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The Digital Loyalty Equation in Distribution Science: A Multi-method Exploration of E-commerce Success Factors*

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Abstract

Purpose: This study explores the complex interplay between service quality, customer engagement, and loyalty in the e-commerce sector, examining the moderating effect of technological adoption on these crucial relationships. **Research design, data and methodology:** Employing a robust multi-method approach, the research analyzes data from 481 e-commerce users, leveraging the complementary strengths of partial least squares structural equation modeling (PLS-SEM) and fuzzy-set qualitative comparative analysis (fsQCA). A comprehensive multi-group analysis is conducted to uncover differences between experienced and non-experienced users. **Results:** PLS-SEM reveals that service quality significantly influences customer engagement, which in turn drives loyalty. Technological adoption positively moderates the service quality-engagement relationship. The multi-group analysis uncovers notable differences between user segments. fsQCA identifies two distinct configurational paths consistently leading to high customer loyalty: high customer engagement and high service quality. **Conclusions:** This study's innovative integration of PLS-SEM and fsQCA contributes to a deeper understanding of the intricate dynamics driving e-commerce success. Findings provide actionable insights for e-commerce businesses to enhance service quality, foster engagement, and cultivate loyalty. This research lays the groundwork for further exploration of these critical relationships in different contexts, offering a nuanced perspective on the complex interplay of factors shaping customer behavior in the digital marketplace.

Keywords : E-commerce Service Quality, Customer Engagement, Technological Adoption, Emerging Markets, Multi-group Analysis, Distribution Science

JEL Classification Code: M31, L81, O33

1. Introduction

In the rapidly evolving landscape of e-commerce, understanding the factors that drive customer loyalty has

become increasingly crucial for businesses seeking to thrive in the digital marketplace. As e-commerce platforms proliferate and competition intensifies, service quality has emerged as a critical differentiator, shaping customer

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perceptions and behaviors (Parasuraman et al., 2005). However, the unique characteristics of online transactions necessitate a re-examination of the traditional service quality paradigm, taking into account the complex interplay of factors such as customer engagement and technological adoption (Blut, 2016). While numerous studies have explored the relationships between service quality, customer engagement, and loyalty in e-commerce contexts (Pansari & Kumar, 2017), there remains a paucity of research examining these constructs within a single, integrated framework. Moreover, the role of technological adoption in moderating these relationships has received limited attention, despite its potential to significantly influence customer perceptions and behaviors in digital environments (Venkatesh & Davis, 2000).

Vietnam's e-commerce sector provides a compelling context for this study due to its rapid growth and unique market dynamics. As one of the fastest-growing digital economies in Southeast Asia, Vietnam has witnessed a surge in e-commerce adoption, with the sector expected to reach \$52 billion by 2025 (Baijal et al., 2021). This growth has been fueled by increasing internet penetration, a young and tech-savvy population, and the proliferation of mobile devices. However, despite this potential, e-commerce businesses in Vietnam face challenges such as intense competition, evolving consumer preferences, and the need to build trust in online transactions. Understanding the factors that drive customer loyalty in this context is crucial for businesses seeking to capitalize on the opportunities presented by Vietnam's digital transformation. By focusing on Vietnam, this study aims to provide insights that are not only relevant to the local context but also to other emerging markets grappling with similar challenges and opportunities in the e-commerce space.

This study aims to address these gaps by investigating the impact of service quality on customer engagement and loyalty in modern distribution science framework emphasizing on e-commerce, with a particular focus on the moderating role of technological adoption. By integrating established theoretical frameworks such as SERVQUAL (Parasuraman et al., 1988), Customer Engagement Theory (Brodie et al., 2011), and the Technology Acceptance Model (Davis et al., 1989), we seek to provide a comprehensive understanding of the complex dynamics driving customer loyalty in online retail settings. Furthermore, we extend the existing literature by employing a novel methodological approach that combines partial least squares structural equation modeling (PLS-SEM) with fuzzy-set qualitative comparative analysis (fsQCA). This dual approach enables us to capture both the general trends in the relationships between service quality, customer engagement, and loyalty, as well as the specific configurational paths that lead to high customer loyalty. By leveraging the strengths of both

methods, we aim to provide a more nuanced and holistic understanding of the factors driving e-commerce success. The significance of this research extends beyond theoretical contributions to the e-commerce literature. As businesses increasingly rely on digital platforms to reach and retain customers, understanding the complex interplay of factors influencing customer loyalty becomes paramount. Our findings offer valuable practical insights for e-commerce managers seeking to enhance service quality, foster customer engagement, and cultivate long-term loyalty in an increasingly competitive online landscape.

In the following sections, we present a comprehensive review of the relevant literature, outline our methodological approach, and discuss the key findings and implications of our study. Through this research, we aim to contribute to the ongoing discourse on e-commerce success factors and provide actionable insights for businesses navigating the challenges and opportunities of the digital marketplace.

