Factors Affecting the E-Loyalty of Individual Customers Using E-Banking Services at Joint-Stock Commercial Banks

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Abstract

Amid rapid digital transformation and intensifying competition from financial technology platforms, retaining loyal customers has become a strategic imperative for banks operating digital channels. This study investigates how four dimensions of electronic service quality, namely efficiency, reliability, privacy and security, and website and application design, influence the electronic loyalty of individual customers toward joint-stock commercial banks offering digital banking services, with electronic satisfaction posited as a full mediating factor. The primary objective is to determine whether these four dimensions jointly shape customer satisfaction and, through satisfaction, loyalty within a competitive, multi-bank setting in a rapidly digitizing emerging economy, addressing a gap where prior studies typically examined only a single bank or a subset of these dimensions in isolation. The study contributes by jointly testing all four dimensions alongside the mediating role of satisfaction across multiple banks and cities, verified through two complementary statistical criteria. Primary data were collected from 248 valid respondents through a structured questionnaire administered online and in person across four cities, and were analyzed using reliability testing, factor analysis, and structural equation modeling with 5,000 bootstrap resamples. All nine proposed hypotheses were supported at a high level of statistical significance: reliability exerted the strongest effect on satisfaction, followed by website and application design, efficiency, and privacy and security. Satisfaction strongly drove loyalty and fully mediated all four services quality to loyalty relationships, with the mediated effect exceeding 80 percent of the total effect in every case and direct path becoming non-significant once satisfaction was included. The model explained 53.7 percent of variance in satisfaction and 45.4 percent of variance in loyalty, and a post-hoc power analysis confirmed statistical power above 99.9 percent. These findings offer actionable evidence for bank managers prioritizing digital service-quality investments, particularly in transaction reliability, to build sustainable customer retention in competitive emerging markets.

Keywords: E-loyalty, E-banking, E-S-QUAL, E-satisfaction, Vietnamese JSCBs, PLS-SEM

1. Introduction

E-banking services have become the primary transaction channel at Vietnamese joint-stock commercial banks (JSCBs) amid rapid digital transformation. According to the State Bank of Vietnam (2024), the number of transactions through digital channels exceeded 8.5 billion in 2023, growing at an average rate of over 40% per year. However, amid intense competition from major JSCBs (Vietcombank, VietinBank, BIDV, Techcombank, MB Bank, ACB) as well as Fintech companies and e-wallets (MoMo, ZaloPay, VNPay), the loyalty of individual customers toward e-banking is being seriously challenged. The cost of acquiring a new customer is 5–7 times higher than the cost of retaining an existing one [1], while switching digital banks takes only a few minutes. Although the e-banking user rate has reached 82% of the adult population, the loyalty rate (defined as remaining with the same bank for more than two years) is only approximately 43%, significantly lower than the 58% recorded in more developed Southeast Asian markets.

To retain customers under these competitive pressures, banks require a theoretical account of what drives digital service quality perceptions toward loyalty; this study grounds its model in the extended E-Service Quality (E-S-QUAL) framework [9] and Expectation-Confirmation Theory (ECT), detailed in Section 2, to explain how efficiency, reliability, privacy and security, and interface design translate into customer satisfaction and, in turn, loyalty [2],[3].

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Despite the scale of this shift, most domestic studies to date focus on a single bank and have not simultaneously tested the four core E-S-QUAL dimensions alongside the mediating role of Satisfaction in a multi-bank context, a gap substantiated against the international and domestic literature in Section 2 [4],[5],[6]. Following COVID-19, the share of cashless transactions increased from 25% (2019) to 56% (2023), necessitating a more comprehensive and up-to-date study in the 'post-digitalization' era of the Vietnamese JSCB system. Moreover, no study has assessed the individual contribution (f^2) of each E-S-QUAL dimension in a multi-bank environment, nor tested measurement invariance across user generations in this market.

Drawing on these gaps, this study tests the model: 'Factors affecting the e-loyalty of individual customers using e-banking services at Vietnamese JSCBs.' This study contributes to the literature in three specific ways: (i) it is the first to jointly test all four extended E-S-QUAL dimensions alongside the mediating role of E-Satisfaction within a single multi-bank, multi-city Vietnamese sample; (ii) it verifies full mediation using two complementary statistical criteria (Variance Accounted For and direct-path non-significance) rather than a single criterion [23],[24]; and (iii) it quantifies the individual effect size (f^2) of each service-quality dimension [16],[19], translating the results into effect-size-based managerial priorities. The findings are expected to provide valuable empirical evidence to help JSCBs prioritize investment in digital service quality pillars to build sustainable loyalty in the digital era.

2. Literature Review and Hypothesis Development

At the international level, Sasono et al. [2] in Indonesia (n = 384, SEM-PLS) confirmed that electronic service quality positively affects satisfaction and loyalty, with satisfaction as the key mediating variable (β = 0.612). Ul Haq and Awan [3] in Pakistan confirmed the mediating role of e-satisfaction in the quality–loyalty chain during the COVID-19 pandemic (β = 0.589). Al-Hawary and Hussien [4] in Jordan showed that usefulness and security are the two factors that most strongly affect e-banking loyalty. Prior studies in digitally emerging banking markets have affirmed the roles of service quality dimensions, usage habit, and security on mobile banking loyalty, and confirmed positive satisfaction–loyalty relationships in internet banking contexts [5]. Taken together, this body of work establishes that electronic service quality reliably predicts satisfaction and loyalty, but each study relies on evidence from a single institution or a partial set of quality dimensions; none jointly tests the full four-dimension E-S-QUAL structure across multiple banks, leaving open whether the relative importance of each dimension generalizes beyond a single-institution setting.

