Research Journal of Applied Sciences, Engineering and Technology 4(21): 4380-4396, 2012
ISSN: 2040-7467

Submitted: April 17, 2012 Accepted: May 23, 2012 Published: November 01, 2012

Ranking Parameters on Quality of Online Shopping Websites Using Multi-Criteria Method

[1]Mehrbakhsh Nilashi, [2]Karamollah Bagherifard, [1]Othman Ibrahim,
[3]Nasim Janahmadi and [4]Leila Ebrahimi
[1]Faculty of Computer Science and Information Systems, University Technologi Malaysia, Johor, Malaysia
[2]Department of Computer Engineering, Islamic Azad University, Yasooj branch, Yasooj, Iran
[3]Department of Computer Engineering, Ahrar Institute of Technology and Higher Education, Rasht, Iran
[4]Commercial and Social Science College, Payame Noor University, Qeshm Br, Iran

Abstract: The growing use of Internet in Malaysia provides a developing prospect of online shopping for international students. Also, international students are an outstanding group in online shopping in Malaysia. In view of this, in order to improve increase online shopping among international students and Malaysian online shopping, a research framework was proposed and a survey of international student was done. Proposed research framework considers three key dimensions service quality, information quality and system quality for online shopping website. To gather initial data, international students of UTM were asked. Data was collected from 300 international students of UTM. Using normal TOPSIS and fuzzy-TOPSIS approaches all parameters in hierarchy were ranked. Our findings demonstrated that using fuzzy-TOPSIS method trust, response time, reliability, responsiveness, empathy, timeliness, accuracy of information, navigation and accessibility are the nine first important parameters in online website quality.

Keywords: Fuzzy-TOPSIS, information quality, international students, online shopping, service quality, system, quality

INTRODUCTION

The amount of interest in online shopping has increased dramatically over recent years how it becomes progressive obvious that online shopping offers advantages for vendors and customers similarly. Demands and preferences of consumers are altering to the expanse that online shopping is becoming the more suitable option for many consumers.

A study by International Data Corporation (IDC) Asia Pacific indicates that the future forecast for online shopping in Malaysia looks bright and promising (Louis and Leon, 1999). Malaysia moved towards advanced information, communications based on the growing trend of Internet users in the last three years and multimedia services.

Furthermore, because of a rapid rise in the number of PCs, PDA, mobile phone technology in Malaysia, as well as each year provides greater opportunities for Malaysians to conduct both business and shop online.

Moreover, the number of international students in Malaysia has increased from 30 thousand in the year 2003 to about 70 thousand in 2010 (MOHE, 2010). Principally, in many university of Malaysia most of the international students are studying from Southeast Asia, Middle Eastern countries, Middle Asia and African countries and a minimal number from Europe.

According to the latest statistics, there are more than 90,000 international students currently studying in the various institutions of higher learning in Malaysia. Immigration Department records shows, the number of foreigners holding student passes number 90,501 as of 31 December 2008. This is close to the target set by the Ministry of Higher Education, which are 100,000 by 2010. Statistics results by the Immigration Department shows that Indonesia and China constitute the highest number of international students in this country. And the numbers of Indonesia and China students were estimated 14, 359 and 11, 628, respectively. There are also a big number of students from Nigeria (6, 765), Iran (6, 514), Bangladesh (3, 820) and the Middle East countries.

International student of university have high knowledge background and by present have been one of

Corresponding Author: Mehrbakhsh Nilashi, Faculty of Computer Science and Information Systems, University Technologi Malaysia, Johor, Malaysia

Table 1: The criteria of course website quality

	System quality					Information quality					Service quality			
Researcher	Learnability	Innovativeness	Navigability	Response ime	Accessibility	Accuracy	Currency	Completeness	Timeliness	Coherence	Reliability	Responsiveness	Trust	Empathy
Chiu *et al*. (2005)	◆		◆					◆		◆				◆
Cho *et al*. (2009)	◆			◆	◆									◆
Lee *et al*. (2005)	◆											◆		
Lin (2007)	◆				◆	◆	◆	◆			◆	◆		◆
Marks *et al*. (2005)													◆	
Ong *et al*. (2004)	◆												◆	
Madu and Madu (2002a)													◆	
Loiacono *et al*. (2002)													◆	
Pituch and Lee (2006)	◆			◆						◆		◆		
Roca *et al*. (2006)				◆			◆			◆	◆	◆		◆
Saade and Bahli (2005)											◆			
Teo *et al*. (2003)	◆				◆						◆			
Tung and Chang (2008)	◆					◆	◆	◆		◆				
Lee (2006)										◆				
Wang (2003a)	◆					◆	◆	◆					◆	
Kaynama and Black (2000)														◆
		◆												
Hakman (2000)		◆												
Tzeng *et al*. (2007)			◆	◆	◆	◆	◆							◆
Janda *et al*. (2002)			◆			◆			◆					
Kim and Lim (2001)			◆						◆				◆	
Katerattanakul (2002)			◆						◆					
Madu and Madu (2002b)			◆			◆			◆					

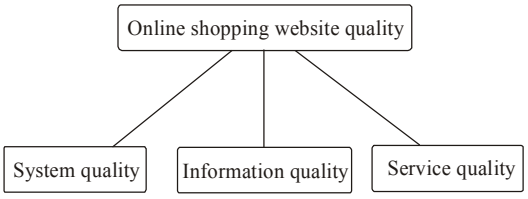


Fig. 1: Research framework of online shopping website quality

the major groups among online users. Meanwhile, university international students have comparatively economical autonomy and immense potential of online consuming. University international students will probably dominate future online consumption, becoming the core strength of developing e-commerce industry of Malaysia.

According to Elliot and Fowell (2000), the quality of e-tail websites, particularly such attributes as responsiveness of customer service, ease of site navigation, implicitly of checkout process and security of transaction and personal information are factors that online shopper consider them in online shopping.

Many researchers have studied Website quality widely (Marks *et al*., 2005; Chiu *et al*., 2005). Previous studies have been organized to detect effect on course website effectiveness or quality. Moreover, functionally-based website features have surveyed by some researchers in assisting the design of effective course websites through increasing interactivity and supporting learning (Cho *et al*., 2009; Roca *et al*., 2006).

Website quality is one of the most important consumer reactions in online shopping and its importance is reflected in the ability to intend buying in online shopping. As shown in Table 1, website quality has been conceptualized in a variety of ways.

For instances, some researchers focus on the impact of system quality on quality of websites based on consumer perceptions of website characteristics such as Learnability, Innovativeness, Navigability, Response time and Accessibility. Also several researchers considered the impact of service quality on quality of websites such as Reliability, Responsiveness, Trust and Empathy. Furthermore, information quality is on of another important entity that affect on website quality has been considered by researches such as Accuracy, Currency, Completeness, Complexity and Coherence.

Table 1 summarizes the criteria that affect on website quality from some researches.

Therefore, the objective of this research is to identify important parameters of online shopping

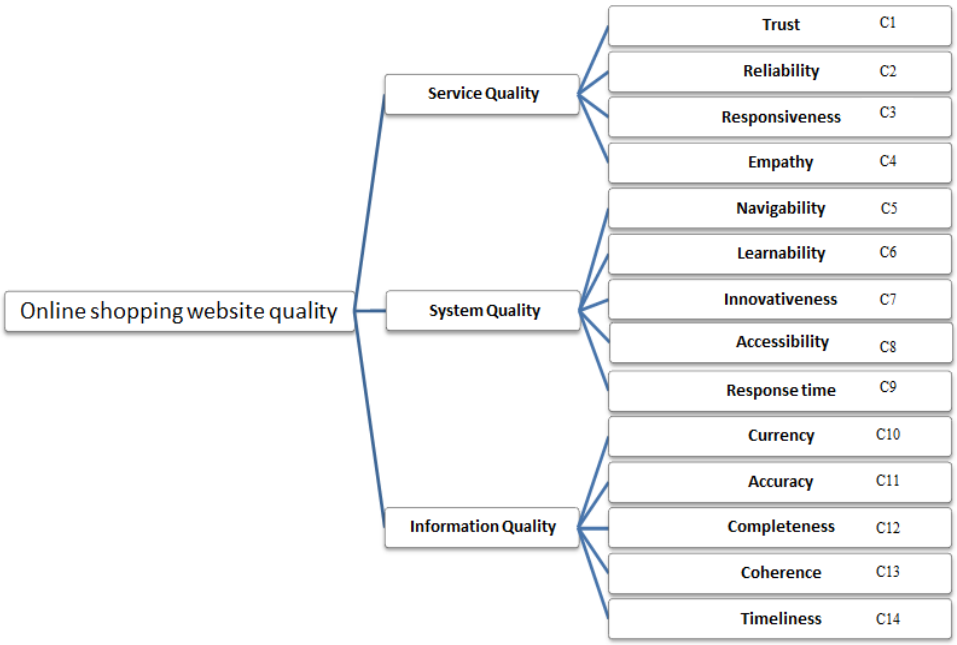


Fig. 2: Hierarchical structure of online shopping website quality

websites and analyze key attributes on online shopping websites in Malaysia that these attributes affect online shopping intention of university international student.

Research framework: The key components of the research framework for online shopping website quality can be seen in Fig. 1. According to the previous researches, our framework suggested that online shopping website quality is based on information quality, system quality and service quality.

In the research framework, System quality refers to the detected ability of a website to provide suitable functions in relation to customer. Higher quality of a website depends on usefulness and more functionality (Chatterjee and Sambamurthy, 1999). System Accessibility, timeliness and Response time are examples of qualities valued by traditional IS (Bailey and Pearson, 1983).

In the context of Internet shopping, system quality the interaction between consumers and the website is considered largely such as information searching, downloading and doing e-commerce transactions (Javenpaa and Todd, 1997).