2. Literature Review

2.1. Service Quality in E-commerce

E-service quality plays a crucial role in e-commerce customer satisfaction, distribution science, and loyalty. Key dimensions of e-service quality include website design, reliability, responsiveness, trust, personalization, fulfillment, availability, ease of use, assurance, credibility, accessibility, efficiency, and privacy (Md Sabri et al., 2022; Ganie & Bhat, 2023; Nguyen, 2013). Both e-service quality and logistics service quality directly and positively affect customer satisfaction and loyalty (Rachmawati & Agus, 2020). E-commerce platforms should focus on improving these critical e-service quality components to meet customer needs and preferences, ensuring long-term success (Ganie & Bhat, 2023). Understanding these factors can help e-commerce businesses and website developers enhance their offerings and attract new customers while retaining existing ones.

2.2. Customer Engagement in Digital Platforms

Customer engagement in digital platforms has become increasingly important as consumers take on more active roles in brand interactions. Research shows that digitalized interactive platforms can satisfy psychological needs and influence customer engagement, which in turn affects subjective well-being (Roy et al., 2023). Carlson et al. (2018) found that perceived interactivity, vividness, and novelty of online brand content significantly influence customer engagement. As digital media evolves, firms have opportunities to proactively engage with consumers and

respond to user-generated content (Malthouse & Calder, 2015). In the banking sector, service quality on digital platforms influences customer satisfaction, which together drive customer engagement behavior (Lodeiros-Zubiria, 2021). These studies highlight the complex relationships between digital platforms, customer engagement, and business outcomes.

2.3. Customer Loyalty in Online Retail

Customer loyalty in online retail is influenced by various factors. Web-store design elements, including functionality and brand assortment, impact loyalty through flow and customer satisfaction (Soni, 2021). Brand association and awareness significantly affect customer loyalty and willingness to pay (Phong et al., 2020). Critical factors contributing to e-commerce loyalty include delivery conditions, shopping convenience, social media presence, shipment impressions, credibility, and promotion (Pierański et al., 2022). Trust plays a crucial role, with on-time delivery, perceived security, product variety, and perceived ease of use being key antecedents (Mofokeng, 2023). Online shopping experience and e-shopping spending moderate the impact of these factors on trust and loyalty (Mofokeng, 2023).

2.4. Technological Adoption in E-commerce

Technological adoption in e-commerce has become increasingly important, particularly for small and medium enterprises (SMEs) (Aswar & Ermawati, 2021). Research has identified several factors influencing e-commerce adoption, including technological, organizational, and environmental contexts (Fonseka et al., 2020; Aswar & Ermawati, 2021). The Technology Acceptance Model (TAM) has been widely used to examine e-commerce adoption, with studies showing that perceived usefulness and ease of use positively impact attitudes and behavioral intentions to use e-commerce (Zakiah et al., 2024). However, challenges remain, particularly in developing countries, where issues such as inadequate legal frameworks and limited mobile web configurations hinder widespread adoption (Ibrahim & Abubakar, 2016).

2.5. The E-commerce Context of Emerging Markets

Emerging markets, such as Vietnam, present unique opportunities and challenges for e-commerce growth. Several factors contribute to e-commerce adoption among Vietnamese SMEs, including perceived usefulness, ease of use, and social influence. However, concerns about security and privacy remain significant barriers to widespread adoption. Understanding the unique dynamics of e-

commerce in emerging markets is crucial for both local and international players.

2.6. Application of fsQCA in E-commerce Research

Recent research has explored the application of fuzzy-set Qualitative Comparative Analysis (fsQCA) in e-commerce and consumer behavior studies. Chang et al. (2024) used fsQCA to analyze trust transfer mechanisms and socio-technical aspects in live streaming e-commerce, revealing diverse configurations shaping consumer behavior. Phung et al. (2020) demonstrated fsQCA's effectiveness in examining eWOM and social influence on product adoption intention, confirming results from statistical approaches. Diwanji (2022) conducted a systematic literature review of fsQCA in consumer research, highlighting its potential to better predict and explain consumer decisions in complex contexts. Gligor et al. (2021) explored the benefits and current state of fsQCA in B2B marketing research, emphasizing its ability to address increasingly complex phenomena in B2B relationships. These studies collectively underscore fsQCA's value in uncovering nuanced insights and addressing asymmetries in e-commerce and marketing research.

Despite the growing body of literature on e-commerce, several research gaps persist. Few studies have examined service quality, customer engagement, and loyalty within a single, integrated framework in the e-commerce setting. The moderating role of technological adoption in these relationships has received limited attention. Moreover, while fsQCA has shown promise in e-commerce research, its application in conjunction with traditional statistical methods remains underexplored. This study aims to address these gaps by investigating the impact of service quality on customer engagement and loyalty in Vietnam's e-commerce sector, with a focus on the moderating role of technological adoption, using a novel combination of PLS-SEM and fsQCA.

