and alternatives

Main criterion	Symbol	Alternative	Symbol
Costs	C1	Technical quality of the system	A1
Improvement capacity	C2	Service quality	A2
Flexibility	C3	Quality of system support	A3
Profitability	C4	Information quality	A4
Satisfaction	C5	Learner quality	A5
		Educational quality of the system	A6
		Use intention	A7
		Trainer quality	A8

### Calculating The Attribute Weights Using Shannon's Entropy Technique

For the research criteria to be determined in the current study, a set of numerous items was initially collected based on the literature review and the results gained from interviews with experts. In the majority of multi-criteria decision-making problems, multi-attribute type in particular, having and knowing the relative weights of the existing attributes are considered a requirement and contribute effectively to the problem-solving process. The Shannon's entropy technique as one of the most popular attribute weight calculation techniques has been used in the current study. The details of this method are as follows.

In similarity with other multi-criteria decision-making techniques, the decision-making matrix is comprised in the first stage. If the decisive matrix is shown by M and each matrix entry is shown by  $m_{ij}$ , the decisive matrix needs to be firstly normalized. The normalized matrix is shown by N and each entry

is shown by  $n_{ij}$ . Normalization is done clockwise. The final weight is calculated using the following algorithm.

$$n_{ij} = \frac{x_{ij}}{\sum \frac{1}{x_{ij}}} \text{ for } x^- \quad (1)$$

$$n_{ij} = \frac{x_{ij}}{\sum x_{ij}} \text{ for } x^+ \quad (2)$$

$$k = \frac{1}{\ln(a)} \quad (3)$$

$a = \text{The number of alternatives}$

$$E_j = -k \sum [n_{ij} \ln(n_{ij})] \quad (4)$$

$$D_j = 1 - E_j \quad (5)$$

$$W_j = \frac{D_j}{\sum D_j} \quad (6)$$

Considering the obtained weights of the attributes in this stage, the attributes with higher weights are of greater importance than other attributes and will have a greater impact on the selection of the optimized alternative.

The decisive matrix is, therefore, comprised in the first stage. The scores gained from the decisive matrix regarding the problem are shown in Table 4.

C5	C4	C3	C2	C1	
5.727	4.182	4.182	3.455	5.091	A1
3.182	3.364	3.545	3.364	3.182	A2
3.545	4.000	2.636	3.727	3.091	A3
4.364	3.818	3.364	4.273	4.727	A4
4.636	3.636	5.000	2.909	4.091	A5
3.273	4.091	3.545	4.727	3.636	A6
4.455	4.818	4.364	3.636	3.364	A7
3.455	3.818	3.364	4.000	4.455	A8

Forming the decisive matrix is followed by normalizing the numbers of the resulting matrix. A normalized matrix is referred to as a matrix in which the sum of the entries in each column equals one. Table 5 indicates the results of the normalization.

The weight of each attribute is to be determined in the next stage. In this regard, the following calculations are in use and the weight of each attribute ( $E_j$ ) is gained from the following equation:

$$D_j = 1 - E_j$$

$$E_j = -k \sum [n_{ij} \ln(n_{ij})]$$

where  $k$  is calculated in the following equation:

$$k = \frac{1}{\ln(a)} = \frac{1}{\ln(5)} = 0.480$$

The following equation is used to calculate the normalized weight:

$$W_j = \frac{D_j}{\sum D_j}$$

Based on the performed calculations, the final weight of each studied attribute using Shannon's entropy technique is presented in Table 6.

C5	C4	C3	C2	C1	
0.175	0.132	0.139	0.115	0.094	A1
0.097	0.106	0.118	0.112	0.151	A2
0.109	0.126	0.088	0.124	0.155	A3
0.134	0.120	0.112	0.142	0.101	A4
0.142	0.115	0.167	0.097	0.117	A5
0.100	0.129	0.118	0.157	0.132	A6
0.136	0.152	0.145	0.121	0.142	A7
0.106	0.120	0.112	0.133	0.108	A8

C5	C4	C3	C2	C1	
0.293	0.076	0.248	0.148	0.235	W

### TOPSIS TECHNIQUE STRATEGY

The TOPSIS technique was used in a case study to prioritize the process alternatives. The Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) was suggested by Hwang

and Yoon in 1981. This technique is known as one of the best multi-criteria decision-making techniques in selecting the best strategy. The best strategy is pointed as the technique with the furthest from the negative factors and the closest to the positive ones.

