Ranking Determinants on Quality of Online Shopping Websites Using Integrated Entropy and TOPSIS Methods

Nesrin Alptekin

Elif Eroğlu Hall

Faculty of Business Administration
Anadolu University, Eskişehir
Turkey

Nurdan Sevim
School of Applied Sciences
BilecikŞeyhEdebali University, Bilecik
Turkey

Abstract

The rapidly growing Internet transforms websites pages an easy and fast trade tool to conduct commercial transactions. Online shopping becomes more and more popular with the liberalization of trade all over the world and with technological developments that accelerates information communication in a more secure way. From this perspective, evaluating the service quality determinants of online shopping websites are important for customers, companies and researchers which is the aim of this study. In this study, importance weights of online shopping website determinants are calculated by TOPSIS method. Twenty six sub-criteria under four main categories are used in the evaluation of the most popular determinants. The findings demonstrated that security, trust, reliability, accuracy, completeness, responsiveness, timeliness, response time, understandability and accessibility are the first ten important determinants of online shopping website quality.

Keywords: Online shopping, Website quality, TOPSIS method, Entropy

1. Introduction

The digitalization process in the world is reflected in economies through online shopping. With the increase in online shopping volume in recent years, almost all sectors are structurally affected by this reflection. This condition creates an important competitive opportunity for businesses but a well-thought analysis is essential. Businesses can obtain a very significant competitive economic tool if they can evaluate this fact actively and use the existing electronic commerce infrastructure effectively.

Online shopping volume is expected to reach $ 2.3 trillion in 2017. Global electronic trade is led by North America followed by Asia-Pacific and Western Europe. Annual electronic commerce volume in Turkey was around $ 26 million in 2013 with a 30% increase compared to the previous year. B2C (Business to Consumer) is found to be more popular among the sales through the electronic commerce websites which amount to around 12 thousand. Apart from that, Turkey ranks 17th in the global list for total internet population. Considering those who don't use the Internet yet, Turkey is believed to have a high potential of growth in electronic commerce volume (www.eticaret.com).

SERVQUAL model is commonly used in the evaluation of service businesses in particular. SERVQUAL model is a method developed by Parasuraman,Berry and Zeithalm and used to evaluate service quality (Parasuraman et al., 1993). SERVQUAL model can be used for the evaluation of Internet websites while having different quality aspects. A new aspect is brought in the evaluation of service quality of websites by e-SQ which was adapted from the SERVQUAL scale (Parasuraman et al., 2005). This study includes evaluation of the criteria that affect the quality of online shopping websites. For this purpose, literature review was performed and new aspects were revealed in the evaluation of the quality of online shopping websites.

Website quality assessment is a multi-criteria evaluation problem. There are several multi-criteria decision making techniques used for quality assessment of online shopping websites. TOPSIS method is a frequently used multi-criteria decision making technique due to its easy calculation steps and simultaneous consideration of the ideal and anti-ideal solutions. In this study, TOPSIS method is used to calculate key determinants of online shopping websitequality. In the developed methodology, weights of each sub-criteria are calculated by Entropy method and then, importance weights of criteria are calculated by TOPSIS method. The primary data were gathered through questionnaires that have been distributed to the 21 graduate students of Anadolu University in Turkey.

The rest of the paper is organized as follows: In section 2, a brief literature review on quality of online shopping website evaluation criteria is given. Section 3 discusses TOPSIS and Entropy methodologies. In section 4, integrated Entropy-TOPSIS application is presented. Conclusion of the study is given in the last section.

2. Literature Review

The issue of measuring the quality of an online shopping web page is important due to its critical role in soliciting customers and retaining existing customers in the system. Scales were developed to measure service quality in web information system and to test different aspects, which is important to determine the customer expectations. Quality service matching the customer expectations will ensure continuity and customer loyalty to the system. Thus formed online shopping web pages will consolidate their places in the Internet as structures that are demanded, used and trusted.

Online website quality is one of the most important consumer reactions in purchasing and its importance is reflected in the buying intention in online shopping (Nilashi et al., 2012).