3. Theoretical Framework and Hypotheses Development

3.1. Service Quality and Customer Engagement

Recent studies highlight the significant relationship between service quality and customer engagement across various contexts. In the e-commerce context, service quality encompasses various dimensions, including website design, fulfilment, customer service, and security (Blut, 2016). Customer engagement, as conceptualised by Brodie et al. (2011), comprises cognitive, emotional, and behavioural components. Prior research has suggested a positive

relationship between service quality and customer engagement in various contexts. For mobile e-commerce applications, interactivity positively influences customer engagement behaviors, while service quality moderates certain aspects of this relationship (Utami et al., 2021). In the context of AI-powered hotel services, customer perceptions of AI service quality impact satisfaction and engagement, with AI preference moderating these effects (Prentice et al., 2020). Based on these theoretical foundations and empirical evidence, we propose the following hypothesis:

H1: Service quality positively influences customer engagement in Vietnam's e-commerce sector.

3.2. Service Quality and Customer Loyalty

The relationship between service quality and customer loyalty has been extensively studied in various contexts, including e-commerce. Recent studies have further refined our understanding of this relationship. Rita et al. (2019) found that e-service quality significantly influences e-satisfaction and e-loyalty in online shopping. In the context of emerging markets, Pham and Ahammad (2017) demonstrated that e-service quality positively affects customer loyalty in Vietnamese online shopping platforms, with trust playing a mediating role. Given the consistent empirical evidence and the theoretical underpinnings from the service profit chain (Heskett et al., 1994), we propose:

H2: Service quality positively influences customer loyalty in Vietnam's e-commerce sector.

3.3. Customer Engagement and Customer Loyalty

The relationship between customer engagement and loyalty has garnered significant attention in marketing literature, particularly in the digital realm. Empirical evidence strongly supports this connection. Thakur (2019) revealed that customer engagement significantly influences loyalty intentions in mobile shopping applications. In the e-commerce sector, So et al. (2020) demonstrated that customer engagement positively impacts both attitudinal and behavioural loyalty. Drawing from these theoretical foundations and empirical findings, we propose:

H3: Customer engagement positively influences customer loyalty in Vietnam's e-commerce sector.

3.4. The Moderating Role of Technological Adoption

The Technology Acceptance Model (TAM) proposed by Davis et al. (1989) provides a theoretical foundation for understanding how users adopt and use technology. Recent research suggests that technological adoption may play a

crucial moderating role in the relationships between service quality, customer engagement, and loyalty. Chopdar et al. (2018) found that technology readiness moderates the relationship between mobile shopping app quality and user satisfaction, which in turn influences loyalty. The moderating effect of technological adoption can be explained through the lens of the Elaboration Likelihood Model (ELM) (Petty & Cacioppo, 1986). According to ELM, individuals with higher levels of technological adoption are likely to process information about e-commerce services more thoroughly, potentially strengthening the impact of service quality on engagement and loyalty. Based on these theoretical perspectives and empirical evidence, we propose:

H4a: Technological adoption positively moderates the relationship between service quality and customer engagement in Vietnam's e-commerce sector.

H4b: Technological adoption positively moderates the relationship between service quality and customer loyalty in Vietnam's e-commerce sector.

These hypotheses suggest that the impact of service quality on both customer engagement and loyalty will be stronger for users with higher levels of technological adoption.

3.5. Conceptual Model

The conceptual model, illustrated in Figure 1, synthesises the hypothesised relationships among the key constructs of this study. It depicts service quality as the independent variable, customer engagement and customer loyalty as dependent variables, and technological adoption as a moderating variable.

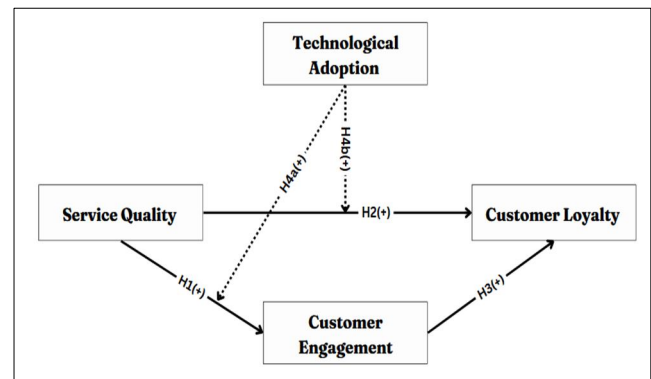


Figure 1: Conceptual framework

The model proposes that service quality directly influences both customer engagement (H1) and customer loyalty (H2). Additionally, it posits that customer engagement has a direct effect on customer loyalty (H3).

The moderating role of technological adoption is represented by its influence on the relationships between service quality and customer engagement (H4a), and between service quality and customer loyalty (H4b). This framework provides a comprehensive approach to understanding the dynamics of customer behaviour in Vietnam's e-commerce sector.

4. Methodology

4.1. Research Design

This study employs a quantitative research design to examine the relationships between service quality, customer engagement, customer loyalty, and the moderating role of technological adoption in Vietnam's e-commerce sector. A cross-sectional survey approach was adopted to collect data from e-commerce users in Vietnam. This method allows for the efficient collection of a large amount of data and is suitable for testing the hypothesized relationships in our conceptual model.