Information quality refers to the quality of the information provided by the online services. High-quality information presentation can effectively facilitate doing transaction in online website shopping. According to Turban and Gehrke (2000) research information quality is the content of the Web site that either attracts or repels online customers. Moreover, Szymanski and Hise (2000) uncovered that consumer satisfaction with online shopping is largely determined by the quality of a site's product information.

In the follows, the quality of service also plays an important role in enhancing website quality. Typical dimensions of service quality include reliability, responsiveness, trust and empathy (Pitt, Watson and Kavan, 1995). These dimensions are likely to meet customer expectations and support online users in each step of the transaction process. Indeed, the study of online service quality with dimensions of SERVQUAL was conducted by Gefen (2002).

Furthermore, Zeithmal and Parasuraman (2002) offered that higher service quality is vital to encourage repeat purchases and build customer loyalty.

Hierarchy framework: In this research according to reviewing the literature on website quality in Table 1, a proposed hierarchical structure of the research problem was defined that has been shown in Fig. 2. The goal is to rank the sub-criteria in this hierarchical structure.

As seen in Fig. 2, there are 14 sub-criteria in hierarchical structure.

METHODOLOGY

In this research, the primary data were collected through questionnaires that have been distributed to the

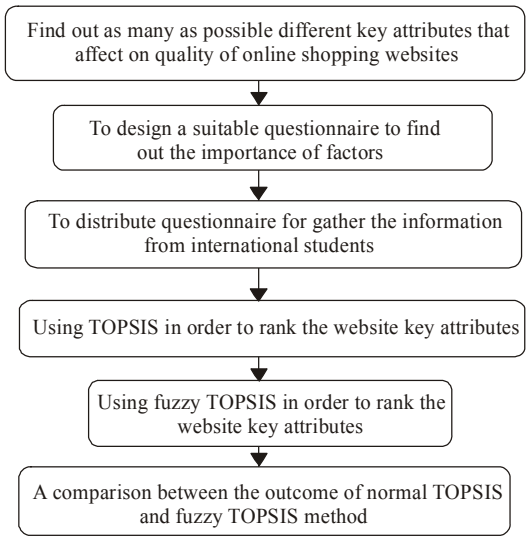


Fig. 3: The schematic form of research methodology of this research

Table 2: The respondents' demographic profile

Variable	Category	Frequency	(%)
Gender	male	225	75
	female	75	25
Age	23-25	90	30
	26-30	120	40
Degree of studying	Master	189	63
	P.HD	111	37
Country	Nigeria	15	5
	Pakistan	60	20
	Indonesia	45	15
	Iran	180	60

international student of UTM who are online users. For this study, a number of respondents are 300 students.

The structured questionnaire is used in collecting the data for the study. The questionnaires were designed properly in order to get the maximum accuracy of information and the maximum understanding to the respondents. The question is designed into six sections, where every section has been tested using the reliability analysis except for the demographic question. The first section comprise of information on respondent demographic profile, four sections on the independent variable namely, trust, website quality, internet knowledge and internet advertising and one section on online shopping. It had also five options (index) ranked by 1-5 for the raised questions could be found as follows:

1 = Not important, 2 = low important, 3 = average, 4 = Important, 5 = very important

Figure 3 shows the schematic form of research methodology of this research.

Table 2 provides the respondents' demographic profile. About 75% of them were male and 25% were female. Fifty four percent were Malay and 46% were Chinese. The mean age of the respondents was about 25 years old. About 37% were P.HD student, while 63% were master student.

Research objectives and outcome: The objective of this research is to identify important parameters of online shopping websites and analyze key attributes on online shopping websites in Malaysia that these attributes affect online shopping intention of university international student.

TOPSIS and fuzzy-TOPSIS: TOPSIS, one of the known classical MCDM methods, was first developed by Hwang and Yoon (1981) that can be used with both normal numbers and fuzzy numbers.

In addition, TOPSIS is attractive in that limited subjective input is needed from decision makers. The only subjective input needed is weights.

Since the preferred ratings usually refer to the subjective uncertainty, it is natural to extend TOPSIS to consider the situation of fuzzy numbers. Fuzzy TOPSIS can be intuitively extended by using the fuzzy arithmetic operations as follows (Hwang and Yoon, 1981; Gwo-Hshiung and Jen-Jia, 1997; Opricovic and Tzeng, 2004):

Given a set of alternatives, $A = \{A_i \mid i = 1, \cdots, n\}$, and a set of criteria, $C = \{C_j \mid j = 1, \cdots, m\}$, where, $\tilde{X} = \{\tilde{x}_{ij} \mid i = 1, \cdots, n; j = 1, \cdots m\}$ denotes the set of fuzzy ratings and $\tilde{W} = \{\tilde{w}_j \mid j = 1, \cdots, m\}$ is the set of fuzzy weights.

The first step of TOPSIS is to calculate normalized ratings by:

$$\tilde{r}_{ij}(\boldsymbol{x}) = \frac{\tilde{x}_{ij}}{\sqrt{\sum_{i=1}^{n} \tilde{x}_{ij}^2}}, \quad i = 1, \cdots, n; \quad j = 1, \cdots, m \tag{1}$$

And then to calculate the weighted normalized ratings by:

$$\tilde{v}_{ij}(\boldsymbol{x}) = \tilde{w}_j \tilde{r}_{ij}(\boldsymbol{x}), \quad i = 1, \cdots, n; \quad j = 1, \cdots, m. \tag{2}$$

Next the positive ideal point (PIS) and the negative ideal point (NIS) are derived as:

$$PIS = \tilde{\boldsymbol{A}}^{+} = \{\tilde{v}_1^{+}(\boldsymbol{x}), \tilde{v}_2^{+}(\boldsymbol{x}), \cdots, \tilde{v}_j^{+}(\boldsymbol{x}), \cdots, \tilde{v}_m^{+}(\boldsymbol{x})\}$$
$$= \{(\max_i \tilde{v}_{ij}(\boldsymbol{x}) \mid j \in J_1),\ (\min_i \tilde{v}_{ij}(\boldsymbol{x}) \mid j \in J_2) \mid i = 1, \cdots, n\} \quad (3)$$

$$PIS = \tilde{\boldsymbol{A}}^{-} = \{\tilde{v}_1^{-}(\boldsymbol{x}), \tilde{v}_2^{-}(\boldsymbol{x}), \cdots, \tilde{v}_j^{-}(\boldsymbol{x}), \cdots, \tilde{v}_m^{-}(\boldsymbol{x})\}$$
$$= \{(\min_i \tilde{v}_{ij}(\boldsymbol{x}) \mid j \in J_1),\ (\max_i \tilde{v}_{ij}(\boldsymbol{x}) \mid j \in J_2) \mid i = 1, \cdots, n\} \quad (4)$$

where, J_1 and J_2 are the benefit and the cost attributes, respectively.

Similar to the crisp situation, the following step is to calculate the separation from the PIS and the NIS between the alternatives. The separation values can also be measured using the Euclidean distance given as:

$$\tilde{S}_i^{+} = \sqrt{\sum_{j=1}^{m} [\tilde{v}_{ij}(\boldsymbol{x}) - \tilde{v}_j^{+}(\boldsymbol{x})]^2}, i = 1, \cdots, n \quad (5)$$

and

$$\tilde{S}_i^{-} = \sqrt{\sum_{j=1}^{m} [\tilde{v}_{ij}(\boldsymbol{x}) - \tilde{v}_j^{-}(\boldsymbol{x})]^2}, i = 1, \cdots, n \quad (6)$$

where,

$$\max\{\tilde{v}_{ij}(\boldsymbol{x})\} - \tilde{v}_j^{+}(\boldsymbol{x}) = \min\{\tilde{v}_{ij}(\boldsymbol{x})\} - \tilde{v}_j^{-}(\boldsymbol{x}) = 0. \quad (7)$$

Then, the defuzzified separation values should be derived using one of defuzzified methods, such as CoA to calculate the similarities to the PIS.
Next, the similarities to the PIS is given as:

$$C_i^{*} = D(S_i^{-}) \Big/ [D(S_i^{+}) + D(S_i^{-})] \quad , i = 1, \cdots, n \quad (8)$$

where,
$C_i^{*} \in [0,1] \quad \forall i = 1, \cdots, n$

Finally, the preferred orders are ranked according to C_i^{*} in descending order to choose the best alternatives.

Applying TOPSIS method: In this research TOPSIS was used for ranking effective parameters on online website shopping. Based on 14 parameters in hierarchy structure in previous section, a questionnaire was developed for gathering data from 300 international students. Afterward, TOPSIS was applied for ranking. Table 3 show results of respondents' responses categorized by their importance. TOPSIS method has been described in this section.

Table 3: The result of questionnaire

Question no.	Not important 1	Low important 2	Moderate 3	Important 4	Very important 5
1	0	1	70	89	140
2	1	13	46	80	160
3	0	30	40	130	100
4	4	21	34	99	142
5	10	16	55	130	89
6	8	23	80	90	99
7	2	20	80	116	82
8	8	13	17	92	170
9	4	16	80	80	120
10	12	8	100	100	80
11	4	7	21	130	138
12	7	14	89	120	70
13	6	80	12	140	62
14	12	20	30	78	160

Table 4: Dividing each cell of Table 4 on square of related column

	n_{ij}				
Question No.	1	2	3	4	5
1	0.00	0.01	21.55	19.72	43.51
2	0.04	1.67	9.31	15.93	56.83
3	0.00	8.90	7.04	42.08	22.20
4	0.63	4.36	5.08	24.40	44.77
5	3.91	2.53	13.30	42.08	17.59
6	2.50	5.23	28.15	20.17	21.76
7	0.16	3.95	28.15	33.50	14.93
8	2.50	1.67	1.27	21.07	64.16
9	0.63	2.53	28.15	15.93	31.97
10	5.63	0.63	43.98	24.90	14.21
11	0.63	0.48	1.94	42.08	42.28
12	1.92	1.94	34.84	35.85	10.88
13	1.41	63.28	0.63	48.80	8.53
14	5.63	3.95	3.96	15.15	56.83

First Step:

$$n_{ij} = r_{ij} \,/ \left(\sum_{i=1} (r_{ij})^2\right)^{1/2} \quad (9)$$

Table 4 shows divide of each cell of Table 5 on square of related column. For example in the frits cell of Table 5, 10 divides to (25.57 = 3.91).