Table 1 shows a summary of the criteria used in the online shopping website quality evaluation models in prior studies. Some researchers studied the impact of service quality of websites based on consumer perceptions of website characteristics such as trust, reliability, responsiveness, empathy and tangibles. Other researchers considered the impact of system quality of websites such as navigability, learnability, innovativeness, response time, accessibility and telepresence. Information quality is another important factor that affects online shopping website that has been evaluated by researchers for its accuracy, completeness, timeliness, relevance, understandability and richness. Furthermore, some researchers focus on the impact of vendor-specific quality such as awareness, price saving and reputation.

Table 1: The Evaluation Studies of Online Shopping Website Quality

Authors	*Service Quality*					*System Quality*									*Information Quality*								*Vendor-Specific Quality*		
	Trust	Reliability	Responsiveness	Empathy	Tangibles	Navigability	Learnability	Innovativeness	Response time	Accessibility	Telepresence	Personalization	Security	Interaction	Usability	Accuracy	Completeness	Timeliness	Relevance	Understandability	Richness	Entertainment	Usefulness of content	Awareness	Price savings	Reputation
Argawal and Venkatesh (2002)															*								*			
Barnes and Vidgen (2001)	*			*											*											
Çebi (2013)		*	*			*				*						*										*
Chiu et al. (2005)				*		*	*										*									
Cho et al. (2009)				*			*		*	*																
DeLone and McLean (2003)		*	*	*	*	*			*			*	*		*		*		*	*					*	
Devaraj et al. (2002)	*			*											*			*					*		*	
Ecer (2014)		*		*		*			*	*									*	*	*					
Hakman (2000)								*																		
Janda et al. (2002)						*										*		*								
Katerattanakul (2002)						*												*								
Kaynama and Black (2000)				*																						
Kim and Lim (2001)	*					*												*								
Koufaris (2002)															*						*	*				
Lee et al. (2005)			*				*																			
Lee and Kozar (2006)		*	*	*	*	*			*		*	*						*	*	*				*	*	*
Lin (2007)		*	*	*			*			*						*	*									
Loiacono et al. (2002)																						*	*			
Marks et al. (2005)	*																									
Negash et al. (2003)	*	*	*	*	*					*				*								*				
Nilashi et al. (2012)	*	*	*	*		*	*	*	*	*						*	*	*								
Ong et al. (2004)	*						*																			
Palmer (2002)			*			*								*												
Parasuraman et al. (2005)	*	*	*							*	*	*	*													
Pituch and Lee (2006)																										
Roca et al. (2006)		*	*	*					*																	
Saade and Bahli (2005)																										
Sun and Lin (2009)	*												*													
Teo et al. (2003)		*					*		*																	
Tung and Chang (2008)							*									*	*									
Tzeng et al. (2007)				*		*			*	*						*										
Wang (2003)	*						*									*	*									
Webb and Webb (2004)		*		*	*	*							*		*	*			*							
Yang et al. (2005)														*	*								*			

The objective of this research is to identify important criteria of online shopping websites in Turkey which effect shopping intention of graduate students.

Figure 1 shows the key components of the research framework for online shopping website quality. Our framework showed that online shopping website quality is based on service quality, system quality, information quality and vendor-specific quality. Service quality refers to the overall support delivered by the Internet retailers. Service quality becomes more critical in e-business since online customers transact with retailers in virtual environment. To provide better service, retailers implement several service functions into the website such as 24/7 services, FAQs, online delivery tracking systems, and complaint management systems (Lee and Kozar, 2006).
Service quality, the overall support delivered by the service provider, applies regardless of whether the support is delivered by the information systems department or a new organizational unit or is outsourced to an Internet service provider (DeLone and McLean, 2004). 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 functionality (Nilashi et al., 2012). McKinney et al. (2002) defined information quality as ‘‘users’ perception of the quality of information presented on a Web site.’’ Scholars in the area of traditional computing settings have established well-known models to measure information quality (Yang et al., 2005). Vendor-specific quality, the awareness of Internet vendors and their reputation and price competitiveness, also has been considered as important e-business success factors (Lee and Kozar, 2006).