The research design incorporates the use of partial least squares structural equation modeling (PLS-SEM) to analyze the data. PLS-SEM is particularly appropriate for this study due to its ability to handle complex models with multiple constructs and relationships, as well as its robustness in dealing with non-normal data distributions (Hair et al., 2017). Furthermore, we employ fuzzy-set qualitative comparative analysis (fsQCA) to complement the PLS-SEM analysis and provide a more nuanced understanding of the complex causal relationships among the constructs.

4.2. Sampling and Data Collection

The target population comprises adult internet users in Vietnam who have made at least one online purchase in the past six months. A non-probability sampling technique, specifically purposive sampling, was employed to ensure that respondents met the criteria of being active e-commerce users. Data collection was conducted through an online survey platform over a period of two months. The survey was distributed through various channels, including social media platforms, e-commerce forums, and consumer groups, to reach a diverse sample of e-commerce users. A total of 527 responses were received, of which 481 were deemed complete and valid for analysis after data cleaning. The sample size exceeds the minimum requirement for PLS-SEM analysis, which is ten times the largest number of structural paths directed at a particular construct in the structural model (Hair et al., 2017).

Table 1: Sample Description with Detailed Distribution

Criteria	Categories	Frequency	Percentage(%)
Gender			
	Male	225	46.78
	Female	256	53.22
Age			
	18-25	220	45.74
	26-40	181	37.63
	Above 40	80	16.63
Income Level			
	Low Income	150	31.19
	Middle Income	231	48.02
	High Income	100	20.79
Geographical Location			
	Urban	300	62.37
	Rural	181	37.63
Online Shopping Experience			
	Frequent Online Shoppers	265	55.09
	Occasional Online Shoppers	216	44.91
Type of Products Purchased			
	Technology and Electronics	130	27.02
	Fashion and Beauty	160	33.26
	Daily Consumer Goods	191	39.71
Technological Proficiency			
	High	200	41.58
	Medium	181	37.63
	Low	100	20.79

4.3. Measures and Instrument Development

The measurement scales for the constructs in this study were adapted from existing validated scales in the literature. All items were measured on a five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). The questionnaire was initially developed in English and then translated into Vietnamese using the back-translation method to ensure equivalence (Brislin, 1970). Table 2 presents the constructs, their dimensions, and the sources of the measurement scale.

4.4. Data Analysis Techniques

This study employs a rigorous multi-method approach, leveraging the complementary strengths of partial least squares structural equation modeling (PLS-SEM) and fuzzy-set qualitative comparative analysis (fsQCA) to examine the relationships between service quality, customer engagement, customer loyalty, and the moderating role of technological adoption in Vietnam's e-commerce sector.

The PLS-SEM analysis is conducted using SmartPLS 4.1 software, following a two-step approach (Anderson & Gerbing, 1988). First, the measurement model is assessed for reliability and validity using confirmatory composite

analysis (CCA) and heterotrait-monotrait ratio of correlations (HTMT). Second, the structural model is evaluated using consistent PLS (PLSc) bootstrapping with 5,000 subsamples. To examine the moderating effects of technological adoption, the orthogonalizing approach is implemented to mitigate potential multicollinearity issues (Henseler & Chin, 2010). Furthermore, a comprehensive multi-group analysis (MGA) is conducted using the permutation test available in SmartPLS 4.1, enabling a nuanced comparison between experienced and non-experienced e-commerce users and providing deeper insights into group-specific differences in structural relationships. For the fsQCA analysis, the direct method of calibration (Ragin, 2008) is employed, with thresholds for full membership, cross-over point, and full non-membership set based on the survey scale and theoretical considerations. The truth table is then analyzed to identify configurations consistently leading to high customer loyalty, with the frequency threshold set at 1 case and the consistency threshold at 0.8, following recommendations in the literature (Ragin, 2008).

The integration of PLS-SEM and fsQCA findings is achieved through a systematic comparison and synthesis of results, ensuring a comprehensive understanding of the complex relationships among the constructs.

5. Results

5.1. Sample Characteristics

The final sample comprised 481 valid responses from Vietnamese e-commerce users. The gender distribution was

relatively balanced, with 53.22% female and 46.78% male participants. The majority of respondents (45.74%) were aged 18-25, followed by 37.63% in the 26-40 age group. In terms of income levels, 48.02% of respondents fell into the middle-income category. The sample showed a predominance of urban residents (62.37%) over rural dwellers (37.63%). Notably, 55.09% of participants identified as frequent online shoppers. The most common product categories purchased were daily consumer goods (39.71%), followed by fashion and beauty items (33.26%), and technology and electronics (27.02%). Regarding technological proficiency, 41.58% of respondents reported high proficiency, suggesting a technologically savvy sample.

5.2. Measurement Model Assessment

The measurement model was rigorously evaluated using SmartPLS 4.1, focusing on reliability, validity, and model fit assessments. Table 2 presents the results of the construct reliability and validity analyses.

