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Integrating Digital Transformation into the SyarDigBankQual Measurement: An Empirical Study of Sharia Financial Institutions in Bandung

Tini Supartini[1], Kadir[2], Djadjun Juhara[3]
[1,2,3] Sekolah Tinggi Ilmu Ekonomi Pasundan, Bandung, Indonesia
Email: tini@stiepas.id[1], kadir@stiepas.id[2], djadjun@stiepas.id[3]

Abstract

This study aims to examine the impact of digital-based Islamic banking service quality on customer satisfaction and to identify operational improvement priorities in Bandung City. The originality of this research lies in its methodological integration, combining a symmetrical approach to predict satisfaction drivers with an asymmetrical approach to detect the absolute prerequisites that could bottleneck customer satisfaction. The researchers applied a quantitative design involving 244 customers from five Islamic banks selected through simple random sampling. Data were analyzed using a robust combination of Partial Least Squares Structural Equation Modeling (PLS-SEM), Importance-Performance Map Analysis (IPMA), and Necessary Condition Analysis (NCA). The PLS-SEM results prove that digital service quality exerts a positive and highly significant impact on customer satisfaction. The IPMA confirms that banks must sustain their empathy-driven services while urgently addressing performance gaps in system responsiveness, with security aspects acting merely as hygiene factors. Reinforcing these findings, the NCA contributes empirical novelty by establishing Empathy & Personnel Effectiveness as the sole large-effect bottleneck condition that must be fulfilled from the early stages of service. In conclusion, the technological sophistication of Islamic banking must be grounded in a humanistic touch. Management is advised to prioritize empathetic communication training for personnel while reinforcing server infrastructure.

Keywords: *Digital Service Quality; Customer Satisfaction; Islamic Banking; Service Novelty*

Introduction

This study emphasizes the critical need for Islamic financial institutions to actively embrace digital transformation. The current digital economy presents modern financial sectors with unprecedented challenges and opportunities, compelling them to adapt swiftly to technological advancements (Qizam, Berakon & Ali, 2025; Mujiatun, Trianto, Cahyono & Rahmayati, 2023). Consequently, Sharia-compliant banks must proactively align their operations with rapid technological shifts while continuously satisfying customer demands (Harsanto, et al., 2024; Khattak, Ali, Azmi & Rizvi, 2023; Hassan, Zulfikar, Rabbani & Atif, 2022).

The widespread adoption of digital platforms, including e-wallets and mobile banking applications, fundamentally transforms how consumers interact with their financial providers (Kitsios, Giatsidis & Kamariotou, 2021; Aldaarmi, 2024). Thus, Islamic banking management must accurately evaluate their service quality within this new digital landscape (Li, et al., 2021; Diener & Špaček, 2021). Evaluating digital performance empowers these institutions to precisely grasp and fulfill user expectations, ultimately elevating the customer experience to foster long-term satisfaction and loyalty.

Merging service quality metrics with technological shifts significantly boosts client satisfaction and retention across the banking industry. Furthermore, Porfirio, Felício, and Carrilho (2024) assert that industry leaders must comprehensively understand the distinct drivers of digital transformation while simultaneously delivering superior services. Technological integration revolutionizes internal banking operations and heavily upgrades customer interactions, thereby crafting a superior service journey. Delivering exceptional digital banking quality directly amplifies consumer loyalty intentions, acting as a crucial mechanism to ensure technological innovations successfully meet or surpass user expectations (Zhou, et al., 2021). Corroborating this perspective, Mavlutova, et al. (2022) highlight that digital modernization serves as a primary engine for sustainable financial sector growth, actively expanding financial inclusion and streamlining operational efficiency.

Numerous investigations (Onorato, Pampurini & Quaranta, 2024; Bueno, et al., 2024; Khan, Kutan & Qureshi, 2024) reveal that integrating information technology successfully upgrades operational efficiency and service excellence. Furthermore, this technological adoption strongly captivates modern consumers, particularly the millennial demographic who heavily favor digital platforms for executing their financial transactions.

Bapat (2022) and Gunawardane (2023) emphasize the crucial role of user experience within digital finance, proving that seamless cross-platform interactions significantly elevate customer satisfaction. Additionally, Mir, Rameez, and Tahir (2023) alongside Faizi, et al. (2025) note that financial providers utilizing digital assessment tools can more accurately evaluate service performance and decode consumer preferences. Beyond operational benefits, digital modernization actively fortifies adherence to Islamic principles. For instance, Taufik Syamlan, Wahyuni, Heruwasto, and Hamsal (2026) demonstrate how advanced technologies enforce strict transparency and accountability across all Sharia-compliant dealings.

By deploying robust service quality metrics, financial organizations easily pinpoint critical areas requiring enhancement, which perfectly aligns with their ongoing efforts to streamline digital workflows. Through a concentrated focus on how digital transformation upgrades service delivery, this study aims to supply actionable insights that boost the competitive edge of Islamic financial institutions. Simultaneously, this initiative drives the progression of an inclusive and sustainable digital economy.

Consequently, this research investigates the specific factors that construct the service quality of digitally transformed Islamic financial institutions operating throughout Bandung City.

Research Method

This research adopts a quantitative explanatory design to examine and quantify how digitally integrated service quality influences customer satisfaction within the Islamic banking sector. The target population

comprises all clients actively engaging with the digital platforms of five prominent Islamic commercial banks located throughout Bandung City. To guarantee an equal probability of selection for every client across these institutions, the researchers implemented a simple random sampling procedure. By distributing randomized yet strictly controlled online questionnaires, the study successfully harvested valid data from 244 respondents who firmly met the inclusion criteria as active users of Islamic digital banking applications.