Figure 1: Research Framework of Online Shopping Website Quality

Based on the online shopping website quality previous researchers hadpresented in Table 1, a proposed hierarchical structure of the research problem was defined and shown in Figure 2. It gives 26 sub-criteria in hierarchical structure. The goal is to rank the sub-criteria in this hierarchical structure.

Figure 2: Hierarchical Structure of Online Shopping Website

1. Service Quality	**2. System Quality**	**3. Information Quality**	**4. Vendor-Specific Quality**
1. Trust	6. Navigability	16. Accuracy	24. Awareness
2. Reliability	7. Learnability	17. Completeness	25. Price savings
3. Responsiveness	8. Innovativeness	18. Timeliness	26. Reputation
4. Empathy	9. Response time	19. Relevance	
5. Tangibles	10. Accessibility	20.Understandability	
	11. Telepresence	21. Richness	
	12. Personalization	22. Entertainment	
	13. Security	23. Usefulness of content	
	14. Interaction		
	15. Usability		

3. Methodology

In this paper, the primary data were gathered through questionnaires that have been distributed to 21 graduate students. There are five options ranked by 1-5 as follows: 1= not important, 2=less important, 3=moderate, 4=important, 5= very important. The schematic form of research methodology of this research is shown in Figure 3.

Figure 3: The Schematic Form of Research Methodology

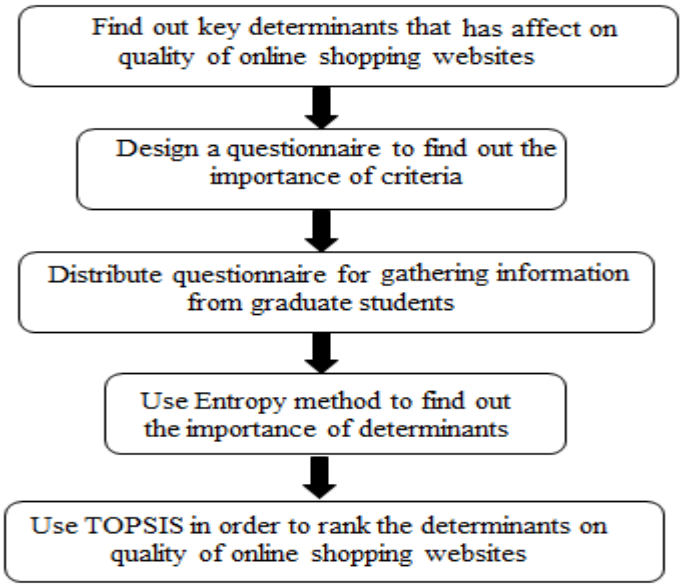


Table 2: Demographic Profile of Graduate Students

Variable	Category	Frequency	%
Gender	Female	6	28,6
	Male	15	71,4
Age	25-29	12	57,1
	30-33	9	42,9
MonthlyIncome (TL)	2001-3000	12	57,1
	3001- andover	9	42,9
Degree of Studying	Master	7	33,3
	PhD	14	66,7

Distribution of demographic profile of students with regard to gender, age, income and education are shown in Table 2.The gender breakdown is 71% of male and 29% of female. Regarding the age distribution of the students; 57% of the sample is in 25-29 age range, 43% in 30-33 age range. The demographics on monthly income identify two dominant categories; 57% of the students have between 2001-3000 TL, 43 % of the students have 3001 TL and over monthly income. Approximately 67% of the sample is PhD student and 33 % of the sample is master student.