Internal consistency reliability was assessed using Cronbach's alpha and composite reliability. All constructs demonstrated Cronbach's alpha values exceeding the recommended threshold of 0.7 (Nunnally, 1978), ranging from 0.868 to 0.920. Composite reliability values, both ρ_a and ρ_c , were well above the 0.7 criterion (Hair et al., 2017), indicating excellent internal consistency. Convergent validity was evaluated using the Average Variance Extracted (AVE). All constructs exhibited AVE values above the 0.5 threshold (Fornell & Larcker, 1981), ranging from 0.572 to 0.606, confirming adequate convergent validity.

Table 2. Construct Measurement and Construct Reliability and Validity

Construct/ Dimensions	Measurement Scale (Survey Questions)	Cronbach's alpha	Composite reliability (ρ_a)	Composite reliability (ρ_c)	Average variance extracted (AVE)
Service Quality (SQ)	Parasuraman et al. (1988)	0.920	0.922	0.932	0.580
Tangibility	1. The e-commerce platform uses modern equipment.				
	2. The platform's facilities are visually appealing.				
Reliability	1. The e-commerce platform provides dependable services.				
	2. Orders are fulfilled accurately by the platform.				
Responsiveness	1. The platform provides prompt service.				
	2. The platform staff are willing to help customers.				
Assurance	1. The staff are knowledgeable and courteous.				
	2. I feel safe using the e-commerce platform.				
Empathy	1. The platform gives individualized attention to customers.				
	2. The platform understands my specific needs.				
Customer Engagement (CE)	Vivek et al. (2012)	0.870	0.872	0.902	0.606
Cognitive	1. I spend a lot of time on the e-commerce platform.				
	2. I frequently visit the platform.				

Construct/ Dimensions	Measurement Scale (Survey Questions)	Cronbach's alpha	Composite reliability (rho_a)	Composite reliability (rho_c)	Average variance extracted (AVE)
Emotional	1. I feel pleasure when using the platform.				
	2. I am satisfied with my experiences on the platform.				
Behavioral	1. I participate in activities on the platform (e.g., writing reviews).				
	2. I engage with other users on the platform.				
Technological Adoption (TA)	Davis et al. (1989)	0.895	0.911	0.914	0.572
Perceived Usefulness	1. Using the e-commerce platform enhances my shopping experience.				
	2. The platform makes shopping easier for me.				
Perceived Ease of Use	1. It is easy to navigate the e-commerce platform.				
	2. I find the platform easy to use.				
Attitude Towards Using Technology	1. I have a positive attitude towards using the e-commerce platform.				
	2. Using the platform is a good idea.				
Behavioral Intention to Use Technology	1. I intend to use the e-commerce platform in the future.				
	2. I will continue to use the platform regularly.				
Customer Loyalty (CL)	Zeithaml et al. (1996)	0.868	0.875	0.900	0.601
Repurchase Intention	1. I will make future purchases from this e-commerce platform.				
	2. I plan to buy from this platform again.				
Willingness to Recommend	1. I will recommend this e-commerce platform to others.				
	2. I will tell my friends and family about this platform.				
Overall Satisfaction	1. Overall, I am satisfied with the services provided by the platform.				
	2. My experience with the platform meets my expectations.				

Discriminant validity was assessed using the Heterotrait-Monotrait ratio (HTMT) method, as shown in Table 3.

Table 3: Heterotrait-monotrait ratio (HTMT) – Matrix

	CE	CL	SQ	TA	TA x SQ
CE					
CL	0.254				
SQ	0.310	0.104			
TA	0.059	0.135	0.154		
TA x SQ	0.267	0.019	0.203	0.215	

All HTMT values were well below the conservative threshold of 0.85 (Henseler et al., 2015), with the highest value being 0.310 between CE and SQ. This result strongly supports the discriminant validity of the constructs. Additionally, we examined the Variance Inflation Factor (VIF) values to assess potential multicollinearity issues. All VIF values were below the stringent threshold of 3.0 (Hair et al., 2019), with the highest value being 2.47, indicating that multicollinearity is not a concern in our model. To evaluate the overall model fit, we employed the Standardized Root Mean Square Residual (SRMR) and the Normed Fit Index (NFI). The SRMR value of 0.062 is below the recommended threshold of 0.08 (Hu & Bentler, 1999), and the NFI value of 0.912 exceeds the recommended 0.9

threshold (Bentler & Bonett, 1980), both indicating good model fit.

5.3 Structural Model Assessment

5.3.1. Hypothesis Testing

Table 4 presents the results of the hypothesis testing.

Table 4: Path coefficients

	Original sample (O)	Sample mean (M)	Standard deviation (STDEV)	T statistics (O/STDEV)	P values
CE→CL	0.212	0.213	0.051	4.162	0.000
SQ→CE	0.253	0.260	0.046	5.548	0.000
SQ→CL	0.055	0.056	0.049	1.121	0.262
TA x SQ→CE	0.218	0.211	0.037	5.821	0.000
TA x SQ→CL	-0.036	-0.035	0.044	0.812	0.417

The results indicate strong support for H1, with service quality (SQ) positively influencing customer engagement (CE) ($\beta=0.253$, $p<0.001$). H3 is also supported, demonstrating a significant positive relationship between customer engagement (CE) and customer loyalty (CL) ($\beta=0.212$, $p<0.001$). However, H2, which posited a direct relationship between service quality (SQ) and customer loyalty (CL), is not supported ($\beta = 0.055$, $p>0.05$). The R^2

values for the endogenous constructs were 0.279 for customer engagement and 0.318 for customer loyalty, indicating moderate explanatory power of the model (Hair et al., 2017).