A systematic comparison with prior literature substantiates these gaps: [2] and [3] each tested the full E-S-QUAL structure but within a single-institution setting rather than a multi-bank system; [4] examined only two of the four dimensions (usefulness and security); and prior studies in comparable emerging-economy settings each tend to focus on a single institution or city without jointly modeling all four E-S-QUAL dimensions alongside the mediating role of Satisfaction [5]. Based on this comparison, four main research gaps were identified: (1) No study has simultaneously tested the four EFF–REL–PS–WD dimensions in a multi-bank context within the Vietnamese JSCB system; (2) The full mediation role of Satisfaction has not been tested using PLS-SEM Bootstrapping within the same four-variable model; (3) The individual contribution (f^2) of each dimension in a multi-bank environment has not been assessed; and (4) Measurement invariance and the moderating effect of user generation groups (Gen Z, Millennial, Gen X) on the E-S-QUAL → SAT → LOY chain remain untested and are proposed as directions for future research (Section 6.3), rather than objectives of the present study. Table 1 presents a systematic comparison with these prior studies to substantiate the identified gaps.

Table 1. Systematic comparison with prior studies

Study	Context	E-S-QUAL Dimensions	Mediator Tested	Setting	Key Gap vs. Present Study
Sasono et al. [2]	Indonesia, internet banking	Full E-S-QUAL	Satisfaction (β = 0.612)	Single institution	Not multi-bank; no f^2 decomposition
Ul Haq & Awan [3]	Pakistan, e-banking, COVID-19 era	Full E-S-QUAL	Satisfaction (β = 0.589)	Single institution	Not multi-bank; no f^2 decomposition
Al-Hawary & Hussien [4]	Jordan, commercial banks	2 of 4 (usefulness, security)	Not tested	Single country	Partial dimension set; no mediation model
Alalwan et al. [5]	Jordan, mobile banking	UTAUT2 constructs, not E-S-QUAL	Trust (moderator)	Single country	Different theoretical lens (UTAUT2)

Present study	Vietnam, multi-bank, 4 cities	Full E-S-QUAL + WD	Satisfaction (β = 0.675) + VAF + direct-path test	Multi-bank, multi-city	Addresses all four gaps jointly

Source: Authors' own compilation and comparative synthesis of cited studies

2.1. Key Concepts

E-banking services refer to distribution channel systems that allow customers to carry out banking transactions through Internet-connected electronic devices without visiting a branch [6]. In Vietnam, e-banking encompasses Internet Banking and Mobile Banking, from VCB Digibank, VietinBank iPay, and BIDV SmartBanking to MB App and ACB ONE. E-Loyalty is the customer's deep commitment to continue using a preferred service despite switching pressures from competitors [7]. In the digital environment, e-loyalty is expressed through: (i) behavioral loyalty: high transaction frequency, multi-service use, low switching; and (ii) attitudinal loyalty: psychological commitment, willingness to recommend, resistance to Fintech and competing banks.

E-Satisfaction refers to the degree of fulfillment when customers compare initial expectations with their actual digital service experience [8]. In this study, Satisfaction serves as a mediating variable, converting the four service quality dimensions into Loyalty. The four extended E-S-QUAL dimensions are: (1) Efficiency (EFF): the degree of ease, speed, and convenience in completing transactions [9]; (2) Reliability (REL): the ability to provide accurate, stable, and committed services [8]; (3) Privacy & Security (PS): the level of personal information protection and prevention of online fraud [9][10]; and (4) Website/App Design (WD): the attractiveness, intuitiveness, and user-friendliness of the e-banking application interface [11].

This study deliberately scopes the model to the four extended E-S-QUAL dimensions rather than incorporating other commonly examined antecedents of e-loyalty such as trust, perceived usefulness, switching costs, or service recovery. This choice follows the E-S-QUAL tradition of parsimony [9]: the four dimensions represent the core, empirically validated components of electronic service quality perception, allowing this study's contribution to be concentrated on breadth of institutional coverage (multi-bank, multi-city) and methodological rigor (full mediation verification via both VAF and direct-path testing) rather than on horizontal expansion of the nomological network. Constructs such as trust and switching costs are conceptually adjacent but theoretically distinct — they capture relational and economic barriers to exit rather than perceptions of service delivery quality — and their omission is a deliberate scope boundary rather than an oversight; they are accordingly proposed as directions for model extension in Section 6.3.

2.2. Theoretical Foundations

The E-S-QUAL model [9] was developed to measure electronic service quality through four components. This study inherits and extends E-S-QUAL by integrating the Website/App Design dimension, which is particularly important in the context of Mobile Banking in Vietnam where the application interface is the main point of contact with customers. The Expectation-Confirmation Theory (ECT) [12] explains that satisfaction is formed from the comparison between initial expectations and perceived actual performance. Bhattacherjee [13] extended ECT to online services (ECM), affirming that satisfaction is the key factor driving continued use intention. ECT provides the foundation for the chain: EFF + REL + PS + WD → Satisfaction → Loyalty.

The UTAUT2 model [14] explains the behavior of technology acceptance and continued use in a consumer context, providing a theoretical basis for understanding why customers remain loyal to a specific JSCB's e-banking through performance expectancy (related to EFF and REL), facilitating conditions (related to WD), and hedonic motivation.