3.1. Entropy Method

Entropy method firstly appeared in thermodynamics and was introduced into the information theory later by Shannon (1948). Entropy theory is an objective way for weight determination (Zou, Yun and Sun, 2006). The determination of weight by calculating entropy is to choose the best indicators which could reflect the different service quality level among determinants of service quality of online shopping websites. The calculation steps of entropy method are as follows:

(1) Calculation of the entropy value for each criterion

In decision matrix D, feature weight p_{ij} is of the *i*th alternatives to the *j*th criterion which is calculated by

$$D = \begin{array}{c} \\ A_1 \\ A_2 \\ \vdots \\ A_m \end{array} \begin{array}{c} \begin{array}{cccc} C_1 & C_2 & \dots & C_n \end{array} \\ \begin{bmatrix} x_{11} & x_{12} & \dots & x_{1n} \\ x_{21} & x_{22} & \dots & x_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ x_{m1} & x_{m2} & \dots & x_{mn} \end{bmatrix} \end{array} \quad p_{ij} = \frac{x_{ij}}{\sum_{i=1}^{m} x_{ij}}, \; i = 1,...,m; \; j = 1,...,n. \qquad (1)$$

The output entropy e_j of the *j*th criterion becomes

$$e_j = -K\sum_{i=1}^{m} r_{ij} \ln(r_{ij}) \quad , \quad j = 1,...,n \quad (2)$$

where $K = \frac{1}{\ln(m)}$ is a constant that assures $0 \le e_j \le 1$ and e_j indicates the entropy value with respect to criterion C_j.

(2) Variation coefficient of the *j*th criterion

$$d_j = 1 - e_j, \; j = 1,...,n \quad (3)$$

(3) Objective weight of each criterion

$$w_j = \frac{d_j}{\sum_{j=1}^{n} d_j} \quad , \sum_{i=1}^{n} w_j = 1 \;\; j = 1,...,n \quad (4)$$

where w_j indicates the objective weight for criterion C_j.

3.2. TOPSIS Method

TOPSIS is one of the useful MCDM (Multi- Criteria Decision Making) techniques that are very simple and easy to implement, so that it is used when the user prefers a simpler weighting approach.TOPSIS method was first proposed by Hwang & Yoon (1981).The basic principle of TOPSIS method is that the chosen alternative should have the shortest distance from the ideal solution and the farthest distance from the negative-ideal solution (Opricovic and Tzeng, 2003). The positive ideal solution is a solution that maximizes the benefit criteria and minimizes the cost criteria, whereas the negative ideal solution maximizes the cost criteria and minimizes the benefit criteria.

The TOPSIS method consists of the following steps:

(1) Construction of the decision matrix

TOPSIS Method builds on the assumption that *mxn* decision matrix D includes *m* alternatives and *n* criteria as follows:

$$D = \begin{array}{c} \\ A_1 \\ A_2 \\ \vdots \\ A_m \end{array} \begin{array}{c} \begin{array}{cccc} C_1 & C_2 & \dots & C_n \end{array} \\ \begin{bmatrix} x_{11} & x_{12} & \dots & x_{1n} \\ x_{21} & x_{22} & \dots & x_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ x_{m1} & x_{m2} & \dots & x_{mn} \end{bmatrix} \end{array} \quad (5)$$

(2) Normalization of the decision matrix

The decision matrix is normalized by vector normalization as shown below:

$$r_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^{m} x_{ij}^{\,2}}}, \;\; i = 1,...,m; \;\; j = 1,...,n \quad (6)$$

This results in normalized decision matrix as follows.

$$R = \begin{bmatrix} r_{11} & r_{12} & \dots & r_{1n} \\ r_{21} & r_{22} & \dots & r_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ r_{m1} & r_{m2} & \dots & r_{mn} \end{bmatrix}_{m \times n} \quad (7)$$

(3) Weighted normalized decision matrix is formed as:

$$v_{ij} = w_i * r_{ij}, \; i = 1,...,m; \;\; j = 1,...,n. \quad (8)$$

(4) PIS (positive ideal solution) and NIS (negative ideal solution) are determined as respectively,

$$A^* = \left(v_1^*, v_2^*, ..., v_j^*, ..., v_n^*\right) \text{maximum values,} \quad (9)$$

$$A^- = \left(v_1^-, v_2^-, ..., v_j^-, ..., v_n^-\right) \text{minimum values.} \quad (10)$$

(5) The distance of each alternative from PIS and NIS is calculated as:

$$d_i^* = \sqrt{\sum_{j=1}^{n} (v_{ij} - v_j^*)^2}, \quad i = 1,2,...,m. \tag{11}$$

$$d_i^- = \sqrt{\sum_{j=1}^{n} (v_{ij} - v_j^-)^2}, \quad i = 1,2,...,m. \tag{12}$$

(6) The closeness coefficient of each alternative (CC_i) is calculated as:

$$CC_i = \frac{d_i^-}{d_i^* + d_i^-} \tag{13}$$

(7) The ranking of alternatives is determined by comparing CC_i values.

