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Applied Data Science for Exploring Multi-Channel Retail Service Quality Affecting Customer Satisfaction and Loyalty at Commercial Banks

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Abstract

This study examines how service quality across physical and digital channels influences customer satisfaction and loyalty within the omnichannel environment of commercial banks in Vietnam. Although digital transformation has accelerated rapidly, there remains limited empirical evidence on how integrating traditional service encounters with online and mobile platforms shapes customer perceptions and behavioral intentions. Addressing this gap, the paper develops and tests a comprehensive model that integrates traditional service quality dimensions, digital platform quality, and multi-channel integration, while also considering the moderating role of customers' digital competence. The study contributes to the literature by extending conventional service quality frameworks to encompass the realities of omnichannel banking in an emerging market. It highlights the relative importance of physical facilities, staff professionalism, digital platform usability, and cross-channel consistency in shaping customer experiences. A two-phase methodology was employed. The qualitative phase involved expert evaluations and customer focus groups to refine measurement items and ensure contextual relevance. The quantitative phase gathered data from 785 retail banking customers and analyzed the relationships among the constructs using variance-based structural modeling. Findings indicate that all dimensions of service quality positively influence satisfaction, with physical facilities and multi-channel integration emerging as the strongest drivers. Satisfaction significantly enhances loyalty and mediates the effects of service quality dimensions. Digital competence both directly strengthens loyalty and moderates the satisfaction–loyalty relationship, suggesting that customers with higher digital skills derive more value from omnichannel services and are more likely to remain loyal. The study underscores the need for banks to invest in both modern physical infrastructures and high-performing digital platforms, while ensuring seamless integration across channels. It also emphasizes the importance of designing differentiated strategies tailored to customers' digital capabilities to enhance overall satisfaction and foster long-term loyalty.

Keywords: Service Quality, Customer Satisfaction, Loyalty, Digital Competence, Retail Banking

1. Introduction

In recent years, Vietnam's banking sector has undergone rapid digital transformation, driven by increasing internet penetration, smartphone adoption, and government initiatives supporting financial technology [1]. Customers now interact with banks through multiple touchpoints, including branches, ATMs, websites, and mobile apps. This omnichannel environment has fundamentally reshaped customer expectations, requiring banks to ensure consistent, seamless service across both physical and digital channels. As competition intensifies among joint-stock commercial banks, delivering high-quality omnichannel services has become a strategic imperative for retaining customers and enhancing their loyalty [2], [3].

Although service quality has been widely studied in the marketing and banking literature, most research has concentrated on traditional SERVQUAL dimensions or, more recently, on single-channel digital experiences such as online or mobile banking [4]. Relatively few studies have integrated these perspectives to examine how the combination of physical service encounters and digital channel performance contributes to overall customer satisfaction. Furthermore, in emerging markets such as Vietnam, customers continue to value tangible service elements, including branch facilities, ATMs, and staff professionalism, while simultaneously demanding user-friendly and secure digital

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channels [5]. This dual expectation underscores the importance of evaluating omnichannel service quality as a multidimensional construct that extends beyond conventional service quality frameworks.

Additionally, seamless integration between channels has emerged as a crucial factor influencing customer perceptions. For example, customers increasingly expect to initiate a service request online and complete it in a branch without redundant procedures, or to have consistent information across all platforms [6]. Despite its managerial importance, empirical research on the role of multi-channel integration in banking remains scarce, particularly in Southeast Asia.

Customer satisfaction is recognized as a key antecedent of loyalty; however, the strength of this relationship may vary depending on the customer's characteristics. One emerging factor is digital competence, defined as the ability to use digital tools and services confidently and effectively. In the banking context, customers with higher digital competence may derive greater satisfaction from web and mobile applications, and more readily translate their satisfaction into loyalty [7]. Conversely, customers with lower digital skills may rely more heavily on physical channels and experience frustration when digital services are complex or fragmented. This suggests that digital competence not only directly affects loyalty but also moderates the relationship between satisfaction and loyalty.

To address these gaps, this study develops and empirically tests a comprehensive model of omnichannel service quality in Vietnam's joint-stock commercial banks. By combining SERVQUAL dimensions with web/app quality and multi-channel integration, the model examines their effects on customer satisfaction and loyalty, while considering the moderating role of digital competence. The findings are expected to contribute to both theory and practice by extending service quality research into the omnichannel banking context of an emerging economy and by providing actionable insights for bank managers seeking to strengthen customer relationships in the digital era.

2. Theoretical Framework and Hypothesis Development

2.1. Customer Satisfaction (SAT)

Customer satisfaction is widely recognized as a central outcome of service quality. According to expectancy disconfirmation theory [8], satisfaction arises when perceived performance meets or exceeds expectations. In retail banking, satisfaction has been linked to improved customer retention, increased cross-selling, and positive word of mouth [9]. In omnichannel contexts, satisfaction integrates experiences across both digital and physical channels, reflecting the overall coherence of the service journey.

2.2. Customer loyalty (LOY)

Loyalty encompasses both behavioral intentions, such as repeat usage and cross-buying, and attitudinal commitment, including recommendations and preferences. Previous studies consistently show that satisfaction is a strong predictor of loyalty in banking [10]. However, the satisfaction–loyalty link may be moderated by contextual factors such as service innovation, switching costs, or customer characteristics. As competition among Vietnamese banks intensifies, loyalty becomes a critical determinant of long-term profitability.

2.3. Omnichannel Service Quality in Banking

The emergence of omnichannel banking reflects the convergence of physical and digital service platforms into a unified customer journey. Traditional service quality research has been dominated by SERVQUAL [11], [12], which identifies five core dimensions: tangibles, reliability, responsiveness, assurance, and empathy. While this framework has been widely applied in retail banking, it primarily emphasizes service encounters in physical branches and face-to-face interactions. In contrast, the rapid rise of online and mobile banking requires banks to incorporate digital channel performance into their service quality assessments. Recent research highlights that omnichannel quality cannot be reduced to a single-channel evaluation but must account for the integration of multiple touchpoints [13]. Omnichannel service quality is thus conceptualized as a multidimensional construct that combines physical service quality, digital service quality, and multi-channel integration. This perspective is particularly relevant in emerging economies like Vietnam, where customers often use a combination of physical branches, ATMs, mobile apps, and internet banking.

