

Validation and Invariance of an Electronic Service Quality Scale

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Abstract

This study evaluated electronic service quality in a virtual bookstore in Peru using the Electronic Service Quality Scale. A cross-sectional design was used, collecting data from 412 online bookstore customers. A first-order confirmatory factor analysis confirmed the Spanish version's four dimensions (Design, Functionality, Privacy, and Reliability), with all items significantly loading on their respective factors. Additionally, a gender-based factorial invariance analysis showed that thresholds, factor loadings, intercepts, and residuals were consistent across both groups, suggesting that score differences between genders result from true latent trait discrepancies rather than potential bias in the evaluation tool. These findings are important for future research on electronic service quality in Peru, allowing for more accurate and reliable comparisons of results between groups.

Keywords:

Electronic Service Quality, E-Commerce, Virtual Library, Factorial Invariance, Peru.

Introduction

In recent years, e-commerce has gained significant relevance in the buying and selling market, especially after the COVID-19 pandemic, where nearly 90% of the global population made purchases online (Orus, 2022). In Peru, the use of electronic services has continued to advance, with almost 42% of Peruvians making electronic purchases in 2021 (CAPECE, 2021). This growth has provided new impetus to electronic service quality, leading to the implementation of various measures and strategies to improve quality in the marketplace (Barrera et al., 2020).

E-commerce refers to conducting economic activities using an electronic connection, supported by electronic means and especially the internet (Thompson, 2005). Electronic service quality or e-service quality is defined as customers' overall evaluations and judgments about the excellence and quality of electronic service delivery in the marketplace (Santos, 2003). E-service quality is measured in different dimensions, such as virtual quality (website quality), physical quality (logistical fulfillment and human interaction), and integration quality (providing customers with a seamless service experience across multiple channels) (Sousa & Voss, 2006).

The adoption of e-commerce is a significant driver of economic success in both developed and developing countries, where adoption rates of such technologies are still lagging behind (Tan & Ludwig,

2016). E-service quality is crucial for e-commerce success (Khan et al., 2018). Moreover, the ease of comparing product or service information online is one of the advantages of e-commerce (Muhammad et al., 2016). As consumer preference for online shopping has increased, e-service quality plays an important role in all societies (Shankar & Jebarajakirthi, 2019). Customers can be satisfied if the website gives them reasons to trust it, and when customers perceive an improvement in e-service quality, their buying behavior is favorably influenced in future purchasing decisions, increasing their loyalty and decreasing complaints (Al-Dweeri et al., 2019).

On the other hand, the use of e-services is an important strategy in commerce, as it can be faster and more standardized, but it can also pose risks such as privacy and security (Rod & Ashill, 2010). Additionally, the advent of e-commerce makes customer loyalty even more challenging, as competition has increased, and switching costs for consumers have become minimal, making it essential to have a clear conceptualization and measurement of consumer loyalty (García & de Marcos, 2016). Overall, the evolution of the internet has made e-commerce one of the most effective and efficient methods of doing business, considering that consumer preference has increased and is one of the most used trends today (Miluska et al., 2020). Service innovation with customer value evaluation helps improve service skills, therefore, e-service quality can influence the values perceived by customers (Lee et al., 2022).