4. Application

Before applying TOPSIS method, graduate students' responses categorized by their importance. Table 3 shows the results of categorized questionnaire questions according to their importance.

Table 3: Results of Questions

Criteria	Not important 1.00	Lessimportant 2.00	Moderate 3.00	Important 4.00	Veryimportant5.00
Trust	0	0	0	3	18
Reliability	0	0	0	3	18
Responsiveness	0	0	1	5	15
Empathy	0	5	6	6	4
Tangibles	0	2	8	7	4
Navigability	0	0	2	10	9
Learnability	0	2	5	10	4
Innovativeness	2	2	2	9	6
Response Time	0	0	1	7	13
Accessibility	0	1	1	7	12
Telepresence	5	3	6	5	2
Personalization	3	3	5	7	3
Security	0	0	0	1	20
Interaction	1	1	4	8	7
Usability	0	1	3	8	9
Accuracy	0	0	0	4	17
Completeness	0	0	0	5	16
Timeliness	0	0	0	7	14
Relevance	0	0	2	8	11
Understandability	0	0	2	7	12
Richness	0	1	5	9	6
Entertainment	5	3	7	5	1
Usefulness of content	0	2	3	8	8
Awareness of thewebsite	3	2	4	8	4
PriceSavings	0	0	3	7	11
Reputation	3	2	6	8	2

Afterward, each cell of Table 1 is divided by square root of related column sum. Obtained values are shown in Table 4.

Table 4: Normalized Decision Matrix

	1	2	3	4	5
Trust	0	0	0	0,084382	0,320866
Reliability	0	0	0	0,084382	0,320866
Responsiveness	0	0	0,051503	0,140636	0,267389
Empathy	0	0,552158	0,309016	0,168763	0,071304
Tangibles	0	0,220863	0,412021	0,19689	0,071304
Navigability	0	0	0,103005	0,281272	0,160433
Learnability	0	0,220863	0,257513	0,281272	0,071304
Innovativeness	0,219529	0,220863	0,103005	0,253145	0,106955
Response Time	0	0	0,051503	0,19689	0,231737
Accessibility	0	0,110432	0,051503	0,19689	0,213911
Telepresence	0,548821	0,331295	0,309016	0,140636	0,035652
Personalization	0,329293	0,331295	0,257513	0,19689	0,053478
Security	0	0	0	0,028127	0,356518
Interaction	0,109764	0,110432	0,20601	0,225018	0,124781
Usability	0	0,110432	0,154508	0,225018	0,160433
Accuracy	0	0	0	0,112509	0,30304
Completeness	0	0	0	0,140636	0,285215
Timeliness	0	0	0	0,19689	0,249563
Relevance	0	0	0,103005	0,225018	0,196085
Understandability	0	0	0,103005	0,19689	0,213911
Richness	0	0,110432	0,257513	0,253145	0,106955
Entertainment	0,548821	0,331295	0,360518	0,140636	0,017826
Usefulness of content	0	0,220863	0,154508	0,225018	0,142607
Awareness of thewebsite	0,329293	0,220863	0,20601	0,225018	0,071304
PriceSavings	0	0	0,154508	0,19689	0,196085
Reputation	0,329293	0,220863	0,309016	0,225018	0,035652

Then, by using entropy method, objective weights of criteria were calculated. Using by equations (2), (3) and (4) entropy measure of each index is obtained. The obtained values of e_j, d_j and w_j are presented in Table 5.