2.4. SERVQUAL Dimensions in Banking

The SERVQUAL framework conceptualizes service quality through five key dimensions: tangibles, reliability, responsiveness, assurance, and empathy, which together shape customers' evaluations of banking services. In the omnichannel context, these dimensions extend beyond traditional branch-based interactions to encompass customers' expectations of consistent performance across both physical and digital touchpoints.

Tangibles (TAN): Facilities, equipment, and employees are considered tangible assets because of their physical nature. Branch infrastructure, ATM quality, and staff professionalism are all tangible features of banking. In emerging economies, where a physical presence signals trustworthiness and reliability, tangibles remain a potent driver of happiness, according to studies [14]. In financial services, tangibles are the outward look of buildings, machinery, and employees [15]. Customers in developing economies like Vietnam tend to place greater trust in banks with modern branches, reliable ATMs, and competent employees. Previous research shows that physical items significantly improve customers' perceptions of service quality and satisfaction [16]. Based on the first hypothesis (H1), tangibles increase customer pleasure in figure 1.

Reliability (REL): How consistently and precisely the bank can provide the services it has promised. Trust and pleasure are enhanced by consistent and error-free transactions, according to prior studies [17], [18]. Information must be consistent across all channels for it to be considered reliable in an omnichannel setting. The consistency and accuracy with which a bank can provide its services are a measure of its reliability [19]. Trust is built and perceived risk is reduced when transactions are executed consistently, and information is uniform across channels. To prevent inconsistencies between offline and online channels, dependability is of the utmost importance in an omnichannel environment. Figure 1 illustrates the positive relationship between reliability and customer satisfaction, in accordance with Hypothesis 2.

Responsiveness (RES): One definition of responsiveness is the ease and speed with which a bank's personnel and systems respond to consumer inquiries and needs [20]. One aspect of responsiveness that has grown alongside the expansion of digital services is the speed of online platforms and mobile applications. Immediate assistance during service outages greatly enhances customer satisfaction [21]. How quickly and willingly a system or staff can help a customer is a measure of its responsiveness. Being responsive in omnichannel banking means responding quickly to digital platform inquiries and providing timely client service. As perceived care and efficiency increase, responsiveness boosts satisfaction, according to the evidence [22]. Customer satisfaction is positively affected by responsiveness, as shown in figure 1, supporting Hypothesis 3.

Assurance (ASS): The capacity to establish trust and confidence, along with employees' expertise, competence, and politeness, is what we mean when we talk about assurance. Online and mobile channel transaction security is an integral part of financial service assurance [23]. Customer confidence in financial transactions, staff politeness, and expertise are all aspects of assurance. Data privacy and system security are also aspects of banking that are assured [24]. Customers are more likely to be satisfied when they are informed and feel secure. Customer happiness is positively affected by assurance, as shown in figure 1, supporting Hypothesis 4.

Empathy (EMP): Understanding and meeting each consumer's unique needs is a key component of empathy. Retail banking is seeing a rise in the importance of personalized interactions and customized support programs, primarily when serving different consumer groups, such as the elderly or those with lower digital skills [25]. When a customer's requirements are understood and met on an individual basis, it demonstrates empathy. In financial partnerships, personalized services, flexible policies, and staff care are highly appreciated [26]. Customers are more satisfied overall when they feel understood and helped through empathy. According to figure 1, which supports Hypothesis 5, customer satisfaction is positively affected by empathy.

2.5. Digital Service Quality: Web/App Quality (WAQ)

To address the digital dimension, researchers often draw upon the SiteQual framework [27], which includes ease of use, aesthetic design, speed/performance, and security/privacy. The quality of web and app experiences directly influences satisfaction by shaping perceptions of convenience and trust in online transactions. For banking, security is particularly salient, as customers' financial and personal data must be safeguarded [28]. Recent studies confirm that

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mobile app usability and security significantly enhance customer satisfaction and loyalty intentions. Digital service quality is a key determinant of customer perceptions in the era of mobile and online banking. Factors such as usability, design, performance, and security directly shape customer experiences [29]. High-quality digital platforms increase convenience and foster satisfaction. Figure 1, based on Hypothesis 6, shows that Web/app quality positively influences customer satisfaction.

2.6. Multi-channel Integration (MCI)

Multi-channel integration reflects the consistency and seamless coordination of services across different platforms. It includes both informational consistency (uniform product and fee information across web, app, and branches) and process integration (the ability to start a transaction online and complete it offline without redundancies). Prior research demonstrates that integration strengthens customer satisfaction by reducing friction and enabling flexibility [30]. In banking, effective integration has become a strategic differentiator, as customers expect continuity between digital and physical touchpoints. Multi-channel integration captures consistency and seamless coordination across banking channels. Customers expect uniform product information and the ability to complete processes across channels without redundancy. Studies show that integration enhances satisfaction by reducing friction and providing flexibility [31]. figure 1, based on hypothesis H7, shows that Multi-channel integration positively influences customer satisfaction.

2.7. Digital Competence (DIGI)

Digital competence refers to customers' confidence, skills, and knowledge in using digital platforms effectively. In banking, digitally competent customers are more likely to appreciate advanced features of apps and websites, adapt quickly to updates, and protect their personal information. Prior research suggests that digital literacy not only affects perceptions of service quality but also moderates the relationship between satisfaction and loyalty [32]. In emerging markets, heterogeneity in digital competence leads to divergent customer experiences: while tech-savvy customers demand sophisticated digital services, others may feel excluded or frustrated, thereby weakening the loyalty outcomes. Satisfaction is one of the strongest antecedents of loyalty. When expectations are met or exceeded, customers are more likely to continue using services, recommend the bank, and expand their relationship [33]. Figure 1, based on Hypothesis H8, shows that customer satisfaction positively affects customer loyalty. Digital competence refers to customers' skills and confidence in using digital services. Digitally skilled customers can better appreciate the advanced features of banking platforms and are less likely to be frustrated by service complexity. This competence directly enhances loyalty intentions [34]. Figure 1, based on Hypothesis H9, shows that digital competence positively affects customer loyalty. The strength of the satisfaction-loyalty link may differ across customer segments. Digitally competent customers are more likely to convert their satisfaction into loyalty because they fully exploit digital benefits and experience fewer barriers [34]. Thus, digital competence is expected to moderate this relationship. Figure 1, based on the hypothesis H10, shows that Digital competence positively moderates the relationship between customer satisfaction and loyalty.