Although EFF and WD both relate to the usability of the e-banking channel, they are conceptually distinct constructs rather than overlapping facets of a single factor. EFF, drawn from E-S-QUAL [9], captures the functional dimension of usability — the speed, ease, and productivity of completing a transaction once the interface is in use. WD, drawn from WebQual [11], captures the aesthetic-structural dimension — the visual organization, professional appearance, and interface design that shape perceptions before and independent of any specific transaction. This distinction is supported empirically: the EFA (Section 4.2) extracted EFF and WD as separate factors with no significant cross-loading, and the HTMT value between EFF and WD (0.548) falls well below the discriminant-validity threshold reported in Section 4.3, comparable to or lower than most other inter-construct HTMT values reported for either dimension. The two dimensions are therefore treated as related but empirically and theoretically separable components of e-service quality.

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2.3. Research Hypotheses and Conceptual Model

Based on E-S-QUAL [9], ECT [12], and UTAUT2 [14], the study proposes a full mediation model with four independent variables (EFF, REL, PS, WD), one mediating variable (SAT), and one dependent variable (LOY):

Based on the theoretical foundations above, nine hypotheses are proposed for this study. Grounded in E-S-QUAL's efficiency construct and UTAUT2's performance expectancy, H1 posits that Efficiency (EFF) positively affects E-Satisfaction (SAT), as faster and more convenient transactions more readily confirm customers' pre-usage expectations under ECT. Reflecting E-S-QUAL's core reliability construct, H2 posits that Reliability (REL) positively affects E-Satisfaction (SAT), since consistent and accurate service delivery directly determines whether performance meets or falls short of expectations. Drawing on E-S-QUAL and the e-trust literature, H3 posits that Privacy & Security (PS) positively affects E-Satisfaction (SAT), as perceived protection from fraud and data misuse reduces the perceived risk that would otherwise undermine confirmation. Grounded in WebQual and UTAUT2's facilitating-conditions construct, H4 posits that Website/App Design (WD) positively affects E-Satisfaction (SAT), because an intuitive, well-organized interface lowers the effort required to confirm expected functionality. Consistent with ECT's central proposition that confirmation drives continuance behavior, H5 posits that E-Satisfaction (SAT) positively affects E-Loyalty (LOY). H6 through H9 posit that E-Satisfaction (SAT) fully mediates the relationships between each of EFF, REL, PS, and WD and E-Loyalty (LOY), respectively, following the theoretical reasoning for full mediation detailed below. The proposed research model integrating these hypotheses is illustrated in figure 1.

A full, rather than partial, mediation structure is theoretically preferred here on grounds internal to ECT [12]. Under ECT, satisfaction is the outcome of comparing expectations against perceived performance, and it is this comparison — not the perceived quality attributes themselves — that is theorized to drive continuance and loyalty behavior [13]. Perceptions of efficiency, reliability, privacy/security, and interface design are inputs to the expectation-confirmation judgment; they are not themselves posited to carry independent behavioral weight once that judgment (satisfaction) is formed. A partial mediation specification, by contrast, would imply that service-quality perceptions influence loyalty through some additional pathway ECT does not specify. The four-direct-path test reported in Section 4.4 is therefore best understood as an empirical check on this a priori theoretical expectation rather than a comparison between two equally plausible competing models.

Figure 1 illustrates the proposed conceptual research model of this study. The model places E-Satisfaction (SAT) as the central mediating construct connecting the four E-S-QUAL service quality dimensions (EFF, REL, PS, WD) to E-Loyalty (LOY). The four dimensions serve as independent variables that are hypothesized to jointly determine customer satisfaction with e-banking services (H1 through H4). E-Satisfaction in turn drives E-Loyalty (H5), and is posited to fully mediate the relationships between each service quality dimension and e-loyalty (H6 through H9). The structural model is grounded in the E-S-QUAL framework [9] and Expectation-Confirmation Theory (ECT) [12].

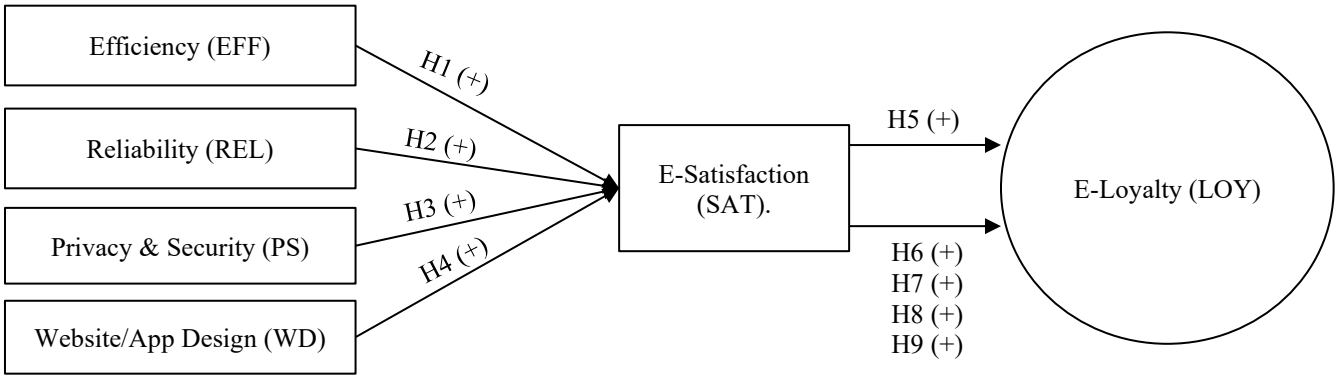


Figure 1. Proposed research model

3. Methodology

3.1. Measurement Scale and Observed Variables

The measurement scale was developed based on original studies, adjusted to the multi-JSCB Vietnamese banking context and content-validated through group discussions with 5 banking experts and 15 individual customers. All observed variables use a 5-point Likert scale (1 = Strongly Disagree, 5 = Strongly Agree). Table 2 summarizes the full set of observed variables, their construct assignment, source references, and exploratory factor analysis outcomes.