Therefore, success in e-commerce largely depends on enhancing customers' positive experiences by improving the high levels of service quality delivered through the interaction process (Chang et al., 2019). It is important to highlight that e-services mainly attract young and tech-savvy consumers who enjoy the convenience of not having to rush to physical stores (Muhammad et al., 2016). Therefore, it is necessary to consider customer characteristics and preferences when designing and improving e-services to increase their satisfaction and loyalty. Thus, a) web design is a fundamental aspect of e-service quality. According to studies conducted by Cohen et al. (2021), Choi & Lee (2012), Pelet & Taieb (2022), and Coursaris et al. (2008), aesthetic attributes such as color, contrast, and typography are the most determining factors (Dianat et al., 2019) found that web design and performance are the main predictors of website usability and that customer satisfaction is influenced by web design attributes. Therefore, website designers should focus more on this attribute to improve usability and user satisfaction. b) Website functionality is positively related to customer satisfaction, according to the study conducted by Tandon et al. (2018). Additionally, Barrera-Barrera et al. (2015) mentioned that functionality is determined by verifying if the web page is available, easy, and fast. It is also important to have a set of objective metrics to measure website functionality. Also, c) privacy in the digital economy, the privacy and security of personal data on website applications are of vital importance. According to Lin et al. (2022) and Wu et al. (2021), websites must implement basic measures to protect personal information and disclose personal information protection policies. The issue of user privacy has become one of the main obstacles to the development and application of e-commerce. Finally, d) website reliability is important as the information displayed on the website must match the product offered. According to Karim (2011), Pavlou & Chai (2002), and Barusman (2019), the quality of websites depends greatly on reliability and response time. Moreover, reliability and trust are among the factors that influence consumers in choosing online merchants.

In Spain, a scale was developed to measure the quality of purchasing services online, such as transport tickets, accommodation reservations, and ticket purchases. The scale consists of four dimensions: design, functionality, privacy, and reliability. A first-order factorial model was used to evaluate the validity and reliability of the scale, and it was shown that the scale used is valid and reliable in each of the three services. Furthermore, it was found that the scale possesses measurement equivalence among different services, allowing the use of the same measurement scale to evaluate quality in purchasing different electronic services.

It is necessary to evaluate an online bookstore since online businesses are in high demand today, and this method offers advantages for both companies and customers (Barrera-Barrera et al., 2015). It is observed that, in the Peruvian context, the construct of electronic service quality in a virtual bookstore has not yet been evaluated. Therefore, it is necessary to assess reliability, validity, and invariance by gender to verify if it is an efficient tool in this cultural context.

Methods

Design and Study Population

An instrumental study was designed (Ato et al., 2013). The sample size was determined using the Soper electronic calculator (Soper, 2021), considering the number of observed and latent variables in the model, the anticipated effect size ($\lambda = 0.1$), the desired statistical significance ($\alpha = 0.05$), and the statistical power level ($1 - \beta = 0.90$), which suggested a sample of 199. A total of 412 customers of the Peruvian online bookstore participated, aged between 18 and 72 years ($M = 31.8$, $SD = 8.3$). Regarding gender, 58.7% of respondents were male, while 41.3% were female. In terms of education, the majority of respondents, 76.9%, had a university level education. Finally, regarding religion, an overwhelming majority of 98.3% identified as Adventists.

Procedure

Prior to data collection, approval was obtained from the ethics committee of Peruvian Union University

(2023-CEUPeU-023). The guidelines stipulated in the Declaration of Helsinki and confidentiality standards were followed, informing participants about the nature of the project, followed by obtaining informed consent. Permission was requested from the company's manager. Once permissions were granted, data were collected via Google Forms, Gmail, WhatsApp, and phone calls. The collection took place from April to September 2022.

Table 1. Sociodemographic Characteristics

| Characteristics | | n | % |
|-----------------|-------------------|-----|------|
| Gender | Female | 170 | 41.3 |
| | Male | 242 | 58.7 |
| Education | None | 4 | 1.0 |
| | Other | 19 | 4.6 |
| | Postgraduate | 36 | 8.7 |
| | Secondary | 21 | 5.1 |
| | Technical | 15 | 3.6 |
| | University | 317 | 76.9 |
| Religion | Adventist | 405 | 98.3 |
| | Catholic | 2 | 0.5 |
| | Other | 4 | 1.0 |
| | Jehovah's Witness | 1 | 0.2 |

Instrument

The Electronic Service Quality Scale - ONTSI (Barrera-Barrera et al., 2015) was used, validated in a Spanish context. The scale consists of 16 Likert-type items: Strongly Disagree = 1; Strongly Agree = 7. It is composed of four factors: Design, Functionality, Privacy, and Reliability. The scale had good internal consistency with a Cronbach's alpha for the four dimensions: 0.776, 0.876, 0.767, and 0.823.

