


Evaluating the Electronic Service Quality of E-Shops Using AHP-TOPSIS: The Case of Greek Coffee Chains During the COVID-19 Lockdown

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ABSTRACT

The purpose of this study is to evaluate and rank the e-shops of the top Greek coffee chains, based on their electronic service quality. Data were collected from experts during the first COVID-19 lockdown. Based on the E-S-QUAL model, the authors applied a 12-step multi-criteria decision-making methodology utilizing analytic hierarchy process (AHP) and technique for order performance by similarity to ideal solution (TOPSIS). The results indicate that system availability and fulfillment are the two most crucial dimensions of the model. Protection of credit card information, webpages that do not freeze during the ordering process, delivery of the ordered items, and truthfulness about products and services offered by the e-shop are considered the most important sub-dimensions. The findings can aid managers, and practitioners focus on the most important service quality elements when developing e-commerce websites. Furthermore, the study's results highlight the positive and negative areas of performance of the e-shops under evaluation.

KEYWORDS

AHP, E-Commerce, E-S-QUAL, E-Service Quality, MCDMTOPSIS, Website Evaluation

INTRODUCTION

The COVID-19 outbreak has altered our lives. The enforcement of lockdowns and self-isolation has decreased companies' revenues in many different sectors, leading to bankruptcies and the loss of many jobs. Online technology has helped in several cases, offering solutions for entertainment, workout, education, communication with others, shopping, and working from home. According to recent surveys, Internet sales have increased more than 100% in many countries during the last year, as a result of the pandemic (ContactPigeon, 2020; ELTRUN, 2020). The sectors of consumer electronics and food & drink present the highest rise.

This rapid growth of online shoppers, along with the emergence of constantly new e-commerce websites, raises issues regarding customers' satisfaction, a vital concern for repurchase intention, word of mouth, and website revisit (Rita et al., 2019). Companies selling their products and services online

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need to diversify from the competition, by enhancing the e-shoppers' experience. Electronic service quality has proven to be a crucial factor affecting customers' satisfaction and trust (Hallencreutz & Parmler, 2021; Rita et al., 2019).

Thus, in this study, we focus on evaluating the electronic service quality of e-shops during COVID-19 lockdown in Greece. The objectives of this study are:

- To weight and rank the dimensions and sub-dimensions that affect electronic service quality, based on the E-S-QUAL model.
- To evaluate three shops of the top coffee-chains in Greece.

The contribution of our study is threefold. Firstly, our research provides a ranking between e-service quality items in the cultural environment of Greece. Service quality dimensions differ between countries (Ladhari, 2010), creating the need to examine the importance of the E-S-QUAL model items in different contexts. Secondly, we apply a multi-criteria decision-making approach based on AHP and TOPSIS to evaluate and rank the e-shops on one of the most positively affected e-commerce sectors during COVID-19 lockdown, food & drink. The findings reveal the coffee-chain website that can be considered as the benchmark in that area. Finally, our study's results enrich the literature and provide insight to managers and web developers regarding the e-service quality items they should consider more during the implementation of e-shops.

The remainder of this paper is organized as follows. The second section presents a brief overview of service quality and specifically the E-S-QUAL model used in this study. The third section describes the research methodology, based on AHP and TOPSIS. The fourth section discusses the study's findings enriched by sensitivity analysis and finally, the last section offers conclusion remarks and implications.

LITERATURE REVIEW

Service quality, which is defined as the global judgment, or attitude, relating to the superiority of the service (Parasuraman et al., 1988) has been studied in many types of research (Akroush et al., 2021; Suhartanto et al., 2019). Customer satisfaction, loyalty, and trust are some of the outcomes of service quality (Akroush et al., 2021; Dalbehera, 2020). To measure the quality of service, many instruments have been developed. Among them, SERVQUAL (Parasuraman et al., 1988) is the most widely used.

The evolution of the world wide web and the transition of traditional business to online environments has led to the development of new instruments, capable of measuring electronic service quality. Examples of these newly developed scales are the following:

- WebQual, with three dimensions and five factors (Barnes & Vidgen, 2000).
- SITEQUAL, with four dimensions and nine items (Yoo & Donthu, 2001).
- WebQualTM, with twelve dimensions (Loiacono et al., 2002).
- eTailQ, with four factors (Wolfinbarger & Gilly, 2003).
- e-SERVQUAL, with seven dimensions (Zeithaml et al., 2002).
- E-S-QUAL, with four dimensions and twenty-two items (Parasuraman et al., 2005).
- e-TransQual, with five dimensions (Bauer et al., 2006).
- PeSQ, with four dimensions (Cristobal et al., 2007).
- The hierarchical model, with four dimensions and sixteen attributes (Blut et al., 2015).