*First step: forming the decisive matrix*

Five decision-making attributes are used in this study which have been presented in Table 4.5. The alternatives were evaluated based on these attributes; therefore, the alternatives scoring matrix is formed based on the criteria. Expert opinion and a Likert scale were used to score the alternatives based on each criterion.

The decisive

matrix with  $n$  attributes and  $m$  alternatives is calculated as follows:

$$\tilde{D} = \begin{bmatrix} d_{11} & d_{12} & \dots & d_{1n} \\ d_{21} & d_{22} & \dots & d_{2n} \\ \vdots & \vdots & & \vdots \\ d_{m1} & d_{m2} & & d_{mn} \end{bmatrix}$$

$$\tilde{w} = \tilde{w}_1, \tilde{w}_2, \dots, \tilde{w}_n$$

In the current study, the number of decision-making attributes ( $n=5$ ) and the number of decision-making alternatives ( $m=8$ ); the decision-making matrix is, therefore,  $D_{8 \times 5}$ .

Secondly, when using the fuzzy approach with triangular fuzzy numbers, the decisive matrix  $\tilde{D}$  is shown as follows.

Each matrix entry is shown by  $\tilde{d}_{ij}$  :

$$D = [\tilde{d}_{ij}]_{m \times n}$$

$$\tilde{d}_{ij} = (l_{ij}, m_{ij}, u_{ij})$$

The normalized matrix is shown by  $\tilde{N}$  and each matrix entry of the normalized matrix is shown by  $\tilde{n}_{ij}$ . To normalize, the following equations are used for profit (positive) criteria

$$\tilde{n} = \left\langle \frac{c_j^-}{l_{ij}} \left| \frac{c_j^-}{m_{ij}} \right| \frac{c_j^-}{u_{ij}} \right\rangle \quad c_j^- = \min_{i,j} l_{ij} \quad (7)$$

$$\tilde{n} = \left\langle \frac{l_{ij}}{c_j^+} \left| \frac{m_{ij}}{c_j^+} \right| \frac{u_{ij}}{c_j^+} \right\rangle \quad c_j^+ = \max_{i,j} u_{ij} \quad (8)$$

In the third stage, the fuzzy weighted unscaled matrix needs to be formed. This matrix is shown by  $\tilde{V}$ . Having the attribute weights are shown by a vector we will have:

$$\tilde{V} = [\tilde{v}_{ij}]_{m \times n} \quad i = 1.2.3 \dots m \quad j = 1.2.3 \dots$$

$$\tilde{v}_{ij} = \tilde{n}_{ij} \cdot \tilde{w}_{ij} \quad (9)$$

Generally speaking, the unscaled matrix ( $N$ ) must be transformed into the weighted unscaled matrix ( $V$ ) in this stage. The attribute weights are required to obtain the weighted unscaled matrix. Each attribute weight is calculated using Shannon's entropy method and is displayed in Table 4.7. In this

regard, the unscaled matrix is multiplied by the square matrix ( $W_{n \times n}$ ), where its main diagonal entries are attribute weights and the rest of its entries equal zero. The obtained matrix is called a weighted unscaled matrix and is shown by  $V$  (Mo'meni & Sharifi, 2010: 153).

$$V = N \times W_{n \times n} \quad (10)$$

The positive and negative ideals must be calculated in the following stage:

$$A^+ = (\tilde{v}_1^+, \tilde{v}_2^+, \tilde{v}_3^+, \dots, \tilde{v}_n^+) \quad (11)$$

$$A^- = (\tilde{v}_1^-, \tilde{v}_2^-, \tilde{v}_3^-, \dots, \tilde{v}_n^-) \quad (12)$$