The analysis reveals a significant positive moderating effect of technological adoption on the relationship between service quality and customer engagement ($\beta=0.218$, $p<0.001$), supporting H4a. This suggests that the impact of service quality on customer engagement is stronger for users with higher levels of technological adoption. However, the moderating effect of technological adoption on the relationship between service quality and customer loyalty (H4b) is not supported ($\beta = -0.036$, $p>0.05$).

5.3.2. Multi-Group Analysis

To examine potential differences between experienced (Exp) and non-experienced (NoExp) e-commerce users, we conducted a multi-group analysis (MGA). Table 5 presents the results of the bootstrap MGA.

Table 5: Bootstrap MGA

	Difference (Exp - NoExp)	1-tailed (Exp vs NoExp) p value	2-tailed (Exp vs NoExp) p value
CE→CL	0.145	0.075	0.151
SQ→CE	-0.132	0.925	0.149
SQ→CL	-0.184	0.952	0.097
TA x SQ→CE	0.055	0.239	0.477
TA x SQ→CL	-0.087	0.826	0.349

The MGA results reveal no statistically significant differences between experienced and non-experienced users at the conventional $p < 0.05$ level. However, the relationship between service quality and customer loyalty (SQ → CL) shows a marginally significant difference ($p = 0.097$, two-tailed), with a stronger effect for non-experienced users.

To further explore these differences, we examined the path coefficients for each group separately, as shown in Table 6.

Table 6: Bootstrapping Results

	Original (Exp)	Original (NoExp)	p value (Exp)	p value (NoExp)
CE→CL	0.288	0.143	0.000	0.066
SQ→CE	0.208	0.340	0.002	0.000
SQ→CL	-0.030	0.154	0.728	0.028
TA x SQ→CE	0.221	0.166	0.009	0.001
TA x SQ→CL	-0.092	-0.005	0.244	0.925

These results reveal interesting differences between the two groups. The relationship between customer engagement and loyalty (CE → CL) is stronger and more significant for experienced users ($\beta = 0.288$, $p < 0.001$) compared to non-

experienced users ($\beta = 0.143$, $p = 0.066$). Conversely, the impact of service quality on customer engagement (SQ → CE) is stronger for non-experienced users ($\beta = 0.340$, $p < 0.001$) than for experienced users ($\beta = 0.208$, $p = 0.002$). Notably, the direct effect of service quality on customer loyalty (SQ → CL) is significant only for non-experienced users ($\beta = 0.154$, $p = 0.028$), while it is non-significant for experienced users. This suggests that as users gain more experience with e-commerce, the direct impact of service quality on loyalty diminishes, possibly being mediated by other factors such as customer engagement.

The moderating effect of technological adoption on the relationship between service quality and customer engagement (TA x SQ → CE) is significant for both groups, but slightly stronger for experienced users ($\beta=0.221$, $p=0.009$) compared to non-experienced users ($\beta=0.166$, $p=0.001$).

5.3.3. fsQCA Analysis

Table 7 presents the results of the fsQCA analysis. The parsimonious solution reveals two configurational paths consistently leading to high customer loyalty. The first path involves the presence of high customer engagement (ce_c) (raw coverage = 0.739, consistency = 0.739), while the second path involves the presence of high service quality (sq_c) (raw coverage = 0.715, consistency = 0.722). The overall solution coverage is 0.853, indicating that these two paths together explain a substantial proportion of the cases with high customer loyalty. The solution consistency is 0.685, suggesting that these configurations are sufficient for high customer loyalty.

These findings highlight the importance of considering user experience when developing strategies to enhance customer engagement and loyalty in e-commerce platforms.

Table 7: The Results of the fsQCA Analysis

Solution	Condition	Raw Coverage	Unique Coverage	Consistency
Parsimonious & Intermediate	ce_c	0.739866	0.138136	0.739581
Parsimonious & Intermediate	sq_c	0.715167	0.113437	0.722590
Solution Coverage: 0.853303; Solution Consistency: 0.685795				
Frequency cutoff: 30; Consistency cutoff: 0.826544				

Note: ce_c: Customer Engagement; sq_c: Service Quality; cl_c: Customer Loyalty (outcome variable)

6. Discussion

6.1. Interpretation of Findings

This study provides valuable insights into the complex relationships between service quality, customer engagement,

customer loyalty, and technological adoption in Vietnam's e-commerce sector. Our findings, derived from both PLS-SEM and fsQCA analyses, reveal several important dynamics that contribute to the growing body of knowledge in this field.