Table 2. Summary of research measurement scale

Code	Construct	Observed Variable (abbreviated)	Reference	EFA Result
EFF1	Efficiency	Helps complete transactions faster	[9]; [3]	Retained
EFF2		Improves financial transaction efficiency		Retained
EFF3		Increases personal finance management productivity		Retained
EFF4		Makes transactions easy and useful		Retained
REL1	Reliability	Provides services as promised	[3]	Retained
REL2		Provides services on time as committed		Retained
REL3		Retrieves transaction details accurately		Retained
REL4		Provides accurate and reliable information		Retained
REL5		System operates stably with minimal errors		Retained
PS1	Privacy & Security	Personal information is protected	[9]; [10]	Retained
PS2		Financial information is secured		Retained
PS3		Transactions are secure		Retained
PS4		Protection from fraud and cyber threats		Retained
WD1	Website/App Design	Interface is regularly updated	[11]; [9]	Retained
WD2		Interface layout is well-organized		Retained
WD3		Interactive features work effectively		Retained
WD4		Interface is user-friendly		Retained
WD5		Creates a professional and trustworthy impression		Retained
SAT1	E-Satisfaction	Very satisfied with e-banking service	[15]; [3]	Retained
SAT2		Very fond of e-banking service		Retained
SAT3		Positively rates e-banking products/services		Retained
SAT4		E-banking service meets expectations		Retained
LOY1	E-Loyalty	Will continue using e-banking in the future	[7]; [3]	Retained
LOY2		Will recommend to family and friends		Retained
LOY3		Prioritizes e-banking over other channels		Retained
LOY4		Willing to share positive reviews		Retained
LOY5		Remains loyal even if other banks offer better deals		Retained

Source: Authors' own compilation and adaptation

3.2. Data Collection, Analysis Methods, and Research Procedure

The study employs a mixed-methods approach, with quantitative methods as the primary component. The qualitative phase involved group discussions with 5 banking experts (from ≥ 2 JSCBs) and 15 individual customers currently using e-banking from ≥ 2 JSCBs to refine the measurement scale. The quantitative phase employed convenience and snowball sampling via a nationwide online and face-to-face survey (focusing on Ho Chi Minh City, Hanoi, Da Nang, and Can Tho), distributed through Google Forms shared in banking-customer online communities and social media groups, supplemented by face-to-face intercepts near JSCB branch premises in the four target cities, collecting 248 valid questionnaires from 260 distributed (validity rate: 95.38%). Respondent criteria: individual customers who had been using e-banking services from at least one Vietnamese JSCB within the past 6 months. To reduce selection bias, respondents were recruited from multiple independent channels (online communities, in-person intercepts across four

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geographically distinct cities, and multiple JSCBs) rather than a single source, and quota checks were applied across banks and cities to avoid overrepresentation of any single institution or region; nonetheless, as a non-probability method, convenience/snowball sampling cannot fully eliminate self-selection bias, a limitation discussed further in Section 6.3. Data were analyzed using SPSS 26 (Cronbach's Alpha, EFA) and SmartPLS 4 (PLS-SEM, Bootstrapping N = 5,000). The sample of 248 exceeds the minimum threshold per [16] for PLS-SEM with a six-construct model. A post-hoc power analysis using the minimum R^2 method [17] confirms that this sample size provides statistical power of approximately 0.999–1.000 for both structural models (SAT: $f^2 = 1.160$; LOY: $f^2 = 0.832$), well above the conventional 0.80 threshold, indicating the sample is adequate to detect the observed effect sizes.

3.3. Sample Description

The sample consists of 248 respondents: Gender: female 62.5%, male 37.5%. Age: the 22–30 group accounted for 38.7%, 31–40 accounted for 31.9%. Educational level: university 63.7%, postgraduate 19.4%. Income: VND 5–10 million/month accounted for 35.1%, VND 10–20 million accounted for 35.9%. E-banking usage duration: over 3 years accounted for 54.8%, ensuring sufficient depth of experience to assess loyalty. Banks currently used: Vietcombank (32.3%), VietinBank (21.8%), BIDV (15.7%), Techcombank (14.1%), MB Bank (8.5%), ACB and others (7.6%), ensuring multi-bank diversity. Mean values of variables ranged from 3.45 to 4.12 on the 5-point Likert scale, with the REL variable group recording the highest mean.

3.4. Research Process Flowchart

Table 3 presents the systematic research process employed in this study, proceeding through four sequential phases from conceptual design to final reporting.