Then, the distance between each alternative and the positive and negative ideals needs to be obtained. Given  $F1$  and  $F2$  as two triangular fuzzy numbers, the distance between the two is then obtained by the following formula:

$$F_1 = (l_1, m_1, u_1)$$

$$F_2 = (l_2, m_2, u_2)$$

$$D(F_1, F_2) = \sqrt{\frac{1}{3}[(l_1 - l_2)^2 + (m_1 - m_2)^2 + (u_1 - u_2)^2]} \quad (13)$$

The distance from each alternative to positive and negative ideals is shown by  $d^+$  and  $d^-$ , respectively. On this basis, the distance between each alternative and the positive and negative ideals is calculated as follows:

$$D_i^+ = \sum_{j=1}^n d(\tilde{v}_{ij} - \tilde{v}_j^+) \quad i = 1.2. \dots m \quad (14)$$

$$D_i^- = \sum_{j=1}^n d(\tilde{v}_{ij} - \tilde{v}_j^-) \quad i = 1.2. \dots m \quad (15)$$

The final stage includes obtaining the ideal solution. In this stage, the relative closeness of each alternative to the ideal solution is calculated. To do so, the following formula is utilized:

$$CL_i = d_i^- / (d_i^- + d_i^+) \quad (16)$$

The  $CL$  value is between zero and one. The closer this value is to one, the closer the strategy is to the ideal solution and, therefore, a better strategy it is.

After the decisive matrix ( $D_{8 \times 5}$ ) was formed and the expert opinion was gathered, the collected data are shown in Table 7.

Table 7. The evaluation matrix

C5	C4	C3	C2	C1	
(3/5/7)	(3/5/7)	(0/1/3)	(0/1/3)	(0/0/1)	A1

(5/7/9)	(0/0/1)	(9/10/10)	(5/7/9)	(9/10/10)	<b>A2</b>
(5/7/9)	(7/9/10)	(0/1/3)	(0/1/3)	(0/1/3)	<b>A3</b>
(7/9/10)	(5/7/9)	(5/7/9)	(0/0/1)	(9/10/10)	<b>A4</b>
(0/0/1)	(3/5/7)	(3/5/7)	(3/5/7)	(9/10/10)	<b>A5</b>
(0/1/3)	(0/0/1)	(9/10/10)	(1/3/5)	(1/3/5)	<b>A6</b>
(0/0/1)	(5/7/9)	(5/7/9)	(3/5/7)	(5/7/9)	<b>A7</b>
(1/3/5)	(1/3/5)	(7/9/10)	(0/0/1)	(1/3/5)	<b>A8</b>

As group perspective is taken into account, the expert opinions are unified using the fuzzy mean technique.

The next stage is to calculate the unscaled matrix. Considering the previously defined equations, the FTOPSIS technique output for the unscaled matrix  $\tilde{N}$  is as follows:

The weighted unscaled matrix is formed in the third stage. The defuzzified weighted unscaled matrix is demonstrated in Table 9. After obtaining the weighted unscaled matrix, the distance between each alternative and the positive and negative ideals is then calculated. The positive and negative ideals are initially obtained.

The distance from each alternative to positive and negative ideals is shown by  $d^+$  and  $d^-$ , respectively. The relative closeness of each alternative to the ideal solution is calculated to obtain the ideal solution. The closer *the CL* value is to one, the closer the strategy is to the ideal solution and the better strategy it is. The calculation output of the fuzzy TOPSIS for these equations is shown in Table 11.