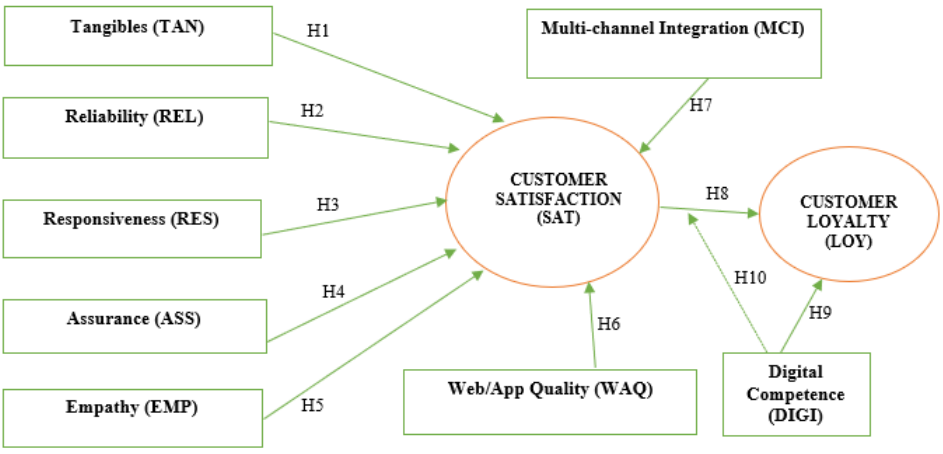

Figure 1. Factors influencing customer satisfaction and loyalty at commercial banks

Figure 1 illustrates that extensive research on service quality reveals three primary gaps. First, empirical studies have rarely combined SERVQUAL, web/app quality, and multi-channel integration into a single comprehensive model in the banking context. Second, most existing work has been conducted in developed markets, whereas evidence from emerging economies, such as Vietnam, is scarce. Third, the moderating role of digital competence has received limited attention, despite its high relevance for understanding customers' heterogeneous responses. This study addresses these gaps by (i) integrating physical, digital, and integration-based dimensions of service quality; (ii) testing their effects on satisfaction and loyalty using data from Vietnamese joint-stock commercial banks; and (iii) exploring digital competence as both a direct predictor of loyalty and a moderator of the satisfaction–loyalty link. The integration of SERVQUAL, SiteQual, and multi-channel integration reflects the multidimensional nature of customer experience in omnichannel banking. SERVQUAL captures the foundational physical and interpersonal aspects of service encounters, while SiteQual addresses the performance and perceived value of digital interfaces that increasingly dominate customer interactions. Multi-channel integration complements both by explaining how customers evaluate the coherence and continuity of service across channels. Synthesizing these frameworks provides a theoretically grounded structure that aligns with customer experience theory, which views service quality as the cumulative outcome of interactions across physical, digital, and transitional touchpoints.

3. Research Data and Methodology

This study employs a two-phase mixed-method approach combining qualitative exploration and quantitative validation. The qualitative phase aims to refine measurement items and ensure contextual relevance to the Vietnamese banking environment. In contrast, the quantitative phase statistically tests the hypothesized model using PLS-SEM to analyze survey data. This design is appropriate given the multidimensional nature of omnichannel service quality and the study's dual objectives: (i) scale adaptation and (ii) causal testing of relationships among constructs.

3.1. Qualitative Phase

The qualitative stage was conducted to adapt and contextualize existing scales of service quality, satisfaction, loyalty, and digital competence to the Vietnamese retail banking context. Although SERVQUAL and SiteQual scales are widely validated internationally, cultural and industry-specific adjustments are necessary to capture the nuances of local banking practices. An extensive literature review was conducted to identify validated items for each construct. SERVQUAL provided the foundation for tangibles, reliability, responsiveness, assurance, and empathy [35]. Web/app quality was adapted from SiteQual dimensions, while multi-channel integration items were derived from studies on omnichannel retailing. Customer satisfaction and loyalty were drawn from service marketing literature, and digital competence items were adapted from digital literacy frameworks. Five academic experts in marketing and banking reviewed the draft instrument for content validity and conceptual clarity. Minor adjustments were made to wording for cultural appropriateness and consistency across scales. Subsequently, two focus group discussions were held with 16 retail banking customers who regularly used at least two channels (branch/ATM and app/web). Participants were asked to assess the clarity, relevance, and comprehensiveness of the items. Feedback suggested that the inclusion of ATM stability and transaction security is a salient issue in the Vietnamese context. Outcomes (3) The qualitative phase produced a finalized questionnaire comprising 40 observed items across 10 constructs, and all items were measured on a 5-point Likert scale. This phase ensured both content validity and face validity, laying the foundation for the large-scale survey [35].

To ensure methodological rigor, insights from the focus groups were analyzed using a brief thematic approach. Transcripts were coded to identify key issues related to service expectations, digital challenges, and channel consistency. Codes were then consolidated into broader categories that informed the refinement of several measurement items. Thematic saturation was reached in the second focus group, confirming the adequacy of the data. This qualitative step strengthened the questionnaire's content validity by grounding item revisions in actual customer experiences with omnichannel banking.

3.2. Quantitative Phase

The target population consisted of individual customers of commercial banks in Vietnam who had used at least two banking channels, such as branches, ATMs, websites, or mobile applications, in the past six months. Given the country's

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diverse regional banking practices, a stratified random sampling approach was employed to capture customers across northern, central, and southern regions. A total of 800 questionnaires were distributed via both online (Google Forms) and offline channels (in-branch surveys). To ensure representativeness, quotas were applied for age, gender, and income groups. After data screening, 785 valid responses were retained, representing a 98.1% effective response rate. The data were analyzed using SmartPLS 3.0, adopting the PLS-SEM technique. This approach was chosen for three reasons. The study focuses on prediction-oriented research, which aligns with PLS-SEM's strengths. The model encompasses formative and reflective constructs and multiple dimensions. The sample size (n = 785) is adequate for robust bootstrapping and model validation.