Afterward, by using entropy method, objective weights were calculated. The following equation Calculates entropy measure of every index.

$$E_j = -K \sum_{i=1}^{m} \left[n_{ij} Ln(n_{ij})\right] \Rightarrow \left\{ \begin{array}{l} \forall j = 1,2,...n \\ K = \dfrac{1}{Ln(m)} \end{array} \right\} \quad (10)$$

Table 5: Multiply each cell by itself result of Table 1

Question no.	Not important 1.00	Low important 2.00	Moderate 3.00	Important 4.00	Very important 5.00
1	0.00	1.00	4900.00	7921.00	19600.00
2	1.00	169.00	2116.00	6400.00	25600.00
3	0.00	900.00	1600.00	16900.00	10000.00
4	16.00	441.00	1156.00	9801.00	20164.00
5	100.00	256.00	3025.00	16900.00	7921.00
6	64.00	529.00	6400.00	8100.00	9801.00
7	4.00	400.00	6400.00	13456.00	6724.00
8	64.00	169.00	289.00	8464.00	28900.00
9	16.00	256.00	6400.00	6400.00	14400.00
10	144.00	64.00	10000.00	10000.00	6400.00
11	16.00	49.00	441.00	16900.00	19044.00
12	49.00	196.00	7921.00	14400.00	4900.00
13	36.00	6400.00	144.00	19600.00	3844.00
14	144.00	400.00	900.00	6084.00	25600.00
SUM	654.00	10230.00	51692.00	161326.00	202898.00
SQRT	25.57	101.14	227.36	401.65	450.44

Table 6: Max row of matrix V

Max Vi1	Max Vi2	Max Vi3	Max Vi4	Max Vi5
0.050879	5.722108	8.429407	16.86465	23.30857

Table 7: Min row of matrix V

Min Vi1	Min Vi2	Min Vi3	Min Vi4	Min Vi5
0	0.000894	0.121383	5.234924	3.100281

The degree of divergence *dj* of the intrinsic information of each criterion *C* (*j* = 1, 2, …, *n*) may be calculated as:

$$d_j = 1 - E_j \tag{11}$$

The value *dj* represents the inherent contrast intensity of *cj*. The higher the *dj* is, the more important the criterion *cj* is for the problem. The objective weight for each criterion can be obtained. Accordingly, the normalized weights of indexes may be calculated as:

$$W_j = \frac{d_j}{\sum_{k=1}^{n} d_k} \tag{12}$$

$$E_1 = -k\sum_{i=1}^{m}(n_{ij}\ln(n_{ij})) = 1/(-2.484907(-0.12677 - 0.29336 + 5.3334 + 2.296349 - 0.2902 + 2.296349 - 0.29336 + 9.73362 - 0.29336 + 1.246368 + 0.481641 + 9.73362)) = -12.0532$$

$$E_2 = -k\sum_{i=1}^{m}(n_{ij}\ln(n_{ij})) = 1/(-2.639057(-0.04564 + 0.857855 + 19.45126 + 6.420702 + 2.350603 + 8.653563 + 5.437844 + 0.857855 + 2.350603 - 0.28958 - 0.35109 + 1.282137 + 262.4511 + 5.437844)) = -111.631$$

$$E_3 = -k\sum_{i=1}^{m}(n_{ij}\ln(n_{ij})) = 1/(-2.639057(-66.17362 + 20.76119 + 13.73135 + 8.268259 + 34.43481 + 93.94845 + 93.94845 + 0.30493 + 93.94845 + 166.4235 + 1.285041 + 123.7042 - 0.28927 + 5.446315)) = -235.472$$

$$E_4 = -k\sum_{i=1}^{m}(n_{ij}\ln(n_{ij})) = 1/(-2.639057(58.80239 + 44.11359 + 157.3443 + 77.95556 + 157.3443 + 60.58187 + 117.6449 + 64.23065 + 44.11359 + 80.03882 + 157.3443 + 128.3291 + 189.7149 + 41.16847)) = -423.813$$

$$E5 = -k\sum_{i=1}^{m}(n_{ij}\ln(n_{ij})) = 1/(-2.639057(164.1772 + 229.6136 + 68.82416 + 170.1714 + 50.41712 + 67.01719 + 40.35256 + 266.9915 + 110.76437.70647158.303225.9638418.29701229.6136)) = -445.461$$

$$w_1 = \frac{-11.0532}{-1223.43} = 0.009035$$

$$w_2 = \frac{-110.631}{-1223.43} = 0.090427$$

$$w_1 = \frac{-234.472}{-1223.43} = 0.191651$$

$$w_4 = \frac{-422.813}{-1223.43} = 0.345596$$

$$w_5 = \frac{-444.461}{-1223.43} = 0.363291$$

$$\sum w_i = 1 \Rightarrow w_1 + w_2 + w_3 + w_4 + w_5 = 0.009035 + 0.090427 + 0.191651 + 0.345596 + 0.363291 = 1$$

Therefore, matrix w can be defined as:

$$w = \begin{bmatrix} 0.009035 & 0 & 0 & 0 & 0 \\ 0 & 0.090427 & 0 & 0 & 0 \\ 0 & 0 & 0.191651 & 0 & 0 \\ 0 & 0 & 0 & 0.345596 & 0 \\ 0 & 0 & 0 & 0 & 0.345596 \end{bmatrix}$$

Table 8: The negative and positive Ideal (id-, id+)

Sum $(v_{ij}\, v_{j+})^2$	d i+	SQRT	Sum Of $(v_{ij}\, v_{j+})^2$	d i-	SQRT	Sum of d i + and d i-
208.4607	d 1+	14.43817	180.0539	d 1-	13.41842	27.85659
211.2885	d 2+	14.53577	310.7482	d 2-	17.62805	32.16382
312.0761	d 3+	17.66568	113.4148	d 3-	10.64964	28.31531
204.6971	d 4+	14.30724	184.3624	d 4-	13.57801	27.88525
356.4309	d 5+	18.87938	103.3747	d 5-	10.16734	29.04671
371.9530	d 6+	19.28608	54.12443	d 6-	7.356931	26.64301
385.8273	d 7+	19.64249	73.56760	d 7-	8.577156	28.21964
189.8565	d 8+	13.77884	412.6065	d 8-	20.31272	34.09156
305.1503	d 9+	17.46855	100.4178	d 9-	10.02087	27.48942
429.6291	d 10+	20.72750	84.63215	d 10-	9.199573	29.92707
165.7567	d 11+	12.87465	236.9635	d 11-	15.39362	28.26827
428.5371	d 12+	20.70114	94.93147	d 12-	9.743278	30.44442
477.3995	d 13+	21.84947	167.9829	d 13-	12.96082	34.81030
229.9524	d 14+	15.16418	308.4245	d 14-	17.56202	32.72620

$$V = N_d \times w_{n\times n} = \begin{bmatrix} 0.000000 & 0.000894 & 4.130409 & 6.815555 & 15.80789 \\ 0.000353 & 0.151099 & 1.783663 & 5.506823 & 20.64704 \\ 0,000000 & 0.804671 & 1.348705 & 14.54146 & 8.065248 \\ 0.005653 & 0.394289 & 0.974439 & 8.433184 & 16.26277 \\ 0.035333 & 0.228884 & 2.549896 & 14.54146 & 6.388483 \\ 0.022613 & 0.472968 & 5.39482 & 6.969573 & 7.90475 \\ 0.001413 & 0.357632 & 5.39482 & 11.5781 & 5.423073 \\ 0.022613 & 0.151099 & 0.24361 & 7.282774 & 23.30857 \\ 0.005653 & 0.228884 & 5.39482 & 5.506823 & 11.61396 \\ 0.050879 & 0.057221 & 8.429407 & 8.604412 & 5.161759 \\ 0.005653 & 0.04381 & 0.371737 & 14.54146 & 15.35946 \\ 0.017313 & 0.17524 & 6.676933 & 12.39035 & 3.951972 \\ 0.01272 & 5.722108 & 0.121383 & 16.86465 & 3.100281 \\ 0.050879 & 0.357632 & 0.758647 & 5.234924 & 20.64704 \end{bmatrix}$$

To specify positive ideal and negative ideal:

Positive Ideal = A+ = {(max Vij), (max Vij), i = 1, 2, ..., m} = {V1+, V2+, …, Vn+} (13)

Negative Ideal = A+ = {(minxVij), (min Vij), i = 1, 2, ..., m} = {V1-, V2-, …, Vn-} (14)

Positive ideal and negative ideal of *V* has been shown in Table 6 and 7. These tables show the maximum and the minimum of each column of matrix *V* in two rows. A+ is all the maximum numbers and A- is all the minimum numbers.

To calculated the distance the following equation used for positive and negative ideal.

$$\text{Distance i from positive Ideal} = \{\sum_{j=1} (v_{ij^-} - v_{j^+})^2\}^{1/2} \quad (15)$$

Table 8 shows the sum and square of five $(v_{ij^-} v_{j+})^2$ and $(v_{ij^-} v_{j-})^2$ that were in the Table 9 and 10. Square is shown as di+ or distance i from positive ideal and di- or distance i from negative Ideal. Also, in last column sum of the di+, di- has been calculated. The results of distance between Ai and ideal solution are shown in Table 11.