**Table 8. The unscaled matrix**

C5	C4	C3	C2	C1	
(0.3/0.5/0.7)	(0/0/0.11)	(0.56/0.78/1)	(0/0.11/0.33)	(0/0/0.11)	A1
(0.9/1/1)	(0/0.1/0.3)	(0.3/0.5/0.7)	(0.5/0.7/0.9)	(0.3/0.5/0.7)	A2
(0/0.1/0.3)	(0.3/0.5/0.7)	(0.5/0.7/0.9)	(0/0/0.1)	(0/0.1/0.3)	A3
(0/0/0.1)	(0.5/0.7/0.9)	(0/0/0.1)	(0.5/0.7/0.9)	(0/0/0.1)	A4
(0/0/0.1)	(0/0.1/0.3)	(0/0.1/0.3)	(0.9/1/1)	(0.9/1/1)	A5
(0.5/0.7/0.9)	(0.5/0.7/0.9)	(0.9/1/1)	(0.5/0.7/0.9)	(0/0.1/0.3)	A6
(0/0/0.1)	(0.1/0.3/0.5)	(0/0/0.1)	(0.7/0.9/1)	(0.1/0.3/0.5)	A7
(0.5/0.7/0.9)	(0.7/0.9/1)	(0.3/0.5/0.7)	(0.1/0.3/0.5)	(0/0/0.1)	A8

**Table 9. The fuzzy weighted unscaled matrix**

C5	C4	C3	C2	C1	
(0.33/0.56/0.78)	(0.33/0.56/0.78)	(0/0.11/0.33)	(0/0.11/0.33)	(0/0/0.02)	A1
(0.5/0.7/0.9)	(0/0/0.1)	(0.9/1/1)	(0.5/0.7/0.9)	(0.07/0.11/0.1)	A2
(0.5/0.7/0.9)	(0.7/0.9/1)	(0/0.1/0.3)	(0/0.1/0.3)	(0/0.02/0.07)	A3
(0.7/0.9/1)	(0.5/0.7/0.9)	(0.5/0.7/0.9)	(0/0/0.1)	(0/0/0.02)	A4
(0/0/0.1)	(0.3/0.5/0.7)	(0.3/0.5/0.7)	(0.3/0.5/0.7)	(0.21/0.23/0.2)	A5
(0/0.1/0.3)	(0/0/0.1)	(0.9/1/1)	(0.1/0.3/0.5)	(0/0.02/0.07)	A6
(0/0/0.1)	(0.5/0.7/0.9)	(0.5/0.7/0.9)	(0.3/0.5/0.7)	(0.02/0.07/0.1)	A7
(0.1/0.3/0.5)	(0.1/0.3/0.5)	(0.7/0.9/1)	(0/0/0.1)	(0/0/0.02)	A8

**Table 10. Positive and negative ideals**

(0.33/0.56/0.78)	(0.33/0.56/0.78)	(0.9/1/1)	(0.5/0.7/0.9)	(0,0,0.02)	v+
(0/0/0.1)	(0/0/0.1)	(0.3/0.5/0.7)	(0/0/0.1)	(0.2/0.23/0.23)	v-

**Table 11. The distance from each alternative to positive and negative ideals**

CL value	D-	D+	
0.5283	0.56	0.5	<b>A1</b>
0.3113	0.33	0.73	<b>A2</b>
0.5755	0.61	0.45	<b>A3</b>
0.4623	0.49	0.57	<b>A4</b>
0.4673	0.5	0.57	<b>A5</b>

0.4717	0.5	0.56	<b>A6</b>
0.4225	0.45	0.61	<b>A7</b>
0.4906	0.52	0.54	<b>A8</b>

Considering the graph and the performed calculations in the fuzzy TOPSIS software:

The *quality of system support* alternative with a distance of 0.575 from the ideal is the priority.

The *technical quality of the system* alternative with a weight of 0.528 is the second priority.

The *trainer quality* alternative with a weight of 0.490 is found to be the third priority.

The *quality of education of the system* alternative with a weight of 0.471 is the fourth priority.

The *learner quality* alternative with a weight of 0.467 is the fifth priority.

The *information quality* alternative with a weight of 0.462 is the sixth priority.

The *exploitation intention* alternative with a weight of 0.422 is the seventh priority.

The *service quality* alternative with a weight of 0.311 is the eighth priority.

To identify the key factors contributing to the success of e-learning, a great deal of previous studies were primarily investigated. All of the studied components of those studies were then extracted and given to the experts. This was followed by the categorization of all considered factors into eight sections. Then, five criteria (attributes) were selected and the matrix was formed. The required information was, then, gathered through questionnaires distributed among 375 individuals, and the collected data was analyzed. The analysis results were indicative of the fact that the alternatives of the system support quality, technical quality of the system, education quality of the system, learner quality, information quality, exploitation intention, and service quality were respectively ranked the first to eighth priorities. The comparison between the findings of the present research and those of the previous studies is shown in Table 12.