Most of the above-mentioned scales have been criticized, for either been used only to students, not capturing all aspects of the purchasing process, lacking internal consistency (Parasuraman et al., 2005), excluding some key factors (Loiacono et al., 2002), being more relevant to interface design (Zeithaml

et al., 2002) or lacking specific application and validation (Ladhari, 2010). The most acceptable and widely used scale is E-S-QUAL, developed by Parasuraman et al. (Parasuraman et al., 2005). E-S-QUAL captures all phases of a customer's interactions with an e-commerce website (Kim & Kim, 2010) while being simple to use (Sheng & Liu, 2010), focusing mainly on measuring the quality of the most important service attributes (Barnes & Vidgen, 2000), having a rigorous conceptualization (Rafiq et al., 2012) and being based on the experience of real online shoppers (Ghosh, 2018).

E-S-QUAL scale consists of four dimensions, i.e. efficiency, system availability, fulfillment, and privacy. The dimensions and sub-dimensions of the E-S-QUAL model are presented in Table 1. Efficiency refers to the ease and speed of accessing and using a website. System availability measures the technical functionality of the website. Fulfillment inspects the extent to which the website's promises about order delivery and item availability are fulfilled. Finally, privacy measures the degree to which a website is safe and protects customer information.

Table 1. Dimensions and sub-dimensions of E-S-QUAL model

Dimensions	Sub-dimensions
Efficiency	This site makes it easy to find what I need (EFF1)
	It makes it easy to get anywhere on the site (EFF2)
	It enables me to complete a transaction quickly (EFF3)
	Information at this site is well organized (EFF4)
	It loads its pages fast (EFF5)
	This site is simple to use (EFF6)
	This site enables me to get on to it quickly (EFF7)
	This site is well organized (EFF8)
System Availability	This site is always available for business (SYS1)
	This site launches and runs right away (SYS2)
	This site does not crash (SYS3)
	Pages at this site do not freeze after I enter my order information (SYS4)
Fulfillment	It delivers orders when promised (FUL1)
	This site makes items available for delivery within a suitable time frame (FUL2)
	It quickly delivers what I order (FUL3)
	It sends out the items ordered (FUL4)
	It has in stock the items the company claims to have (FUL5)
	It is truthful about its offerings (FUL6)
	It makes accurate promises about the delivery of products (FUL7)
Privacy	It protects information about my Web-shopping behavior (PRI1)
	It does not share my personal information with other sites (PRI2)
	This site protects information about my credit card (PRI3)

Many researchers tend to use the E-S-QUAL scale in their studies, since it performs a holistic assessment of the quality of online services (Ghosh, 2018). The scale has been implemented in many

areas, such as online tourism (Xu & Lu, 2020), online banking (Ahmed et al., 2020) and digital library (Dalbehera, 2020).

The scale's validity has been confirmed in different cultural environments. Ghosh (Ghosh, 2018) tested the four dimensions of E-S-QUAL in the e-commerce industry in India and his findings confirmed the model's validity. Kandulapati and Bellamkonda (Kandulapati & Bellamkonda, 2014) used E-S-QUAL to measure online shops quality in an Indian context. The results proved that the scale was valid for measuring electronic service quality. Dalbehera (Dalbehera, 2020) used the scale to assess the service quality of a University library website in Odisha. His findings indicated that the E-S-QUAL scale was a valid model, capable of measuring electronic service quality in the digital library context. Ahmed et al. (Ahmed et al., 2020) used the scale to test the service quality of e-banking. The results of their study showed an affirmative and potent impact of the instrument's dimensions on customer's satisfaction.

Several studies focus on the evaluation of websites using different methodologies. Kang (Kang et al., 2016) used E-S-QUAL and fuzzy hierarchical TOPSIS to evaluate six widely used Korean e-commerce websites. Their results were validated by comparing them with other representative MCDM methods. Two main online travel agencies in the US market were evaluated by Soleymaninejad et al. (Soleymaninejad et al., 2016) using TOPSIS and a model with six criteria. The results indicated that the most important criteria were visibility and findability. Another study evaluated e-commerce websites using fuzzy AHP and hierarchical fuzzy TOPSIS (Masudin & Saputro, 2016). Their findings showed that security and privacy were the most important factors, followed by trust, loading time, easy transaction, and e-payment support. Ostovare and Shahraki (Ostovare & Shahraki, 2019) used the fuzzy Delphi method, PROMETHEE and GAIS to evaluate the electronic services provided by five-star hotels. According to their study, customer orientation was the most important factor, followed by marketing, security, and technology.