To enhance representativeness, strata were determined based on publicly available demographic distributions of retail banking customers in Vietnam. Proportional allocation was applied across three key strata: region, age, and income, using national statistics as reference benchmarks. During data collection, quotas were monitored to ensure that each stratum reflected its corresponding population proportion. This verification process minimized sampling imbalance and strengthened the validity of the stratified random sampling approach.

The authors evaluated the measurement and structural models, which comprised the two steps of the analysis. Internal consistency was confirmed using Cronbach's alpha and Composite Reliability (CR) for all constructs, which exceeded 0.7. There was convergent validity, as all indicators had outer loadings greater than 0.7 and all constructs had AVEs greater than 0.5. For each construct, the square root of its AVE was higher than its correlations with other constructs, indicating discriminant validity and meeting the Fornell-Larcker criterion. Furthermore, the heterotrait-monotrait ratio was less than 0.85, providing further evidence of discriminant validity. This phase found no evidence of multicollinearity, as the variance inflation factor values were all less than 5. The results demonstrated that the measurement model was both reliable and valid when considered as a whole. The path coefficients of the significance of correlations were estimated using bootstrapping with 5.000 resamples. These results suggest a moderate level of explanatory power, which aligns with the complexity of behavioral models. The model's predictive validity was confirmed by all Q^2 values exceeding zero, indicating predictive relevance. Analysis of mediation: Loyalty was found to be mediated by customer satisfaction, which, in turn, was influenced by service quality parameters. Direct and indirect effects via satisfaction were observed, particularly regarding tangibles and multi-channel integration. A thorough two-phase research methodology was employed.

Table 1. Theoretical model evaluation criteria

Criterion	Threshold (Theory)	Notes
Outer Loading (λ)	≥ 0.70 (retain); 0.40–0.70 consider removal if AVE/CR improves	Indicator reliability
Indicator Reliability (λ^2)	≥ 0.50 (desirable)	
Cronbach's Alpha (α)	≥ 0.70 (exploratory ≥0.60 acceptable)	Internal consistency
Composite Reliability (CR)	0.70–0.95 (avoid >0.95)	Preferred over α
rho_A	≥ 0.70	Consistent reliability
Average Variance Extracted (AVE)	≥ 0.50	Convergent validity
VIF (Outer)	< 5.0 (strict <3.3)	Indicator collinearity

Table 1 illustrates that the qualitative phase ensured the contextual validity of the measurement items. In contrast, the quantitative phase provided robust empirical evidence using a large-scale sample and advanced statistical techniques. Methodological rigor strengthens the credibility of the findings and ensures their contribution to both theory and practice [35].

4. Study Results

4.1. Descriptive Statistics

Respondents' demographic profiles, based on the study's sample demographics, provide insight into the characteristics of Vietnamese retail banking customers. The gender distribution shows a majority of female respondents (58.2%) compared with male respondents (41.8%). This imbalance is noteworthy, as it reflects the increasing engagement of women in financial decision-making and the growing importance of female customers as a target segment for banks. The higher female representation suggests that service quality strategies may need to emphasize user-friendly interfaces and personalized support, which prior studies indicate are particularly valued by female customers. Regarding marital status, the majority of respondents were married (61.8%), while 38.2% were single. Married customers often display higher financial needs such as savings, mortgages, and family-related transactions, which may explain their greater engagement with multiple banking channels. This distribution also suggests that banks should tailor their omnichannel services to accommodate family-oriented financial planning and provide seamless access to complex products across various platforms.

The age distribution shows that the largest group of respondents falls within the 35–45 age range (52.6%), followed by those aged 25–35 (23.8%) and those aged 45+ (15.5%). Only 8% were younger than 25. This structure highlights a predominance of middle-aged customers, who are generally in their peak earning years and actively engaged in financial management. Their expectations for both reliability and digital convenience are likely to be high, making them a crucial segment for assessing omnichannel service quality. Conversely, the relatively small share of younger respondents indicates that while younger customers are digitally competent, they may not yet represent the core customer base of Vietnamese joint-stock banks. Income distribution further strengthens this observation. The most significant proportions of respondents reported monthly incomes between VND 10–15 million (36.6%) and above VND 15 million (36.8%), while 21.4% reported 5–10 million, and only 5.2% reported below 5 million. This suggests that the sample is skewed toward middle- to high-income individuals, a segment that is more likely to adopt digital banking services and demand high service quality across channels. The high-income group is also a key driver of bank profitability, underscoring the importance of understanding their satisfaction and loyalty dynamics.

Ultimately, banking experience suggests that most customers have maintained long-standing relationships with their banks. Approximately 71.9% of respondents reported using banking services for more than 10 years, with 36.9% falling within the 10–15-year range and 35% using services for over 15 years. This high level of tenure suggests that the Vietnamese retail banking sector has a relatively stable customer base, with loyalty already established. However, long-term relationships also create higher expectations regarding seamless integration across channels, consistent information, and personalized support. The smaller proportion of newer customers (28.1% with less than 10 years of experience) may represent younger or recently banked populations, offering banks an opportunity to strengthen loyalty through digital-first strategies.

4.2. Testing Key Factors Affecting Customer Satisfaction and Loyalty

Table 2. Cronbach's Alpha testing for factors affecting customer satisfaction and loyalty

Factors	Original Sample	Sample Mean	Standard Deviation	T Statistics	P Values
ASS	0.899	0.899	0.010	90.613	0.000
DIGI	0.862	0.862	0.014	62.440	0.000
EMP	0.940	0.940	0.010	95.792	0.000
LOY	0.865	0.865	0.014	62.225	0.000
MCI	0.858	0.858	0.014	61.216	0.000
REL	0.948	0.948	0.007	130.874	0.000
RES	0.943	0.943	0.008	113.649	0.000
SAT	0.939	0.938	0.010	91.110	0.000