The measurement instrument evaluates a second-order independent construct—specifically, Digital Islamic Banking Service Quality—which researchers structured using six first-order dimensions, while positioning Customer Satisfaction as the targeted dependent variable. The authors meticulously formulated these six distinct service quality dimensions by synthesizing and extending three highly established conceptual frameworks: Bank Service Quality (BSQ), E-S-QUAL, and E-banking Service Quality (Parasuraman, Zeithaml & Malhotra, 2005; Abdullah, Suhaimi, Saban & Hamali, 2011; Ulkhaq, Rabbani, Wibowo & Rachmania, 2017; Chandel & Vij, 2019; Ho & Lin, 2010).

Integrating these foundational frameworks yielded six comprehensive measurement dimensions: Assurance, Security & Privacy; Efficiency & System Availability; Empathy & Personnel Effectiveness; Price Transparency; Responsiveness & Reliability; and Tangibles & Aesthetics. The researchers coined this newly integrated construct "SyarDigBankQual". The study evaluated all operational indicators by applying a seven-point Likert scale, ranging from "Strongly Disagree" to "Strongly Agree". Consequently, the authors formulated the primary hypothesis, asserting that Digital Islamic Banking Service Quality (SyarDigBankQual) positively and significantly drives Customer Satisfaction across Bandung City.

To rigorously assess this hierarchical and highly complex theoretical model, the investigators executed Partial Least Squares Structural Equation Modeling (PLS-SEM) utilizing SmartPLS software. The analytical procedure encompasses two primary phases. First, the researchers evaluated the measurement model (outer model) to rigidly verify

convergent validity, discriminant validity (via HTMT), and internal consistency reliability. Second, they assessed the structural model (inner model) to determine the significance of causal relationships through bootstrapping procedures, measured the structural predictive strength (R2, $f2$), and validated the out-of-sample predictive accuracy by deploying the Cross-Validated Predictive Ability Test (CVPAT).To deliver substantial methodological novelty and enrich managerial implications, the authors deliberately expanded beyond traditional symmetrical PLS-SEM by integrating advanced analytical frameworks. Specifically, the researchers performed Importance-Performance Map Analysis (IPMA) to chart the strategic priorities of variables by contrasting their actual performance scores against their structural importance (total effect). Furthermore, they applied an asymmetrical approach known as Necessary Condition Analysis (NCA), executing both Ceiling Envelopment (CE-FDH) and Ceiling Regression (CR-FDH) techniques. The authors utilized NCA precisely to pinpoint which service dimensions operate as absolute bottleneck conditions—essential prerequisites whose absence strictly prevents consumers from achieving their targeted satisfaction thresholds.

Results and Discussion

An examination of the respondents' demographic profiles reveals that female participants heavily dominated the study, constituting 64.8% of the total sample, while male participants accounted for the remaining 35.2%. Regarding age classification, younger generations aged below 30 years overwhelmingly commanded the customer demographic structure with a striking representation of 71.3%. Meanwhile, middle-aged adults (spanning 31 to 40 years) and those exceeding 40 years old registered relatively balanced participation rates, recording 13.9% and 14.8%, respectively. This specific age distribution strongly indicates that digital Islamic banking services in Bandung City exert a massive magnetic appeal among Generation Z and millennial cohorts.

Furthermore, a review of the professional backgrounds exposes a fairly even distribution of work experience, although the data leans significantly

toward established professionals. Individuals holding more than five years of career experience secured the top position, comprising 38.1% of the sample. This demographic closely trailed by workers possessing two to four years of experience, who made up 36.9%. Meanwhile, entry-level employees—or those holding less than a year of professional tenure—contributed exactly 25% to the overall respondent pool.

Concerning the historical interaction with the banking institutions, the duration of customer membership presents a highly intriguing data polarization. Islamic banks operating in Bandung City undeniably maintain a robust and loyal customer base, perfectly mirrored by the high volume of respondents utilizing their services for over five years (38.9%). Simultaneously, these institutions display aggressive market expansion capabilities, successfully capturing new audiences where novice customers (holding less than one year of membership) contributed an almost identical proportion at 38.1%. Clients maintaining mid-level membership durations (two to four years) completed this profile by representing 23%. These empirical facts solidify the premise that Islamic banks successfully preserve their long-standing customer retention while persistently driving new consumer growth through their digital service channels.

Table 1. Validity, Reliability and VIF Result

	EffSys	Emp & Person Eff	Price Trans	ResRel	SEC	Tang & Aesth	VIF	CA	AVE
EFF1	0.857						3.990		
EFF2	0.888						3.197		
EFF3	0.904						3.539		
SYS1	0.904						2.112	0.901	0.775
SYS2	0.794						4.094		
SYS3	0.900						4.459		
SYS4	0.911						2.963		
EMP1		0.911					3.561	0.944	0.825
EMP2		0.945					5.166		

EMP3	0.917				3.752		
EMP4	0.929				4.190		
PRC1		0.875			2.365		
PRC2		0.935			3.449	0.935	0.813
PRC3		0.936			3.591		
PRC4		0.912			4.484		
REL1			0.922		3.756		
REL2			0.900		3.063		
REL3			0.863		4.281		
REL4			0.915		4.036	0.938	0.808
RES1			0.923		3.397		
RES2			0.879		4.734		
RES3			0.909		4.869		
RES4			0.925		3.256		
SEC1				0.925	4.061		
SEC2				0.945	3.505	0.925	0.805
SEC3				0.927	4.195		
SEC4				0.945	3.512		
TA1					0.905	3.178	
TA2					0.918	4.274	0.924	0.803
TA3					0.944	3.749		
TA4					0.932	4.358		

The data processing results reveal that all indicators constructing the service quality variables successfully recorded outer loading values exceeding the ideal threshold of 0.708 (Hair et al., 2021). These factor loadings ranged from a minimum of 0.794 (the SYS2 indicator) to a peak of 0.945 (the EMP2 and SEC2 indicators). Consequently, these empirical findings prove that each specific indicator shares a highly robust correlation with its designated principal construct.

