



Evaluation of quality of online shopping services in times of COVID-19 based on E-S-QUAL model and Fuzzy TOPSIS method

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Abstract

This paper aims to propose an approach to evaluate the quality of online shopping services in times of pandemic COVID-19, from the ordering of quality attributes taking into account customers' perception. The proposed approach was developed from a structured questionnaire containing 25 quality attributes adapted from the E-S-QUAL model and applied to consumers of online shopping services. Fuzzy set theory was used in the approach to simplify the subjectivity of human judgment, along with the extension of Technique for Order Performance by Similarity to Ideal Solution (TOPSIS). Therefore, this research was classified as applied, exploratory, quantitative and survey. To achieve the research objective, 819 questionnaires were collected. Among the main findings, it is highlighted that the attributes “product availability”, “products with excellent quality”, “confidence in online shopping processes” and “ease of buying online” were the ones that presented the best perceptions of quality by the respondents. At the other end, the attributes “opinion sharing on social networks”, “buying online is a good option when you have little time”, “distraction in online shopping searches” and “shopping online is a pleasure” showed the highest level of dissatisfaction with the service. Thus, this article highlights the importance of online shopping services in times of the pandemic caused by COVID-19, and its main contribution and originality is the development of an approach that aims to support the decision-making process, establishing strategic actions for the continuous improvement of online shopping services with the reduction of subjectivity in customer perception and with successive refinements.

Keywords Evaluation of quality · Online shopping · E-S-QUAL · TOPSIS · Fuzzy set

1 Introduction

Coronavirus (COVID-19) was discovered in the 1960s, and its nomenclature is characterized by its profile like a crown. In December 2019, a new agent of this virus was identified in China, which was named COVID-19 (Zhu et al. 2019; Han et al. 2020; Perlman 2020; Huang et al. 2020).

According to the World Health Organization (WHO), the form of contagion happens from one sick person to another or through close contact through the touch of the handshake or saliva droplets. Some laws were created to face the public health emergency with preventive measures resulting from this 2019 outbreak (WHO 2020). Moreover, behavioural changes have been affecting society, and some preventive attitudes have been put into practice, due to the COVID-19 pandemic situation. Social isolation was the most effective measure adopted by government agencies

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for flattening the contagion curve (Wu et al. 2020; Chen 2020; Huang et al. 2020; Perlman 2020).

Anguish and fear of contamination cause those who have this privilege to reduce the number of times that they leave their homes to shop, choosing new alternatives to make their purchases. As a result, social isolation becomes an ally for a significant increase in online shopping, while in physical stores client turn out may be slowing, although some factors need further observation.

Alharthey (2020) checked the impact of online shopping confidence on online shopping intentions in the Kingdom of Saudi Arabia. The study included 452 people, and the author concluded that online trust positively impacts online buying attitudes.

Rubin et al. (2020) examined the role of 103 consumers' mindset on online shopping cart abandonment. Their conclusion was that abstract consumer mindset tended to rank products inserted into shopping carts as a purchase priority (most important) and that such an attitude reduced shopping abandonment.

Duong and Liaw (2021) developed a statistical model to identify the factors that determine online shopping addiction among Vietnamese university students. There was a strong correlation between daily online shopping frequency and daily internet shopping use, and internet experience had a significant negative effect on online shopping addiction.

Moon et al. (2021) analysed the common characteristics between 251 consumers who used offline and online shopping channels during the pandemic in Korea. The researchers concluded that, in times of pandemic like that of COVID-19, consumers are likely to decrease consumption through offline distribution channels (purchase in person), and increase consumption through online distribution channels. The authors further noted that male consumers between the ages of 20 and 30 tend to use more offline distribution channels, and this audience decreased purchases from these distribution channels due to COVID-19.

Al-Hattami (2021) developed a model to assess the intention to continue using online shopping during COVID-19 by integrating the expectancy confirmation model, the task technology adjustment model, and the trust factor. The model was applied to 222 individuals. The results indicated that the factors "satisfaction", "perceived usefulness" and "trust" have positive impacts on consumers' intention.

Chang and Meyerhoefer (2021) checked how the COVID-19 pandemic impacted online food shopping services in Taiwan. Online shopping grew around 5.7%, in the sector of grains, fresh fruits and vegetables, with frozen foods growing the most. The study also showed that the

media influenced online food shopping in the COVID-19 pandemic.

It is clear that, with the arrival of the COVID-19 pandemic, the theme related to online shopping has been widely studied, but few are the studies that sought to evaluate the quality of online shopping services taking into account the particularities of the COVID-19 pandemic. Thus, this paper seeks to answer the following research problem: Which attributes related to online shopping services in times of the pandemic of COVID-19 are considered of quality by the customer?

To answer the research problem, this paper aims to propose an approach to evaluate the quality of online shopping services in times of pandemic COVID-19, from the ordering of quality attributes taking into account customers' perception. The proposed approach was developed from a structured questionnaire containing 25 quality attributes adapted from the E-S-QUAL model and applied to consumers of online shopping services. Fuzzy set theory was used in the approach to simplify the subjectivity of human judgment, along with the extension of Technique for Order Performance by Similarity to Ideal Solution (TOPSIS) proposed by Chen (2000), adapted by Wang and Lee (2007) and used by Aquino et al. (2019), Melo et al. (2022a) and Melo et al. (2022b) in the quality assessment scenario to rank the investigated attributes. In these works, the technique was used to order the attributes based on the perception of the service user, this being the only item for the managerial decision-making process related to the continuous improvement of the services provided. Although the traditional TOPSIS method takes into consideration several alternatives and criteria, being classified in this way as a multi-criteria decision method, the present research uses the extension of the TOPSIS technique proposed by Chen (2000), adapted by Wang and Lee (2007) and used by Aquino et al. (2019), Melo et al. (2022a) and Melo et al. (2022b) to order the quality attributes from the perception of the service user in online shopping. Thereby, the TOPSIS extension used in this paper cannot be classified as a multi-criteria decision method, since the definition assumes that there are at least two action alternatives that can be chosen, being motivated by the desire to achieve multiple goals, often conflicting with each other, associated with the consequences of the choice for the alternative to be followed (Almeida, 2007, Frej et al., 2017 and Roselli et al., 2020).