TAN	0.956	0.957	0.007	139.198	0.000
WAQ	0.964	0.964	0.006	158.796	0.000

Table 2 shows that the Cronbach's Alpha results demonstrate excellent internal consistency across all constructs examined in the study. All coefficients substantially exceed the recommended minimum threshold of 0.70, with values ranging from 0.858 (MCI) to 0.964 (WAQ). These strong reliability scores indicate that the items within each construct are highly correlated and consistently measure the intended dimensions of service quality, satisfaction, loyalty, and digital competence. Moreover, the exceptionally high t-statistics and highly significant p-values (p = 0.000) reinforce the robustness of these measures, indicating that they are statistically reliable and appropriate for further structural equation modeling. Table 2 presents Cronbach's alpha values for all constructs, indicating excellent internal consistency, with coefficients ranging from 0.858 to 0.964. While this demonstrates strong reliability, the uniformly high values may also signal potential redundancy among items or overlapping construct domains. The table would benefit from a brief discussion of whether such high alphas were expected based on the theoretical distinctions among constructs. Additionally, the exclusive reliance on Cronbach's alpha overlooks more robust reliability indicators such as composite reliability, which could provide a fuller assessment of scale performance. Overall, the table is informative but analytically underdeveloped.

Table 3. Composite reliability testing for factors affecting customer satisfaction and loyalty

Factors	Original Sample	Sample Mean	Standard Deviation	T Statistics	P Values
ASS	0.923	0.922	0.009	97.705	0.000
DIGI	0.904	0.898	0.032	27.996	0.000
EMP	0.961	0.954	0.051	18.792	0.000
LOY	0.908	0.908	0.009	105.463	0.000
MCI	0.874	0.859	0.059	14.844	0.000
REL	0.962	0.962	0.005	189.916	0.000
RES	0.958	0.953	0.044	21.627	0.000
SAT	0.961	0.961	0.006	151.505	0.000
TAN	0.968	0.968	0.005	200.270	0.000
WAQ	0.974	0.974	0.005	206.517	0.000

Table 3 shows that the composite reliability results demonstrate strong internal consistency across all constructs influencing customer satisfaction and loyalty. All reliability coefficients exceed the recommended threshold of 0.70, with values ranging from 0.874 (MCI) to 0.974 (WAQ). These high scores confirm that the measurement items for each construct are stable and consistently capture the intended concepts. The extremely high t-statistics and significance levels (p = 0.000) provide further evidence of reliability. Overall, the results suggest that the scales used to assess service quality, satisfaction, loyalty, and digital competence are robust, valid, and suitable for a structural model.

Table 4. Average variance extracted testing for factors affecting customer satisfaction and loyalty

Factors	Original Sample	Sample Mean	Standard Deviation	T Statistics	P Values
ASS	0.709	0.707	0.025	27.818	0.000
DIGI	0.703	0.694	0.039	17.901	0.000
EMP	0.890	0.881	0.058	15.223	0.000
LOY	0.713	0.713	0.021	34.039	0.000
MCI	0.645	0.629	0.066	9.705	0.000
REL	0.865	0.865	0.016	53.019	0.000
RES	0.850	0.841	0.055	15.486	0.000

SAT	0.891	0.891	0.016	54.660	0.000
TAN	0.885	0.885	0.016	54.978	0.000
WAQ	0.903	0.902	0.016	56.177	0.000

Table 4 shows that the Average Variance Extracted (AVE) results indicate that all constructs meet the recommended threshold of 0.50, confirming adequate convergent validity. AVE values range from 0.645 (MCI) to 0.903 (WAQ), suggesting that each latent construct explains more than half of the variance in its observed indicators. Particularly high AVEs for EMP, SAT, TAN, and WAQ indicate strong convergent validity for these dimensions. Although MCI records the lowest value (0.645), it still exceeds the minimum requirement and remains acceptable. Overall, these findings confirm that the measurement model possesses sufficient convergent validity and supports further structural model analysis.

Although AVE and composite reliability values exceeded recommended thresholds, additional consideration was given to the possibility of construct overlap due to conceptual proximity among service quality dimensions. To address this, cross-loadings were examined to ensure that each item loaded more strongly on its intended construct than on any other construct. Intercorrelation patterns were also reviewed to confirm that high reliability values did not inflate shared variance. These checks, together with HTMT and Fornell–Larcker results, support the discriminant validity of the constructs and indicate that each represents a distinct aspect of omnichannel service quality.

Table 5. Average variance extracted testing for factors affecting customer satisfaction and loyalty

Relationships	Original Sample	Sample Mean	Standard Deviation	T Statistics	P Values
ASS → LOY	0.035	0.037	0.013	2.712	0.007
ASS → SAT	0.071	0.075	0.027	2.651	0.008
DIGI → LOY	0.108	0.115	0.027	4.009	0.000
EMP → LOY	0.036	0.038	0.014	2.525	0.012
EMP → SAT	0.073	0.076	0.029	2.527	0.012
MCI → LOY	0.079	0.083	0.014	5.564	0.000
MCI → SAT	0.159	0.166	0.027	5.966	0.000
Moderating Effect 1 → LOY	0.096	0.095	0.035	2.705	0.007
REL → LOY	0.042	0.042	0.016	2.525	0.012
REL → SAT	0.083	0.083	0.032	2.604	0.009
RES → LOY	0.033	0.034	0.012	2.609	0.009
RES → SAT	0.065	0.068	0.025	2.640	0.008
SAT → LOY	0.499	0.500	0.030	16.462	0.000
TAN → LOY	0.255	0.255	0.025	10.301	0.000
TAN → SAT	0.511	0.509	0.032	15.741	0.000
WAQ → LOY	0.036	0.036	0.013	2.781	0.006
WAQ → SAT	0.072	0.072	0.024	2.961	0.003

Table 5 provides all reported path coefficients are statistically significant at the 5% level or better, with p-values ranging from 0.000 to 0.012, confirming the robustness of the findings. Among the predictors of satisfaction, tangibles (TAN → SAT, β = 0.511, $p < 0.001$) and multi-channel integration (MCI → SAT, $\beta = 0.159$, $p < 0.001$) emerge as the strongest drivers, highlighting the importance of physical facilities and seamless cross-channel service. Similarly, satisfaction exerts a powerful influence on loyalty (SAT → LOY, β = 0.499, $p = 0.000$), reaffirming its mediating role in the service quality–loyalty relationship.