Table 3. Research Process Flowchart

Phase	Activities & Outputs
Phase 1	Theoretical review: E-S-QUAL [9], ECT [12], UTAUT2 [14] → Research model & hypotheses (H1–H9)
Phase 2	Scale development: 27-item instrument adapted from E-S-QUAL [9], validated via expert panel (n=5) & pilot (n=15) → Finalized questionnaire
Phase 3	Data collection: Convenience/snowball sampling, 4 cities, multiple JSCBs, n=248 valid responses (SPSS 26: Cronbach's α, EFA)
Phase 4	PLS-SEM (SmartPLS 4): Outer model (CR, AVE, HTMT) → Inner model (path coefficients, VAF, f^2) → Bootstrapping N=5,000 → Hypothesis testing & implications

3.5. Key Measurement Formulas

The following formulas underpin the quantitative assessments conducted in this study:

Composite Reliability (CR) [16]:

$$CR = \frac{(\sum \lambda_i)^2}{(\sum \lambda_i)^2 + \sum(1 - \lambda_i^2)} \quad (1)$$

λ denotes the outer loading of each indicator. CR ≥ 0.70 indicates adequate reliability.

Average Variance Extracted (AVE) [18]:

$$AVE = \frac{\sum \lambda_i^2}{n} \quad (2)$$

where n is the number of indicators per construct. AVE ≥ 0.50 confirms convergent validity.

Effect Size (f^2) [17]:

$$f^2 = \frac{(R^2 included - R^2 excluded)}{(1 - R^2 included)} \quad (3)$$

Thresholds: $f^2 = 0.02$ (small), 0.15 (medium), 0.35 (large). The SAT→LOY path yielded $f^2 = 0.587$ (large).

Variance Accounted For (VAF) [16]:

$$VAF = \frac{Indirect\ Effect}{(Indirect\ Effect\ +\ Direct\ Effect)\ )} \times\ 100\% \quad (4)$$

VAF > 80% indicates full mediation; 20%–80% indicates partial mediation [16]. All four pathways in this study achieved VAF > 80%.

4. Results

4.1. Cronbach's Alpha Results

Reliability of each construct was first assessed using Cronbach's Alpha, with results summarized in table 4.

Table 4. Summary of Cronbach's Alpha results

Scale	No. of Items	Cronbach's Alpha	Min Item-Total Corr.	Conclusion
Efficiency (EFF)	4	0.865	0.638	Accepted
Reliability (REL)	5	0.881	0.676	Accepted
Privacy & Security (PS)	4	0.873	0.684	Accepted
Website/App Design (WD)	5	0.896	0.739	Accepted
E-Satisfaction (SAT)	4	0.887	0.733	Accepted
E-Loyalty (LOY)	5	0.891	0.748	Accepted

All six scales achieved Cronbach's Alpha above 0.8, well in excess of the conventional 0.70 acceptability threshold, indicating that the items within each construct consistently measure the same underlying concept. Item-total correlation coefficients all exceeded the 0.3 threshold, ranging from 0.638 (Efficiency) to 0.748 (E-Loyalty), confirming that every individual item contributes coherently to its intended scale rather than diluting it. Notably, WD achieved $\alpha = 0.896$, the highest among the four independent variables, suggesting the interface-design items were interpreted with particular consistency by respondents, while Efficiency recorded the lowest (though still acceptable) alpha of 0.865. Because no item fell below the retention thresholds, no observed variable was eliminated at this stage, and all 27 items proceeded to exploratory factor analysis.

4.2. Exploratory Factor Analysis (EFA)

KMO = 0.873 (very good per Kaiser) and Bartlett's Test Sig. = 0.000 confirmed data suitability for EFA. The Principal Component Analysis extraction method with Varimax rotation identified 5 factors with Eigenvalue > 1. Total variance explained reached 71.903%, exceeding the minimum 50% threshold [19]. All factor loadings exceeded 0.7; no significant cross-loading was observed. The factor structure was fully consistent with the theoretical model: 5 factors corresponding to REL, EFF, PS, WD, and SAT. Table 5 summarizes the EFA suitability diagnostics and the resulting factor structure.

Table 5. Exploratory factor analysis summary

Diagnostic / Factor	Value	Eigenvalue	Interpretation
KMO measure of sampling adequacy	0.873	—	Very good per Kaiser criterion; data suitable for factor analysis
Bartlett's Test of Sphericity	Sig. = 0.000	—	Correlation matrix significantly differs from identity matrix
Factor 1: Reliability (REL)	5 items	> 1	Highest-loading factor, consistent with REL construct
Factor 2: Efficiency (EFF)	4 items	> 1	Consistent with EFF construct
Factor 3: Privacy & Security (PS)	4 items	> 1	Consistent with PS construct
Factor 4: Website/App Design (WD)	5 items	> 1	Consistent with WD construct
Factor 5: E-Satisfaction (SAT)	4 items	> 1	Consistent with SAT construct
Total variance explained	71.903%	—	Exceeds the 50% minimum threshold [19]

Source: SPSS 26 analysis results. Extraction method: Principal Component Analysis with Varimax rotation. E-Loyalty (LOY) items were retained on the E-Loyalty construct outside the five-factor solution reported here and are addressed in the outer model assessment (table 6).

4.3. Outer Model Assessment (PLS-SEM)

The measurement model was evaluated for composite reliability, convergent validity, and discriminant validity, with the outer loadings, Composite Reliability, and Average Variance Extracted for each construct summarized in table 6.