Furthermore, the analytical outcomes confirm that all latent variables achieved highly satisfactory Average Variance Extracted (AVE) scores. These AVE metrics spanned from 0.775 (the EffSys variable) to an impressive 0.825 (the Empathy & Personnel Effectiveness variable). Because all recorded figures greatly surpass the stringent 0.50 minimum

requirement, the analysis firmly asserts that every latent variable within the digital Islamic banking framework effectively explains more than 50% of the variance belonging to its respective constituent indicators.

The analytical results also demonstrate that the six research variables generated exceptionally high Cronbach's alpha coefficients, extending from 0.901 to 0.944. Since all these coefficients easily eclipse the 0.70 baseline standard, the researchers definitively conclude that the utilized questionnaire instrument possesses outstanding internal consistency.

Finally, the vast majority of the research indicators registered Variance Inflation Factor (VIF) statistics remaining well below the maximum threshold of 5.0, fluctuating between 2.112 and 4.869. Although the EMP2 indicator displayed a VIF score of 5.166—marginally eclipsing the 5.0 limit—the researchers deliberately retained this specific item. This retention decision directly stems from its exceptional convergent validity score (loading = 0.945) alongside its incredibly strong theoretical contribution to the Empathy construct.

Table 2. HTMT

	EffSys	Empathy & Person Eff	Price Transp	ResRel	SEC	Tangibles & Aesthetics
EffSys						
Empathy & Person Eff	0.637					
Price Transp	0.373	0.683				
ResRel	0.432	0.664	0.434			
SEC	0.395	0.616	0.444	0.403		
Tangibles & Aesthetics	0.529	0.709	0.455	0.513	0.496	

Scholars widely recognize the Heterotrait-Monotrait Ratio (HTMT) criterion as a superior and more precise mechanism for identifying discriminant validity issues compared to conventional methods. A measurement model successfully establishes discriminant validity when the HTMT values between constructs fall strictly below the stringent 0.85 threshold (Henseler et al., 2015).

Analyzing the processed HTMT data reveals that all inter-construct ratios achieved highly satisfactory scores. The data matrix illustrates that the highest HTMT correlation emerged between the Tangibles & Aesthetics and Empathy & Personnel Effectiveness variables, peaking at 0.709. Conversely, the lowest HTMT ratio materialized in the relationship between Price Transparency and EffSys, recording a mere 0.373.

Because no single value within the entire matrix breached the maximum 0.85 limit, the researchers firmly declare that all examined variables successfully passed the discriminant validity test. These empirical findings substantiate that the six digital Islamic banking service quality dimensions (spanning from EffSys to Tangibles & Aesthetics) genuinely and independently measure completely distinct constructs.

Having seamlessly satisfied the criteria for convergent validity, internal reliability, and discriminant validity—without encountering any collinearity complications—the authors conclude that the measurement instrument and the overall outer model exhibit exceptional robustness. Consequently, this structural solidity perfectly clears the path to advance into the hypothesis testing phase (inner model evaluation).

Table 3. Total Effect, R2 and $f2$

	Total effects	
SyarDigBankQual -> EffSys	0.736	
SyarDigBankQual -> Empathy & Personnel Effectiveness	0.900	
SyarDigBankQual -> Price Transparency	0.672	
SyarDigBankQual -> ResRel	0.792	
SyarDigBankQual -> SEC	0.667	
SyarDigBankQual -> Tangibles & Aesthetics	0.763	
	R2	f-square

EffSys	0.542	1.184
Empathy & Personnel Effectiveness	0.811	4.281
Price Transparency	0.451	0.823
ResRel	0.627	1.678
SEC	0.445	0.803
Tangibles & Aesthetics	0.583	1.397

The analytical results demonstrate that all service dimensions generated exceptionally high and positive total effects. Specifically, the Empathy & Personnel Effectiveness dimension secured the highest contribution score, peaking at 0.900. These empirical findings strongly indicate that the capacity of banking personnel to exhibit genuine empathy and deliver effective service serves as the absolute dominant reflection of digital Islamic banking quality.

Following this lead, the ResRel (0.792), Tangibles & Aesthetics (0.763), and EffSys (0.736) dimensions consecutively occupied the subsequent positions, with each demonstrating highly substantial contributions. Meanwhile, the Price Transparency (0.672) and Security or SEC (0.667) dimensions contributed the smallest proportions to the overarching construct. Nevertheless, from a strict statistical standpoint, these two lower-ranked elements firmly maintain their essential positions as the foundational pillars of service quality.

Drawing upon the structural model evaluation criteria established by Hair et al. (2024), the researchers classified the Empathy & Personnel Effectiveness dimension into the substantial (strong) category, evidenced by a coefficient of determination (R2) reaching 0.811. This specific metric signifies that the overarching service quality directly explains 81.1% of the variance within the customer's empathy perception. Furthermore, the ResRel (0.627), Tangibles & Aesthetics (0.583), and EffSys (0.542) dimensions comfortably settled into the moderate category, as their respective values exceeded the 0.50 threshold. Conversely, the analysis categorized Price Transparency (0.451) and SEC (0.445) as moderate-to-weak, given that their coefficients fell slightly below the 0.50 baseline.

To quantify the structural predictive magnitude of the primary construct, the investigators evaluated the effect size ($f2$). Adhering to Cohen's (1988) criteria—which rigorously designates values exceeding 0.35 as having a "large effect"—the processed data unequivocally prove that all dimensions within this study exert massive predictive impacts, dynamically ranging from 0.803 to 4.281. Once again, Empathy & Personnel Effectiveness completely dominated the structural evaluation by producing a massive $f2$ score of 4.281. The ResRel (1.678), Tangibles & Aesthetics (1.397), and EffSys (1.184) dimensions trailed respectively behind. Ultimately, despite occupying the lowest ranks within the structural model, both Price Transparency (0.823) and SEC (0.803) continued to project undeniably large predictive effect sizes.