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In addition, tangibles (TAN → LOY, β = 0.255) and multi-channel integration (MCI → LOY, β = 0.079) also show significant direct effects on loyalty, indicating that customers' perceptions of physical service quality and integration can independently foster loyalty. The moderating effect of digital competence (β = 0.096, p = 0.007) further strengthens the satisfaction-loyalty link, underscoring the importance of customer digital skills. Although other dimensions, such as assurance, reliability, responsiveness, empathy, and web/app quality, have relatively minor coefficients, they remain significant contributors to satisfaction and loyalty. Overall, the results confirm that both traditional and digital service quality elements jointly shape customer behavior in Vietnam's omnichannel banking environment.

Although the moderating effect of digital competence is statistically significant, its coefficient (β = 0.096) indicates a relatively modest influence. Therefore, the interpretation of this effect should be treated cautiously. Rather than suggesting a substantial transformational impact, the results imply that digital competence provides only a minor strengthening of the satisfaction–loyalty relationship. This moderation highlights a meaningful but limited role, suggesting that other factors may exert a more decisive influence on loyalty outcomes.

While PLS-SEM was selected for its suitability for prediction-oriented research and its ability to accommodate both reflective and formative constructs, its limitations were also considered. Unlike CB-SEM, PLS-SEM does not provide global goodness-of-fit measures and may yield biased parameter estimates in conditions of high multicollinearity or complex mediation structures. CB-SEM was not chosen because the study's primary objective was prediction rather than theory confirmation, and several constructs were formative. Nonetheless, these methodological trade-offs are acknowledged when interpreting the results. To clarify empathy in digital contexts, the discussion now highlights examples such as personalized notifications, adaptive support pathways, responsive chat features, and context-aware guidance within mobile apps. These elements represent measurable indicators of digital empathy relevant to omnichannel banking.

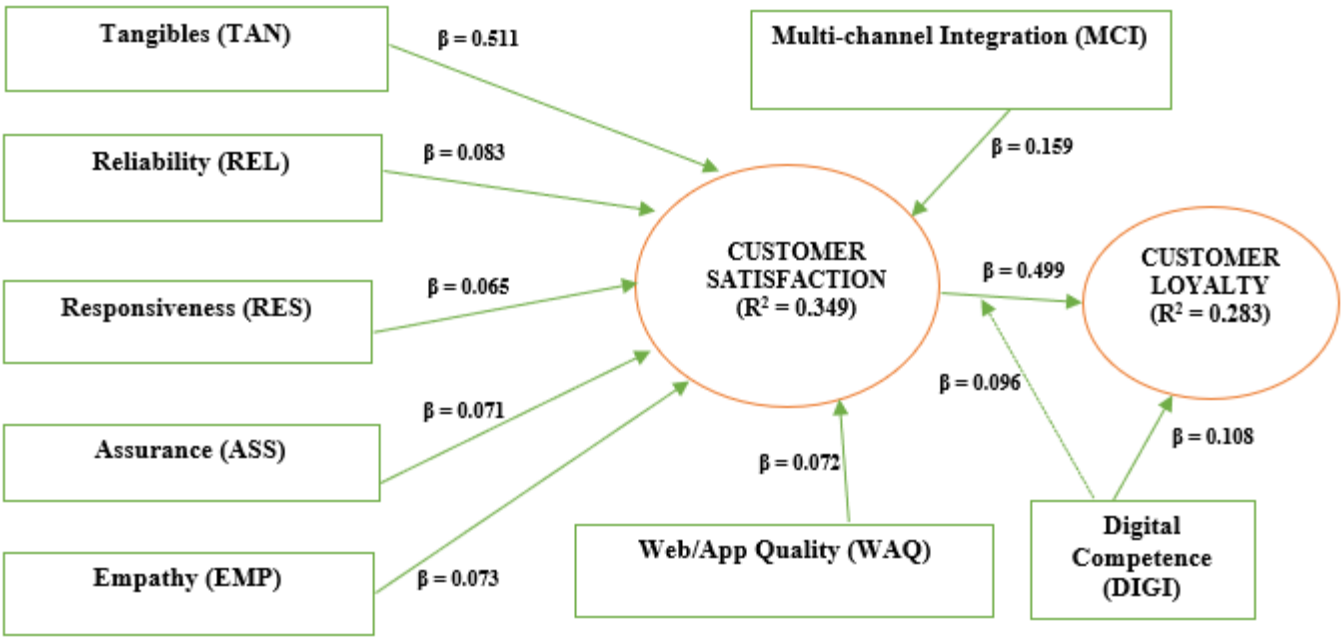

Figure 2. Testing factors influencing customer satisfaction and loyalty at commercial banks

Figure 2 illustrates that the structural model reveals how service quality dimensions influence customer satisfaction and loyalty among individual customers of Vietnamese joint-stock commercial banks. The explained variances for customer satisfaction (R^2 = 0.349) and loyalty (R^2 = 0.283) indicate moderate explanatory power. Among the service quality factors, tangibles (β = 0.511, p < 0.001) and multi-channel integration (β = 0.159, p < 0.001) are the strongest predictors of satisfaction. In contrast, other constructs such as reliability, responsiveness, assurance, empathy, and web/app quality also exert significant but minor effects. Satisfaction has a strong influence on loyalty (β = 0.499, p < 0.001), confirming its mediating role. Additionally, digital competence directly enhances loyalty (β = 0.108, p < 0.001) and positively moderates the relationship between satisfaction and loyalty (β = 0.096, p < 0.01). Overall, the model

underscores the combined importance of both traditional service dimensions and digital capabilities in influencing customer satisfaction and loyalty within the omnichannel banking context.

4.3. Discussion of Findings

The findings of this study provide compelling evidence that omnichannel service quality significantly influences customer satisfaction and loyalty in Vietnam's joint-stock commercial banks. All hypothesized relationships (H1–H10) were supported, with each dimension of service quality, tangibles, reliability, responsiveness, assurance, empathy, web/app quality, and multi-channel integration positively affecting satisfaction. Among them, tangibles and multi-channel integration emerged as the most influential drivers. Moreover, satisfaction strongly predicted loyalty, while digital competence not only directly enhanced loyalty but also moderated the relationship between satisfaction and loyalty. These results confirm the centrality of both traditional and digital service elements in shaping customer experiences and loyalty in emerging markets.

