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Assessment of E-Learning Service Quality using the Fuzzy Analytic Network Process (Case Study: E-learning Department of Shahid Beheshti University)

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Abstract
The present research aimed at evaluating the quality of e-learning services of Shahid Beheshti University in 2010. First, 67 service quality assessment criteria were determined based on theoretical principles, common models of e-services and e-learning in higher education, and experts' interviews. Then, the exploratory factor analysis was used to classify the criteria in 10 dimensions of faculty, reputation, staff, educational planning, access, responsiveness, communication, website design, feedback, and flexibility. The final model for the quality assessment of the e-learning courses was confirmed using the confirmatory factor analysis. Descriptive statistics, inferential statistics, and Chen and Huang's fuzzy spectrum were used to analyze the collected data. Content validity was evaluated and confirmed by e-learning professors and IT professionals. The construct validity was approved using factor analysis, and reliability was measured by calculating Cronbach's alpha as 84%. Fuzzy analytical network process, was used to calculate the relative weights of multiple criteria and to identify interdependencies of the obtained criteria. The case study shows how this approach can be use to assess the services quality.

Keywords: Service quality, e-learning, fuzzy analytical network process, exploratory factor analysis, confirmatory factor analysis.

Introduction

Many institutions that considered virtual education as temporary phenomenon are rapidly providing virtual education programs. However, it has to be noted that despite the excitement, facilities, and attractions virtual education offers, using it without analyzing whether the courses have quality or not may result in their failure. Since the virtual training courses also require high amounts of financial, human, and material capital, both organizers and participants expect the courses to be of high quality.

Research questions:

1-What are the key services affecting e-learning quality?
2-How much is the importance and priority of each e-learning service?
3-How much is the service quality received from each educational service (in the case study)?

1. Literature Review

In a study conducted by Owila and Aspinwal in 1996, experts' views on the quality of higher education were reviewed, and customer-orientation was confirmed as an accepted principle. They concluded that among the clients of higher education, students are the most important. Therefore, identifying service quality in the students' viewpoint is very important.

Literature also shows that the tools available for measuring the services quality such as servqual, Servperf and Servimperf, and also service quality measurement tools such as sitequal and webqual has been somewhat successful in the marketing and sale field and has been used a wide range of industries with a degree of success. However, they would not be suitable for other service sectors, especially in higher education, and their repeated success in higher education remains uncertain. Instead, a tool specifically designed for a particular industry would result in a more suitable research strategy (Abdullah, 2005). In a paper entitled "prioritization of human capital measurement indicators using fuzzy AHP. This research is a part of analytic hierarchy process and fuzzy metrics to measure human capital suggests. Since the fuzzy analytic hierarchy process requires heavy and exhausting computation, it is more of a systematic approach compared to others. It is more efficient compared ambiguous conditions of multi-criteria decision-makings in human evaluation because paired comparisons offers a flexible and pragmatic approach to the adaption of real-life data (Beskes et al, 2006).

Tsaur, Chang, and Yen (2002) used fuzzy MADM to evaluate the service quality of airlines. They first reviewed literature and determined indices and sub-indices. A questionnaire was compiled and distributed among 450 passengers in 29 travel agencies who had the experience of flying with the respective airline. Questions assessing the services quality were divided into two main sections: questions about the relative importance of the criteria, based on which, the weights of the criteria was calculated by AHP, and questions regarding the performance of the indices. A 5-point Likert scale was the range considered for each question. Finally, airlines were rated using TOPSIS method (Tsaur et al, 2009).

Among the research that has been done in this area is an article entitled "Enhancing the quality of online education through measurement". That research investigated a wide range of topics and perspectives that affect e-learning quality. It presented a methodological framework based on the Sloan-C framework, which has been used for many years in the American universities and is also applicable to other universities and not only focuses on outputs of education, but also on its process (Zhao, 2003)

The aforementioned research consisted of 4 main dimensions: course effectiveness, adequate access to technological infrastructure, academic satisfaction, and student satisfaction to assess the e-learning quality.

In an article entitled "Comparing alternative instrument to measure service quality in higher education", the five models of Servqual, Servperf, Weighted Servqual, Weighted Servperf, and HEdPERF were examined.

Their results showed that the HEdPERF and Servperf models were more efficient in measuring service quality, however, it cannot be exactly said which one is better (Brochado et al, 2009).

In an article entitled "Information Technology center service quality", the SERVQUAL model was validated, and the service quality of 3 IT centers was evaluated in the United Arabic Emirates from the clients, service providers, and decision-makers' perspective. The results of the survey showed that the respondents were satisfied with the application of SERVQUAL model in IT centers (Al–Madani, 2005).

In an article entitled "An application of fuzzy AHP for evaluating course website quality", 4 main criteria and 16 sub-criteria for measuring the quality of the courses were identified by reviewing the literature. The fuzzy analytic hierarchy process was also used to determine the relative weights of the criteria. The proposed model and its results is valuable resource for

system designers who are seeking to improve the effectiveness of the Internet courses (Lin, 2009).