Data Analysis

The Confirmatory Factor Analysis (CFA) of the scale was performed using the MLR estimator, appropriate for numerical variables and robust to deviations from inferential normality (Muthen & Muthen, 2017). The model fit was assessed using the chi-square test (χ^2), Confirmatory Fit Index (CFI) and Tucker-Lewis Index ($TLI \geq 0.90$) (Schumacker & Lomax, 2016), the Root Mean Square Error of Approximation (RMSEA), and the Standardized Root Mean Square Residuals ($SRMSR \leq 0.08$) (Kline, 2016). Additionally, to demonstrate internal validity through convergent validity, the Average Variance Extracted (AVE) per factor was calculated ($AVE > 0.50$), indicating that more than 50% of the variance is due to its indicators (Fornell & Larcker, 1981). Furthermore, inter-factor correlations (ϕ) were calculated according to conceptual affinity, as evidence of discriminant validity is assessed by empirical differentiation between the AVE and the square of the inter-factor correlations (ϕ^2), where the former is expected to be greater ($AVE > \phi^2$) (Fornell & Larcker, 1981).

Finally, reliability was analyzed through the alpha coefficient (α) and the omega coefficient (ω) (McDonald, 1999), expecting high magnitudes (> 0.70) (Dominguez-Lara, 2016; Raykov & Hancock, 2005). All statistical analyses were performed using the free software R 4.1.1. (R Foundation for Statistical Computing, Vienna, Austria; <http://www.R-project.org>).

Results

Descriptive Statistics of Items

Table 2 shows the descriptive statistics. The highest mean was for item 5 (5.46) and the lowest for item 9 (4.99). Skewness ($g1$) ranged from -0.6 (items 5 and 8) to 0.25 (item 13), suggesting that the data distribution is not excessively skewed. Kurtosis ($g2$) ranged from -0.68 (item 10) to 1.67 (item 12), indicating that some items have distributions that are more or less peaked than the normal distribution. Item-total correlations ranged from 0.69 to 0.91, suggesting that all items are related to the corresponding construct (>0.30). The internal consistency (Cronbach's alpha) for the complete scale was 0.97, indicating high reliability of the scale.

Validity Based on Internal Structure

A CFA was conducted, considering a first model with all items, which showed adequate fit indices: $\chi^2 = 338.96$, $df = 88$; $p < .001$; $CFI = 0.94$, $TLI = 0.94$, $RMSEA = 0.08$ (90% CI 0.08 - 0.09), $SRMR = 0.04$, and with factor loadings of adequate magnitudes ($\lambda > 0.70$), suggesting that each item reliably measures its corresponding

factor. Similarly, for convergent validity, the AVEs reached an acceptable magnitude (>0.50) and are robust for each factor, indicating that the factors adequately measure the variables they represent. Regarding internal discriminant validity, the AVEs were equal to or higher than the shared variance between factors ($AVE > \varphi^2$) for all factors (Table 3).