METHODOLOGY

The purpose of this paper is to evaluate the electronic service quality of the Greek coffee-chain websites that rank among Europe's top 15 brands, using the E-S-QUAL scale. According to FoodService Europe & Middle East magazine (FoodService, 2019), three websites were found to meet these requirements. Their main characteristics are presented in Table 2. The research took place during April and May 2020, the period of the first COVID-19 lockdown in Greece.

Table 2. Main characteristics of the websites under evaluation

Coffee-chain website	Foundation year	No. of stores	E-shop implementation year
Website 1 (W1)	1965	205	2019
Website 2 (W2)	1972	362	2018
Website 3 (W3)	1999	429	2017

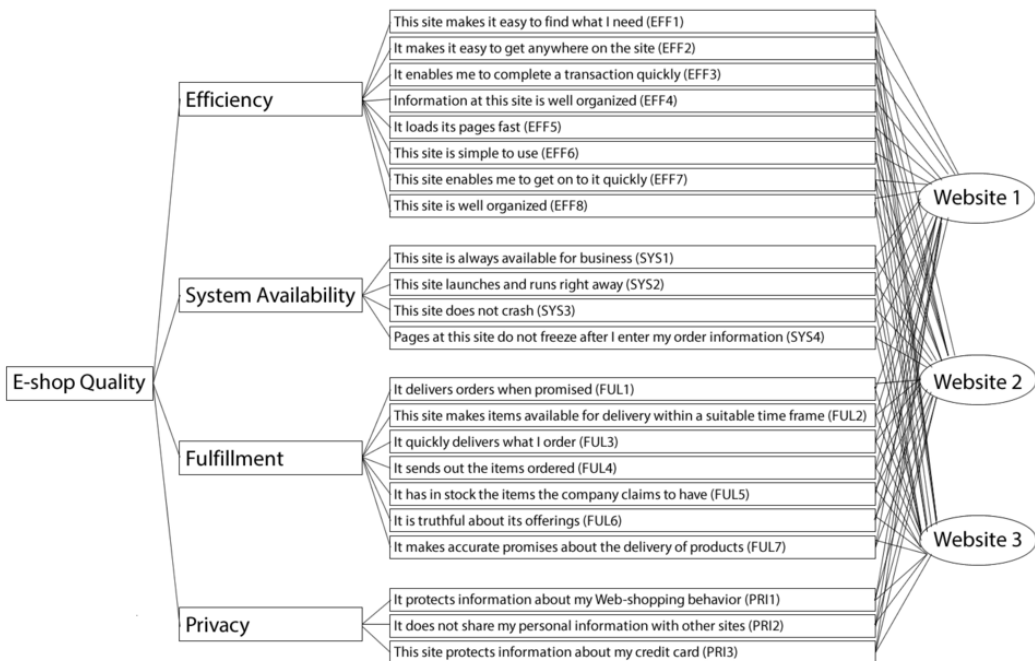
Our study uses a combined technique based on the analytic hierarchy process (AHP) and technique for order performance by similarity to ideal solution (TOPSIS). AHP developed by Saaty (Saaty, 2014), is a structured technique used in decision-making problems, asking experts to evaluate specified criteria through pairwise comparisons. The numerical scale of AHP ranges between 1 and 9, where 1 denotes the equality of importance between two criteria, and 9 indicates that one criterion is extremely more important than the other (Saaty, 2008). AHP has been used in many studies in various fields (Baidya et al., 2018; Yao & Liu, 2016; Yu et al., 2016).

TOPSIS is a multiple-criteria decision-making (MCDM) method, developed by Hwang and Yoon (Hwang & Yoon, 1981). This technique is used to make decisions between alternatives. Its main concept is that the best alternative not only has the shortest distance from the ideal solution but also has the longest distance from the worst solution (Roghianian et al., 2010). TOPSIS has been implemented in many applications (Wang et al., 2014; Zhu & Lin, 2016) to rank alternatives based on their overall performance.

Many types of research are based on multi-criteria decision-making (MCDM) methods to overcome the limitations of a single technique. In this study, we used an integrated combined AHP and TOPSIS methodology that has been used in the past in many studies (Roy & Shaw, 2021; Sharma & Joshi, 2019; Zughoul et al., 2021). This approach has many advantages. It is suitable for evaluating and ranking e-commerce websites, based on the experts' knowledge and experience. It obtains the weights of the different criteria from the experts' opinions, using pair-wise comparisons, and it provides the global ranking of the alternatives.

To evaluate the dimensions and the items of the scale used and to rank the three websites, we asked experts to participate in our research. 25 advanced web users, familiar with online purchases, professionals in website development, and/or UX design agreed to take part. The sample size used in our study is considered acceptable, since similar researches use sample sizes of just 3 (Kang et al., 2016), 7 (Roy & Shaw, 2021), 20 (Sharma & Joshi, 2019) and 27 experts (Ocampo et al., 2019). The methodological hierarchical framework used in this paper is presented in Figure 1.