## Discussion and Conclusion

Table 12. Comparison of the research findings

Research	Options	Results	The result of the comparison
Research by Ghalian et al. (2018)	Infrastructure quality, service quality, information quality, interaction in the online environment	The quality of infrastructure is of the highest importance.	consistent
Hosseini Seno and colleagues (2012)	The educational aspect includes quality of evaluation, continuity, and coherence of content, content suitable for inclusive level, access to educational materials, and the possibility of communication. The technology aspect includes: the Internet, necessary hardware and software, technical support	Educational factors are more important for students.	inconsistent
Ardakani et al. (2017)	Technical infrastructures, written and specific educational goals, educational and research incentives, professors' knowledge and ability, educational executive structures, innovative management, and supportive managers.	Technical infrastructure It is the most important.	consistent
Bilek et al. (2019)	19 components based on technology and e-learning	Technology components	consistent
Rezazadeh et al. (2017)	Organizational and managerial factors, pedagogical factors and educational design, technological factors, presentation factors, and support services	Regarding the organizational and management factors, infrastructure has gained the highest importance factor.	consistent
Rajabi et al.'s study (2018)	Content quality, user-friendliness, teacher's information literacy, ease of use, response time, possibility of interaction	The quality of the e-learning system program is of the highest importance.	inconsistent
Kadri et al. (2020)	Attitude towards e-learning, students' motivation, interaction, commitment, instructor's ability, ethical and legal issues, financial readiness, ease of use, user-friendliness, technology infrastructure	Financial issues and technological infrastructure	consistent
Al-Kahtani et al. (2020)	Instructor characteristics, learner characteristics, support, design characteristics, knowledge management, collaboration level	Technology management	consistent
Garga et al. (2017)	Functionality, usability, ease of use, personalization, content, portability	Functionality	inconsistent
Abdul Hafiz et al. (2020)	Content, design, organization, usability	content	inconsistent

There are challenges to e-learning in Bushehr, Iran, such as intermittent disconnection of the internet, teachers' attitude towards their job safety, lack of knowledge regarding the actual advantages of e-learning, lack of facilities and equipment, lack of training and on-the-job instructional courses for teachers, student unpreparedness for this method of education and, in some cases, parents' reluctance to accept this form of education. Based on the results of the current research, the alternative of the system support quality is the first, the alternative of the system technical quality is the second, the alternative of trainer quality is the third, the alternative of the education quality of the system is

the fourth, the alternative of learner quality is the fifth, the alternative of information quality is the sixth, the alternative of exploitation intention is the seventh and the alternative of service quality is the eighth priority.

Considering the variables found in the quality of system support mentioned in Table 1 including ethical issues and legal issues about upgrading and infrastructures, it is concluded that the schools in Bushehr province, Iran experience a significant shortage of infrastructures required to establish and run e-learning.

## LIMITATIONS

The present study was conducted on only three groups of education field participants in the city of Jam, a district of Bushehr province, Iran. Therefore, caution must be taken into account when generalizing the results to other provinces.

The results of the current work of research are obtained through questionnaires, in which limited alternatives and criteria were considered which, in turn, were determined effective in the study results, and the opinions of other nominees including parents were not taken into consideration.

## SUGGESTIONS

Considering the limitations of the current study, suggestions are made to future researchers to collect data using qualitative methods such as interviews since the data collected for the present study was collected through questionnaires; this is because an advantage to TOPSIS and Fuzzy TOPSIS methods is that it can consider quantitative and qualitative criteria simultaneously. If real data is used in the decisive matrix, this method will respond appropriately. In addition, it would be better to consider the opinions of other nominees, such as students' parents. Besides, considering the following can be useful in delivering more efficient e-learning:

1. Based on the results obtained from user satisfaction, it is suggested that:

To improve the education quality, experienced and skilled experts should be invited to the country, and international training courses special to full-time teachers (teachers who have been selected after observation and correct evaluation of their speech skills and teaching methodology) should be held. As well, training sessions should be held abroad if required, so that utmost user satisfaction is achieved, which will improve learning and enhance work efficiency.