Table 2. Descriptive Statistics and Reliability

| Items | M | SD | g1 | g2 | r.cor | alpha |
|---|------|------|-------|-------|-------|-------|
| Diseño / Design | | | | | | |
| La página web es atractiva / The website is attractive | 5.35 | 0.92 | 0.11 | -0.39 | 0.79 | 0.97 |
| La página web tiene un tipo de letra adecuado / The website has an appropriate font | 5.42 | 0.87 | 0.23 | -0.33 | 0.88 | 0.97 |
| La página web utiliza colores atractivos / The website uses attractive colors | 5.29 | 1.11 | -0.59 | 1.27 | 0.79 | 0.97 |
| Funcionalidad / Functionality | | | | | | |
| La página web está en cualquier momento disponible para su acceso / The website is available for access at any time | 5.51 | 1.02 | -0.4 | 0.23 | 0.84 | 0.97 |
| Los enlaces de la página web funcionan correctamente / The links on the website work correctly | 5.46 | 1.13 | -0.6 | 0.87 | 0.76 | 0.97 |
| El tiempo de carga de la página web es rápido / The website loads quickly | 5.49 | 1.12 | -0.59 | 0.71 | 0.88 | 0.97 |
| La página web permite un acceso rápido / The website allows quick access | 5.46 | 1.07 | -0.4 | 0.1 | 0.89 | 0.97 |
| Resulta fácil y rápido navegar dentro de la página web / It is easy and quick to navigate within the website | 5.37 | 1.16 | -0.6 | 0.6 | 0.86 | 0.97 |
| Privacidad / Privacy | | | | | | |
| En la página web aparecen símbolos y mensajes que indican la seguridad de esta / The website shows symbols and messages indicating security | 4.99 | 1.14 | 0.15 | -0.47 | 0.75 | 0.97 |
| La página web garantiza la protección de la información personal del cliente / The website guarantees the protection of personal information | 5.05 | 1.09 | 0.13 | -0.68 | 0.78 | 0.97 |
| La página web garantiza que la información del cliente no la compartirá con otras empresas o sitios webs / The website ensures that customer information is not shared with other companies or websites | 4.99 | 1.09 | -0.04 | -0.02 | 0.69 | 0.97 |
| Fiabilidad / Reliability | | | | | | |
| El servicio ofrecido es exactamente el contratado en la página web / The service offered is exactly as advertised on the website | 5.28 | 1.05 | -0.56 | 1.67 | 0.79 | 0.97 |
| El proveedor online realiza una facturación del servicio sin errores / The online provider invoices the service without errors | 5.26 | 0.94 | 0.25 | -0.18 | 0.83 | 0.97 |
| La información que aparece en la página web es fácil de comprender / The information on the website is easy to understand | 5.33 | 0.92 | -0.09 | 0.1 | 0.88 | 0.97 |
| La información que aparece en la página web está actualizada / The information on the website is up-to-date | 5.22 | 1.05 | -0.34 | 0.4 | 0.89 | 0.97 |
| La información que aparece en la página web es detallada / The information on the website is detailed | 5.24 | 0.96 | -0.12 | 0.29 | 0.91 | 0.97 |

Table 3. CFA and Reliability

| Items | F1 | F2 | F3 | F4 |
|-------|------|------|------|----|
| 1 | 0.84 | | | |
| 2 | 0.91 | | | |
| 3 | 0.79 | | | |
| 4 | | 0.83 | | |
| 5 | | 0.75 | | |
| 6 | | 0.91 | | |
| 7 | | 0.92 | | |
| 8 | | 0.84 | | |
| 9 | | | 0.91 | |
| 10 | | | 0.96 | |
| 11 | | | 0.79 | |

| | | | | |
|----------|------|-------|-------|-------|
| 12 | | | | 0.74 |
| 13 | | | | 0.81 |
| 14 | | | | 0.81 |
| 15 | | | | 0.91 |
| 16 | | | | 0.92 |
| AVE | 0.72 | 0.73 | 0.79 | 0.71 |
| F1 | | 0.656 | 0.462 | 0.706 |
| F2 | 0.81 | | 0.372 | 0.792 |
| F3 | 0.68 | 0.61 | | 0.548 |
| F4 | 0.84 | 0.89 | 0.74 | |
| α | 0.88 | 0.93 | 0.91 | 0.92 |
| Ω | 0.88 | 0.92 | 0.92 | 0.90 |

Note: α = Cronbach's alpha; Ω = McDonald's omega; λ = Factor loading; AVE = Average Variance Extracted

Factorial Invariance

After conducting a factorial invariance analysis by gender, it was found that the thresholds, factor loadings, intercepts, and residuals are consistent across both groups (Brown, 2015). In other words, the questionnaire items measure the latent variable similarly in both men and women, suggesting that differences in scores between genders result from true discrepancies in the latent trait rather than potential bias in the evaluation tool. These findings are important for future research on electronic service quality by gender, as they allow for more accurate and reliable comparisons of results between both groups (Table 4).