2. Materials and Methods

This article is an applied descriptive field research. Desk research (English and Persian books and articles, theses, internet sites) was used to collect information about the literature and theories related to the present study. Questionnaires and worksheets of paired comparisons were used to collect data. The questionnaire consisted of 72 questions, including 2 sets of distinct questions. Five questions were about the general characteristics of the responders, and 67 questions were about the e-learning quality. The questions were designed using the available e-learning literature and the questionnaires used by other researchers to evaluate the e-learning quality. The seven-item Likert scale was used to design the questions. Open interviews were used to achieve basic issues. To obtain the e-learning quality criteria and the possibility of adapting the identified criteria with e-learning system in Iran, researcher interviewed e-learning experts and professors.

Worksheets were used to collect data from experts in order to identify the importance of each quality evaluation criterion. Since the quality evaluation criteria were verbal, data needed for prioritizing them were collected using fuzzy spectrum and then were prioritized. The worksheet had fuzzy number spectrum with triangular fuzzy type. The worksheet had a matrix of pair comparisons used for fuzzy network analysis methods. The study population consisted of all students and professors of e-learning courses in Shahid Beheshti University. The statistical sample consisted of 13 professors, 8 instructors, and 259 students. Morgan chart was used estimate the sample size so that the maximum sample size for students of the 3 major (IT management, computer software, and computer architecture) consisted of 155 individuals. The results of the suitability of sample size for factor analysis, KMO were also calculated for questions. The KMO for the questions was calculated as 0.795, which was greater than 0.6 and was suitable for factor analysis.

Validity and reliability of an evaluation tool is very important. The content validity of "the questionnaire of students' received services" was confirmed by supervisors, a group of industry experts, reading books and articles related to research, reading the questionnaires of study and research papers and their strengths and weaknesses, and initial distribution of the questionnaire among a number of professors. Thus, questionnaire had the required validity. Construct validity (convergent and divergent) was confirmed using exploratory and confirmatory factor analysis. The validity of the questionnaire was analyzed using SPSS and Cronbach's alpha, which was 84%. Therefore, the questionnaire had high validity.

Regardless of the assumed correlation between the criteria, the experts or decision-makers were asked to evaluate all suggested criteria through paired comparisons. They responded to questions such as "Which criteria should be considered in evaluating the quality of services more? And how much more?"

Although the experts use their intellectual competence and ability to perform comparisons, it should be noted that the analytic hierarchy process may not fully reflect the style of human thinking. In other words, fuzzy sets are more compatible with some vague explanation of human language, and therefore, it is recommended to use fuzzy numbers. The fuzzy scales used in the fuzzy analytic hierarchy process are shown in Table 1.

Table 1- Linguistic scales to express the degree of importance

Linguistic scales to express the	Triangular fuzzy numbers	Inverse of triangular

degree of importance		fuzzy numbers
Just equal	(1,1,1)	(1,1,1)
Equally important	$\frac{1}{2}$ $\frac{3}{2}$ (2,1,2)	$\frac{2}{3}$ (3, 1,2)
Weakly more important	$\frac{3}{2}$ (1,2,2)	$\frac{1}{2}$ $\frac{2}{3}$ (2,3,1)
Strongly more important	$\frac{3}{2}$ $\frac{5}{2}$ (2,2,2)	$\frac{2}{5}$ $\frac{1}{2}$ $\frac{2}{3}$ (5,2,3)
Very strongly more Important	$\frac{5}{2}$ (2,2,3)	$\frac{1}{3}$ $\frac{2}{5}$ $\frac{1}{2}$ (3,5,2)
Absolutely more important	$\frac{5}{2}$ $\frac{7}{2}$ (2,3,2)	$\frac{2}{7}$ $\frac{1}{3}$ $\frac{2}{5}$ (7,3,5)

In order to perform some calculations, such as the fuzzy analytic network process and fuzzy data analysis methods, FUZZY AHP and MICROSOFT EXCEL were used. SPSS was used to examine the reliability and validity and to perform exploratory factor analysis, and LISREL was used to perform confirmatory factor analysis.

3. Data Analysis

First question - After identifying the criteria for e-learning services quality by reviewing the theoretical background of the study, professors and experts in e-learning system were interviewed to finalize the theoretical model of the study. They were asked to express their opinion about the model and its indices. A collection of comments was received, collected, and then applied as a finalized modification. A total of 67 indices were identified. The questionnaire of quality of service received by the students was distributed among the e-learning students of Shahid Beheshti University. The factor loadings higher than 0.5 were identified and considered through the exploratory factor analysis. In the first order confirmatory factor analysis, 65 criteria were classified as constituent criteria of theoretical model in the form of 10 main criteria including: faculty dimension, reputation dimension, staff dimension, educational planning dimension, access dimension, responsiveness dimension, communication dimension, website design dimension, feedback dimension, and flexibility dimension. Finally, at the second exploratory factor analysis, these10 indices were placed within an electronic service quality index. At the next step, to confirm the model and the validity, confirmatory factor analysis was conducted. It should be noted that in order to reduce the variables and consider them as a latent variable, the obtained factor loading must be greater than 0.3 (4). In examining each model, the basic question is whether this measurement models are suitable? To answer to this question, x2 (Chi-square) and other model fitting suitability criteria have to be examined. A suitable model has the following optimum conditions. Lesser chi-square test is more suitable because it shows the difference between the data and the model. Lower ARMSE test is better, because this is the mean square error.