The PLS-SEM analysis supports the positive relationship between service quality and customer engagement (H1) and between customer engagement and customer loyalty (H3), highlighting the crucial role of customer engagement in mediating the relationship between service quality and loyalty. This finding aligns with previous research (e.g., Pansari & Kumar, 2017; So et al., 2020) and extends these insights to the Vietnamese e-commerce context.

Notably, the PLS-SEM results reveal the significant moderating effect of technological adoption on the relationship between service quality and customer engagement (H4a), suggesting that customers with higher levels of technological proficiency are more likely to engage with e-commerce platforms when they perceive high service quality. This finding expands our understanding of how technological adoption interacts with service quality perceptions to influence customer behavior, building upon the Technology Acceptance Model (Davis et al., 1989).

However, the PLS-SEM analysis does not find support for the direct relationship between service quality and customer loyalty (H2) or the moderating effect of technological adoption on this relationship (H4b). These results suggest that, in the Vietnamese e-commerce context, the impact of service quality on loyalty may be primarily mediated by customer engagement, rather than having a direct effect.

The multi-group analysis (MGA) within the PLS-SEM framework reveals subtle but important differences between experienced and non-experienced e-commerce users. While the overall model holds for both groups, the strength and significance of certain relationships vary. For instance, the relationship between customer engagement and loyalty is stronger for experienced users, suggesting that as customers become more familiar with e-commerce platforms, their engagement becomes a more powerful driver of loyalty. Conversely, the impact of service quality on customer engagement is stronger for non-experienced users, indicating that for newcomers to e-commerce, the quality of service plays a more crucial role in fostering engagement.

The fsQCA analysis complements the PLS-SEM findings by revealing two distinct configurational paths leading to high customer loyalty: one involving high customer engagement (ce_c) and the other involving high service quality (sq_c). This result underscores the importance of both engagement and service quality in driving loyalty, while also suggesting that there may be

multiple routes to achieving customer loyalty in e-commerce.

Interestingly, the fsQCA results do not highlight the role of technological adoption (ta_c) in any of the configurational paths leading to high customer loyalty. This absence suggests that, while technological adoption may moderate the relationship between service quality and customer engagement (as indicated by the PLS-SEM results), it may not be a necessary condition for achieving high customer loyalty in the Vietnamese e-commerce context.

The divergence between the PLS-SEM and fsQCA results regarding the role of technological adoption highlights the value of employing a multi-method approach in this study. While PLS-SEM captures the general relationships and moderating effects among the constructs, fsQCA provides a more nuanced view of the specific configurations that lead to high customer loyalty. The absence of technological adoption in the fsQCA solutions does not necessarily invalidate its moderating role found in the PLS-SEM analysis; rather, it suggests that technological adoption may not be a necessary condition for high loyalty in all cases.

6.2. Theoretical Implications

This study makes several significant contributions to the theoretical understanding of e-commerce dynamics, particularly in the context of emerging markets like Vietnam.

Firstly, our research extends the application of the SERVQUAL model (Parasuraman et al., 1988) and its e-commerce adaptations (e.g., E-S-QUAL by Parasuraman et al., 2005) to the Vietnamese context. By demonstrating the significant impact of service quality on customer engagement, we provide further validation for the relevance of service quality concepts in digital distribution and retail environments across different cultural contexts.

Secondly, our study contributes to the growing body of literature on customer engagement in digital platforms (e.g., Hollebeek et al., 2014; Pansari & Kumar, 2017) by examining its role in the distribution and e-commerce sector of an emerging economy. The strong relationship found between customer engagement and loyalty underscores the importance of engagement as a key construct in understanding online consumer behavior.

Thirdly, our research extends the Technology Acceptance Model (Davis et al., 1989) by exploring the moderating role of technological adoption in e-commerce relationships. The significant moderating effect on the service quality-engagement relationship provides new insights into how technological proficiency interacts with service perceptions to influence customer behavior.

Fourthly, our multi-group analysis contributes to the literature on customer experience evolution in distribution network and e-commerce (Khalifa & Liu, 2007). By revealing differences between experienced and non-experienced users, we provide a more nuanced understanding of how the relationships between service quality, engagement, and loyalty evolve as customers gain experience with e-commerce platforms.

Finally, our study addresses a significant gap in the literature by examining these relationships in the context of Vietnam's rapidly growing e-commerce sector. This contributes to the broader understanding of e-commerce dynamics in emerging markets, which may differ from those in more developed economies.

6.3. Practical Implications

Our findings have several important implications for e-commerce practitioners, particularly those operating in emerging markets like Vietnam.

Firstly, the strong relationship between service quality and customer engagement underscores the importance of investing in high-quality online services. E-commerce platforms should focus on enhancing various aspects of service quality, including website design, fulfillment, customer service, and security, as these factors significantly influence customer engagement. To achieve this, businesses can conduct regular audits of their online platforms, gather customer feedback, and benchmark their performance against industry best practices.