It is worth mentioning that there are many ways to evaluate the quality of the service provided like the following examples. Guimarães Jr et al. (2020) sought to explore the relationship between the five dimensions of quality and perceived quality in the logistical service of internet purchases in Brazil through structural equation modelling, that is, using the statistical model. In the study

developed by Chen et al. (2014) to assess the quality of home delivery of products in Taiwan, the quality function deployment (QFD) was used to propose a model of a home delivery service model.

The analytic hierarchy process (AHP) was used in the work proposed by Li et al. (2015) to develop a three-tier hierarchical model for online purchasing product quality control in China. Jakhar et al. (2020) used the fuzzy AHP to develop a model to assess the quality of online clothing stores. Kuo and Liang (2011) used the Fuzzy VIKOR integrated with the GRA to propose an approach to assess the quality of service at international airports in Northeast Asia.

Despite the diversity of the highlighted methods, the Fuzzy TOPSIS method was used in this article at the expense of other methods such as statistical models, QFD, AHP, Fuzzy VIKOR, among others, due to the method's own purpose and suitability for the purpose of this article, in addition to the method has proved to be an easy-to-apply tool in the multi-criteria decision-making process and allows a comparison with the perfect alternative through the screening process, thus reducing subjectivity in the client's perception.

The originality of the research is based on the proposal to evaluate quality taking into account attributes perceived by customers in the services offered; on the absence, verified by the literature review, of studies that present the integration of the E-S-QUAL scale with the Fuzzy TOPSIS method; and on the gap of studies that perform the application of these methods in the provision of online shopping services in times of pandemic COVID-19. From this application, actions can be developed and implemented for organizations to unfold their strategies for improvements in quality services.

This article is structured in seven sections. This section contains the introduction of the paper, and the context of the problem to be discussed, as well as the purpose of the study. In the second section, there is a theoretical background that will base the research dealing with subjects such as quality in service, the E-S-QUAL model and the TOPSIS technique. The third section presents the methodology adopted with the characterization of the research and the structure of the proposed approach for assessing quality in services. The fourth section presents the profile of the sample, as well as the application of the proposal. Section five is the discussion, and the sixth section describes the Managerial Implications of the research. Finally, the conclusion of this paper is presented in the seventh section.

2 Theoretical background

In this section, the main topics that will guide this research are described as: quality in service, the E-S-QUAL model and the TOPSIS technique.

2.1 Quality in services

The concept of quality of service is defined as a long-term cognitive judgment regarding an organization's "excellence or superiority" (Ma and Zhao 2012; Wahab et al. 2017). The term "quality of service" is used to assess service through customer satisfaction (Jeeradist et al. 2016). Service quality is a measure of how well the service level has delivered customer expectations (Yang et al. 2012).

According to Suresh and Mohan (2016), the quality of services is determined by several dimensions that customers expect from the service they want. Improving quality does not mean that customers will be completely satisfied with the service, so the objective is to find the factors that will help determine the quality assurance in the service.

The search for satisfying personal needs and desires, past experiences that the customer has had with the service, communication between customers, external communication, and the price of the service are factors that influence the formation of customer expectations. As the service is an experience, the quality of the service is strictly linked to customer satisfaction (Bezerra and Gomes 2015; Silva et al. 2017).

Several relevant models for assessing quality in service have already been created, such as the Grönroos (1984) technical and functional quality model, the GAP Analysis model (SERVQUAL) by Parasuraman et al. (1985; 1988), the performance-based model (SERVPERF) by Cronin and Taylor (1992), the Evaluated Performance / Normed Quality model by Teas (1993), the E-S-QUAL model by Parasuraman et al. (2005), the HEDPERF model by Abdullah (2006), among other models.

With the evolution of commercial transactions, accelerated by the COVID-19 pandemic, services migrated and expanded their activities to e-commerce, the physical suddenly became digital, what was only a trend has become the current and growing business model. In this not so new scenario, it is fundamental for organizations to continue investing in the quality of their products and services. This investment has customer satisfaction as its main purpose (Anderson et al. 2020; Bhatti et al. 2020). According to Lopes et al. (2019), the studies that measure quality evaluation in electronic services are still being developed both theoretically and empirically.

Recent research on the quality of electronic services is concentrated on e-banking as described in the articles by Mujinga (2020); Li et al. (2021) and Egala et al. (2021). However, with the increase in food delivery services in the pandemic, this niche has also become of academic interest, as reported by Belanche et al. (2021); Uzir et al. (2021) and Hernando and Gunawan (2021).

With the intensification of virtual retail, the demand for online customers also grows in the same proportion. In addition, the online customer also takes into account the information, contents, opinions and experiences of other users and digital influencers, which has led some companies to raise the quality of their services. And with the popularization of the use of electronic services, consumers do not tolerate the poor quality of the service provided (Lopes et al. 2019).

Therefore, understanding and measuring the quality of e-shopping services is essential for maintaining competitiveness and success in this sector, because first, it is necessary to understand how the consumer assesses quality to only then provide a service of superior quality (Akinci et al. 2010; Li et al. 2021).

To achieve the objective of this work, the E-S-QUAL model was adapted to assess the quality of the online shopping purchase service in times of the COVID-19 pandemic by ordering the attributes using the Fuzzy TOPSIS.

2.2 Quality of online shopping service

Online retailing is among the fastest-growing areas today. Understanding the factors that contribute to both the success and the survival of companies is essential to improving the quality of the services provided (Shankar et al. 2020).

The search to understand the issue of quality of online shopping services is not new today, but we have gone through a global transformation that radically changed consumer behaviour both in their physical purchases, but especially in their online purchases (Gezer et al. 2022).

Consumers now look at the products and brands from a new perspective, characterized by being more sensitive and considering several factors to only then acquire a product or service in their online shopping (Wang et al. 2022).