In the first-order confirmatory factor analysis, results of the estimates in the standard estimate case indicated that the model was suitable in all 10 main dimensions. Also, given that all factor loadings were above 0.5, it can be concluded that the questions had convergent validity. The measurement model in a standard estimate case showed the effect of each of the variables or criteria in explaining the variance of the variable or the main factor. Also, all the coefficients obtained in significant numbers case were significant because the significance

test greater than 1.96 or less than -1.96 indicated the significance and was a confirmation of the exploratory factor analysis.

In the second-order confirmatory factor analysis, all factor loadings were above 0.5 which indicated that all factors related to e-service quality (10 main criteria) could well explain the variance of e-services quality. The significant of the obtained coefficients and parameters from e-service quality measurement model and the results of the second order confirmatory factor analysis were significant in all cases. The model fitting also showed the suitability of the model.

After the first order factor analysis, the mean scores for each identified factor were entered in second-order factor analysis. The second-order factor analysis was used to distinguish and identify e-services quality.

Measure of sampling adequacy (KMO) and Bartlett's test of sample sphericity in exploratory factor analysis by SPSS was 0.787 and 0.000, respectively. As shown in Table 2, all 10 factors were summarized in one class. It is reasonable to call the factor e-service quality. The factor also explains about 79% of the variance in mean scores of the 10 factors (Table 2)

Table 2: Bartlett's test of sample sphericity

KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.787
Bartlett's Test of Sphericity	Approx. Chi-Square	95.518
	Df	45
	Sig.	.000

To obtain the e-service quality scores, factor analysis was conducted in two stages.

Ten factors of faculty, reputation, staff, educational planning, access, responsiveness, communication, website design, feedback, and flexibility were extracted in factor analysis of e-service quality. Finally, in the second-order factor analysis, the 10 factors were placed within a factor of e-service quality. The following conceptual model shows the stages of factor analysis for the e-service quality variable. The model was used as the measurement model in confirmatory factor analysis (Table 3).

Table 3: Second-order exploratory factor analysis

	E-service Quality
	1
FA1	.514
FA2	.518
FA3	.705
FA4	.556
FA5	.626
FA6	.572
FA7	.939
FA8	.791
FA9	.826
FA10	.831

Second question- To reflect the dependencies between criteria, it was necessary to identify the precise relationship between them in the analytic network process structure. Guided interviews were used in order to identify the relationships. According to experts' comments, seven dependent and three independent criteria were evaluated. The relative importance of criteria was obtained by taking into account the dependence through integrating the results and using the relation ω_c= B.W (equation 10).
Decision-makers used linguistic scales in Table 1 to express their views and then expressed their views in the form of fuzzy numbers. The results of the decision-makers' evaluation yielded the importance of each dimension as follows: Communication dimension, flexibility dimension, feedback dimension, educational planning dimension, reputation dimension, access dimension, responsiveness dimension, faculty dimension, website design dimension, and the staff dimension.

$$\omega_c = \begin{pmatrix} C_1 \\ C_2 \\ C_3 \\ C_4 \\ C_5 \\ C_6 \\ C_7 \\ C_8 \\ C_9 \\ C_{10} \end{pmatrix} = \begin{pmatrix} 0.103 \\ 0.116 \\ 0.007 \\ 0.118 \\ 0.115 \\ 0.103 \\ 0.175 \\ 0.011 \\ 0.123 \\ 0.134 \end{pmatrix}$$

Third question- In this study, the quality of received service was calculated using the Chen and Huang's method and the population mean test. When comparing two fuzzy numbers, whichever has the greater mean is larger. In case of equality of means, whichever has lower standard deviation is considered larger. Results showed that students believed that the dimensions of reputation, staff, access, accountability, page design, and flexibility were suitable, and the dimensions of faculty, feedback, communication, and planning needed to be improved.

4. Conclusion and Suggestions

E-service quality model proposed in this study can be used by organizations and universities for assessing the e-learning quality, which includes different criteria and interactions. However, they should be used with a few adjustments because certain organization- or university-specific criteria should also be accounted for.
This research utilized the analytic network process due to its capabilities as an analysis tool in evaluating the service quality. Interdependencies exist in most real issues related to the evaluation of service quality. However, analytic network process requires more comparisons compared to the analytic hierarchy process, and thus, requires more effort. Complex decisions require a more rigorous methodology. On the other hand, fuzzy approach was used to compare the service quality questionnaire data and to determine the service quality which led to a greater accuracy and precision.

5. References

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