Figure 1. Methodological framework for website evaluation



To estimate the importance of the E-S-QUAL main dimensions and items and to rank the websites under evaluation we developed an online questionnaire. The questionnaire consisted of three main sections. The first section included questions focusing on pairwise comparison judgments between the scale's main and sub-dimensions. The ratings used were the following: 1 = Equally important, 2 =

Slightly more important, 3 = Moderately more important, 4 = Moderately to strongly more important, 5 = Strongly more important, 6 = Strongly to very strongly more important, 7 = Very strongly more important, 8 = Very strongly to extremely more important, 9 = Extremely more important. The data collected from this section were analyzed using AHP to provide the relative importance of the factors that influence online customers when choosing an e-commerce site to make a purchase. The second section included questions based on a 9-level Lickert scale focusing on the evaluation of the three coffee-chain websites. The experts were asked to visit each of the websites, make a purchase and then answer the questions regarding the degree to which each of the sub-dimensions was fulfilled. Their answers were analyzed using TOPSIS and provided the ranking of the websites. The third section of the questionnaire included demographic questions.

The methodology of this study is based on the research of Ocampo et al. (Ocampo et al., 2019) and follows 12 main steps.

Step 1: Determine the criteria to be used for the evaluation and decide on the websites to be ranked. In our study, we used the E-S-QUAL model to define the evaluation criteria and we selected three coffee-chain e-commerce websites from the Greek market.

Step 2: Collect experts' opinions. We constructed and used an online questionnaire. 25 experts agreed to take part in the research making pairwise comparisons among all dimensions and sub-dimensions of the E-S-QUAL model. Their ratings (ranging from 1 = Equally important to 9 = Extremely more important) represent their estimation regarding the relative importance of one criterion over another based on the goal under investigation, as well as on the relative importance of one sub-criterion over another based on the parent criterion.

Step 3: Aggregate rating made by experts. To aggregate experts' opinions, we used the geometric mean. Let $M^k = (m_{ij}^k)_{n \times m}$ be a pairwise comparison matrix of the k^{th} expert, where m_{ij} represents the importance of dimension (or sub-dimension) i over dimension (or sub-dimension) j . Then

$$M = (m_{ij})_{n \times m} = \left(\sqrt[n]{\prod_{k=1}^n m_{ij}^k} \right)_{n \times m} \quad (1)$$

Step 4: Compute the local weights using AHP. To compute the local priority weights of the E-S-QUAL model main dimensions and sub-dimensions we use Eq. 2.

$$Mw = \lambda_{\max} w \quad (2)$$

where λ_{\max} is the maximum eigenvalue of M and w is the corresponding principal eigenvector, considered as the best estimate of the priority weights of the dimensions or sub-dimensions compared in the pairwise comparison matrix.

Step 5: Calculate the consistency. The consistency index (CI) and consistency ratio (CR) for the model's dimensions and sub-dimensions were calculated, using Eq. 3 and 4.

$$CI = \frac{\lambda_{\max} - n}{n - 1} \quad (3)$$

$$CR = \frac{CI}{RI} \quad (4)$$

The random consistency index (RI) displays the consistency of a random pairwise comparison matrix. For the ratings to be consistent, CR value needs to have a value of 0.10 or less.

Step 6: Compute the global weights of the sub-dimensions. The global weight of the sub-dimension w_j is computed by multiplying its local weight with the parent dimension's weight.

Step 7: Obtain the decision matrix using TOPSIS. We calculate the decision matrix D, where d_{ij} represents the quality of the e-commerce website $i = 1, 2, \dots, m$ in the sub-dimension $j = 1, 2, \dots, n$.

$$D = \begin{bmatrix} d_{11} & d_{12} & \dots & d_{1n} \\ d_{21} & d_{22} & \dots & d_{2n} \\ \dots & \dots & \dots & \dots \\ d_{m1} & d_{m2} & \dots & d_{mn} \end{bmatrix} \quad (5)$$

Step 8: Calculate the normalized decision matrix. We calculate the normalized decision matrix $R = (r_{ij})_{m \times n}$ using:

$$r_{ij} = \frac{d_{ij}}{\sqrt{\sum_{i=1}^m d_{ij}^2}} \quad (6)$$

Step 9: Construct the weighted decision matrix. The weighted decision matrix V is constructed by:

$$V = (v_{ij})_{m \times n} = (w_j r_{ij})_{m \times n} \quad (7)$$

Step 10: Define the ideal alternative. Both the ideal (A^+) and non-ideal (A^-) alternatives are defined using:

$$A^+ = \left\{ \left(\max_i (v_{ij}) \text{ if } j \in J \right); \left(\min_i (v_{ij}) \text{ if } j \in J' \right) \right\} \quad (8)$$

$$A^- = \left\{ \left(\min_i (v_{ij}) \text{ if } j \in J \right); \left(\max_i (v_{ij}) \text{ if } j \in J' \right) \right\} \quad (9)$$

where J and J' are the beneficial and non-beneficial attributes, respectively.