With the acceleration of online shopping caused by the pandemic, new sales platforms have also emerged, increasing competition and leading companies to compete for more markets and customer loyalty (Mamakou and Roumeliotou 2022).

Within this strand, studying and understanding customer satisfaction issues has become a vital concern for organizations that need to diversify from the competition and

enhance their customers' consumption experience (Juwaini et al. 2022).

What is already known about online shoppers, is that they seek online shops that are secure with their personal and banking information, in addition to offering ease of site navigation, search functions, price comparison, description devices, the payment system and the information available, as well as customer service ranging from phone, email and chat support, and not the least product delivery within the stipulated time (Akil and Ungan 2022; García-Salirrosas et al. 2022; Rusdiana 2022).

Given the boom of online shopping worldwide and searching for answers to unravel what now impacts customer satisfaction and the quality of online shopping services, many kinds of research have emerged recently, to name a few. Yunus et al. (2022) studied the effect of online shopping service quality on customer satisfaction and their repurchase intention through an online consumer rating tool as an intervening variable in the marketplace of a large online shopping platform.

The researchers, Goutam et al. (2022), analysed the impact of technology readiness on e-service quality and their effect on purchase intention and behavioural loyalty in the context of online shopping.

However, García-Salirrosas et al. (2022) aimed to understand what is the influence of customer satisfaction trust on perceived value and purchase intention of users of small business online shops in countries such as Mexico, Peru and Colombia during the economic crisis caused by the COVID-19 pandemic.

Juwaini et al. (2022) determined various effects of service quality on customer satisfaction and loyalty, online service trust on customer satisfaction and loyalty and the direct effect of online shop customer satisfaction and loyalty. Some research was more sector-specific; for example, Saricam (2022) evaluated service quality and its relationship with customer satisfaction and loyalty in the sportswear retail market.

According to Yang et al. (2022), the quality of the online shopping service is a crucial factor for the success of companies. Soon, e-commerce companies need to provide the best quality of e-services because according to Juwaini et al. (2022), the quality of e-service can affect consumer satisfaction and trust. That can be potential loyal customers.

2.3 E-S-QUAL

The E-S-QUAL model was developed by Parasuraman et al. (2005) to measure customer perceptions about the quality of services provided in online purchases. The authors identified a set of 113 items representative of 11 dimensions, which are: access, ease of navigation,

efficiency, customization, security, responsiveness, guarantee, knowledge of price, aesthetics, reliability, and flexibility.

After identifying the items, the authors used an exploratory factor analysis test, where the dimensions were reduced to 4 (efficiency, system availability, service, and privacy), linked to 22 questions. Thus, with the development of the E-S-QUAL model, several studies were carried out, such as Akinçi et al. (2010), Rafiq et al. (2012), Yaya et al. (2017), Handayani et al. (2018), Ghosh (2018), Lopes et al. (2019); Ketema and Selassie (2020); Raza et al. (2020); Mujinga (2020); Belanche et al. (2021); Egala et al. (2021). Considering the general characteristics of the E-S-QUAL model proposed by Parasuraman et al. (2005), and the attributes considered important in the literature on quality of online shopping services, the dimensions and attributes used in this study are summarized in Table 1.

2.4 TOPSIS

HWANG and Yoon (1981) were the precursors to the TOPSIS technique (Technique for Order Preference by Similarity to Ideal Solution). According to Kin et al. (1997), the main advantage of this technique is understanding the individual's rationality in the decision-making process. It provides a value considered negative and an ideal positive for the alternative, it is simple in the use of technology, for it handles data in electronic spreadsheets, and the technique can be applied to several factors at the same time.

This technique consists of establishing an order for the attributes following norms already established. Therefore, it seeks to evaluate the attributes according to their distance, the ideal positive and negative solutions simultaneously. The positive ideal solution or solution of the ideal point (A^+) is the one desired by the professionals who are evaluating the quality, as it is considered the best alternative in the given quality attribute to be evaluated. Hence, the ideal point will most likely not be present in the feasible set, corresponding to the alternative that would have the combination of the best possible implications for all estimated quality attributes (Choudhury 2015). In contrast, the ideal negative solution, also known as Nadir (A^-), is the least desired since it is the worst possible assessment for the quality attribute. Hence, the ideal negative solution is equivalent to the alternative that would bring the worst possible consequences for all quality attributes considered (Aquino et al. 2019).

3 Methodology

The nature of this scientific research was classified as applied research, for its practical character. As for the objective, it was classified as exploratory because it

provides an approximate view of a problem with a view to making it explicit. It uses a quantitative survey approach for measuring the study variables and, as it sought to know the respondent's behaviour, the research method was classified as a survey type (Forza 2002).

In this section will be presented the structure of the proposed approach, which aims to propose an approach to evaluate the quality of online shopping services in times of pandemic COVID-19, from the ordering of quality attributes taking into account customers' perception. Figure 1 shows the steps of the proposed approach.

Figure 1 illustrates the steps of the proposed approach for assessing the quality of online shopping services. The proposed approach presents the six steps and their respective refinements for the achievement of continuous improvement of the quality management system, with the purpose of satisfying consumers.

It is noteworthy that the proposed approach is justified as it aims to support the decision-making process, making it an essential tool for organizations to establish strategic actions for the continuous improvement of online shopping services (Fofan et al. 2019). For Liou and Chen (2006), the creation of approaches to achieve the desired quality, with the reduction of subjectivity in the customer's perception and with successive refinements, results in the process of continuous organizational improvement. The steps of the proposed approach to evaluate the quality of online shopping services during COVID-19 times are described below.

Step 1: Identify quality attributes—quality attributes are identified through a literature review based on the E-S-QUAL model. After identification, the data collection instrument was developed to capture the perception of quality of the online shopping service in the days of COVID-19 from the customer, based on the E-S-QUAL model. The questionnaire was prepared considering ten dimensions proposed by the E-S-QUAL model (access, ease of use, efficiency, customization, security, assurance, knowledge of price, aesthetics, reliability, and flexibility), together with the dimension "delivery", necessary at this time of pandemic.