2. Based on the results gained from the service quality component, it is suggested that:

Regarding the service quality of the platform in which e-learning is being delivered, anonymous opinion forms should be distributed among the users (students, teachers, and principals) and an estimation of their satisfaction with the mentioned services should be made. If service improvement is needed (appropriate commendations and impact on job promotions, etc.), effective commendations and useful incentives should be considered and included in organizational decisions based on the evaluation of employees working in each given service.

3. Based on the results obtained from the technical quality of the system component, it is suggested that:

In addition to the technical quality check for the system by technical experts in the computer field (hardware, software, and network), multiple choice opinion forms enquiring about technical limitations and shortcomings of the system should be distributed among the electronic unit employees. An empty part should be dedicated at the end of the mentioned form to explain possible suggestions and recommendations so that the technical

quality of the system from the perspective of the technical unit employees is reflected to senior managers. Then, based on the opinions as a whole and taking the conclusions drawn from the opinions into account, proper decisions should be made in terms of retaining the current status or making an economic selection about system improvement.

Software producers and developers in the field of electronic learning should adapt themselves to customers' and users' needs of the day and exert effort to supply the new demands of users. For instance, they can design and deliver mobile versions of the application which could be installed on both mobile phones and tablets, so that users can easily work on their stuff at any given time and place. This will provide an excellent competitive advantage for these types of organizations.

4. Considering the outcomes of the information quality component, it is suggested that:

The syllabuses delivered previously should be reviewed by experts, so that study subjects, material arrangement, consistency, etc. are reorganized, old material is abolished and removed from the syllabuses, and practical up-to-date material replaces them.

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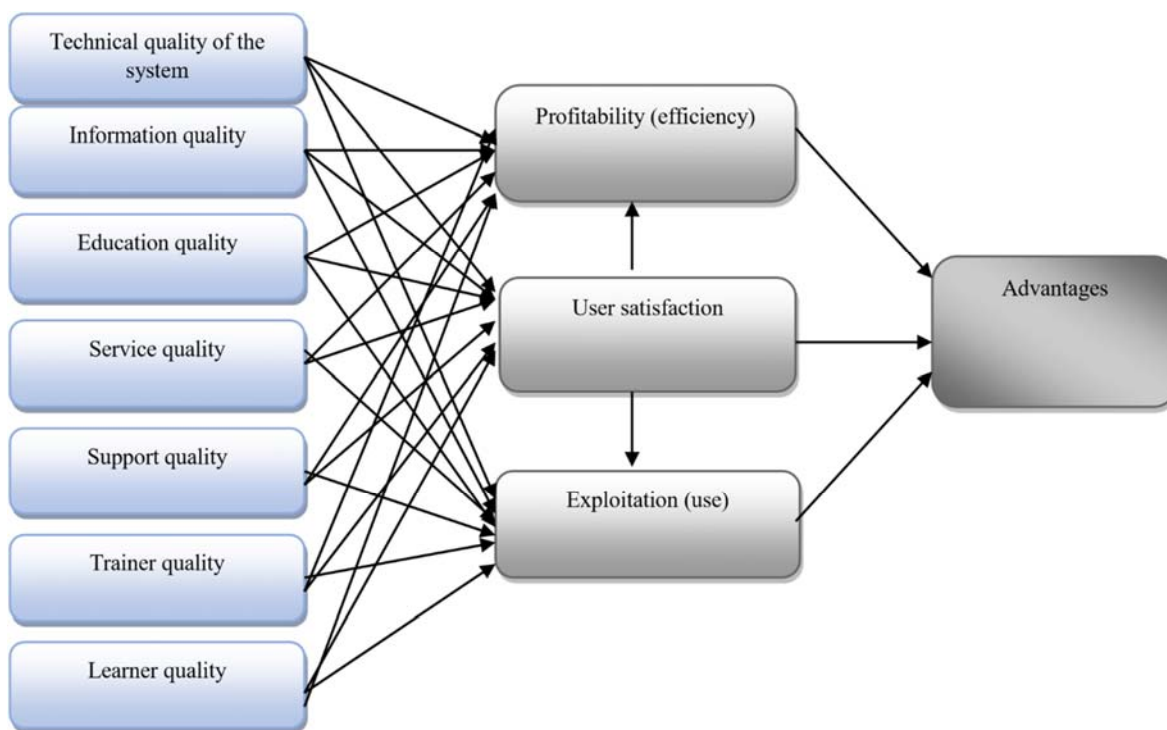