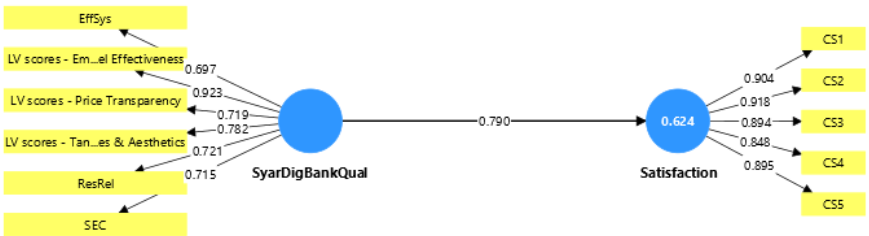


Figure 1. Second Order Model

Upon successfully establishing the robust validity and reliability of the measurement instruments across both the foundational first-order dimensions and the overarching second-order construct, the investigators advanced to evaluate the structural model (inner model). The authors designed this subsequent analytical phase explicitly to validate the central research hypothesis. Ultimately, this crucial stage seeks to empirically prove how Digital Islamic Banking Service Quality (SyarDigBankQual) directly drives Customer Satisfaction.

Table 4. Path, R2 and $f2$

	coefficients	Sample mean (M)	CI 5.0%	CI 95.0%	P values

SyarDigBankQual -> Satisfaction	0.790	0.792	0.740	0.838	0.000
R-square					
Satisfaction					0.624
f^2					
SyarDigBankQual					1.659

The data processing outputs reveal a positive path coefficient of 0.790 concerning the direct relationship between Digital Islamic Banking Service Quality and Customer Satisfaction. This robust metric strongly indicates that elevating the quality of digital services will linearly and substantially upgrade customer satisfaction levels.

To rigidly ascertain the statistical significance, the investigators examined the corresponding T-statistics and P-values. The structural analysis generated an impressive T-statistic of 26.424. Because this figure massively exceeds the critical threshold of 1.96 (evaluated at a 5% significance level), and receives full support from a P-value of 0.000 (falling perfectly below the 0.05 maximum error tolerance), the authors conclusively declare that this causal effect possesses exceptional statistical significance.

Furthermore, evaluating the Confidence Interval (CI) produced a lower bound (5.0%) of 0.740 alongside an upper bound (95.0%) of 0.838. Since this specific interval strictly excludes the value of zero (0), the researchers confidently verify that the resulting positive impact remains entirely consistent and genuine, unequivocally ruling out any random statistical fluctuations.

Assessing the model's predictive accuracy, the data processing establishes that the Customer Satisfaction variable secured a coefficient of determination (R2) of 0.624, coupled with an adjusted R2 of 0.622. Drawing upon the structural model assessment guidelines formulated by Hair et al. (2024), the researchers classify this determination level into a moderate-to-strong category. Empirically, this finding denotes that Digital Islamic Banking Service Quality actively accounts for 62.4% of the total variance in Customer Satisfaction across Bandung City. Consequently, unexamined

external factors or variables operating outside this theoretical framework drive the remaining 37.6% of the variance.

Finally, the researchers computed the effect size ($f2$) for the direct pathway connecting SyarDigBankQual to Satisfaction, yielding a massive score of 1.659. Academically classified as a large-scale effect, this specific figure represents a highly substantial predictive magnitude. Thus, the empirical evidence confirms that the digital service quality construct operates not merely as a valid predictor, but acts as a dominant catalyst that powerfully shapes the satisfaction of Islamic banking customers.

Table 5. Validity, Reliability, HTMT, VIF and Model Fit Second Order Model

	Cronbach's alpha	Composite reliability (rho_a)	Composite reliability (rho_c)	Average variance extracted (AVE)
Satisfaction	0.936	0.938	0.951	0.796
SyarDigBankQual	0.854	0.878	0.892	0.583
HTMT		Satisfaction		
Satisfaction				
SyarDigBankQual		0.871		
VIF				
	SyarDigBankQual -> Satisfaction			1.000
Model Fit				
		Saturated model		**Estimated model**
SRMR		0.058		0.058
d_ULS		0.222		0.222
d_G		0.091		0.091
Chi-square		120.884		120.884
NFI		0.938		0.938
PLSpredict		**Q²predict**	**RMSE**	**MAE**
Satisfaction		0.613	0.630	0.478
CVPAT	**PLS loss**	**IA loss**	**Average loss difference**	**t value**	**p value**
Satisfaction	0.695	1.343	-0.648	5.624	0.000
Overall	0.695	1.343	-0.648	5.624	0.000

The data processing outputs reveal that both the Satisfaction and SyarDigBankQual variables exhibit Cronbach's alpha coefficients (0.936

and 0.854, respectively) alongside Composite Reliability metrics (encompassing both rho_a and rho_c) that completely surpass the 0.70 threshold. Furthermore, the Average Variance Extracted (AVE) scores for Satisfaction (0.796) and SyarDigBankQual (0.583) successfully breached the 0.50 minimum standard. Relying on these criteria, the researchers conclude that the second-order model possesses outstanding internal consistency and solid convergent validity.

Subsequent analytical results display a Heterotrait-Monotrait (HTMT) ratio of 0.871 between Satisfaction and SyarDigBankQual. Although this figure marginally exceeds the strict 0.85 limit, it comfortably satisfies the broader 0.90 tolerance threshold recommended by Henseler et al. (2015). The second-order structural analysis in Table 5 demonstrates that the Heterotrait-Monotrait (HTMT) ratio linking Digital Islamic Banking Service Quality (SyarDigBankQual) and Customer Satisfaction reached 0.871. While this figure marginally breaches the conservative 0.85 boundary, we purposefully preserved our current structural framework. Methodologically, Henseler, Ringle, and Sarstedt (2015) authorize a 0.90 upper limit for latent variables that demonstrate strong theoretical closeness or functional alignment, fully validating our retention strategy.

Therefore, the study adequately establishes the required discriminant validity. Simultaneously, by generating a Variance Inflation Factor (VIF) of exactly 1.000, the structural model guarantees a complete absence of collinearity constraints.