The questionnaire was designed in two parts: the first part consists of collecting basic information about customers and the second part of the questionnaire seeks to assess customer perception by relating customer satisfaction in the service received from the scale of five points by Likert (1932), using linguistic terms: 1. total disagreement, 2. partial disagreement, 3. neither agree nor disagree, 4. partial agreement, and 5. total agreement.

Step 2: Collect data—In this step, data will be collected from customers of the online purchase service. The questionnaires should be applied to consumers buying online through social networks and messaging applications. After data collection, it is recommended to calculate Cronbach's

Table 1 Dimensions and attributes of quality in online shopping in COVID-19 times

Dimension	Attribute	Description	References
Ease of use	1	Ease of Buying Online	Finn (2011), Zavareh et al. (2012), Vos et al. (2014), Bressolles et al. (2014), Tandon et al. (2017), Ghosh (2018), Lopes et al. (2019), Al-dweeri et al. (2019), Ketema and Selassie (2020), Egala et al. (2021), Hernando and Gunawan (2021)
	2	Distraction in online shopping searches	
Aesthetics	3	Shopping online is stimulating	Finn (2011), Zavareh et al. (2012), Fan et al. (2013), Bressolles et al. (2014), Khan et al. (2019), Al-dweeri et al. (2019)
	4	Shopping online is a pleasure	
Access	5	Ease of viewing online shopping reviews on social media	Rafiq et al. (2012), Kurt and Atrek (2012), Zehir and Narcikara (2016), Tsao et al. (2016), Ayo et al. (2016), Jaiyeoba et al. (2018), Lopes et al. (2019), Widodo et al. (2019)
	6	Ease of viewing online shopping reviews on the website	
	7	Searching for information about online stores on websites	
Security	8	Viewing Publications on Social Networks about Products	Rafiq et al. (2012), Kurt and Atrek (2012), Bressolles et al. (2014), Zhang et al. (2015), Ayo et al. (2016), Malik et al. (2016), Tandon et al. (2017), Shahid et al. (2018), Khan et al. (2019), Lopes et al. (2019), Ketema and Selassie (2020), Egala et al. (2021)
	9	Influence of expert opinions on the purchase decision	
	10	Living with other people influences online shopping decisions	
	11	Social media sharing, positive posts about online shopping products	
	12	Opinion sharing on social networks	
Customization	13	Buying online is a good option when you have little time	Fan et al. (2013), Vos et al. (2014), Tandon et al. (2017), Sundaram et al. (2017), Shahid et al. (2018), Wijayanti et al. (2018), Lopes et al. (2019)
Efficiency	14	Convenience regarding distance from home vs. product purchase	Elsharnouby and Mahrous (2015), Zehir and Narcikara (2016), Tsao et al. (2016), Yaya et al. (2017), Jaiyeoba et al. (2018), Javed et al. (2018), Hartwig and Billert (2018), Lopes et al. (2019), Ketema and Selassie (2020), Mujinga (2020), Raza et al. (2020) Belanche et al. (2021), Egala et al. (2021)
	15	Product availability	
Flexibility	16	Flexibility due to opening hours	Yaya et al. (2017), Ghosh (2018), Widodo et al. (2019), Khan et al. (2019), Lopes et al. (2019), Al-dweeri et al. (2019), Hernando and Gunawan (2021)
Reliability	17	Products with excellent quality	Finn (2011), Hussien and El Aziz (2013), Wen et al. (2014), Palese and Usai (2018), Javed et al. (2018), Al-dweeri et al. (2019), Ketema and Selassie (2020), Raza et al. (2020)
knowledge of price	18	Advantage in the relationship between price and quality	Wijayanti et al. (2018), Ghosh (2018), Khan et al. (2019), Lopes et al. (2019)
Assurance	19	Trust in online shopping stores	Finn (2011), Hussien and El Aziz (2013), Wen et al. (2014), Shahid et al. (2018), Palese and Usai (2018), Javed et al. (2018); Widodo et al. (2019)
	20	Confidence in online shopping processes	
Delivery	21	Deadline	Yaya et al. (2017), Handayani et al. (2018), Wijayanti et al. (2018), Ghosh (2018), Aquino et al. (2019), Widodo et al. (2019)
	22	Products are delivered without defect	
	23	The delivery of the products respects the conditions informed by the company	
	24	Similarity between purchased and chosen product	
	25	Contact the online shopping delivery person	

alpha coefficient to analyse the reliability of the scale of the collection instrument. The Cronbach's alpha coefficient was calculated using Jasp Statistical Software. The collected data were treated and analysed in Microsoft Excel

2010 software, where the fuzzification of the data was calculated and the overall quality evaluation was measured.

Step 3: Fuzzification of the Likert (1932) scale—After data collection, a triangular fuzzy number must be proposed for each point on the scale of Likert (1932), since it