Table 9: Distance between max point and each point

$(v_{ij} - v_{j+})^2$	$(v_{ij} - v_{j+})^2$	$(v_{ij} - v_{j+})^2$	$(v_{ij} - v_{j+})^2$	$(v_{ij} - v_{j+})^2$
0.0026	32.7323	18.4814	100.9843	56.2602
0.0026	31.0361	44.1659	129.0002	7.0838
0.0026	24.1812	50.1363	5.3972	232.3588
0.0020	28.3857	55.5765	71.0896	49.6433
0.0002	30.1755	34.5687	5.3972	286.2892
0.0008	27.5535	9.2087	97.9125	237.2776
0.0024	28.7776	9.2087	27.9476	319.8909
0.0008	31.0361	67.0073	91.8123	0.0000
0.0020	30.1755	9.2087	129.0002	136.7639
0.0000	32.0909	0.0000	68.2315	329.3066
0.0020	32.2431	64.9260	5.3972	63.1883
0.0011	30.7677	3.0712	20.0193	374.6778
0.0015	0.0000	69.0233	0.0000	408.3748
0.0000	28.7776	58.8406	135.2505	7.0838

Table 10: Distance between min point and each point

$(v_{ij} - v_{j-})^2$	$(v_{ij} - v_{j-})^2$	$(v_{ij} - v_{j-})^2$	$(v_{ij} - v_{j-})^2$	$(v_{ij} - v_{j-})^2$
0.0000	0.0000	16.0723	2.4984	161.4832
0.0000	0.0226	2.7632	0.0739	307.8886
0.0000	0.6461	1.5063	86.6115	24.6509
0.0000	0.1548	0.7277	10.2289	173.2510
0.0012	0.0520	5.8977	86.6115	10.8123
0.0005	0.2229	27.8091	3.0090	23.0829
0.0000	0.1273	27.8091	40.2358	5.3954
0.0005	0.0226	0.0149	4.1937	408.3748
0.0000	0.0520	27.8091	0.0739	72.4827
0.0026	0.0032	69.0233	11.3534	4.2497
0.0000	0.0018	0.0627	86.6115	150.2874
0.0003	0.0304	42.9752	51.2002	0.7254
0.0002	32.7323	0.0000	135.2505	0.0000
0.0026	0.1273	0.4061	0.0000	307.8886

Applying fuzzy TOPSIS method: Fuzzy-TOPSIS method is another type of fuzzification for the TOPSIS method in fuzzy environment that is defined and investigated by credibility measure. In this method, trapezoid-fuzzy numbers are used for ranking all sub-criteria of website quality. Therefore, using fuzzy

Table 11: The distance between Ai and ideal solution for final ranking

cli +	$d^-_1 / d^-_1 + d^+_1$	Ranking	Sub Criteria No.
cl 1 +	0.481696	0.276130	6
cl 2 +	0.548071	0.303943	7
cl 3 +	0.376109	0.307400	10
cl 4 +	0.486924	0.320035	12
cl 5 +	0.350034	0.350034	5
cl 6 +	0.276130	0.364535	9
cl 7 +	0.303943	0.372327	13
cl 8 +	0.595828	0.376109	3
cl 9 +	0.364535	0.481696	1
cl 10 +	0.307400	0.486924	4
cl 11 +	0.544555	0.536635	14
cl 12 +	0.320035	0.544555	11
cl 13 +	0.372327	0.548071	2
cl 14 +	0.536635	0.595828	8

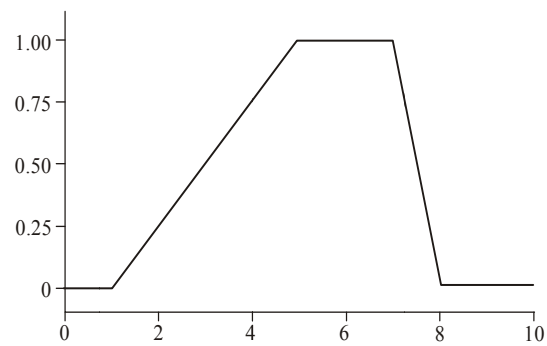


Fig. 4: Fuzzy trapezoid number

trapezoid numbers enabled us to change normal TOPSIS into fuzzy TOPSIS which is more precisely as the result shows in the next paragraph.

One of the characteristic of fuzzy numbers is fuzzy sets with special consideration for easy calculations. Trapezoid Fuzzy Numbers Let $\widetilde{A} = (a, b, c, d)$, a<b<c<d, be a fuzzy set on $R = (-\infty, \infty)$. It is called a trapezoid fuzzy number, if its membership function is:

$$\mu_{\widetilde{A}}(x) = \begin{cases} \dfrac{x-a}{b-a}, & if\ a \le x \le b \\ 1, & if\ b \le x \le c \\ \dfrac{d-x}{d-c}, & if\ c \le x \le d \\ 0, & otherwise \end{cases} \tag{18}$$

Figure 4 shows the shape of a fuzzy trapezoid number.

All process of fuzzy TOPSIS will be calculated upon three of trapezoid numbers that average numbers of experts are shown in Table 12:

A calculation between two fuzzy trapezoid numbers can be defined as:

$$D1 = (a_1, b_1, c_1, d_1)$$
$$D2 = (a_2, b_2, c_2, d_2)$$
$$\Rightarrow D1 + D2 = (a_1 + a_2, b_1 + b_2, c_1 + c_2, d_1 + d_2) \tag{19}$$

Table 12: Fuzzy trapezoid number for fuzzy TOPSIS method

Linguistic variable	Range of fuzzy trapezoid number
Non important	(0.6, 0.8, 1.6, 1.8)
Low important	(1.4, 1.6, 2.5, 2.7)
Moderate	(2.3, 2.5, 3.8, 4)
Important	(3.6, 3.8, 4.6, 4.8)
Very important	(4.4, 4.6, 5.2, 5.4)

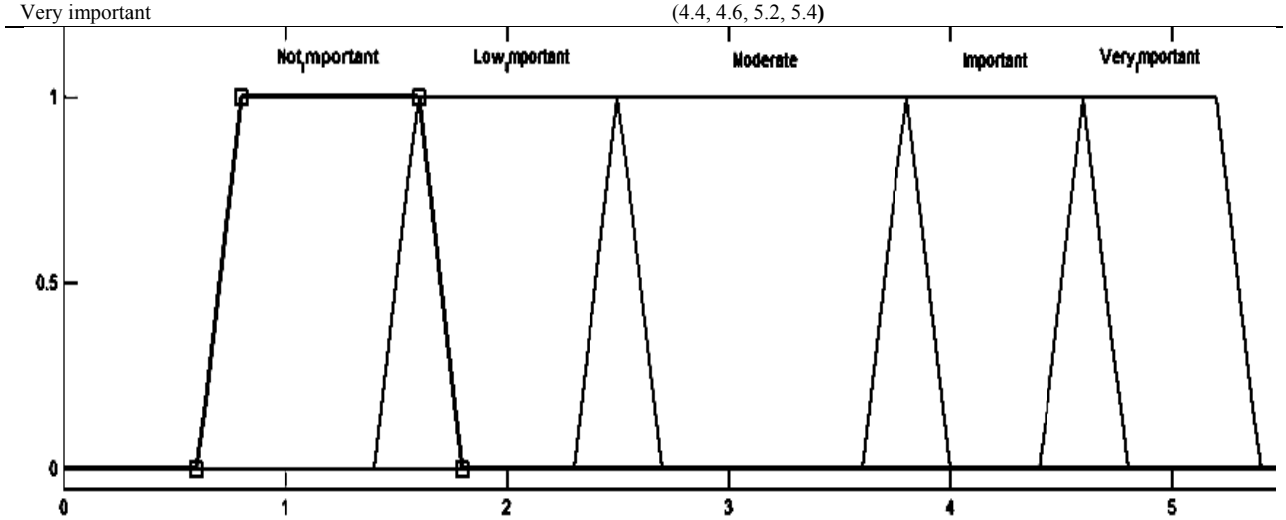


Table 13: The sum of four trapezoid numbers in Table 12

Sum of trapezoid numbers			
1	**2**	**3**	**4**
1098.8	1158.8	1405.9	1465.9
1116.6	1176.6	1408.9	1468.9
1042.0.	1102.0	1345.0	1405.0
1091.2	1151.2	1381.9	1441.9
1014.5	1074.5	1325.8	1385.8
980.6	1040.6	1303.1	1363.1
991.6	1051.6	1317.2	1377.2
1141.3	1201.3	1417.1	1477.1
1024.8	1084.8	1342.4	1402.4
960.4	1020.4	1295.2	1355.2
1135.7	1195.7	1419.3	1479.3
968.5	1028.5	1300.4	1360.4
920.0	980.0	1221.6	1281.6
1089.0	1149.0	1374.0	1434.0

Therefore, Table 13 was calculated from Table 14 by summing of four trapezoid numbers.

In the next step, each cell of Table 15 will be divided by 300 in order to make the 14 fuzzy numbers for starting fuzzy TOPSIS.

In the next step, 14 fuzzy numbers in Table 13 should be multiplied by itself and will come in Table 15.