Figure 1. Conceptual multidimensional model for EESS

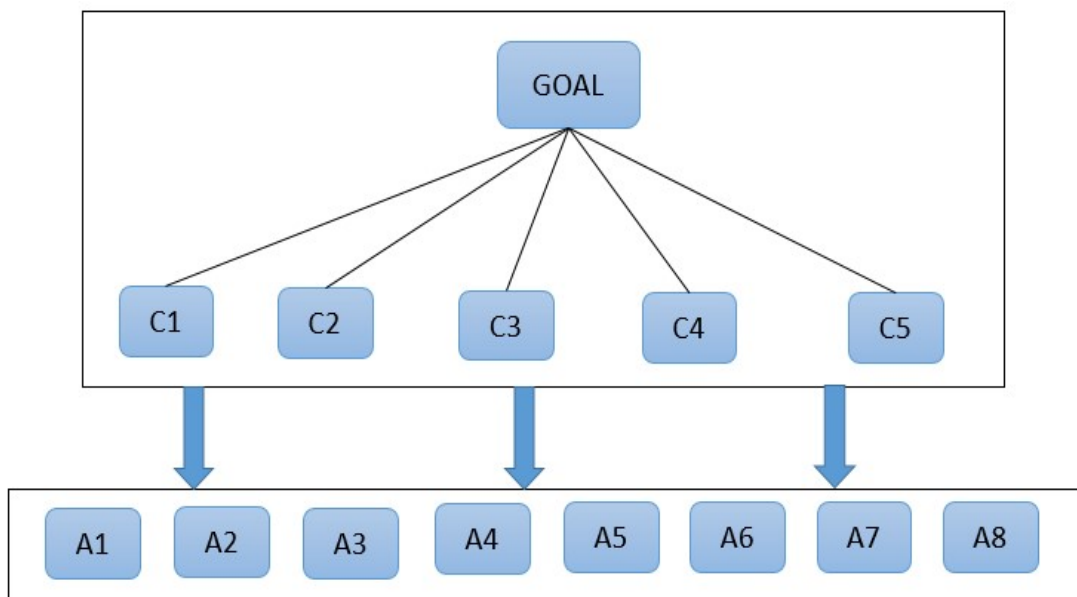


Figure 2. Hierarchical structure of the criteria and alternatives

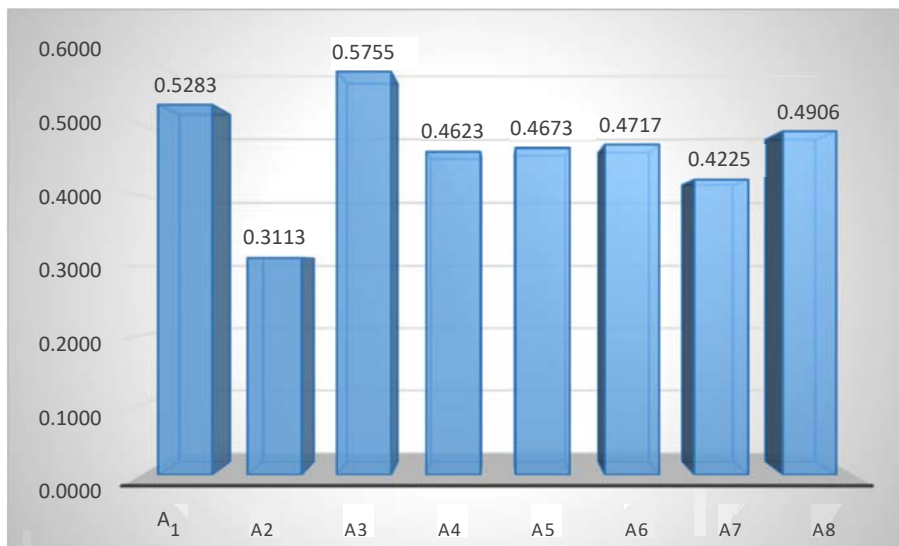


Figure 3. The alternative priority graph

## Appendix

### Questionnaire

The questionnaire below has been selected to conduct a study using the fuzzy TOPSIS method to identify and prioritize key factors contributing to the success of electronic instructions. Since gaining scientifically correct results relies on your precious opinions as a respondent and an honorable colleague, it is respectfully requested to answer the questions asked in the present questionnaire carefully to obtain the results as desired. Please bear in mind that the current questionnaire is anonymous and that your responses will be used only as data for a college study. Your necessary attention and congruous patience are warmly acknowledged in advance.

Demographic information:

Position	Gender	Age
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	Not at all important	Slightly important	Less important	Average	Important	Fairly important	Very important
1. How important is the technical quality of the system based on the 'costs' criterion?							
2. How important is the technical quality of the system based on the 'upgradability' criterion?							
3. How important is the technical quality of the system based on the 'flexibility' criterion?							
4. How important is the technical quality of the system based on the 'profitability' criterion?							
5. How important is the technical quality of the system based on the 'satisfaction' criterion?							
6. How important is the service quality of the system based on the 'costs' criterion?							
7. How important is the service quality of the system based on the 'upgradability' criterion?							
8. How important is the service quality of the system based on the 'flexibility' criterion?							
9. How important is the service quality of the system based on the 'profitability' criterion?							
10. How important is the service quality of the system based on the 'satisfaction' criterion?							
11. How important is the instruction quality of the system based on the 'costs' criterion?							
12. How important is the instruction quality of the system based on the 'upgradability' criterion?							
13. How important is the instruction quality of the system based on the 'flexibility' criterion?							
14. How important is the instruction quality of the system based on the 'profitability' criterion?							