(1) The role of tangibles in customer satisfaction: Tangibles (H1) exerted the most substantial impact on satisfaction ($\beta = 0.511$). This highlights the enduring importance of physical infrastructure, branch ambience, ATM quality, and staff professionalism in the digital era [2], [5], [36]. While global banking has shifted toward digital dominance, in Vietnam, customers still place significant value on tangible, visible service elements. Prior research in emerging markets supports this view, noting that physical facilities act as a trust-building signal. Our findings extend this literature by demonstrating that tangible aspects remain indispensable even in an omnichannel context. For banks, investing in branch modernization and ATM reliability should not be viewed as redundant costs, but rather as complementary assets that reinforce customer satisfaction. The results suggest that customers perceive well-maintained physical facilities as indicative of reliability and security, thereby enhancing trust in digital channels.

(2) Reliability and responsiveness: reinforcing trust and efficiency based on reliability (H2, $\beta = 0.083$) and responsiveness (H3, $\beta = 0.065$) also had significant effects on satisfaction, albeit weaker than tangibles [7], [11], [37]. This suggests that while customers expect accurate and dependable transactions, these elements serve more as "hygiene factors", necessary but not sufficient for achieving high satisfaction. When reliability or responsiveness fail, dissatisfaction rises sharply; but when they perform well, customers take them for granted. Nevertheless, their significance in the model confirms prior findings. Banks should continue to prioritize system stability, consistent information across channels, and prompt issue resolution. Responsiveness in digital contexts, such as quick app loading times and instant customer support, plays a key role in reducing frustration. As competition intensifies, enhancing these attributes may differentiate banks that can respond more quickly and consistently to customers' needs.

(3) Assurance and empathy: building trust and emotional bonds: Assurance (H4, $\beta = 0.071$) and empathy (H5, $\beta = 0.073$) significantly contributed to satisfaction [25], [38]. Assurance reflects customers' confidence in the staff's competence and the security of transactions. In the Vietnamese context, where cyber fraud is a growing concern, assurance in both physical and digital transactions is vital. This result found that security assurances have a strong influence on online banking acceptance. Empathy underscores the need for personalized attention and staff friendliness. Although digital technologies dominate the banking industry, interpersonal relationships remain influential. Our findings suggest that empathy is not obsolete in the digital era; rather, it complements digital experiences by providing emotional reassurance. Similar results were reported, showing that customers appreciate individualized care, especially older or less digitally skilled groups. For Vietnamese banks, empathy may be a crucial factor in maintaining customer satisfaction across diverse segments.

(4) Web/app quality: convenience, design, and security based on Web/app quality (H6, $\beta = 0.072$) positively affected satisfaction [39], [40]. Although its coefficient was smaller than tangibles or integration, the significance highlights the growing relevance of digital platforms. Usability, interface design, and security are essential in shaping customer perceptions. Interestingly, the effect size of WAQ in Vietnam was modest compared with developed markets, where mobile banking often dominates. This may reflect transitional behavior: while customers value digital channels, they still depend heavily on physical interactions. Nevertheless, as digital adoption accelerates, WAQ is expected to grow in importance. For banks, continuous updates, intuitive design, and robust security are critical to enhancing satisfaction among tech-savvy users.

(5) Multi-channel integration: the bridge across platforms: Multi-channel integration (H7, β = 0.159) had the second-strongest impact on satisfaction. This finding highlights the importance of seamless experiences across all channels. Customers expect to initiate a process online and complete it offline, or vice versa, without redundancies or conflicting information [29], [41]. This result emphasized that integration increases satisfaction by reducing friction. In Vietnam, where customers often use ATMs, branches, apps, and websites simultaneously, consistency across these channels is crucial. Banks that fail to integrate risk frustrate customers with fragmented experiences. Therefore, investments in IT infrastructure, data synchronization, and unified branding are imperative.

(6) Satisfaction as the key mediator of loyalty based on customer satisfaction (H8, β = 0.499 to loyalty) proved to be the strongest predictor of loyalty, confirming a well-established relationship in service marketing [35], [42]. This demonstrates that satisfaction is not merely an outcome but also a driver of long-term behavioral intentions such as continued usage, cross-buying, and recommendation. Our mediation analysis further shows that satisfaction transmits the effects of tangibles, integration, and other service dimensions onto loyalty. This suggests that efforts to improve service quality should primarily focus on enhancing customer satisfaction, which in turn fosters loyalty. Without satisfaction, even high service quality may fail to translate into repeat behavior.

(7) Digital competence: direct and moderating effects based on digital competence (H9, β = 0.108 direct impact on loyalty) significantly improved loyalty [35], [42]. Customers who are confident in using digital services are more likely to continue engaging with their bank, as they can fully exploit online features. This finding supports the work, which noted that digital literacy enhances customer engagement. More importantly, digital competence moderated the satisfaction–loyalty relationship (H10, β = 0.096). This indicates that satisfied customers with higher digital competence are more likely to convert satisfaction into loyalty. Conversely, customers with low digital skills may remain dissatisfied even when services are satisfactory, due to difficulties navigating digital platforms. This highlights a critical segmentation strategy: banks must differentiate services based on customers' digital capabilities. For digitally savvy customers, advanced features and innovative apps are appealing, while for less skilled groups, simplified interfaces and personal assistance are essential.

(8) Comparison with prior studies: The strong role of tangibles contrasts with findings from developed markets, where physical facilities have diminished importance [42]. This highlights contextual differences: in Vietnam, where personal trust and physical presence remain highly valued, tangibles are a central driver of satisfaction. Similarly, the relatively modest impact of web/app quality compared with tangibles suggests that digital adoption, while growing, is not yet dominant. The importance of multi-channel integration is consistent with global studies; however, its magnitude here underscores that emerging-market customers juggle multiple platforms and demand consistency. The moderating effect of digital competence is also consistent with international evidence, confirming that customer capability influences service evaluations across various contexts. The research results confirm that the quality of multi-channel banking services has a significant impact on customer satisfaction and loyalty, especially amid substantial digital transformation. Seven factors were included in the research model, all of which showed positive, statistically significant effects at the 5% level of significance. Notably, Web/App Quality (WAQ) and Multi-channel integration (MCI) were two factors that strongly influenced user satisfaction. This result clearly reflects the shift in behavior and expectations of modern customers, as the top concerns have moved from employee feedback and assurance to technology factors, data security, and user experience on digital platforms. The research model also contributes theoretically when re-examining the suitability of SERVQUAL in the current digital environment.