Table 5: Entropy Measures

	Not important 1.00	Lessimportant 2.00	Moderate 3.00	Important 4.00	Veryimportant 5.00
e_i	-1,5043	0,1085	-2,3116	-5,1824	-21,3078
d_i	2,5043	0,8915	3,3116	6,1824	22,3078
w_j	0,0712	0,0253	0,0941	0,1756	0,6338

Table 6: Weighted Normalized Decision Matrix

	1	2	3	4	5
Trust	0	0	0	0,0148174	0,2033651
Reliability	0	0	0	0,0148174	0,2033651
Responsiveness	0	0	0,0048464	0,0246957	0,1694709
Empathy	0	0,0139696	0,0290784	0,0296348	0,0451922
Tangibles	0	0,0055878	0,0387712	0,034574	0,0451922
Navigability	0	0	0,0096928	0,0493914	0,1016825
Learnability	0	0,0055878	0,024232	0,0493914	0,0451922
Innovativeness	0,0156304	0,0055878	0,0096928	0,0444522	0,0677884
Response Time	0	0	0,0048464	0,034574	0,1468748
Accessibility	0	0,0027939	0,0048464	0,034574	0,1355767
Telepresence	0,0390761	0,0083818	0,0290784	0,0246957	0,0225961
Personalization	0,0234456	0,0083818	0,024232	0,034574	0,0338942
Security	0	0	0	0,0049391	0,2259612
Interaction	0,0078152	0,0027939	0,0193856	0,0395131	0,0790864
Usability	0	0,0027939	0,0145392	0,0395131	0,1016825
Accuracy	0	0	0	0,0197565	0,192067
Completeness	0	0	0	0,0246957	0,180769
Timeliness	0	0	0	0,034574	0,1581728
Relevance	0	0	0,0096928	0,0395131	0,1242787
Understandability	0	0	0,0096928	0,034574	0,1355767
Richness	0	0,0027939	0,024232	0,0444522	0,0677884
Entertainment	0,0390761	0,0083818	0,0339248	0,0246957	0,0112981
Usefulness of content	0	0,0055878	0,0145392	0,0395131	0,0903845
Awareness of thewebsite	0,0234456	0,0055878	0,0193856	0,0395131	0,0451922
PriceSavings	0	0	0,0145392	0,034574	0,1242787
Reputation	0,0234456	0,0055878	0,0290784	0,0395131	0,0225961

Table 7: Positive and Negative Ideal Solutions

	1	2	3	4	5
PositiveIdeal	0,0391	0,014	0,0388	0,0494	0,226
NegativeIdeal	0	0	0	0,0049	0,0226

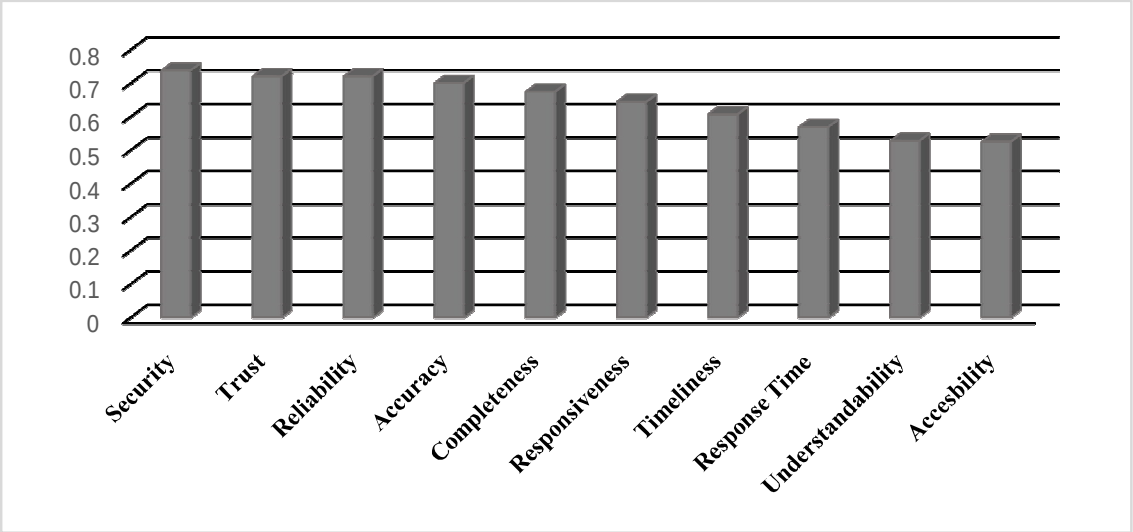
Table 8: Closeness Coefficients and Ranking