Assessing the overall model fit, the evaluation yielded a Standardized Root Mean Square Residual (SRMR) of 0.058. Because this specific metric falls significantly below the maximum 0.080 cutoff designated by Hair et al. (2024), the proposed model demonstrates an excellent fit. A Normed Fit Index (NFI) of 0.938 (surpassing the > 0.90 requirement) firmly corroborates this condition, supported further by the metric consistency of d_ULS and d_G between the estimated and saturated models. Ultimately, these empirical findings prove that the entire architectural framework of the research is highly viable and perfectly suits the collected field data.

Executing the PLSpredict procedure reveals that the Customer Satisfaction variable generated a predictive Q2 value of 0.613. Since this metric decisively exceeds zero (> 0) and leans closely toward 1, the authors conclude that the theoretical model possesses exceptionally high predictive relevance, officially classifying it into the strong category.

To evaluate predictive significance, the investigators deployed the Cross-Validated Predictive Ability Test (CVPAT), explicitly comparing the prediction errors of the PLS-based model (PLS loss = 0.695) against the indicator average baseline model (IA loss = 1.343). The test outputs a negative average loss difference (-0.648), strongly indicating that the PLS model produces a profoundly lower predictive error rate than the standard baseline. Furthermore, securing a t-value of 5.624 alongside an absolute p-value of 0.000 unequivocally confirms that the model's predictive performance is highly significant from a strict statistical standpoint. Analyzed through the lens of psychometrics and service marketing, modern digital banking consumers in Bandung City naturally develop a shared cognitive framework. Within highly interactive digital environments, users actively combine their assessments of automated system performance with their emotional responses to transaction outcomes. As a result, consumers integrate service quality and customer satisfaction into a unified user experience (UX) rather than processing them as completely separate mental constructs. Moreover, our model fit metrics strongly validate this structural design. The Standardized Root Mean Square Residual (SRMR = 0.058) easily satisfies the required threshold (< 0.080). Additionally, the Cross-Validated Predictive Ability Test (CVPAT) generated a highly significant negative average loss difference (-0.648, p = 0.000). This strong predictive outcome demonstrates that, despite their close theoretical relationship, both variables maintain distinct out-of-sample predictive power. Consequently, this empirical evidence ensures that our causal path specification (β = 0.790, p = 0.000) operates independently, remains structurally robust, and avoids critical multicollinearity issues.

Table 6. IPMA Analysis

IPMA	**LV performance**
Satisfaction	76.900
SyarDigBankQual	74.337
	MV performance
CS1	79.012
CS2	77.023
CS3	75.720
CS4	73.594
CS5	78.532
Efficiency & System Availability	72.471
Empathy & Personnel Effectiveness	75.347
Price Transparency	70.929
Tangibles & Aesthetics	76.049
Responsiveness & Reliability	73.740
Assurance, Security & Privacy	76.640
Indicator Total Effect	**Satisfaction**
EffSys	0.147
LV scores - Empathy & Personnel Effectiveness	0.237
LV scores - Price Transparency	0.168
LV scores - Tangibles & Aesthetics	0.172
ResRel	0.151
SEC	0.175

The Importance-Performance Map Analysis (IPMA) outputs presented in Table 6 and Figure 2 at the latent variable level reveal that the Digital Islamic Banking Service Quality (SyarDigBankQual) generated an overall operational performance score of 74.337. Functionally, this service execution culminates in a Customer Satisfaction metric reaching 76.900. These specific figures clearly indicate that the current digital Islamic banking ecosystem across Bandung City performs commendably, settling comfortably above the 70-point baseline. Nevertheless, executive management still faces a performance gap ranging from 23% to 25%, which they must actively bridge to achieve an absolute perfection score of 100.

Performance and Strategic Priorities of Service Quality Dimensions

To precisely identify which operational areas urgently demand immediate resource allocation, the researchers synthesized the dimension performance scores (MV performance) with their respective structural

weights (Total Effect). This strategic mapping effectively divides managerial actions into four distinct focal points:

Primary Enhancement Priorities (High Importance, Relatively Low Performance)

Bank management must direct special attention toward the Responsiveness & Reliability (Performance: 73.740) and Efficiency & System Availability (Performance: 72.471) dimensions. Although both elements possess substantial structural predictive power (importance), their actual operational achievements still fall below the overall service quality average of 74.337. Consequently, the investigators strongly urge Islamic banks to immediately inject investments aimed at accelerating system response times, minimizing application downtime, and vigorously upgrading digital transaction reliability.

Core Strengths to Sustain (Very High Importance, Good Performance)

The Empathy & Personnel Effectiveness dimension unconditionally commands a central position. As previously proven during the structural model evaluation, this specific dimension wields the most crucial level of structural influence. Currently, the empathy performance operates at a highly adequate level (75.347). Furthermore, Tangibles & Aesthetics also demonstrates strong execution (76.049) coupled with significant strategic importance. Therefore, Islamic banks must vigorously preserve their visually appealing user interfaces while continuously nurturing the personalized, Islamic-driven empathetic customer care that Bandung City clients highly appreciate.

Maintenance Focus / Over-resourced (Low Importance, Very High Performance)

Interestingly, the Assurance, Security & Privacy dimension secured the highest performance score (76.640) among all foundational elements, despite holding the lowest importance rating within the overall construct formulation. This statistical phenomenon does not imply that security is irrelevant; rather, it highlights that consumers inherently perceive digital system security as a mandatory, fundamental baseline—a hygiene factor they take for granted—which the banking institutions already execute

exceptionally well. Management simply needs to maintain these existing security protocols routinely without necessarily positioning them as primary promotional instruments.

Low Priority (Low Importance, Lowest Performance)

Finally, Price Transparency recorded the weakest performance score at merely 70.929. However, because this specific dimension also exerts the smallest relative influence on the overarching service quality, executive management should not aggressively channel their immediate resources into this area. Institutions can execute fee transparency improvements gradually alongside their regular day-to-day operational workflows.