Secondly, the crucial role of customer engagement in driving loyalty suggests that e-commerce businesses should prioritize strategies that foster customer interaction and involvement. This could include developing interactive features on the platform, creating engaging content, and encouraging customer participation in online communities. By actively involving customers in the e-commerce experience, businesses can cultivate a sense of belonging and loyalty.

Thirdly, the moderating effect of technological adoption on the service quality-engagement relationship highlights the importance of considering customers' technological proficiency. E-commerce platforms should strive to cater to users with varying levels of technological skills by offering intuitive navigation, clear instructions, and helpful resources such as tutorials or FAQs. Businesses can also segment their customer base based on technological adoption levels and tailor their marketing and support strategies accordingly.

Fourthly, the differences observed between experienced and non-experienced users suggest the need for tailored strategies based on customer experience levels. For new users, emphasizing ease of use, providing clear guidance, and offering incentives for first-time purchases can help

overcome initial barriers and encourage engagement. For experienced users, personalizing the e-commerce experience, offering loyalty rewards, and providing advanced features can deepen their engagement and foster long-term loyalty.

Lastly, the fsQCA results, which reveal multiple configurational paths to high customer loyalty, suggest that e-commerce businesses should adopt a holistic approach to customer loyalty. While service quality and customer engagement are both important, businesses should recognize that there may be different routes to achieving high loyalty depending on the specific context and customer characteristics. By understanding these different paths and adapting their strategies accordingly, e-commerce businesses can optimize their resources and efforts in driving customer loyalty.

6.4. Limitations and Future Research Directions

While this study provides valuable insights into the dynamics of customer loyalty in Vietnam's e-commerce sector, it is not without limitations. Firstly, the cross-sectional nature of our data limits our ability to capture the dynamic evolution of customer behavior over time. Future research could employ longitudinal designs to examine how the relationships between service quality, customer engagement, and loyalty change as customers progress through different stages of their e-commerce journey. This approach would provide a more comprehensive understanding of the factors that drive long-term loyalty in online retail settings.

Secondly, our focus on Vietnam, while providing valuable insights into an important emerging market, may limit the generalizability of our findings to other contexts. Further research could replicate our study in other emerging economies or conduct cross-cultural comparisons to identify potential variations in the relationships between service quality, customer engagement, and loyalty. Such studies would enhance our understanding of the boundary conditions and contextual factors that influence e-commerce success in different markets.

Thirdly, while our study investigated the moderating role of technological adoption, other potential moderators, such as product type purchase frequency, or demographic characteristics, could be explored in future research. Examining these additional moderators would provide a more nuanced understanding of the complex interplay between various factors in shaping customer loyalty in e-commerce. For example, future studies could investigate whether the relative importance of service quality and customer engagement varies across different product categories or customer segments.

Finally, the divergent findings between the PLS-SEM and fsQCA analyses regarding the role of technological adoption highlight the need for further investigation. Future research could delve deeper into the nature of technological adoption's influence on customer loyalty by exploring potential mediating mechanisms such as perceived ease of use or perceived usefulness, that may explain its varying effects. Additionally, qualitative studies, such as in-depth interviews or focus groups, could be conducted to gain a richer understanding of how customers with different levels of technological adoption perceive and respond to e-commerce service quality and engagement initiatives. By triangulating findings from various methodological approaches, future research can paint a more comprehensive picture of the complex dynamics at play in e-commerce customer loyalty.

In conclusion, this study provides a comprehensive understanding of the factors driving customer loyalty in Vietnam's e-commerce sector, leveraging the complementary strengths of PLS-SEM and fsQCA. Our findings contribute to the theoretical understanding of e-commerce dynamics in emerging markets and offer practical insights for businesses seeking to enhance customer engagement and loyalty in the digital marketplace. As e-commerce continues to evolve rapidly, further research in this area will be crucial to stay abreast of changing customer behaviors and preferences.

7. Conclusion

This study provides a comprehensive understanding of the complex interplay between service quality, customer engagement, loyalty, and technological adoption in Vietnam's e-commerce sector. By integrating established theoretical frameworks and employing a multi-method approach combining PLS-SEM and fsQCA, we offer a nuanced view of the factors driving customer loyalty in this rapidly evolving market.

Our findings underscore the crucial role of service quality in fostering customer engagement, which in turn significantly influences customer loyalty. The moderating effect of technological adoption on the service quality-engagement relationship highlights the importance of considering users' technological proficiency in e-commerce strategies. Furthermore, the multi-group analysis reveals notable differences between experienced and non-experienced users, suggesting the need for tailored approaches based on customer experience levels. The fsQCA results complement these findings by identifying multiple configurational paths to high customer loyalty, emphasizing the importance of a holistic approach to understanding e-commerce success. These insights provide

actionable recommendations for e-commerce businesses seeking to enhance service quality, foster customer engagement, and cultivate long-term loyalty in an increasingly competitive online landscape. As the digital marketplace continues to evolve, this study lays the foundation for further exploration of these dynamics in different contexts and offers a roadmap for businesses navigating the challenges and opportunities of the e-commerce frontier.

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