Step 11: Compute the distance of each alternative from the best and the worst alternative. The distance of each evaluated website from the best and the worst website is computed using:

$$S_i^+ = \sqrt{\sum_{j=1}^n (v_{ij} - v_j^+)^2}, i = 1, 2, \dots, m \quad (10)$$

$$S_i^- = \sqrt{\sum_{j=1}^n (v_{ij} - v_j^-)^2}, i = 1, 2, \dots, m \quad (11)$$

Step 12: Rank the e-commerce websites. The closeness coefficient C_i is calculated using Eq. 12 to rank the e-commerce websites under evaluation. The most preferred website is the one with the highest C_i .

$$C_i = \frac{S_i^-}{(S_i^+ + S_i^-)} \quad (12)$$

RESULTS AND DISCUSSION

This study implements the 12 step AHP-TOPSIS methodology, as explained in the previous section, to rank the three top coffee-chain e-commerce websites in Greece. The rankings were based on their electronic service quality, using the E-S-QUAL model. 25 experts participated in the research. Their demographic profile is presented in Table 3.

Table 3. Demographic profile of experts participating in the research (N=25)

Feature	Distribution	Frequency	Percent
Gender	Male	13	52%
	Female	12	48%
Age	18-25	1	4%
	26-35	13	52%
	36-45	9	36%
	46-55	1	4%
	56+	1	4%
Education	Bachelor's Degree	19	76%
	Master's Degree	4	16%
	PhD Degree	2	8%
Occupation	MBA Student	1	4%
	Private Employee	22	88%
	Self-Employed	1	4%
	Academic	1	4%

Using AHP, we calculated the local and global weights of the E-S-QUAL model's sub-dimensions. Each sub-dimension's local weight represents its performance in the main dimension, whereas its global weight represents its overall performance in the model, regardless of its main dimension. Table 4 presents these results, along with the sub-dimensions' rankings.

Table 4. Local, global weights and ranking of E-S-QUAL items

Dimensions	Sub-dimensions	Local weight	Global weight	Ranking
Efficiency (0.185)	EFF1	0.157	0.0290	13
	EFF2	0.154	0.0285	14
	EFF3	0.145	0.0268	16
	EFF4	0.098	0.0181	19
	EFF5	0.083	0.0154	20
	EFF6	0.171	0.0316	12
	EFF7	0.079	0.0146	21
	EFF8	0.113	0.0209	17
System availability (0.284)	SYS1	0.160	0.0454	8
	SYS2	0.227	0.0645	5
	SYS3	0.196	0.0557	6
	SYS4	0.418	0.1187	2
Fulfillment (0.278)	FUL1	0.129	0.0359	10
	FUL2	0.050	0.0139	22
	FUL3	0.071	0.0197	18
	FUL4	0.293	0.0815	3
	FUL5	0.118	0.0328	11
	FUL6	0.240	0.0667	4
	FUL7	0.099	0.0275	15
Privacy (0.253)	PRI1	0.171	0.0433	9
	PRI2	0.186	0.0471	7
	PRI3	0.643	0.1627	1

The consistency ratio (CR) for our data was less than 0.10, indicating that the results of the AHP methodology were consistent.

The results of this analysis suggest that system availability ranks first among all dimensions of the E-S-QUAL model. Fulfillment and privacy follow, leaving efficiency in the final place. Between the sub-dimensions under system availability, pages that do not freeze during the ordering process is the most important one. A website that launches and runs immediately comes second, followed by the absence of crashes. The least important item in this category is the constant availability of the e-commerce site.

Regarding the sub-dimensions under fulfillment, a website that sends out the ordered items comes first. The second most important item in this category is truthfulness about products and services. Products delivered when promised and stating truthful supplies take the third and fourth

place respectively. An e-commerce website that delivers products within a suitable time frame has the lowest score in this category.

Among the items in the privacy dimension, the safeguard of the credit card information is the most important one. A website that does not disclose personal information to third parties is the second-ranked item, leaving the protection of personal information in the last place.

Concerning the efficiency category, simple of use has the highest score. Easiness in finding what the customers needs and navigation take the second and third place, leaving page loading and quick access to customers last in rankings.