Table 6. Measurement model evaluation results (CR, AVE, HTMT)

Construct	Outer Loading (min–max)	CR	AVE	Max HTMT	Conclusion
Efficiency (EFF)	0.816–0.868	0.908	0.712	0.628	Accepted
Reliability (REL)	0.792–0.862	0.913	0.678	0.635	Accepted
Privacy & Security (PS)	0.821–0.894	0.913	0.725	0.628	Accepted
Website/App Design (WD)	0.805–0.874	0.923	0.707	0.623	Accepted
E-Satisfaction (SAT)	0.829–0.879	0.922	0.747	0.635	Accepted
E-Loyalty (LOY)	0.796–0.873	0.920	0.696	0.598	Accepted

Table 6 reports the outer loading range, Composite Reliability (CR), Average Variance Extracted (AVE), and maximum HTMT value for each of the six constructs, jointly establishing the psychometric adequacy of the measurement model before the structural relationships are tested. All CR ≥ 0.908 > 0.70 threshold and AVE ≥ 0.678 > 0.50 threshold [18], confirming that each construct's indicators are internally consistent (composite reliability) and that each construct captures substantially more variance in its indicators than measurement error does (convergent validity). The full HTMT correlation matrix (table 7) shows all values ranging from 0.537 to 0.635, all < 0.85 threshold [20], ensuring discriminant validity between every pair of constructs, meaning each construct is empirically distinct from every other rather than measuring an overlapping concept. Outer VIF ranged from 1.818 to 2.666, both well below the conventional collinearity concern threshold of 5, indicating indicators within each construct are not redundant with one another. Following the full collinearity test approach [21], all Inner VIF values (1.000–1.204) fall well below the conservative 3.3 threshold, providing converging evidence against serious common method bias beyond Harman's test alone. Common method bias was further assessed via Harman's Single Factor Test: the first unrotated factor accounted for 38.62% of total variance, below the 50% threshold [22], indicating no serious common method variance. Together, these outer-model diagnostics indicate the measurement instrument is sufficiently reliable, valid, and free of major method artifacts to support inference from the structural model reported in Section 4.4.

Table 7. Full HTMT correlation matrix

Construct	EFF	REL	PS	WD	SAT	LOY
EFF						
REL	0.571					
PS	0.628	0.602				
WD	0.548	0.591	0.619			
SAT	0.612	0.635	0.589	0.623		
LOY	0.544	0.552	0.563	0.537	0.598	

Note: All values below the 0.85 HTMT threshold [20]; bootstrap 95% confidence intervals do not include 1.

4.4. Structural Model Testing (PLS-SEM and Bootstrapping)

The structural model was tested via PLS-SEM path estimation with 5,000 bootstrap resamples, with the direct and mediated effect results presented in table 8.

Table 8. Results of direct and mediated effect tests

	Relationship			β (original)	Sample Mean	Std Dev	95% CI	T-Stat	p	Conclusion
(H1)	EFF	→	SAT	0.221	0.224	0.045	[0.133, 0.309]	4.915	0.000	Accepted
(H2)	REL	→	SAT	0.415	0.413	0.044	[0.329, 0.501]	9.461	0.000	Accepted
(H3)	PS	→	SAT	0.220	0.220	0.047	[0.128, 0.312]	4.638	0.000	Accepted
(H4)	WD	→	SAT	0.225	0.228	0.046	[0.135, 0.315]	4.945	0.000	Accepted
(H5)	SAT	→	LOY	0.675	0.679	0.033	[0.610, 0.740]	20.218	0.000	Accepted

(H6)	EFF	→	SAT	→	LOY	0.149	0.152	0.031	[0.088, 0.210]	4.900	0.000	Accepted
(H7)	REL	→	SAT	→	LOY	0.280	0.281	0.033	[0.215, 0.345]	8.465	0.000	Accepted
(H8)	PS	→	SAT	→	LOY	0.148	0.150	0.035	[0.079, 0.217]	4.283	0.000	Accepted
(H9)	WD	→	SAT	→	LOY	0.152	0.155	0.032	[0.089, 0.215]	4.726	0.000	Accepted