Table 4. Factorial Invariance by Gender

| Invariance | χ^2 | df | SRMR | TLI | CFI | Δ CFI |
|------------|----------|-----|------|------|------|--------------|
| M1 | 603.86 | 176 | 0.05 | 0.90 | 0.92 | |
| M2 | 626.217 | 188 | 0.06 | 0.90 | 0.92 | 0.00 |
| M3 | 670.408 | 200 | 0.06 | 0.90 | 0.91 | 0.01 |
| M4 | 698.103 | 216 | 0.07 | 0.89 | 0.90 | 0.01 |

M1 = Configural, M2 = Metric, M3 = Scalar, M4 = Strict

Discussion

E-commerce has experienced significant growth in recent years, especially after the COVID-19 pandemic. In Peru, the use of electronic services has also increased, and the quality of electronic service has become very important in the market. Electronic service quality is measured in different dimensions, such as virtual, physical, and integration quality. The ease of comparing product or service information online is one of the advantages of e-commerce. Privacy and security are important risks to consider. Service innovation through customer value evaluation helps improve service skills, and service quality can influence customers' perceived values. Success in e-commerce largely depends on enhancing positive customer experiences by improving high levels of service quality delivered through the interaction process. The quality of design, functionality, privacy, and reliability of the website are important aspects to consider in electronic service quality.

In the Peruvian context, the construct of electronic service quality in a virtual bookstore has not yet been evaluated. Therefore, it is necessary to assess reliability, validity, and invariance to verify if it is an efficient tool in this cultural context.

The factor analysis conducted a first-order model and confirmed the Spanish version's four dimensions. It was found that all items significantly load on their respective factors. Unlike the Spanish version, which also conducted a confirmatory factor analysis but used a second-order model of the electronic service quality scale in each of the three services studied, the Peruvian version shows high internal consistency (Cronbach's alpha of 0.97). The Spanish version also presents high internal consistency, and the fit indices of the factorial model are adequate. Additionally, a factorial invariance analysis by gender was conducted, allowing for a more accurate and reliable comparison of results between both groups. Both versions also evaluated convergent and discriminant validity. It was found that all items significantly load on their respective dimensions, and convergent validity of the electronic service quality scale was ensured.

Furthermore, the questionnaire items measure the latent variable similarly in both men and women,

suggesting that differences in scores between genders result from true discrepancies in the latent trait rather than potential bias in the evaluation tool. In the Spanish case, significant results were obtained in the three services studied, indicating that the scale is useful in different contexts.

Implications

The study presents important theoretical and practical implications in the context of e-commerce and electronic service quality in a virtual bookstore in Peru. From a theoretical perspective, the study validates the electronic service quality scale in a cultural context different from the Spanish one, allowing its use in future studies. Additionally, the findings contribute to understanding the factors that influence electronic service quality, which can be useful for improving the user experience in a virtual store.

From a practical perspective, the study provides valuable information to companies operating in the Peruvian market, especially virtual bookstores, to improve the quality of their electronic service. Evaluating electronic service quality will enable companies to identify strengths and weaknesses in their service, aiding in decision-making regarding improvements and marketing strategies.

Moreover, the factorial invariance by gender found in the study suggests that the scale is a reliable tool for assessing electronic service quality in both men and women, allowing for accurate and reliable comparisons of results between both groups. This finding may be relevant for future studies aiming to identify gender differences in the perception of electronic service quality.

Limitations

The presented study has some important limitations that should be considered when interpreting the results. First, the sample is limited to a single country, which may restrict the generalizability of the results to other populations. Additionally, the study relied on self-reports, which may be biased by individual perceptions and attitudes. Lastly, it should be noted that the study focused on a single variable and did not consider other factors that could have influenced the results. To address these limitations in future research, it is recommended to expand the sample and consider including multiple countries to obtain more representative results. Multiple measurement methods could also be used to gain a more comprehensive view of the variable under study and consider including other variables that may influence the results.

Conclusion

The electronic service quality scale proved to be reliable, valid, and invariant by gender in the Peruvian context. This study provides valuable information for business owners and website designers in creating and improving electronic services to increase customer satisfaction and loyalty in the Peruvian market.

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