The above-mentioned rankings are the result of the sub-dimensions' local weights, as computed from the fourth step of our methodology. During the sixth step, global weights were also calculated, as presented in Table 4. Global weights are very important indicators since they offer a more complete understanding of the ranking of each sub-dimension concerning the overall service quality of the e-commerce website. According to the global weights, the most important item among all 22 is the protection of credit card information. Webpages that do not freeze after the completion of the ordering information rank second. The third most important element is the delivery of the ordered items, followed by the truthfulness about products and services offered by the website.

Coffee-Chain Websites Evaluation

In our study, we used the results of the AHP technique and the experts' opinions regarding the performance of each coffee-chain website (W1, W2, and W3) with respect to the sub-dimensions of the E-S-QUAL model. We then implemented TOPSIS, in order to rank the three websites under evaluation. Starting from our methodology's seventh step and Eq. 5, we calculated the decision matrix as presented in Table 5.

Table 5. Decision matrix showing the evaluation made for each website with respect to the E-S-QUAL sub-dimensions

	EFF1	EFF2	EFF3	EFF4	EFF5	...	SYS6	SYS7	PRI1	PRI2	PRI3
W1	8.08	7.77	7.55	7.51	7.54	...	7.80	7.83	8.56	8.77	8.91
W2	7.60	7.45	7.51	7.40	7.09	...	8.16	8.36	8.72	8.70	9.00
W3	7.25	6.95	6.81	6.67	7.14	...	8.51	8.62	8.34	8.62	8.72

Table 6. Normalized decision matrix

	EFF1	EFF2	EFF3	EFF4	EFF5	...	SYS6	SYS7	PRI1	PRI2	PRI3
W1	0.61	0.61	0.60	0.60	0.60	...	0.55	0.55	0.58	0.58	0.58
W2	0.57	0.58	0.59	0.59	0.56	...	0.58	0.58	0.59	0.58	0.59
W3	0.55	0.54	0.54	0.53	0.57	...	0.60	0.60	0.56	0.57	0.57

Table 7. Weighted normalized decision matrix

	EFF1	EFF2	EFF3	EFF4	EFF5	...	SYS6	SYS7	PRI1	PRI2	PRI3
W1	0.018	0.018	0.016	0.011	0.0090	...	0.037	0.020	0.025	0.027	0.094
W2	0.017	0.017	0.016	0.011	0.0085	...	0.039	0.021	0.025	0.027	0.095
W3	0.016	0.016	0.015	0.010	0.0085	...	0.040	0.022	0.024	0.027	0.092

Using Eq. 6, we normalized the decision matrix, as shown in Table 6.

We then computed the weighted normalized decision matrix, using Eq. 7. The results are presented in Table 7.

We used Eq. 8 and 9 to determine the positive and the negative ideal alternatives shown in Table 8 and we calculated the general distance from the best and the worst alternative, using Eq. 10 and 11. Finally, we applied Eq. 12 to compute the closeness coefficient in order to produce the ranking of the e-shops (Table 9).

Table 8. Positive ideal solution and negative ideal solution

	EFF1	EFF2	EFF3	EFF4	EFF5	...	SYS6	SYS7	PRI1	PRI2	PRI3
A ⁻	0.016	0.016	0.015	0.010	0.008	...	0.037	0.020	0.024	0.027	0.092
A ⁺	0.018	0.018	0.016	0.011	0.009	...	0.040	0.022	0.025	0.027	0.095

The results in Table 9 indicate that the coffee-chain e-shop W2 ranks first, followed very closely by W1. Third in ranking we find W3.

Therefore, W2 could be considered as a benchmark for coffee-chain e-shops, since it has the

Table 9. General distance, closeness coefficient, and ranking of websites

	S ⁺	S ⁻	C _i	Ranking
W1	0.0061	0.0070	0.5377	2
W2	0.0056	0.0068	0.5489	1
W3	0.0077	0.0050	0.3930	3

highest score. E-commerce websites from the same sector could benefit from using W2 as a guideline for improving their electronic service quality and ensure more satisfied customers.

Sensitivity Analysis

To evaluate the robustness of the websites' evaluation results we performed sensitivity analysis. The results of this analysis indicate the impact of criteria weights on the evaluation of the website with the highest quality. In other words, it shows how sensitive the overall evaluation is to changes in the weights obtained during the pair-wise comparison procedure. Sensitivity analysis is performed in related studies (Ahmed et al., 2019; Petrovic & Kankaras, 2020).

Seventeen experiments were conducted, as presented in Table 10 and Figure 2. In each experiment, the values of the criteria weights were changed, to estimate their effect on the evaluation of the three coffee-chain e-shops.