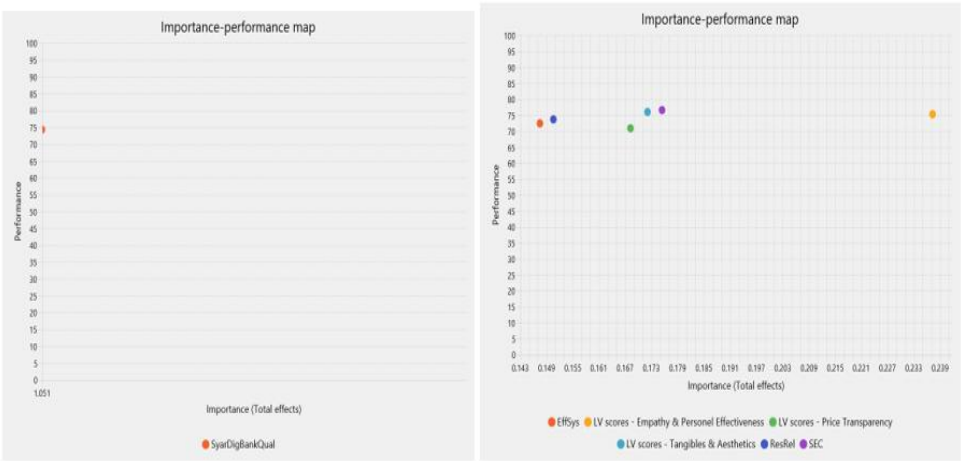


Figure 2. IPMA of SyarDigBankQual

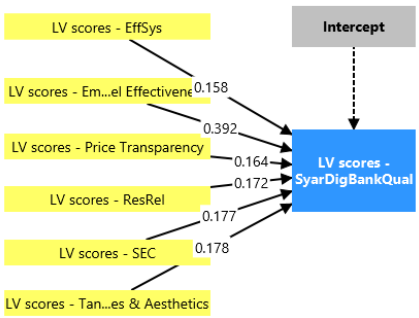


Figure 3. NCA Analysis of SyarDigBankQual

Table 7. Ceiling line effect size

		CE-FDH	CR-FDH
LV scores - Efficiency & System Availability		0.158	0.150
LV scores - Empathy & Personnel Effectiveness		0.392	0.371
LV scores - Price Transparency		0.164	0.145
LV scores - Responsiveness & Reliability		0.172	0.178
LV scores - Assurance, Security & Privacy		0.177	0.181
LV scores - Tangibles & Aesthetics		0.178	0.171
	Effect size	**95.0%**	**Permutation p value**
LV scores - Efficiency & System Availability	0.158	0.102	0.000
LV scores - Empathy & Personnel Effectiveness	0.392	0.120	0.000
LV scores - Price Transparency	0.164	0.099	0.000
LV scores - Responsiveness & Reliability	0.172	0.107	0.000
LV scores - Assurance, Security & Privacy	0.177	0.107	0.000
LV scores - Tangibles & Aesthetics	0.178	0.110	0.000

Analyzing the data outputs presented in Table 7 and Figure 3, the Ceiling Line techniques (incorporating both CE-FDH and CR-FDH methods) reveal that every single digital Islamic banking service quality dimension generated a Permutation p-value of exactly 0.000. Because this precise metric falls radically below the standard 0.05 significance threshold, the researchers definitively conclude that all evaluated dimensions operate as statistically significant necessary conditions for Islamic banks across Bandung City.

Nevertheless, evaluating the effect sizes across these variables exposes highly intriguing operational variations:

Empathy & Personnel Effectiveness (The Dominant Effect):

This specific dimension secured the most massive effect size, yielding 0.392 under the CE-FDH method and 0.371 via the CR-FDH approach. Adhering strictly to Dul's (2024) criteria, these figures successfully breach the 0.30 baseline, thereby confirming empathy and personnel effectiveness as a large-scale absolute necessity. Empirically, this dictates that delivering

robust, personalized empathy acts as a non-negotiable prerequisite for generating digital banking satisfaction. Should management neglect this human aspect, the institution will face an absolute impossibility in attaining premium customer satisfaction levels.

Other Technical and Functional Dimensions (Medium Effect):

The remaining five dimensions—comprising Tangibles & Aesthetics (d = 0.178), Assurance, Security & Privacy (d = 0.177), Responsiveness & Reliability (d = 0.172), Price Transparency (d = 0.164), and Efficiency & System Availability (d = 0.158)—all firmly settle into the medium-effect category. Operationally, this signifies that core elements like data security, system reliability, interface aesthetics, and pricing transparency continue to function as necessary requirements that the bank must fulfill up to a certain threshold, even though their prerequisite stringency does not match the sheer magnitude of the empathy dimension.

Managerial Implications of NCA Findings

These NCA discoveries beautifully supply methodological novelty by complementing the earlier PLS-SEM and IPMA outputs. While the PLS-SEM and IPMA evaluations previously proved that Empathy wields crucial direct influence and top-tier performance priority, the NCA execution rigorously fortifies this evidence by crowning Empathy as an absolute bottleneck condition. Consequently, digital Islamic banking executives in Bandung City must urgently recognize that deploying sophisticated technology, ironclad data security, and seamless application efficiency alone cannot adequately elevate customer satisfaction. If the digital service ecosystem fails to inject a humanistic touch, sincere empathy, and highly effective personalized handling from banking representatives (for instance, through highly responsive hybrid customer service channels), the overall customer satisfaction will suffer a severe bottleneck.

Ultimately, the NCA procedure empirically proves that all digital Islamic banking service quality dimensions inherently operate as necessary conditions for unlocking customer satisfaction, with Empathy & Personnel Effectiveness emerging definitively as a large-effect absolute prerequisite. This breakthrough finding forcefully asserts that any Islamic banking

digitalization strategy must fiercely integrate and prioritize empathetic service elements at the very core of its technological expansion.