Note: Bootstrapping N = 5,000

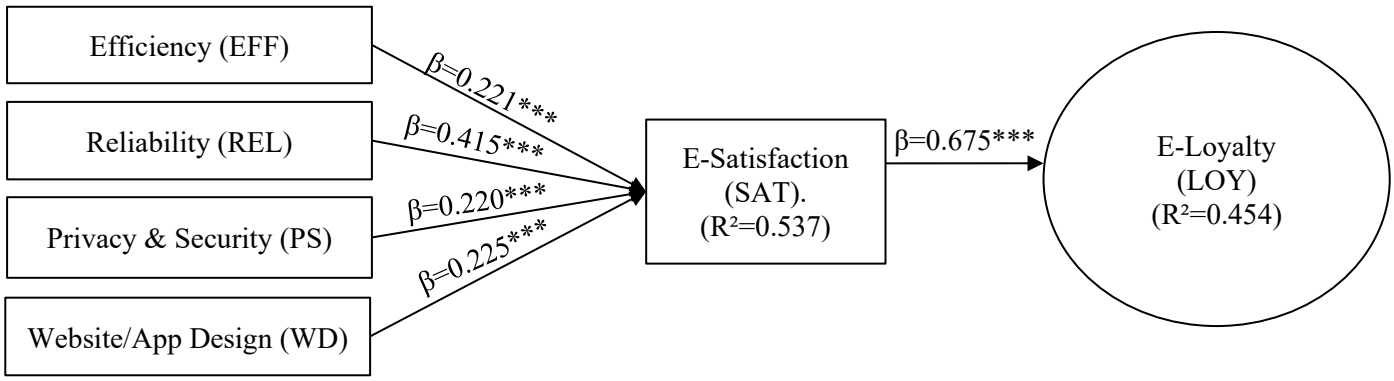
All 9 hypotheses were accepted at the 5% significance level. Order of effects on Satisfaction: REL (β = 0.415) > WD (β = 0.225) > EFF (β = 0.221) > PS (β = 0.220). Satisfaction exerted the strongest effect on Loyalty (β = 0.675, f^2 = 0.587). All indirect effects through SAT were statistically significant (p = 0.000). Table 8 also reports 95% bootstrap confidence intervals (β ± 1.96×SE, N = 5,000 resamples) for all nine path coefficients; none include zero, further confirming the significance of all estimates. Following [16], mediation strength was evaluated using the Variance Accounted For (VAF) criterion: for all four pathways the indirect effect through SAT accounted for VAF > 80% of the total effect, which is classified as full mediation under this criterion. To further validate the full mediation claim, an alternative model specification was estimated by adding four direct paths (EFF → LOY, REL → LOY, PS → LOY, WD → LOY) alongside the indirect pathways through SAT. As reported in table 9, all four direct paths are statistically non-significant (p > 0.10), corroborating the full mediation conclusion under both the VAF criterion [16] and the standard Baron and Kenny [23] / Zhao et al. [24] direct-path approach. This dual-criterion confirmation resolves the previously noted methodological limitation regarding full mediation verification. R^2(SAT) = 0.537; R^2(LOY) = 0.454; Q^2(SAT) = 0.400; Q^2(LOY) = 0.311, calculated using the blindfolding procedure (omission distance D = 7) in SmartPLS 4, confirming strong predictive relevance [19].

Table 9. Direct Path Coefficients (EFF/REL/PS/WD → LOY) in the Full Mediation Model (SAT Included)

Path			β (Original)	Sample Mean	T-Statistic	p-value	Sig.
EFF	→	LOY	0.071	0.069	1.282	0.201	n.s.
REL	→	LOY	0.086	0.084	1.611	0.108	n.s.
PS	→	LOY	0.090	0.092	1.544	0.123	n.s.
WD	→	LOY	0.032	0.031	0.562	0.574	n.s.

Note: Direct paths estimated with SAT included as mediator. Source: SmartPLS 4, Bootstrapping N = 5,000. n.s. = not significant at p > 0.05; all four direct paths non-significant, confirming full mediation through E-Satisfaction (SAT). Std Dev: EFF → LOY = 0.055; REL → LOY = 0.053; PS → LOY = 0.058; WD → LOY = 0.057.

Figure 2 presents the validated structural model with the PLS-SEM computed results derived from SmartPLS 4 with 5,000 bootstrap resamples. All nine hypotheses were supported at p < 0.001. Reliability (REL) exhibits the strongest direct effect on E-Satisfaction (β = 0.415), followed by Website/App Design (WD, β = 0.225), Efficiency (EFF, β = 0.221), and Privacy & Security (PS, β = 0.220). E-Satisfaction significantly drives E-Loyalty (β = 0.675, f^2 = 0.587). The Variance Accounted For (VAF) for all mediated paths exceeds 80%, confirming full mediation in every case.



Note: Bootstrapping N = 5,000. *** p < 0.001

Figure 2. Validated Structural Model with PLS-SEM Computed Results

5. Discussion

Central role of E-Satisfaction (β = 0.675, f^2 = 0.587). This is the largest effect in the entire model, consistent with ECT [12] and aligned with Sasono et al. [2] in Indonesia (β = 0.612) and Ul Haq and Awan [3] in Pakistan (β = 0.589). The

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higher β compared to the regional context reflects low switching costs and multiple alternatives (Fintech, e-wallets) in Vietnam, making Satisfaction a critical determinant of loyalty retention [25]. Prominent influence of Reliability (β = 0.415, f^2 = 0.222). REL is the strongest factor, with a notable gap relative to the other variables. While the present survey data cannot directly establish the cause of this dominance, the finding is plausibly consistent with media-reported incidents of e-banking downtime and transaction errors at several Vietnamese JSCBs in recent years, which may have heightened customers' sensitivity to service reliability; this contextual explanation is offered as a plausible interpretation rather than a claim directly tested by the data. The finding is consistent with Al-Hawary & Hussien [4] in Jordan and prior emerging-market banking studies [5]. Unlike Singapore and Malaysia, where REL is considered a given, in Vietnam, reliability remains a key differentiator.

Website/App Design ranks second (β = 0.225). WD surpassed EFF because during 2022–2025, JSCBs had already achieved a high level of maturity in basic transaction speed, turning EFF into a hygiene factor while WD became a differentiator. This is consistent with threshold expectation theory [8] and the trend of JSCBs investing heavily in UI/UX (MB App, Techcombank Mobile, VCB Digibank). Efficiency (β = 0.221) and Security (β = 0.220). Nearly equal, with small f^2 values but statistically significant. PS did not stand out because JSCBs had already widely deployed biometric authentication and OTP per Circular 17/2024/TT-NHNN, making basic security an expected standard, similar to EFF. Unlike Jordan where PS led [4], this result reflects the maturation of Vietnam's digital banking security infrastructure.