Using (Buckley, 1985; Bailey and Pearson, 1983) method, a calculation between two fuzzy trapezoid numbers can be defined as:

$$D1 = (a_1, b_1, c_1, d_1)$$
$$D2 = (a_2, b_2, c_2, d_2)$$

$$\Rightarrow M' = D1 * D2 = D1 * D2 = (a(L_1, L_2), b, c, d(R_1, R_2)) \quad (20)$$
$$\Rightarrow M' <> \text{Fuzzy trapezoid number}$$

Table 14: Applying fuzzy number on questionnaire data

R_{ij}	Selected option	Fuzzy number 1				Selected option	Fuzzy number 2				Selected option	Fuzzy number 3			
Q.No	1	0.6	0.8	1.6	1.8	2	1.4	1.6	2.5	2.7	3	2.3	2.5	3.8	4
1	0	0	0	0	0	1	1.4	1.6	2.5	2.7	70	161	175	266	280
2	1	0.6	0.8	1.6	1.8	13	18.2	20.8	32.5	35.1	46	105.8	115	174.8	184
3	0	0	0	0	0	30	42	48	75	81	40	92	100	152	160
4	4	2.4	3.2	6.4	7.2	21	29.4	33.6	52.5	56.7	34	78.2	85	129.2	136
5	10	6	8	16	18	16	22.4	25.6	40	43.2	55	126.5	137.5	209	220
6	8	4.8	6.4	12.8	14.4	23	32.2	36.8	57.5	62.1	80	184	200	304	320
7	2	1.2	1.6	3.2	3.6	20	28	32	50	54	80	184	200	304	320
8	8	4.8	6.4	12.8	14.4	13	18.2	20.8	32.5	35.1	17	39.1	42.5	64.6	68
9	4	2.4	3.2	6.4	7.2	16	22.4	25.6	40	43.2	80	184	200	304	320
10	12	7.2	9.6	19.2	21.6	8	11.2	12.8	20	21.6	100	230	250	380	400
11	4	2.4	3.2	6.4	7.2	7	9.8	11.2	17.5	18.9	21	48.3	52.5	79.8	84
12	7	4.2	5.6	11.2	12.6	14	19.6	22.4	35	37.8	89	204.7	222.5	338.2	356
13	6	3.6	4.8	9.6	10.8	80	112	128	200	216	12	27.6	30	45.6	48
14	12	7.2	9.6	19.2	21.6	20	28	32	50	54	30	69	75	114	120

R_{ij}	Selected option	Fuzzy number 4				Selected option	Fuzzy number 5			
Q.No	4	3.6	3.8	4.6	4.8	5	4.4	4.6	5.5	5.7
1	89	320.4	338.2	409.4	427.2	140	616	644	728	756
2	80	288	304	368	384	160	704	736	832	864
3	130	468	494	598	624	100	440	460	520	540
4	99	356.4	376.2	455.4	475.2	142	624.8	653.2	738.4	766.8
5	130	468	494	598	624	89	391.6	409.4	462.8	480.6
6	90	324	342	414	432	99	435.6	455.4	514.8	534.6
7	116	417.6	440.8	533.6	556.8	82	360.8	377.2	426.4	442.8
8	92	331.2	349.6	423.2	441.6	170	748	782	884	918
9	80	288	304	368	384	120	528	552	624	648
10	100	360	380	460	480	80	352	368	416	432
11	130	468	494	598	624	138	607.2	634.8	717.6	745.2
12	120	432	456	552	576	70	308	322	364	378
13	140	504	532	644	672	62	272.8	285.2	322.4	334.8
14	78	280.8	296.4	358.8	374.4	160	704	736	832	864

Table 15: Fourteen fuzzy numbers generated by dividing Table 13 by 300

R_{ij} = Sum/n			
1	2	3	4
3.662667	3.862667	4.686333	4.886333
3.722000	3.922000	4.696333	4.896333
3.473333	3.673333	4.483333	4.683333
3.637333	3.837333	4.606333	4.806333
3.381667	3.581667	4.419333	4.619333
3.268667	3.468667	4.343667	4.543667
3.305333	3.505333	4.390667	4.590667
3.804333	4.004333	4.723667	4.923667
3.416000	3.616000	4.474667	4.674667
3.201333	3.401333	4.317333	4.517333
3.785667	3.985667	4.731000	4.931000
3.228333	3.428333	4.334667	4.534667
3.066667	3.266667	4.072000	4.272000
3.630000	3.830000	4.580000	4.780000

Table 16: The μM(x) for non -trapezoid fuzzy number

x	$\mu M'(x)$
$\le a$	0
$\ge d$	0
$b \le x \le c$	1
$a \le x \le b$	$\alpha \in [0,1]$
$c \le x \le d$	$\alpha \in [0,1]$

$$a = a1 * a2 \quad L1 = (b1 - a1) * (b2 - a2) \tag{21}$$

$$b = b1 * b2 \quad L2 = a2 * (b1 - a1) + a1 * (b2 - a2) \tag{22}$$

$$c = c1 * c2 \quad R1 = (d1 - c1) * (d2 - c2) \tag{23}$$

$$d = d1 * d2 \quad R2 = - [d2 * (d1 - c1) + d1 * (d2 - c2)] \tag{24}$$

Therefore, $\mu M'(x)$ is defined as in Table 16:

$$\text{If } a \le x \le b \ \& \ x_1 = [a_1, b_1], x_2 = [a_2, b_2] \text{ so that}: x_i = (b_i - a_i)\,\alpha + a_i \tag{25}$$

$$\text{Then } x = x_1 \times x_2 \text{ will be like this form}: \quad x = L_1\,\alpha^2 + L_2\,\alpha + a, \alpha \in [0,1] \tag{26}$$

$$\text{If } c \le x \le d \text{ Then } x = x_1 \times x_2 \text{ will be like this form}: \quad x = R_1\,\alpha^2 + R_2\alpha + d, \alpha \quad [0,1] \tag{27}$$

In this manner, by multiplying the Table 13 by itself, result will be a non trapezoid number as in Table 17.

Table 17 that disclose 14 non trapezoid numbers that each one has about 8 elements.

Therefore trapezoid number will be:

$$(a,b,c,d) = (0.056941, 0.059474, 0.072677, 0.076847) \tag{28}$$

Table 17: 14 Fuzzy non trapezoid numbers generated from multiplying R_{ij} by itself

	$(R_{ij})^2$							
Q. No	a	L1	L2	b	c	d	R1	R2
1	13.41513	0.040000	1.465067	14.92019	21.96172	23.87625	0.040000	-1.954533333
2	13.85328	0.040000	1.488800	15.38208	22.05555	23.97408	0.040000	-1.958533333
3	12.06404	0.040000	1.389333	13.49338	20.10028	21.93361	0.040000	-1.873333333
4	13.23019	0.040000	1.454933	14.72513	21.21831	23.10084	0.040000	-1.922533333
5	11.43567	0.040000	1.352667	12.82834	19.53051	21.33824	0.040000	-1.847733333
6	10.68418	0.040000	1.307467	12.03165	18.86744	20.64491	0.040000	-1.817466667
7	10.92523	0.040000	1.322133	12.28736	19.27795	21.07422	0.040000	-1.836266667
8	14.47295	0.040000	1.521733	16.03469	22.31303	24.24249	0.040000	-1.969466667
9	11.66906	0.040000	1.366400	13.07546	20.02264	21.85251	0.040000	-1.869866667
10	10.24854	0.040000	1.280533	11.56907	18.63937	20.4063	0.040000	-1.806933333
11	14.33127	0.040000	1.514267	15.88554	22.38236	24.31476	0.040000	-1.972400000
12	10.42214	0.040000	1.291333	11.75347	18.78934	20.5632	0.040000	-1.813866667
13	9.404444	0.040000	1.226667	10.67111	16.58118	18.24998	0.040000	-1.708800000
14	13.17690	0.040000	1.452000	14.6689	20.9764	22.8484	0.040000	-1.912000000
Sum	169.33300	0.560000	19.43333	189.3264	282.7161	308.4198	0.560000	-26.26373333
SQRT	13.01280	0.748331	4.408325	13.75959	16.81416	17.56188	0.748331	#NUM
1/SQRT	0.076847	1.336306	0.226844	0.072677	0.059474	0.056941	1.336306	#NUM

Table 18: The 14 fuzzy trapezoid numbers for fuzzy TOPSIS processes

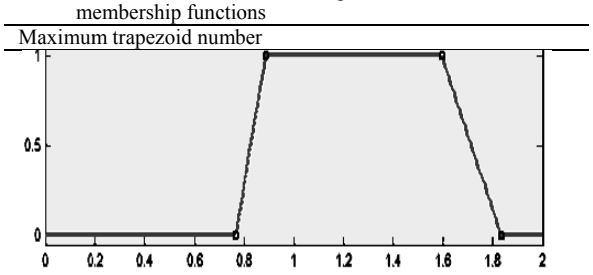
	n_{ij}			
Q.No	a	b	c	d
1	0.763877	0.887359	1.596103	1.834828
2	0.788827	0.914829	1.602922	1.842346
3	0.686945	0.802501	1.460819	1.685541
4	0.753347	0.875757	1.542074	1.775239
5	0.651164	0.762948	1.41941	1.639788
6	0.608373	0.715566	1.371221	1.586507
7	0.622099	0.730775	1.401056	1.619499
8	0.824112	0.953642	1.621634	1.862973
9	0.664454	0.777645	1.455177	1.679308
10	0.583567	0.688055	1.354645	1.568171
11	0.816044	0.944771	1.626673	1.868526
12	0.593452	0.699022	1.365545	1.580229
13	0.535503	0.63465	1.205064	1.402464
14	0.750312	0.872413	1.524493	1.755840

Table 19: Maximum and minimum of fuzzy trapezoid numbers for A+ and A-

Max Vi	No. 10			
A+	0.787573	0.840805	1.108558	1.161955
Min Vi	No. 8			
A-	1.112209	1.165353	1.327045	1.380392

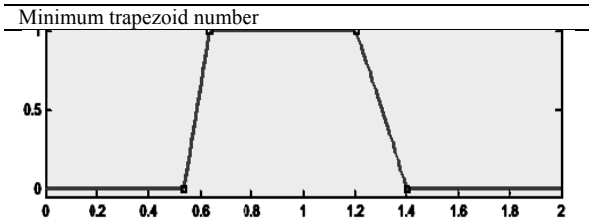
Table 20: Minimum and maximum trapezoid numbers with their membership functions

Maximum trapezoid number



area = 0.889847

Minimum trapezoid number



area = 0.718687

Afterward, each cell in Table 16 should be multiplied by (0.056941, 0059474, 0.072677, 0.076847) that is transpired. Table 18 demonstrates result of this multiplication.