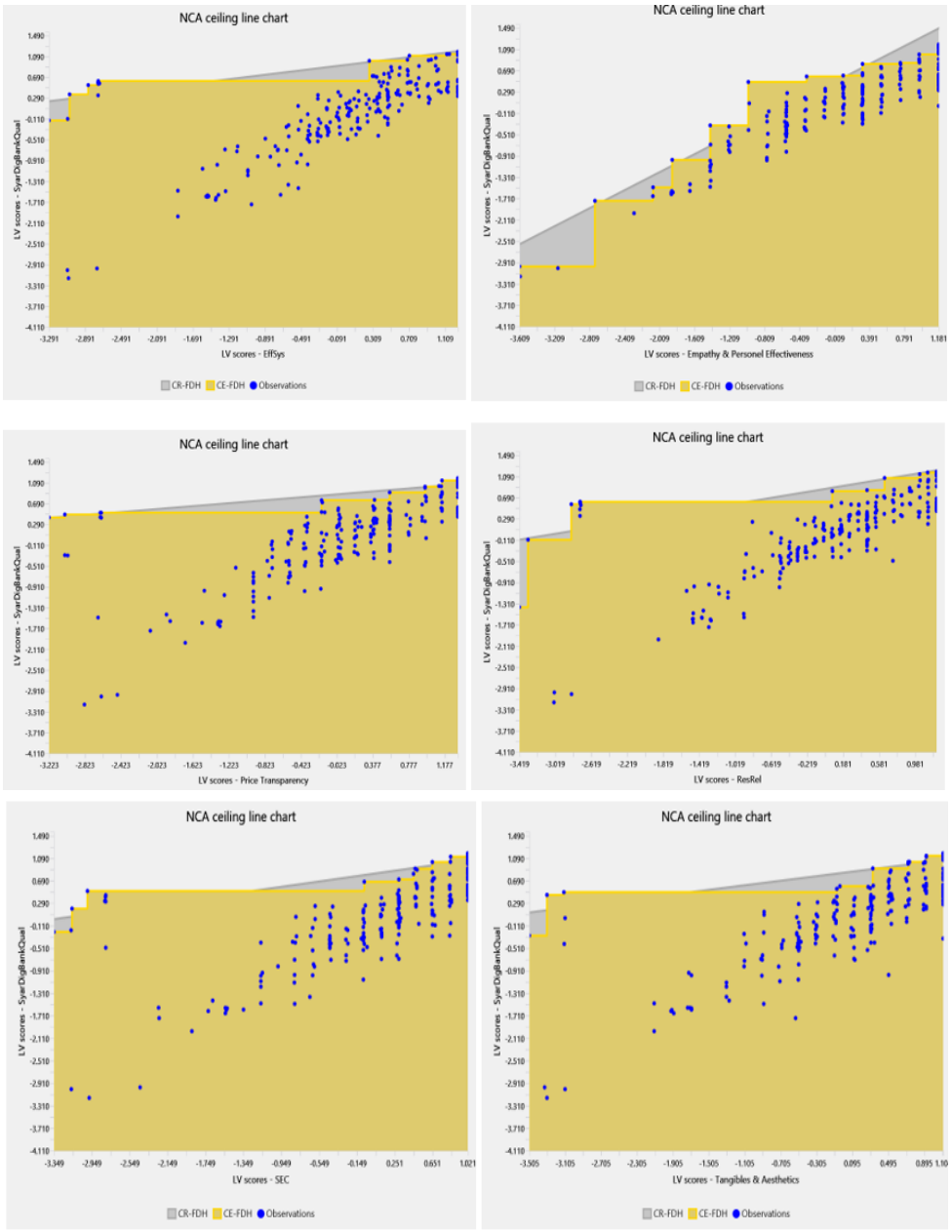


Figure 4. NCA Ceiling Line Chart

Table 8. Bottleneck CE and CR FDH

CE	LV scores - SyarDigBank Qual	LV scores - EffSys	LV scores - Empathy & Personnel Effectiveness	LV scores - Price Transparency	LV scores - ResRel	LV scores - SEC	LV scores - Tangibles & Aesthetics
0%	-4.110	NN	NN	NN	NN	NN	NN
10%	-3.544	NN	NN	NN	NN	NN	NN
20%	-2.977	NN	-2.748	NN	NN	NN	NN
30%	-2.410	NN	-2.748	NN	NN	NN	NN
40%	-1.843	NN	-2.748	NN	NN	NN	NN
50%	-1.276	NN	-1.865	NN	-3.323	NN	NN
60%	-0.709	NN	-1.430	NN	-3.323	NN	NN
70%	-0.143	NN	-0.994	NN	-3.323	-3.158	-3.308
80%	0.424	-2.856	-0.994	-3.047	-2.842	-2.995	-3.308
90%	0.991	0.267	0.958	0.957	0.639	0.646	0.715
100 %	1.558	1.250	1.181	1.321	1.218	1.021	1.104

CR	LV scores - SyarDigBank Qual	LV scores - EffSys	LV scores - Empathy & Personnel Effectiveness	LV scores - Price Transparency	LV scores - ResRel	LV scores - SEC	LV scores - Tangibles & Aesthetics
0%	-4.110	NN	NN	NN	NN	NN	NN
10%	-3.544	NN	NN	NN	NN	NN	NN
20%	-2.977	NN	NN	NN	NN	NN	NN
30%	-2.410	NN	-3.424	NN	NN	NN	NN
40%	-1.843	NN	-2.753	NN	NN	NN	NN
50%	-1.276	NN	-2.082	NN	NN	NN	NN
60%	-0.709	NN	-1.411	NN	NN	NN	NN
70%	-0.143	NN	-0.740	NN	NN	NN	NN
80%	0.424	-2.368	-0.069	-3.148	-1.550	-1.607	-2.025
90%	0.991	0.312	0.602	0.850	0.458	0.760	0.782
100 %	1.558	1.250	1.181	1.321	1.218	1.021	1.104

The strategic mapping results illustrate a sequential fulfillment pattern of absolute prerequisites, which the researchers categorize into three crucial operational phases:

1. The Foundation Stage (0% - 40% Quality Target): The Empathy Dominance

The bottleneck data consistently position Empathy & Personnel Effectiveness as the absolute first prerequisite to materialize. Extracting insights from the CE-FDH method, the moment banking executives set a lower-tier service quality target (starting at just 20%), the empathy dimension immediately sheds its Not Necessary (NN) status, strictly demanding a minimum threshold score of -2.748. The CR-FDH approach robustly corroborates this phenomenon, where empathy solidifies into an absolute requirement at the 30% level. These empirical findings strongly dictate that management completely fails to construct any early-stage quality perception without first guaranteeing that their personnel—encompassing both human customer service and digital interactions—possess highly adequate empathetic capabilities.