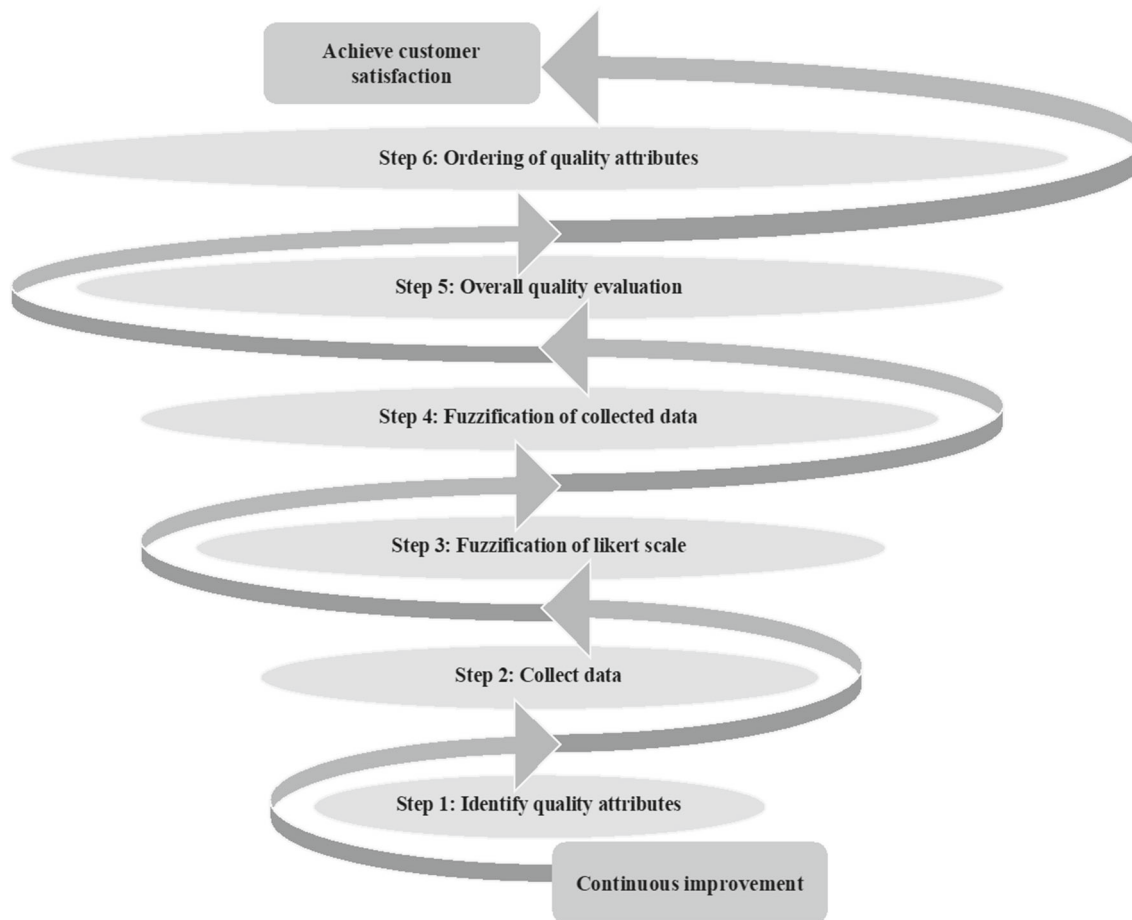


Fig. 1 proposed approach to assessing the quality of online shopping services

is desired to measure the quality level of online purchasing services in times of crisis. This transformation begins with the identification of the points on the scale “Total disagreement”, “Partially disagreement”, “Neither agree nor disagree”, “Partially agreement” and “Total agreement”, followed by their transformation into a fuzzy number. To reduce the subjectivity of the evaluation in the data analysis, the points on the scale of Likert (1932) must go through the fuzzification process; that is, for each point a fuzzy triangular number represented by (a, b, c) will be associated as shown in Table 2.

The triangular numbers used are evenly distributed between zero and ten. The use of the triangular fuzzy number is given by the best representation of the client’s preferences in each linguistic term and degree of relevance in the range of [0.1].

Step 4: Fuzzification of collected data—Once the service is studied through its variables, it will be evaluated by several customers. Thus, it is necessary to create a single fuzzy triangular number for each variable. Then, the fuzzified evaluations of each user were aggregated, according to Chen (2000) and Aquino et al. (2019),

Table 2 Linguistic terms in the fuzzy environment

Linguistic term	Scale	Fuzzy number
Total disagreement	1	(0; 1; 3)
Partially disagreement	2	(1; 3; 5)
Neither agree nor disagree	3	(3; 5; 7)
Partially agreement	4	(5; 7; 9)
Total agreement	5	(7; 9; 10)

according to Eq. 1, where M is the global value of each fuzzy evaluation of the “n” clients of the service studied for the variable z. Through this operator, the individual assessments for each analysed variable are aggregated into global assessments.

$$M = (a_1, b_1, c_1) = \frac{1}{n} \oplus (M_1 \oplus M_2 \oplus \dots \oplus M_n) \left\{ \frac{\sum_{i=1}^n a_1^{(i)}, \sum_{i=1}^n b_1^{(i)}, \sum_{i=1}^n c_1^{(i)}}{n} \right\} \tag{1}$$

Step 5: Overall quality evaluation—As previously described, the triangular fuzzy number is represented by

(a, b, c) these being the values of the linguistic terms, and “ n ” the number of individuals of each linguistic variable by category of attribute. To assess quality from the numbers obtained by fuzzification, the evaluation scale was proposed by Aquino et al. (2019), where if parameter “ b ” is between 0 and 2.0, the quality assessment is terrible, the customer is dissatisfied with the service provided; between 2.0 and 4.0, the quality assessment is rated as bad; between 4.0 and 6.0, the evaluation is considered regular; between 6.0 and 8.0, the quality assessment is considered good; between 8.0 and 10.0, the quality assessment is considered excellent.

Step 6: Ordering of quality attributes—To order the attributes using the TOPSIS Method proposed by Wang and Lee (2007) and Chen (2000), it is necessary to determine the ideal solutions, determine the Euclidean distance of the fuzzy assessments, calculate the sums of the Euclidean distances, and calculate the ordering itself.