In this step for finding minimum and maximum fuzzy trapezoid number for A+ and A-, was tried to calculate the area under each of the curve. Each curve forms a trapezoid shape. Table 19 shows minimum and maximum trapezoid numbers with their membership functions.

Table 21: The square of distance between maximum point and each point

$(v_{ij} - v_{j+})^2$	$(v_{ij} - v_{j+})^2$	$(v_{ij} - v_{j+})^2$	$(v_{ij} - v_{j+})^2$
0.000000	0.000000	0.000000	0.000000
0.000622	0.000755	0.000047	0.000057
0.005919	0.007201	0.018302	0.022287
0.000111	0.000135	0.002919	0.003551
0.012704	0.015478	0.031220	0.038041
0.024182	0.029513	0.050572	0.061663
0.020101	0.024518	0.038043	0.046367
0.003628	0.004393	0.000652	0.000792
0.009885	0.012037	0.019860	0.024186
0.032512	0.039722	0.058302	0.071106
0.002721	0.003296	0.000935	0.001136
0.029045	0.035471	0.053157	0.064821
0.052155	0.063862	0.152911	0.186939
0.000184	0.000223	0.005128	0.006239

Table 22: The square of distance between minimum point and each point

$(v_{ij} - v_{j-})^2$	$(v_{ij} - v_{j-})^2$	$(v_{ij} - v_{j-})^2$	$(v_{ij} - v_{j-})^2$
0.052155	0.063862	0.152912	0.186939
0.064173	0.078500	0.158291	0.193496
0.022935	0.028174	0.065411	0.080133
0.047456	0.058133	0.113576	0.138961
0.013377	0.016460	0.045944	0.056323
0.005310	0.006547	0.027608	0.033872
0.007499	0.009240	0.038413	0.047104
0.083295	0.101756	0.173531	0.212069
0.016628	0.020448	0.062557	0.076643
0.002310	0.002852	0.022375	0.027459
0.078703	0.096175	0.177754	0.217214
0.003358	0.004144	0.025754	0.031600
0.000000	0.000000	0.000000	0.000000
0.046143	0.056531	0.102035	0.124875

Therefore, the maximum and minimum vectors are for question number 1 and 13, respectively. Table 20 shows minimum and maximum trapezoid numbers with their membership functions.

After calculating reverse sum matrix (Table 23, 24), it is time now to multiple this matrix with matrix in Table 21 and 22.

In this case, two matrixes are with fuzzy number and result of multiplication of them is also fuzzy but not trapezoid number. Therefore, 14 none trapezoid numbers has been demonstrated in Table 25. Each8 parts in a row make a curve. Therefore, totally 14 curves was generated (Table 26, 27).

For ranking all parameters, area under any curve should be calculated. Therefore, according to the Adamo (1980).

In the Table 28, from first 9 important parameters, eight of them were repeated both in TOPSIS and fuzzyTOPSIS and it means that the outcomes of two methods are close to each other that can say approximately the results are the same however, in the fuzzy TOPSIS due to fuzzy numbers that are more accurate than normal numbers, it is obvious that the results are more exact than the results with normal numbers.

Table 23: The square distance between minimum and maximum for di+ and di-

di+				di –			
0.000000	0.000000	0.000000	0.000000	0.052155	0.063862	0.152912	0.186939
0.000622	0.000755	0.000047	0.000057	0.064173	0.078500	0.158291	0.193496
0.005919	0.007201	0.018302	0.022287	0.022935	0.028174	0.065411	0.080133
0.000111	0.000135	0.002919	0.003551	0.047456	0.058133	0.113576	0.138961
0.012704	0.015478	0.031220	0.038041	0.013377	0.016460	0.045944	0.056323
0.024182	0.029513	0.050572	0.061663	0.005310	0.006547	0.027608	0.033872
0.020101	0.024518	0.038043	0.046367	0.007499	0.009240	0.038413	0.047104
0.003628	0.004393	0.000652	0.000792	0.083295	0.101756	0.173531	0.212069
0.009885	0.012037	0.019860	0.024186	0.016628	0.020448	0.062557	0.076643
0.032512	0.039722	0.058302	0.071106	0.002310	0.002852	0.022375	0.027459
0.002721	0.003296	0.000935	0.001136	0.078703	0.096175	0.177754	0.217214
0.029045	0.035471	0.053157	0.064821	0.003358	0.004144	0.025754	0.031600
0.052155	0.063862	0.152911	0.186939	0.000000	0.000000	0.000000	0.000000
0.000184	0.000223	0.005128	0.006239	0.046143	0.056531	0.102035	0.124875

Table 24: Reverse sum of A+ and A-

Reverse Sum			
a	b	c	d
5.349344	6.539720	15.65882	19.17362
5.166547	6.315614	12.61753	15.43329
9.763784	11.945656	28.26876	34.65724
7.016943	8.584056	17.16234	21.02298
10.597333	12.959306	31.31031	38.34209
10.467346	12.790995	27.73148	33.9075
10.698523	13.079388	29.62222	36.23188
4.697904	5.741099	9.420696	11.50443
9.917764	12.133463	30.7838	37.71735
0.145609	12.395205	23.48849	28.71748
4.579813	5.596316	10.05317	12.28139
10.371174	12.672493	25.24331	30.86134
5.349350	6.539743	15.65884	19.17362
7.626959	9.331577	17.61974	21.58568

CONCLUSION

This study utilized normal TOPSIS and fuzzy TOPSIS method to rank the parameters that affect on website quality in online shopping based on Malaysian International student' perceptions.

The problem in this research is to identify parameters of website quality of online shopping websites in Malaysia. All parameters was identified from previous researches of several researchers.

This research makes a significant innovation, which is to analyze that "which parameters of online shopping website quality are important for international students".

After collecting information through the literature Review, hierarchical structure of online shopping website quality was organize that shows parameters that affect on online shopping website quality. Then in the second step, based on the hierarchical structure a questionnaire was prepared just to gather information. from international students in Malaysia. Afterward, all the collected data processed and ranked with the normal TOPSIS methods.

In the next step, using fuzzy TOPSIS with trapezoid numbers all parameters were ranked to compare with normal TOPSIS.

Accordingly the results of both fuzzy TOPSIS and TOPSIS compared with each other that have been shown in the Table 29. Findings show fuzzy TOPSIS due to fuzzy numbers that are more accurate than normal numbers. Therefore, 8 parameters that had been

Table 25: 8 Parts of 14 non trapezoid numbers

Cl +								
Q. No	a	l1	l2	b	c	d	r1	r2
1	0.27899503	0.01393544	0.12470753	0.41763800	2.39441814	3.58429329	0.11959811	-1.30947326
2	0.33155279	0.01646289	0.14776112	0.49577680	1.99724491	2.98628544	0.09912907	-1.08816961
3	0.22393239	0.01143061	0.10119274	0.33655575	1.84908192	2.77717859	0.09405070	-1.02214737
4	0.33299604	0.01673129	0.14928536	0.49901269	1.94922934	2.92138169	0.09800383	-1.07015617
5	0.14176052	0.00728275	0.06427124	0.21331451	1.43853171	2.15953315	0.07297888	-0.79398032
6	0.05558161	0.00287522	0.02529059	0.08374741	0.76561761	1.14851166	0.03868447	-0.42157852
7	0.08022823	0.00414505	0.03648007	0.12085334	1.13787796	1.70667701	0.05744656	-0.62624561
8	0.39131192	0.01925820	0.17361995	0.58419007	1.63478124	2.43973102	0.08030293	-0.88525271
9	0.16491259	0.00846291	0.07472377	0.24809926	1.92573186	2.89076003	0.09766632	-1.06269449
10	0.02343636	0.00121945	0.01069627	0.03535208	0.52554485	0.78854982	0.02658581	-0.28959078
11	0.36044499	0.01776029	0.16002009	0.53822537	1.78699551	2.66769000	0.08792463	-0.96861912
12	0.03482640	0.00180822	0.01587681	0.05251143	0.65012270	0.97523293	0.03284421	-0.35795444
13	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
14	0.35193079	0.01770785	0.15788628	0.52752491	1.79783127	2.69550696	0.09058093	-0.98825662