In experiment 1, all criteria weights were given an equal value. In experiments 2 to 5, the weight of each criterion was set as highest one by one, leaving all the rest to the lowest possible value. In experiments 6 to 11, the weight of each pair was set as the highest one, leaving the other pair to the lowest value, and finally, in experiments 12 to 17, the weight of each pair was slightly changing. For each experiment, the closeness coefficients (C_i) were computed to produce the new ranking of the three websites under evaluation.

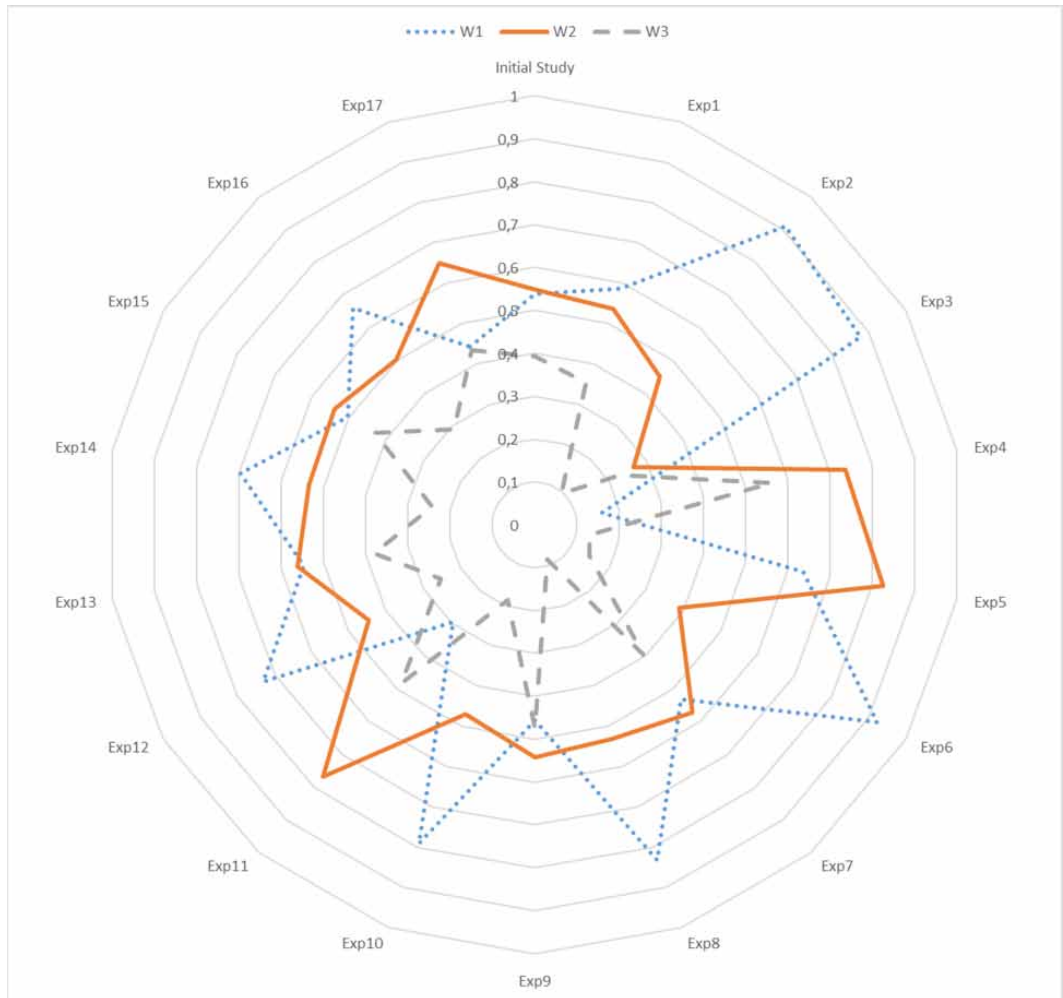
Table 10. Sensitivity analysis output

	Criteria Weight				Ci			
Exp. No	Efficiency	System Availability	Fulfillment	Privacy	W1	W2	W3	Ranking
Initial Study	0.185	0.284	0.278	0.253	0.538	0.549	0.393	W2>W1>W3
1	0.250	0.250	0.250	0.250	0.586	0.537	0.352	W1>W2>W3
2	0.750	0.083	0.083	0.083	0.909	0.453	0.096	W1>W2>W3
3	0.083	0.750	0.083	0.083	0.877	0.267	0.231	W1>W2>W3
4	0.083	0.083	0.750	0.083	0.160	0.736	0.561	W2>W3>W1
5	0.083	0.083	0.083	0.750	0.636	0.826	0.130	W2>W1>W3
6	0.450	0.450	0.050	0.050	0.922	0.389	0.146	W1>W2>W3
7	0.450	0.050	0.450	0.050	0.532	0.573	0.394	W2>W1>W3
8	0.450	0.050	0.050	0.450	0.832	0.531	0.086	W1>W2>W3
9	0.050	0.450	0.450	0.050	0.456	0.542	0.474	W2>W3>W1
10	0.050	0.450	0.050	0.450	0.791	0.470	0.186	W1>W2>W3
11	0.050	0.050	0.450	0.450	0.297	0.768	0.483	W2>W3>W1
12	0.333	0.333	0.167	0.167	0.731	0.446	0.253	W1>W2>W3
13	0.333	0.167	0.333	0.167	0.548	0.561	0.382	W2>W1>W3
14	0.333	0.167	0.167	0.333	0.697	0.534	0.244	W1>W2>W3
15	0.167	0.333	0.333	0.167	0.503	0.540	0.430	W2>W1>W3
16	0.167	0.333	0.167	0.333	0.661	0.503	0.292	W1>W2>W3
17	0.167	0.167	0.333	0.333	0.441	0.650	0.432	W2>W1>W3

The results indicate that from the total 18 cases (the initial study and the 17 experiments), Website 1 had the highest score in half of the cases and the lowest in three of them. Website 2 was the first in rankings in half of the cases and second in the other half. Website 3 was the last in scores in 15 cases and second in only 3 of them.

These results indicate that the decision-making process is relatively sensitive to the criteria weights, especially for the first two websites. Website 1 should improve its performance in fulfillment and privacy, while Website 2 should focus more on efficiency and system availability. The ranking of Website 3 was improved when fulfillment was considered as the most important criterion. However, when only efficiency was considered, its ranking deteriorated. Consequently, W3 should improve the quality of efficiency, in order to have a better performance.

Figure 2. Sensitivity analysis results



CONCLUSIONS

This paper uses an AHP-TOPSIS technique to evaluate and rank the e-shops of the coffee-chain leaders in the Greek market, based on the E-S-QUAL model. The presented 12-step methodology was used to define the evaluation criteria and to select the websites under evaluation. An online questionnaire was developed and used to collect experts' opinions through pair-wise comparisons, in order to calculate the local and global weights of the model's main and sub-dimensions. The output of this analysis, based on the analytic hierarchy process, was used to construct a decision matrix, compute the distance of each alternative from the best and the worst alternative using TOPSIS, and finally rank the three coffee-shops websites.