Criteria	d_i^+	d_i^-	CC_i	Rank
Trust	0,070275	0,181037	0,720368	**2**
Reliability	0,070275	0,181037	0,720368	**3**
Responsiveness	0,081753	0,148278	0,644601	**6**
Empathy	0,186294	0,046507	0,199772	**25**
Tangibles	0,185771	0,054087	0,225495	**20**
Navigability	0,134264	0,091255	0,404644	**13**
Learnability	0,185751	0,055752	0,230855	**19**
Innovativeness	0,162863	0,063054	0,279104	**18**
Response Time	0,096738	0,12786	0,569284	**8**
Accessibility	0,105846	0,116943	0,524903	**10**
Telepresence	0,205206	0,053241	0,206004	**23**
Personalization	0,193942	0,047066	0,19529	**26**
Security	0,07216	0,203361	0,738097	**1**
Interaction	0,152193	0,069523	0,313569	**16**
Usability	0,1334	0,087586	0,396342	**14**
Accuracy	0,072529	0,170117	0,701092	**4**
Completeness	0,076723	0,159403	0,675076	**5**
Timeliness	0,089725	0,138782	0,607343	**7**
Relevance	0,114092	0,107845	0,485926	**11**
Understandability	0,104729	0,11721	0,528118	**9**
Richness	0,164079	0,064818	0,283175	**17**
Entertainment	0,216247	0,057164	0,209077	**22**
Usefulness of content	0,143797	0,077688	0,35076	**15**
Awareness of thewebsite	0,182981	0,051626	0,220052	**21**
PriceSavings	0,113492	0,106913	0,485076	**12**
Reputation	0,204649	0,05123	0,200213	**24**

To apply the TOPSIS method, the findings in Tables 4 and 5 are used. The weighted normalized decision matrix is calculated using Eqs. (6), (7) and (8). Table 6 shows the results. According to Eqs. (11) and (12) the positive ideal and negative ideal solutions are calculated and they are given in Table 7. Table 8 shows the distance of each determinant from the positive ideal solution and negative ideal solution. The ranking of the preference order these determinants according to the closeness coefficient is shown in the final column of Table 8.

The first ten important determinants of online shopping website quality are, in order of importance, security, trust, reliability, accuracy, completeness, responsiveness, timeliness, response time, understandability and accessibility. These are shown in Fig.4.

Figure 4.The Most Important Ten Determinants



5. Conclusion

Electronic commerce is a constantly growing sector in the World and Turkey. Measuring the quality of an online shopping website is important to solicit customers and retain existing customers in the system. Scales were developed to measure service quality in web information system and to test different aspects and also including reliability of the service quality measurementof website which are important to determine the customer expectations.

This study integrated Entropy and TOPSIS methods to rank the determinants that effect website quality in online shopping based on graduate students' perceptions. Website quality evaluation is a multi-criteria decision problem. The integrated methodology is applied to 26 sub-criteria under four main categories: service quality, system quality, information quality and vendor-specific quality.

This study makes a significant innovation to identify which determinants of online shopping website quality are important for graduate students. Using integrated Entropy-TOPSIS methodology, all determinants are ranked by their weighted importance. This study determines the first ten important determinants of online shopping website quality as security, trust, reliability, accuracy, completeness, responsiveness, timeliness, response time, understandability and accessibility.

For further research, the results of this study may be compared with other multi-criteria evaluation techniques such as VIKOR, ELECTRE or PROMETHEE. Moreover, the proposed methodology for determining online shopping website quality may be applied to specific business sector websites such as bookshops, music, health, airline or banking.

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