6. Conclusions and Policy Implications

6.1. Conclusions

This study successfully tested the extended four-factor E-S-QUAL model affecting the e-loyalty of 248 individual customers using e-banking across multiple Vietnamese JSCBs. As the sample was drawn using convenience and snowball sampling and skews toward younger, more experienced e-banking users (Section 6.3), these findings should be interpreted as applicable to the studied sample rather than generalized to all Vietnamese JSCB customers. PLS-SEM results (R^2(SAT) = 0.537; R^2(LOY) = 0.454; $Q^2 > 0.35$) confirmed all 9 hypotheses. The order of effects on Satisfaction: REL (β = 0.415) > WD (β = 0.225) > EFF (β = 0.221) > PS (β = 0.220). E-Satisfaction plays a full mediating role (per the VAF criterion; see Section 4.4) with β = 0.675 and f^2 = 0.587, the most decisive factor in the model. The study adds useful empirical evidence in a multi-bank context, consistent with the broader applicability of the E-S-QUAL framework to Mobile Banking in emerging markets, though further replication would be needed to establish universality.

6.2. Managerial Implications

The following recommendations are prioritized according to each dimension's estimated effect size on Satisfaction; the specific operational targets cited (e.g., uptime percentages, response-time thresholds, update frequency) reflect common industry benchmarks and practitioner guidance rather than figures directly estimated from the survey data, and are offered as illustrative reference points for managerial action rather than empirical findings. The priority ordering follows directly from the path coefficients and effect size reported in Section 5: Reliability's f^2 = 0.222 is the only individually reported effect size among the four antecedents and, combined with its markedly higher β relative to WD, EFF, and PS, indicates it carries the largest marginal influence on Satisfaction. A bank facing a binding digital-transformation budget constraint therefore obtains the largest expected gain in Satisfaction per unit of investment by addressing Reliability first; because the β coefficients for WD, EFF, and PS are close in magnitude (0.225, 0.221, and 0.220, respectively), the remaining three dimensions offer comparable, smaller marginal returns and can be sequenced according to institution-specific cost of implementation.

Reliability (REL, β = 0.415): Priority 1. JSCBs should: (i) upgrade core banking to support high uptime and fast processing time, in line with common industry benchmarks; (ii) fulfill commitments on processing time and service fees; (iii) deploy AI chatbots and 24/7 support to resolve incidents promptly; and (iv) periodically publish transaction success rates to build trust. Website/App Design (WD, β = 0.225): Priority 2. JSCBs should: (i) conduct quarterly A/B testing of interfaces and collect in-app feedback; (ii) minimize the number of steps required for common transactions;

(iii) update applications on a regular cadence consistent with industry practice; (iv) support accessibility for elderly users; and (v) personalize interfaces using AI.

Efficiency (EFF, β = 0.221): Priority 3. Pursue fast application loading times and near-instant payments, consistent with industry benchmarks; synchronize multi-channel experience (Mobile, Internet Banking, ATM); integrate multi-services (payments, savings, investment, insurance) into a single application Privacy & Security (PS, β = 0.220): Priority 4. Deploy biometrics and OTP per FIDO2 standards; proactively communicate security measures in-app; comply with Decree 13/2023/ND-CP; respond to and remediate confirmed security breaches promptly, in accordance with Decree 13/2023/ND-CP requirements and prevalent industry practice. Integrated Implication: Building sustainable E-Satisfaction (β = 0.675): deploy real-time NPS and CSAT; leverage AI personalization to proactively address dissatisfaction points; implement loyalty programs tied to transaction frequency; build an integrated digital ecosystem combining financial and non-financial services to increase switching costs.

6.3. Limitations and Future Research Directions

The study has several limitations: (1) The convenience/snowball sample (54.8% with > 3 years of e-banking experience, concentrated in the 22–40 age group) does not fully represent all Vietnamese e-banking customers, particularly older users, less-experienced users, and rural residents; findings should be interpreted within the bounds of this sample rather than generalized to the full population of Vietnamese JSCB customers; (2) The model has not integrated emerging factors such as AI, CSR, Switching Costs, or Usage Habit; (3) The cross-sectional design does not capture changes in loyalty over time; (4) Measurement invariance across bank types (state-owned vs. private) and user generations has not been tested; (5) An overall model-fit index (e.g., SRMR) was not computed in the original analysis, and its applicability to PLS-SEM remains debated [26]; this is noted as an additional reporting limitation; and (6) Common method bias (CMB) is potentially present, although Harman's Single Factor Test (first factor = 38.62% of variance, below the 50% threshold) and VIF < 3.3 revealed no serious CMV indicators.

Future research directions: (1) Expand the model to integrate AI and CSR; (2) Conduct longitudinal studies to track loyalty changes over time; (3) Perform multi-group analysis by JSCB type and user generation (Gen Z, Millennial, Gen X); (4) Integrate moderating variables on usage frequency and technology experience; and (5) Test measurement invariance by user generation to develop personalized segment-based strategies.

6.4. Author Contributions

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

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6.6. Institutional Review Board Statement

Not applicable. This study involved an anonymous voluntary survey of adult bank customers and did not require IRB approval under applicable institutional guidelines.

6.7. Informed Consent Statement

Informed consent was obtained from all respondents prior to participation in the survey.

6.8. Data Availability Statement

The data that support the findings of this study are available from the corresponding author (linhcd@hub.edu.vn) upon reasonable request.

6.9. 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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