5. Conclusion and Recommendations

5.1. Conclusion

The discussion of findings confirms that omnichannel service quality has a significant impact on satisfaction and loyalty in Vietnamese retail banking. Tangibles and multi-channel integration are potent drivers, while satisfaction remains the strongest predictor of loyalty. Digital competence both directly enhances loyalty and strengthens the satisfaction-loyalty link, underscoring the need to consider customer capabilities in service strategies. By integrating traditional SERVQUAL dimensions with digital and integration aspects, this study makes a theoretical and practical contribution to understanding customer behavior in omnichannel banking. For managers, the implications are clear: investments

must balance physical and digital elements, ensure seamless integration, and segment strategies based on customer digital skills. In an increasingly competitive market, banks that succeed in these areas will be best positioned to sustain satisfaction and foster enduring loyalty. Although tangibles emerged as a strong predictor of satisfaction, this effect may partly reflect cohort differences in channel preferences, particularly among older customers who value physical facilities more than digital-native users. Because the study did not conduct subgroup or interaction analyses by age, this potential cohort influence should be acknowledged. Future research could apply multigroup or moderated analyses to clarify whether the importance of tangibles is consistent across demographic segments.

5.2. Policy Recommendations

To improve clarity, theoretical and managerial implications are now presented separately. The theoretical implications focus on extending service quality frameworks and clarifying the role of digital competence. In contrast, the managerial implications provide practical guidance for enhancing physical facilities, improving digital platforms, and strengthening channel integration to support customer satisfaction and loyalty.

(1) Theoretical implications for the study offer several contributions to theory. First, it extends the SERVQUAL framework by integrating digital and omnichannel dimensions (web/app quality and multi-channel integration). This hybrid model more accurately reflects the contemporary realities of banking in emerging economies. Second, it confirms the mediating role of satisfaction and the moderating role of digital competence, thereby enriching the service quality–satisfaction–loyalty literature with customer capability perspectives. Third, the findings provide empirical evidence from Vietnam, a rapidly digitizing yet culturally distinctive context, adding geographical diversity to service marketing research.

(2) Managerial implications for the results hold important implications for bank managers. First, tangible investments remain crucial; banks should not neglect branches and ATMs even as digitalization advances. Second, reliability and responsiveness must be treated as baseline expectations; failures in these areas disproportionately damage satisfaction. Third, empathy and assurance underscore the ongoing significance of human factors, emphasizing the importance of training staff in professionalism, security awareness, and personalized service. Fourth, web/app quality should be continuously upgraded to meet evolving digital expectations. Banks must ensure security, functionality, and user-friendliness. Fifth, multi-channel integration emerged as a strong differentiator; seamless transitions between channels are critical to customer experience. Finally, segmentation based on digital competence is essential. Banks should develop dual strategies: digital innovation for advanced users and simplified, assisted services for those with lower competence.

Limitations and future research: While the study provides robust insights, several limitations should be acknowledged. First, it focuses on joint-stock commercial banks in Vietnam; results may differ in state-owned or foreign banks. Second, the cross-sectional design captures relationships at a single point in time, whereas customer expectations can evolve rapidly in response to technological changes. Third, the study measures self-reported digital competence rather than objectively testing skills; future studies could combine subjective and objective measures. Ultimately, a qualitative exploration of why customers value specific dimensions more strongly could enhance our understanding. Future research should examine cross-country comparisons in Southeast Asia to investigate the interplay between cultural and economic influences. Longitudinal designs could track how digital transformation shifts the relative importance of service dimensions over time. Furthermore, advanced modeling, such as multigroup analysis, could explore differences across age, income, or urban–rural segments. Digital competence was assessed using self-reported Likert-scale items that reflect users' perceived confidence in digital banking services. Although objective performance measures could strengthen construct validity, such data were not available. To reduce bias, items were adapted from established digital literacy frameworks, and this limitation is acknowledged when interpreting the moderating results. The study's findings should be interpreted with caution, as the moderation effect of digital competence is statistically significant but weak; the strong influence of tangibles may reflect unexamined cohort effects, and multi-channel integration may conceptually overlap with reliability or responsiveness. Future research should conduct subgroup analyses, refine construct boundaries, and explore stronger or more objective measures of digital competence.

The study acknowledges several limitations. The moderating effect of digital competence, though significant, is weak and may have been overstated. Tangibles may appear critical due to cohort effects, particularly among older customers,

which were not examined through subgroup analysis. Potential conceptual overlap with reliability and responsiveness persists, and the model explains only 28.3% of loyalty, suggesting that additional variables, such as trust or switching costs, warrant future investigation. Differences between online and offline survey responses were not examined, and the distribution of the sample across data collection modes was not reported. This omission may introduce mode-related bias. Future research should compare response patterns across collection methods to assess potential systematic differences. The use of the term "exploratory" to justify accepting Cronbach's alpha values above 0.60 is inconsistent with the confirmatory nature of the study. Because the research aims to validate a theoretically grounded model, higher reliability thresholds should apply, and this inconsistency should be acknowledged as a methodological limitation.

6. Declarations

6.1. Author Contributions

Conceptualization: M.T.L., P.T.T.; Methodology: P.T.T.; Software: M.T.L.; Validation: M.T.L. and P.T.T.; Formal Analysis: M.T.L. and P.T.T.; Investigation: M.T.L.; Resources: P.T.T.; Data Curation: P.T.T.; Writing Original Draft Preparation: M.T.L. and P.T.T.; Writing Review and Editing: P.T.T. and M.T.L.; Visualization: M.T.L.; All authors have read and agreed to the published version of the manuscript.

6.2. Data Availability Statement

The data presented in this study are available on request from the corresponding author.

6.3. Funding

The authors received financial support for the research from Lac Hong University and Dong Nai Technology University.

6.4. Institutional Review Board Statement

Not applicable.

6.5. Informed Consent Statement

Not applicable.

6.6. Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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