Initially, the ideal positive (A^+) and negative ideal (A^-) solutions must be determined. The ideal positive solution is represented by the maximum consumer rating and is described by the triangular number ($A^+ = \{7, 9, 10\}$). On the other hand, the ideal negative solution is represented by the minimum consumer rating and is described by the triangular number ($A^- = \{0, 1, 3\}$) (Chen 2000; Wang and Lee 2007; Massami et al. 2016; Aquino et al. 2019). After determining the ideal solutions, it is necessary to determine the Euclidean distance of the fuzzy evaluations using Eqs. (2) and (3). The Euclidean distance shows how far the evaluation of the attribute is from the positive and negative ideal solution (Chen 2000; Wang and Lee 2007; Aquino et al. 2019).

$$d^+(V_{ij}, A_j^+) = \left[\frac{(a_1^+ - a_1)^2 + (a_2^+ - b_2)^2 + (a_3^+ - c_3)^2}{3} \right]^{1/2} \quad (2)$$

$$d^-(V_{ij}, A_j^-) = \left[\frac{(a_1^- - a_1)^2 + (a_2^- - b_2)^2 + (a_3^- - c_3)^2}{3} \right]^{1/2} \quad (3)$$

To calculate two attributes, it is necessary to calculate the Euclidean differences between the Eqs. 4 and (5) and then calculate the order itself (Eq. 6).

$$S_i^+ = \sum_{j=1}^n d^+(V_{ij}, A_j^+) \quad \text{with } i = 1, \dots, m; \quad (4)$$

$$S_i^- = \sum_{j=1}^n d^-(V_{ij}, A_j^-) \quad \text{with } i = 1, \dots, m; \quad (5)$$

$$C_i = \frac{S_i^-}{(S_i^+ + S_i^-)} \quad \text{with } i = 1, \dots, m \text{ e } C_i \in [0, 1] \quad (6)$$

4 Results

The questionnaire based on the E-S-QUAL model used in this research was designed considering the dimensions and attributes identified in Table 1. A total of 819 questionnaires were collected. When asked whether they were shopping online, 279 people said they were shopping online, while 540 people said they were not shopping online. Of the individuals who were shopping online, 31.7% were female and 68.3% male, with an average age of 32 years (minimum 18 and maximum 75 years).

Regarding the fear of COVID-19, it was asked how the participants felt, and 91.8% say they are afraid of COVID-19. Initially, it was possible to obtain the aggregation of the fuzzified evaluations of the respondents, according to Eq. 1. Table 3 presents the fuzzy numbers of the studied attributes.

From Table 3, it can be seen that attribute 15 (Product availability), corresponding to the Reliability dimension (6.36082474; 8.35395189; 9.59106529), attribute 17 (Products with excellent quality), corresponding to the Efficiency dimension (6.27491409; 8.27147766; 9.53264605) and attribute 20 (Confidence in online shopping processes), corresponding to the Assurance dimension (6.24742268; 8.2371134; 9.48109966), were the attributes that presented the greatest modal value of the fuzzy number and were evaluated as excellent.

While attribute 12 (Opinion sharing on social networks), corresponding to the “Security” dimension (2.4467354; 4.15463918; 6.0206185), attribute 13 (Buying online is a good option when you have little time), corresponding to the dimension “Customization” (3,14,089,347; 4,93,814,433; 6,73,539,519) and attribute 2 (Distraction in online shopping searches), corresponding to the dimension “Ease of use” (3,72,508,591; 5,55,670,103; 7,29,553,265), were the attributes that presented the lowest modal value of the fuzzy number and were evaluated as regular.

As seen in Table 3, no dimension presented an assessment considered to be terrible or bad, demonstrating that the online shopping service was not considered unsatisfactory by customers. Seeking an evaluation of the service referenced by its worst and best evaluation, the results of the application of an extension of the Fuzzy TOPSIS method are presented.

Table 3 Fuzzy numbers of the studied attributes

Attributes	Fuzzy triangular number			Overall quality evaluation
	a	b	c	
Attribute 1	5.99312715	7.98969072	9.35051546	Good
Attribute 2	3.72508591	5.55670103	7.29553265	Regular
Attribute 3	4.65292096	6.61512027	8.27147766	Good
Attribute 4	4.1443299	6.07216495	7.75601375	Good
Attribute 5	5.3024055	7.26116838	8.73883162	Good
Attribute 6	5.35738832	7.32989691	8.81099656	Good
Attribute 7	4.94158076	6.88316151	8.43986254	Good
Attribute 8	5.51546392	7.50171821	8.97594502	Good
Attribute 9	4.54295533	6.47079038	8.09965636	Good
Attribute 10	4.75945017	6.71821306	8.35051546	Good
Attribute 11	4.80068729	6.76632302	8.39862543	Good
Attribute 12	2.4467354	4.15463918	6.02061856	Regular
Attribute 13	3.14089347	4.93814433	6.73539519	Regular
Attribute 14	5.73195876	7.70790378	9.11340206	Good
Attribute 15	6.36082474	8.35395189	9.59106529	Excellent
Attribute 16	5.80756014	7.7766323	9.13402062	Good
Attribute 17	6.27491409	8.27147766	9.53264605	Excellent
Attribute 18	4.62886598	6.61512027	8.33333333	Good
Attribute 19	4.83505155	6.81443299	8.4742268	Good
Attribute 20	6.24742268	8.2371134	9.48109966	Excellent
Attribute 21	4.24054983	6.18900344	7.93814433	Good
Attribute 22	5.29209622	7.28865979	8.85223368	Good
Attribute 23	5.39175258	7.38487973	8.94158076	Good
Attribute 24	5.62886598	7.6185567	9.07560137	Good
Attribute 25	5.29209622	7.27491409	8.79725086	Good

From the ideal positive solution ($A^+ = \{7,9,10\}$) and the ideal negative solution ($A^- = \{0, 1, 3\}$), according to the fuzzy scale used and the respondents' evaluation, the Euclidean distances for each variable were calculated according to Eqs. (2) and (3) (Table 4). Then, using Eqs. (4), (5) and (6) it was possible to order the evaluations of the researched variables according to the view of the respondents.

As a reflection of the aggregated fuzzy numbers in Table 4, attribute 15 (Product availability), attribute 17 (Products with excellent quality), attribute 20 (Confidence in online shopping processes) and attribute 1 (Ease of Buying Online) were the ones that presented greater weight in the service evaluation, and were close to the ideal positive solution. Thus, they had the better perception of quality by the respondents and therefore considered as attributes with low priority for management actions. In contrast, the attributes 12 (Opinion sharing on social networks), 13 (Buying online is a good option when you have little time), 2 (Distraction in online shopping searches) and 4 (Shopping online is a pleasure) had greater proximity to

the ideal negative solution. Thus, they presented with the greater level of dissatisfaction with the service.