15. How important is the instruction quality of the system based on the 'satisfaction' criterion?							
16. How important is the trainer quality of the system based on the 'costs' criterion?							
17. How important is the trainer quality of the system based on the 'upgradability' criterion?							
18. How important is the trainer quality of the system based on the 'flexibility' criterion?							
19. How important is the trainer quality of the system based on the 'profitability' criterion?							
20. How important is the trainer quality of the system based on the 'satisfaction' criterion?							
21. How important is the learner quality of the system based on the 'costs' criterion?							
22. How important is the learner quality of the system based on the 'upgradability' criterion?							
23. How important is the learner quality of the system based on the 'flexibility' criterion?							
24. How important is the learner quality of the system based on the 'profitability' criterion?							
25. How important is the learner quality of the system based on the 'satisfaction' criterion?							
26. How important is the support quality of the system based on the 'costs' criterion?							
27. How important is the support quality of the system based on the 'upgradability' criterion?							
28. How important is the support quality of the system based on the 'flexibility' criterion?							
29. How important is the support quality of the system based on the 'profitability' criterion?							

30. How important is the support quality of the system based on the 'satisfaction' criterion?
  31. How important is exploitation intention based on the 'costs' criterion?
  32. How important is exploitation intention based on the 'upgradability' criterion?
  33. How important is exploitation intention based on the 'flexibility' criterion?
  34. How important is exploitation intention based on the 'profitability' criterion?
  35. How important is exploitation intention based on the 'satisfaction' criterion?
  36. How important is the information quality based on the 'costs' criterion?
  37. How important is the information quality based on the 'upgradability' criterion?
  38. How important is the information quality based on the 'flexibility' criterion?
  39. How important is the information quality based on the 'profitability' criterion?
  40. How important is the information quality based on the 'satisfaction' criterion?
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