The implementation of AHP allows managers and web designers to identify the most and least important dimensions of the e-shops' electronic service quality. Furthermore, TOPSIS presents the dimensions in which each Greek coffee-chain website needs to improve. Finally, this multi-criteria decision-making methodology reveals the website that ranks best in providing quality services. This proposed methodology is not limited to the scope of this paper. It can also be used to evaluate e-commerce websites from different contexts. Moreover, it can be applied for the evaluation and

ranking of other areas, where pairwise comparisons are important in providing improvements to service operations.

The study's results suggest that system availability is the most important dimension of the E-S-QUAL model. System availability measures the functionality of the e-shop under evaluation. The second most important dimension is fulfillment that measures the degree to which a website has available and delivers the promised goods. Privacy comes third, which measures the extent to which an e-shop safeguards personal information. Finally, we find efficiency that controls the convenience of visiting and using a website in the last place of the experts' opinions.

Three top coffee-chain e-shops in the Greek market were ranked to specify which of them perform best and worst in electronic service quality. The results indicate that between the two first ranked websites there were differences regarding the dimensions they performed well. This outcome allows coffee-chain e-shops to improve the dimensions they performed poorly and boost customer satisfaction.

Our research has practical implications since our findings help website developers consider the most important criteria when designing e-shops. They should take all necessary measures to safeguard the security of credit card information, develop webpages that do not stop working during the ordering process and launch immediately without crashes.

Our study also has managerial implications. The performance of e-shops can be controlled by managers, taking into consideration the weights of the e-service quality items. Moreover, companies can require changes made to their e-commerce websites, if they discover that some of the important factors are not met. Managers should also focus on other important factors as well, like truthfulness about products and services offered to customers and delivering the ordered goods. Improving their e-shops service quality will lead to more loyal and satisfied customers and online sales could improve during COVID-19 lockdowns and self-isolation. This will result not only in business survival but also in an increased market positioning.

Future research suggestions include implementing the proposed methodology in different market sectors, as well as in other fields of decision making. Moreover, other MCDM techniques could be applied, like Vikor and DEMATEL, or even fuzzy methods that could better capture the vagueness in the experts' responses.

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