5 Discussion

In this study, we explored an approach to measure the quality of online shopping services during COVID-19, that minimizes the subjectivity of customers' perceptions, and thus more precisely provide what attributes influence the quality of online shopping in times of pandemic.

This research was instigated by the atypical and fast scenario that the pandemic caused in commercial transactions, and the diversity of factors that could affect the quality of online shopping services offered by companies in this period. Online shopping has grown astronomically and has become substantial in the pandemic.

Even with the increase and popularization of online purchases, the survey identified that 66% of all participants did not conduct this type of commercial transaction. According to Daroch et al. (2021), despite the advantages, some customers may find online shopping risky and

Table 4 Euclidean distances and ordering of attributes

Attributes	$d^+(V_{ij}, A_j^+)$	$d^-(V_{ij}, A_j^-)$	Ci	Ranking
Attribute 1	0.90486609	6.45761556	0.87709768	4
Attribute 2	3.15676595	4.20679569	0.57129904	23
Attribute 3	2.17441339	5.19511713	0.70494547	19
Attribute 4	2.69335875	4.6733997	0.63439024	22
Attribute 5	1.58070745	5.78077048	0.78527308	13
Attribute 6	1.5167011	5.8462776	0.79400985	10
Attribute 7	1.92804943	5.43516066	0.73815097	14
Attribute 8	1.35368439	6.0112284	0.81619818	8
Attribute 9	2.31266627	5.05221026	0.6859871	20
Attribute 10	2.07745152	5.29082042	0.71805445	17
Attribute 11	2.03229671	5.33673546	0.72421118	16
Attribute 12	4.47382077	2.8903517	0.39248832	25
Attribute 13	3.74384024	3.62065233	0.49163636	24
Attribute 14	1.16382947	6.19744596	0.84189839	6
Attribute 15	0.57536967	6.78190832	0.92179585	1
Attribute 16	1.10581217	6.25237846	0.84971684	6
Attribute 17	0.65189828	6.70632534	0.91140548	2
Attribute 18	2.16700297	5.20898008	0.70620825	18
Attribute 19	1.98256474	5.38988292	0.7310846	15
Attribute 20	0.68741694	6.66860188	0.90655041	3
Attribute 21	2.56693824	4.80601321	0.65184387	21
Attribute 22	1.54520637	5.82529437	0.79035259	11
Attribute 23	1.4508991	5.9200244	0.80315912	9
Attribute 24	1.24404005	6.12106628	0.83109001	7
Attribute 25	1.56412512	5.80198089	0.78765916	12

unreliable. In addition to not providing sensory sensations, the fear of fraud, damaged products and delivery problems are some factors that lead many consumers not to adopt this type of shopping (Al-Debei et al. 2015; Brands and van Wilsem 2021).

García-Salirrosas et al. (2022) state that in developing countries consumers are more traditional and distrustful of technology, and thus, factors such as shipping costs, poor customer service, problems of lack of stock, delivery delays are factors that lead to low consumption of products and services in online shops by the population of these countries.

Another fact reported by the participants of this study was about the feeling caused by the pandemic, and more than 90% reported fear of COVID-19. According to Chi et al. (2021), fear in times of pandemic is natural, because it is a life-threatening event, where contamination passes from person to person. However, this perception of fear can be enhanced by fake news and future uncertainties during and after the pandemic. The degree of fear reported by the

participants corroborated with those presented in the studies by Ahorsu et al. (2020); Sakib et al. (2021) and Iversen et al. (2021).

Based on the methodology of fuzzification, which treats inaccuracies, being an attempt to approximate the required precision, the study found that the attributes of service quality perceived by consumers were classified as excellent, good and regular.

Of the attributes where the perception of the quality of the service was evaluated as excellent were: attribute 15 (Product availability), corresponding to the “Reliability” dimension. This result is consistent with the studies by Mendoza et al. (2020); Raza et al. (2020); Belanche et al. (2021) and Egala et al. (2021), who used the structural equation to confirm this dimension as the one that most influenced the perception of quality of online customer services, be they banking or food delivery services.

The attribute 17 (Products with excellent quality), which had the perception of quality evaluated as excellent, corresponds to the dimension “Efficiency”. This dimension had a positive effect on the satisfaction of perceived quality in online services in the studies by Ketema and Selassie (2020) and Goutam et al. (2021).

The characteristics of this dimension greatly impact the expectation of the online service, because they can control the quality of the system, thus influencing the expectation of consumers, which, if not met, strongly influence the perception of quality (Ketema and Selassie 2020).

And the attribute 20 (Trust in online shopping processes), corresponding to the “Guarantee” dimension, which also had the perception of quality assessed as excellent, was the dimension of the greatest importance for customers in the study by Widodo et al. (2019), which used multiple regressions to reach this conclusion.

Among the attributes in which the perception of the quality of the online service was evaluated as regular, was attribute 12 (Sharing of opinion on social networks), corresponding to the dimension “Security”. This attribute is related to Social Commerce, described by Linda (2010), as the use of social media in the context of e-commerce, to assist in the purchase and sale of products and services online. Through social media, companies can market their products and services, influence consumers, and impact a large number of people around the world. On the other hand, electronic word-of-mouth convinces consumers to share their experiences and knowledge about products and services with other consumers on social networks, and thus influence them in buying decisions (Goraya et al. 2019; Adam and Alhassan 2021). No study addressed this perspective of social networks in the context of E-S-QUAL, and only in the studies of Ketema and Selassie (2020) does this dimension have a high impact on customer satisfaction.

The study by Yunus et al. (2022) does not address E-S-QUAL, but it does suggest that e-service quality has a positive effect on customer evaluations within a shopping platform, and these evaluations have a positive effect on customer repurchase intention.