Table 26: Membership functions of curves

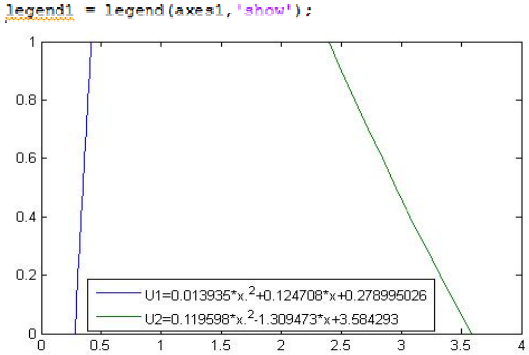
x	Mui(x)	Membership Function
$x \le 0.278995$	0	$U1 = 0.013935\ \alpha^2 + 0.124708\ \alpha + 0.278995$
$x \le 3.584293$	0	$U2 = 0.119598\ \alpha^2 - 1.309473\ \alpha + 3.584293$
$0.417639 \le x \le 2.394418$	1	
$0.278995 \le x \le 0.417638$	$\alpha \in [0, 1]$	
$2.394418 \le x \le 3.584293$	$\alpha \in [0, 1]$	
$x \le 0.331553$	0	$U3 = 0.016463\ \alpha^2 + 0.147761\ \alpha + 0.331553$
$x \ge 2.986285$	0	$U4 = 0.099129\ \alpha^2 - 1.088170\alpha + 2.986285$
$0.495777 \le x \le 1.997245$	1	
$0.331553 \le x \le 0.495777$	$\alpha \in [0, 1]$	
$1.997245 \le x \le 2.986285$	$\alpha \in [0, 1]$	
$x \le 0.223932$	0	$U5 = 0.011431\ \alpha^2 + 0.101193\ \alpha + 0.223932$
$x \ge 2.777179$	0	$U6 = 0.094051\ \alpha^2 - 1.022147\alpha + 2.777179$
$0.336556 \le x \le 1.849082$	1	
$0.223932 \le x\ 0.336556$	$\alpha \in [0, 1]$	
$1.849082 \le x \le 2.777179$	$\alpha \in [0, 1]$	
$x \le 0.332996$	0	$U7 = 0.016731\ \alpha^2 + 0.149285\alpha + 0.332996$
$x \ge 2.921383$	0	$U8 = 0.0981004\ \alpha^2 - 1.070156\alpha + 2.921382$
$0.499013 \le x \le 1.949229$	1	
$0.332996 \le x \le 0.499013$	$\alpha \in [0, 1]$	
$1.94229 \le x \le 2.921282$	$\alpha \in [0, 1]$	
$x \le 0.141761$	0	$U9 = 0.007283\ \alpha^2 + 0.064271\alpha + 0.141761$
$x \ge 2.159533$	0	$U10 = 0.072979\ \alpha^2 - 0.793980\alpha + 2.159533$
$0.213315 \le x \le 1.438532$	1	
$0.141761 \le x \le 0.213315$	$\alpha \in [0, 1]$	
$1.438532 \le x \le 2.159533$	$\alpha \in [0, 1]$	
$x \le 0.055582$	0	$U11 = 0.002875\ \alpha^2 + 0.025291\alpha + 0.055582$
$x \ge 1.148512$	0	$U12 = 0.038684\ \alpha^2 - 0.421579\ \alpha +$
$0.083747 \le x \le 0.765618$	1	1.148512
$0.055582 \le x \le 0.083747$	$\alpha \in [0, 1]$	
$0.765618 \le x \le 1.148512$	$\alpha \in [0, 1]$	
$x \le 0.080228$	0	$U13 = 0.004145\ \alpha^2 + 0.036480\ \alpha + 0.080228$
$x \ge 1.706677$	0	$U14 = 0.057447\ \alpha^2 - 0.626246\alpha + 1.706677$
$0.120853 \le x \le 1.137878$	1	
$0.080228 \le x \le 0.120853$	$\alpha \in [0, 1]$	
$1.137878 \le x \le 1.706677$	$\alpha \in [0, 1]$	
$x \le 0.391312$	0	$U15 = 0.0119258\ \alpha^2 + 0.173620\alpha +$
$x \ge 2.439731$	0	0.391312
$0.54819 \le x \le 1.634781$	1	$U16 = 0.080303\ \alpha^2 - 0.885253\alpha + 2.439731$
$0.391312 \le x \le 0.58419$	$\alpha \in [0, 1]$	
$1.634781 \le x \le 2.439731$	$\alpha \in [0, 1]$	
$x \le 0.164913$	0	$U17 = 0.008463\ \alpha^2 + 0.074724\ \alpha + 0.164913$
$x \ge 2.89076$	0	$U18 = 0.097666\ \alpha^2 - 1.062694\ \alpha + 2.89076$
$0.248099 \le x \le 1.925732$	1	
$0.164913 \le x \le 0.248099$	$\alpha \in [0, 1]$	
$1.925732 \le x \le 2.89076$	$\alpha \in [0, 1]$	
$x \le 0.023436$	0	$U19 = 0.001219\ \alpha^2 + 0.010696\alpha + 0.023436$
$x \ge 0.78855$	0	$U20 = 0.026586\ \alpha^2 - 0.289591\ \alpha + 0.78855$
$0.035352 \le x \le 0.525545$	1	
$0.023436 \le x \le 0.035352$	$\alpha \in [0, 1]$	
$0.525545 \le x \le 0.78855$	$\alpha \in [0, 1]$	
$x \le 0.360445$	0	$U21 = 0.017760\ \alpha^2 + 0.160020\alpha + 0.360445$
$x \ge 2.667689999$	0	$U22 = 0.087925\ \alpha^2 - 0.968619\alpha + 0.360445$
$0.538225 \le x \le 1.786996$	1	
$0.360445 \le x \le 0.538225$	$\alpha \in [0, 1]$	
$1.786996 \le x \le 2.667689999$	$\alpha \in [0, 1]$	
$x \le 0.034826$	0	$U23 = 0.001808\ \alpha^2 + 0.015877\alpha$
$x \ge 0.975232927$	0	$+0.03484826$
$0.052511 \le x \le 0.650123$	1	$U24 = 0.032844\ \alpha^2 - 0.357954\alpha + 0.975233$
$0.034826 \le x \le 0.052511$	$\alpha \in [0, 1]$	
$0.650123 \le x \le 0.975232927$	$\alpha \in [0, 1]$	

Table 26: (Continue)

$x \le 0$	0	U25 = 0
$x \ge 0$	0	U26 = 0
$0 \le x \le 0$		
$0 \le x \le 0$	1	
$0 \le x \le 0$	$\alpha \in [0, 1]$	
	$\alpha \in [0, 1]$	
$x \le 0.351931$	0	$U27 = 0.017708\ \alpha^2 + 157886\alpha + 0.351931$
$x \ge 2.695507$	0	$U28 = 0.090581\ \alpha^2 - 0.988257\alpha + 2.695507$
$0.527525 \le x \le 1.797831$	1	
$0.351931 \le x \le 0.527525$	$\alpha \in [0, 1]$	
$1.797831 \le x \le 2.695507$	$\alpha \in [0, 1]$	

Table 27: Figure of curves for row 1 and row 9 of Table 25

```
function createfigure(X1, Y1, X2)

% Create figure
figure1 = figure;

% Create axes
axes1 = axes('Parent',figure1);
box(axes1,'on');
hold(axes1,'all');

% Create plot
plot(X1,Y1,'Parent',axes1,...
    'DisplayName','U17=0.008463*x.^2+0.074724*x+0.164913');

% Create plot
plot(X2,Y1,'Parent',axes1,...
    'DisplayName','U18=0.097666*x.^2-1.062694*x+2.89076');

% Create legend
legend1 = legend(axes1,'show');
```




```
function createfigure(X1, Y1, X2)

% Create figure
figure1 = figure;

% Create axes
axes1 = axes('Parent',figure1);
box(axes1,'on');
hold(axes1,'all');

% Create plot
plot(X1,Y1,'Parent',axes1,...
    'DisplayName','U1=0.013935*x.^2+0.124708*x+0.278995026'

% Create plot
plot(X2,Y1,'Parent',axes1,...
    'DisplayName','U2=0.119598*x.^2-1.309473*x+3.584293');

% Create legend
legend1 = legend(axes1,'show');
```

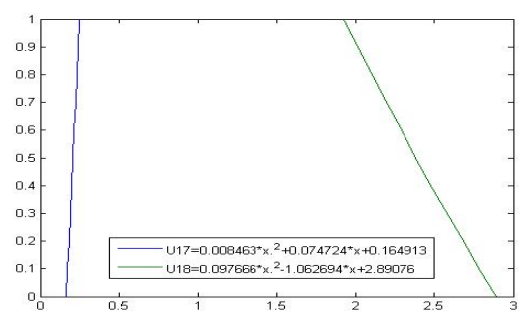


Table 28: A compression between normal TOPSIS and Fuzzy TOPSIS for ranking parameters

Parameters ranking by fuzzy TOPSIS		Parameters ranking by normal TOPSIS	
0	13	0.276130	6
0.6234	10	0.303943	7
0.7638	12	0.307400	10
0.9073	6	0.320035	12
1.3129	7	0.350034	5
1.5394	8	0.364535	9
1.6106	5	0.372327	13
1.7663	11	0.376109	3
1.7948	14	0.481696	1
2.0058	4	0.486924	4
2.0192	3	0.536635	14
2.0643	2	0.544555	11
2.1869	9	0.548071	2
2.6234	1	0.595828	8

Table 29: Area under 14 curves

Ui	Area
U1 = 0.013935α^2 + 0.124708 α + 0.278995	S(U1) = 0.3460→ S = 2.6234
U2 = 0.119598 α^2 – 1.309473α + 3.584293	S(U2) = 2.9694
U3 = 0.016463 α^2 + 0.147761α + 0.331553	S(U3) = 0.4109→ S = 2.0643
U4 = 0.099129 α^2 – 1.088170α + 2.986285	S(U4) = 2.4752
U5 = 0.011431 α^2 + 0.101139α+ 0.223932	S(U3) = 0.2783→ S = 2.0192
U6 = 0.094051 α^2 – 1.022147α + 2.777179	S(U3) = 2.2975
U7 = 0.016731 α^2 + 0.149285α +0.332996	S(U3) = 0.4132 →S = 2.0058
U8 = 0.098004 α^2 −1.07156α +2.91382	S(U3) = 2.4190
U9 = 0.00728 α^2 +0.064271α +0.141761	S(U3) = 0.1763 →S = 1.6106
U10 = 0.072979 α^2 – 0.793980α +2.159533	S(U3) = 1.7869
U11 = 0.002875 α^2 +0.02591α + 0.055582	S(U3) = 0.0389 →S = 0.9073
U12 = 0.038684 α^2 – 0.421579α 1.148512	S(U3) = 0.9462
U13 = 0.004145 α^2 + 0.036480α + 0.080228	S(U3) = 0.0998→ S = 1.3129
U = 14 0.057447 α^2 – 0.0626246α +1.706677	S(U3) = 1.4127
U15 = 0.019258 α^2 + 0.173620α +0.391312	S(U3) = 0.4845→ S = 1.5394
U16 = 0.080303 α^2 – 0.885253α +2.439731	S(U3) = 2.0239
U17 = 0.008463 α^2 + 0.074724 α +0.164913	S(U3) = 0.2051→ S = 2.1869
U18 = 0.097666 α^2 −1.062694α +0.164913	S(U3) = 2.3920
U19 = 0.001219 α^2 +0.010696 α + 0.023436	S(U3) = 0.0292 →S = 0.6234
U20 = 0.026586 α^2 −0.289591α +0.78855	S(U3) = 0.6526
U21 = 0.017760 α^2 + 0.160020α + 0.360445	S(U3) = 0.4464 →S = 1.7663
U22 = 0.087925 α^2 – 0.968619 + 2.66769	S(U3) = 2.2127
U23= 0.001808 α^2 +0.015877α + 0.034826	S(U3) = 0.0434→ S = 0.7638
U24 = 0.032844 α^2 – 0.357954α +0.975233	U24 = 0.8072
U25 = 0	S(U3) = 0→ S = 0
U26 = 0	S(U3) = 0
U27 = 0.017707 α^2 + 0.157886α +0.351931	S(U3) = 0.4368→ S = 1.7948
U28 = 0.09058/1 α^2 – 0.988257α +2.695507	S(U3) = 2.2316

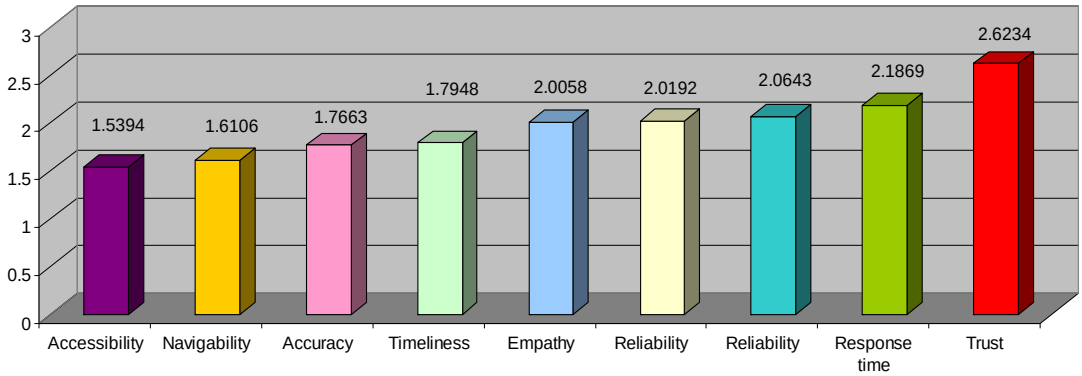


Fig. 5: The most important nine criteria that ranked with fuzzy-TOPSIS method

repeated in two methods of ranking were selected. In addition, based on ranking this is understood that parameters in service quality are very important than two other groups. Finally, according to the ranking, first rank goes to trust that means to be able to providing to customer the trust facilities in online shopping website. The second rank is response time that means ability to perform the promised service faithfully and precisely. The third rank goes to reliability that means to be able to response to customer desires. The rank four belongs to responsiveness that refers to providing the service on time and as ordered online. The rank five belongs to empathy that means to provide a personalized service through customized contents, personal greetings and individualized e-mail. The rank six belongs to the timeliness that refers to whether the information provided on the website is up-to-dated. The rank seven belongs to accuracy of information is concerned with the reliability of website content. In follows rank eight belongs to navigation that deals with the sequencing of pages, the organization of layout and consistency of navigation tools and finally the rank nine goes to accessibility that refers to the speed of access and information downloading and the availability of the

websites at all times. Figure 5: demonstrates the most important nine criteria that ranked with fuzzy-TOPSIS method.

REFERENCES

Adamo, J. M., 1980. Fuzzy decision trees, Fuzzy Sets and Systems, 4, pp: 207-219.

Bailey, J. E. and S.W. Pearson, 1983. Development of a tool for measuring and analyzing computer user satisfaction. Manage. Sci., 29(5): 530-545.

Buckley, J.J., 1985, Fuzzy hierarchical analysis. Fuzzy Set. Syst., 17(3): 233-247.

Chiu, C.M., M.H. Hsu, S.Y. Sun, T.C. Lin and P.C. Sun, 2005. Usability, quality, value and e-learning continuance decisions. Comp. Educ., 45(4): 399-416.

Cho, V., T.C.E. Cheng and W.M.J. Lai, 2009. The role of perceived user-interface design in continued usage intention of self-paced e-learning tools. Comp. Educ., 53(2): 216-227.

Chatterjee, D. and V. Sambamurthy, 1999. Business implications of web technology: An insight into the usage of the world wide web by U.S. companies. Electr. Mark., 9(1): 126-131.

Elliot, S. and S. Fowell, 2000. Expectations versus reality:a snapshot of consumer experiences with internet retailing. Int. J. Inform. Manage. 20: 323-15336.

Gwo-Hshiung, T. and L. Jen-Jia, 1997. Application of TOPSIS multiobjective programming approach to fire station location in tanhai new town. J. City Plann., 24(1): 81-98, (in Chinese).

Gefen, D., 2002. Customer Loyalty in E-Commerce. J. Assoc. Inf. Syst. (3): 27-51.

Hakman, A.W., 2000. Opportunities to enhance a commercial website. Inform. Manage., 38: 15-21.

Hwang, C.L. and K. Yoon, 1981. Multiple Attributes Decision Making Methods and Applications. Springer, Berlin Heidelberg.

Janda, S., P.J. Trocchia and K.P. Gwinner, 2002. Consumer perceptions of Internet retail service quality. Int. J. Serv. Ind. Manage., (13:5): 412-431.

Javenpaa, S.L. and P.A. Todd, 1997. Consumer reactions to electronic shopping on the World Wide Web. Int. J. Electr. Commer. (1:2): 59-88.

Katerattanakul, P., 2002. Framework of effective web site design for business-to-consumer internet commerce. INFOR (40:1): 57-69.

Kaynama, S.A. and C.I. Black, 2000. A proposal to assess the service quality of online travel agencies: An exploratory study. J. Prof. Serv. Mark., 21(1): 63-88.

Kim, S.Y. and Y.J. Lim, 2001. Consumers' Perceived Importance of and Satisfaction with Internet Shopping. Electr. Mark. (11:3): 148-154.

Lee, M.K.O., M.K. Christy and Z. Chen, 2005. Acceptance of internet-based learning medium: The role of extrinsic and intrinsic motivation. Inform. Manage., 42(8): 1095-1104.

Lin, H.F., 2007. Measuring online learning systems success: Applying the updated DeLone and McLean's model. Cyber Psychol. Behav., 10(6): 817-820.

Louis, C. and M.L. Leon., 1999. Computime: Evolving with E-commerce. New Straits Times, Weekly, pp: 26.

Loiacono, E.T., R.T. Watson and D.L. Goodhue, 2002. WEBQUAL: A measure of Web site quality. Market. Educ. Conf. Market. Theor. Appl., 13: 432-7.

Madu, C.N. and A.A. Madu, 2002b. Dimensions of E-quality. Int. J. Qual. Reliab. Manage., (19:3): 246-258.

Marks, R.B., S.D. Sibley and J.B. Arbaugh, 2005. A structural equation model of predictors for effective online learning. J. Manage. Educ., 29(4): 531-563.

Madu, C.N. and A.A. Madu, 2002a). Dimensions of e-quality. Int. J. Qual. Reliab. Manage., 19(3): 246-58.

MOHE, 2010. Perangkaan Pengajian Tinggi Malaysia, Kuala Lumpur: Kementerian Pengajian Tinggi Malaysia.

Ong, C.S., J.Y. Lai and Y.S. Wang, 2004. Factors affecting engineers' acceptance of asynchronous e-learning systems in high-tech companies. Inform. Manage., 41(6): 795-804.

Opricovic, S. and T., Gwo-Hshiung, 2004. Compromise Solution by MCDM Methods: A Comparative Analysis of VIKOR and TOPSIS. Eur. J. Oper. Res., 156(2): 445-455.

Pituch, K.A. and Y.K. Lee, 2006. The influence of system characteristics on e-learning use. Comp. Educ., 47(2): 222-244.

Roca, J.C., C.M. Chiu and F.J. Martinez, 2006. Understanding e-learning continuance intention: An extension of the technology acceptance model. Int. J. Hum. Comp. Stud., 64(8): 683-696.

Saade, R. and B. Bahli, 2005. The impact of cognitive absorption on perceived usefulness and perceived ease of use in on-line learning: An extension of the technology acceptance model. Inform. Manage., 42(2): 317-327.

Szymanski, D.M. and R.T. Hise, 2000. E-satisfaction: An initial examination. J. Retailing, 76(3): 309-322.

Teo, H.H., H.C. Chan, K.K. Wei and Z. Zhang, 2003. Evaluating information accessibility and community adaptivity features for sustaining virtual learning communities. Int. J. Hum. Comp. Stud., 59(5): 671-697.

Tung, F.C. and S.C. Chang, 2008. Nursing students' behavioral intention to use online courses: A questionnaire survey. Int. J. Nurs. Stud., 45(9): b1299-1309.

Tzeng, G.H., C.H. Chiang and C.W. Li, 2007. Evaluating intertwined effects in e-learning programs: A novel hybrid MCDM model based on factor analysis and DEMATEL. Expert Syst. Appl., 32(4): 1028-1044.

Wang, Y.S., 2003a. Assessment of learner satisfaction with asynchronous electronic learning systems. Inform. Manage., 41(1): 75-86.

Turban, E. and D. Gehrke, 2000. Determinants of e-commerce web site. Hum. Syst. Manage., 19(2): 111-120.

Zeithmal, V.A., A. Parasuraman and A. M, 2002. An empirical examination of the service quality - value-loyalty chain in an electronic channel. Working paper, University of North Carolina, Chapel Hill, NC).