Attribute 13 (Buy online is a good option when you have little time), corresponding to the dimension “Customization”, had the perception of quality evaluated as regular. According to Adnan (2014), the advantages of online shopping when one has little time is in the availability of purchases 24 h a day, on all seven days of the week, variety of products and services, ease of price comparison, a greater number of payment options, exclusive products and lower costs. On the other hand, the author reports that the lack of time to analyse the purchases may cause the consumer to hesitate to make online purchases, since they are exposed to financial risks, risks of non-delivery and risks of receiving defective products, for example. It is worth noting that no study has approached this attribute from the perspective raised in this research. The “Customization” dimension is one of the dimensions that significantly impact consumer satisfaction in the studies by Tandon et al. (2017), which addresses the scenario of perceived quality in websites.

Regarding attribute 2 (Distraction in online shopping searches), also classified as regular, corresponding to the dimension “Ease of use”, Huang et al. (2021) claims the distraction in online shopping affects the consumer’s attention and can negatively influence the accuracy of the product’s judgment. The “Ease of use” dimension was highly significant in the judgment of the quality of online services by consumers in the studies by Ketema and Selassie (2020) and Hernando and Gunawan (2021), and it is considered one of the main dimensions to be investigated in online quality of service surveys (Shankar et al. 2020). It may impact online shopping service quality, purchase intention and behavioural loyalty (Goutam et al. 2022).

In agreement with Shankar et al. (2020), the quality perceived by consumers is the foundation for success in digital businesses. And the quality ratio in online services influences the increase in customer satisfaction, their retention, and intention to repurchase, especially in pandemic scenarios such as COVID-19, where consumers are more sensitive to the services provided (Al-Ghraibah 2020).

Mamakou and Roumeliotou (2022) reiterate that the quality of service of e-shops makes customers satisfied and may lead them to be more loyal and online sales may increase in atypical cases as it was in the isolation of COVID-19, resulting not only in the survival of the business, but also in a greater and better positioning of the shop in the market.

This study demonstrated that the E-S-QUAL scale developed by Parasuraman et al. (2005) was valid to measure the quality of the service perceived in the scenario of online purchases in times of pandemic. The methodology Fuzzy TOPSIS helped to reduce the subjectivity in the measurement of the perception of the quality of services, to present an evaluation closer to the reality. Thus, decision-making in the points of improvement and maintenance of the quality of online services was improved.

6 Management implications

From a practical perspective, the findings in this article can provide some useful clarifications for marketing professionals, enabling the development of analyses that help in understanding the characteristics of consumer behaviour in the face of the global COVID-19 pandemic crisis.

The results obtained in this study suggest, first, that companies devote more attention to interaction with their users on social media since digital communication is already an essential aspect of modern consumption (Kim et al. 1997). Companies must build a reputation on social networks to be closer to the thinking of their customers, respond promptly to user comments and provide alternative communication channels for users, to positively impact the consumer and make him visit the site again (Wu et al. 2015).

Secondly, this study suggests the customization of the presentation of products according to the needs of customers, optimally, both to promote the flow necessary to manage consumers’ willingness to buy, and the perception of the risks associated with Internet shopping (Smith and Sivakumar 2004). This customization also permits not to disperse and distract the consumer, and thus not negatively impact the decision to buy, since, according to Huang et al. (2021), in this highly competitive scenario of online commerce, for companies to earn more they must have the ability to hold the consumer’s attention until the purchase takes place.

In addition, one should consider the perception of customers regarding the service provided, so that organizations can invest in the implementation of improvements through new practices in the quality of their services, to meet the needs of their customers and achieve their satisfaction, which is the main objective of an organization.

Finally, managers and entrepreneurs can use the data and results presented in this survey to understand how consumers behave when confronted with an existing product and/or service, to launch new products and services in the online shopping market, to promote a positive experience for your audience target.

7 Conclusion

With the development of this study, it may be possible to build hypotheses about the topic, since it is something unprecedented in society and in the academic literature. It is worth mentioning that the results found in this research were a consequence of the characteristics of the sample.

The behavioural changes in society, resulting from the COVID-19 pandemic, allow the development of new studies to explore factors that lead to consumer satisfaction. Based on the literature review and analysis of the collected data, this paper presented an approach to evaluate the quality of online shopping services in times of pandemic COVID-19, from the ordering of quality attributes taking into account customers' perception, using an integration of extension TOPSIS technique and fuzzy set theory.

It was interesting to notice with the results that even with social isolation as the most effective preventive measure to combat the rapid contagion of the virus, the study pointed out that the vast majority of respondents (91.8%) were afraid of the Coronavirus. Of this percentage, 33% said they felt a lot of fear and 58.8% said they felt little fear, but 65.94% still continued doing their shopping in person, especially in supermarkets.

For the sample of consumers who obeyed the preventive measure and continued shopping online, it was possible to notice that the characteristics linked to 'Efficiency', 'Reliability' and 'Assurance' were the best evaluated attributes, considered as excellent and that led to customer satisfaction. Such characteristics were associated with consumer satisfaction by Parasuraman et al. (1985).

The TOPSIS technique allowed us to establish a ranking for ordering the attributes according to the distance from the positive and negative ideal solution. Through the analysis of the positive ideal solution (A +), it was interesting to realize that among the characteristics that had the highest importance perceived by consumers, the most important was 'Reliability' (attribute 15—Product availability), followed by 'Efficiency' (attribute 17—Products with excellent quality) and 'Assurance' (attribute 20—Confidence in online shopping processes), respectively. In other words, reliability is the assurance of excellence of the functionality in a proper way of the service bringing the perception of trust to the customer, leading to their satisfaction (Liu et al. 2018; Jenelius 2018; Amai 2020).

The main limitation of this research was the scarcity of studies already published on this topic. As the studies with this objective were few, it is common not to obtain published content to compare with our results. In addition, it would be interesting to expand the sample, in order to obtain other perceptions about the services offered.

Therefore, this research contributed to a discussion of the academic literature, enabling the development of future research that helps to understand the behaviour of consumers in relation to their online purchases, in and out of crisis. With this, organizations can invest in the qualification of their services to meet the needs of their customers.

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Declarations

Conflict of interest The authors declare no conflict of interest.

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