2. The Intermediate Stage (50% - 70% Quality Target): The Reliability Demand

As the institution scales its quality targets toward the intermediate tier (50% to 70%), entirely new bottleneck thresholds begin to surface. During this phase, the Responsiveness & Reliability (ResRel) dimension actively transforms into a mandatory prerequisite (triggering at the 50% level within the CE-FDH matrix). Managerially, this reveals a critical insight: once customers receive satisfactory empathetic handling, they instantly demand rapid system responsiveness and rock-solid reliability as their subsequent non-negotiable requirements. Furthermore, upon hitting the 70% benchmark, auxiliary dimensions—specifically Assurance, Security & Privacy (SEC) alongside Tangibles & Aesthetics—actively begin extracting their own minimum compliance limits.

3. The Peak Stage (80% - 100% Quality Target): The Comprehensive Necessity

The most formidable challenge emerges when Islamic banks ambition to deliver superior-tier service quality (80% to 100%). At this critical juncture, both the CE-FDH and CR-FDH matrices clearly dictate that not a single dimension retains a Not Necessary (NN) status. Purely technical elements that institutions could previously tolerate—specifically Efficiency & System Availability (EffSys) and Price Transparency—now dramatically mutate into mandatory conditions possessing positive threshold values (all exceeding 0.000 at the 90% and 100% levels). Operationally, to unlock optimum satisfaction, banks must flawlessly execute quality excellence across every single frontline and backend channel without exception. Failing to satisfy even one technical dimension during this phase will instantly shatter the bank's efforts to sustain peak-level service quality.

Strategic Implications of the Bottleneck Analysis

Drawing upon these bottleneck discoveries, the researchers strongly advocate a highly structured service improvement roadmap for digital Islamic banking across Bandung City. Rather than executing a massive, simultaneous overhaul of the entire system—which heavily burns exorbitant capital—management must initiate their upgrades by revamping human resources to secure service empathy (the foundation phase). Once the institution successfully cements a robust empathetic culture, executives can confidently pivot their investment focus toward system responsiveness and structural reliability (the intermediate phase). Ultimately, to capture supreme customer loyalty at the highest echelons, the bank must thoroughly refine its technical sophistication, significantly upgrading price transparency, advanced operational efficiency, and the UI/UX aesthetic design of the application (the peak phase).

Fundamentally, the NCA methodology empirically proves that "Empathy reigns supreme (Effect Size = 0.392)." These precise bottleneck thresholds definitively answer the managerial question of "Just how important is it?" with a staggering reality: "Even when a bank merely targets a base 20% quality performance, the consumer already actively mandates empathy as an absolute requirement."

Digital Service Quality as the Ultimate Determinant of Customer Satisfaction

This study empirically proves that digital-based Islamic banking service quality (SyarDigBankQual) executes a crucial role in escalating customer satisfaction across Bandung City. The hypothesis testing outputs via PLS-SEM firmly confirm that upgrading digital service quality exerts a highly significant and massive positive impact (generating an $f2$ value of 1.659) on customer satisfaction. Furthermore, rather than strictly relying on traditional causality testing, the researchers deployed the Cross-Validated Predictive Ability Test (CVPAT) and discovered that this measurement model possesses highly precise out-of-sample predictive capabilities. These robust findings solidify the premise that the utilized service quality instrument remains exceptionally relevant and resilient for predicting actual customer behaviors and satisfaction levels in the real world, heavily surpassing mere historical data-fit analyses.

The Empathetic Touch: A Competitive Advantage and Absolute Prerequisite

The most compelling discovery—and the primary source of methodological novelty in this research—lies in the absolute dominance of the Empathy & Personnel Effectiveness dimension. Even though clients actively operate within a digital platform ecosystem, the structural model analysis (PLS-SEM) reveals that users paradoxically position human empathy and personalized interactions as the paramount drivers of satisfaction, decisively outperforming purely technical elements like system efficiency or data security.

The Necessary Condition Analysis (NCA) rigorously reinforces these findings by crowning empathy as the sole large-effect absolute prerequisite (bottleneck condition). Consequently, regardless of how sophisticated the Islamic banking technology becomes, the institution will completely fail to satisfy its clientele if management neglects to pair these technological advancements with a highly responsive, welcoming, and empathetic customer service channel.

This phenomenon perfectly aligns with the fundamental philosophy of Islamic banking, which heavily prioritizes partnership relationships, contractual transparency, and the profound values of universal brotherhood (ukhuwah). Culturally, banking customers in Bandung City deeply cherish a sincere "human touch" whenever they encounter technical disruptions or seek financial product consultations. The urban population of Bandung exhibits strong communal-religious cultural traits. In the context of Islamic banking, consumers treat digital technologies like mobile banking platforms solely as pragmatic channels for everyday transactional execution. Yet, in the event of system breakdowns or when individuals require expert guidance on complex Islamic financing instruments (mudharabah and murabahah), they mandate a distinct human element. Under these specific circumstances, customers explicitly demand a humanistic touch and expect communicative interactions built upon the Islamic partnership principles of brotherhood (ukhuwah). Therefore, Islamic banks that successfully harmonize the artificial intelligence sophistication of chatbots with the genuine human empathy of live operators will ultimately capture and conquer customer loyalty.

System Security as a Fundamental Hygiene FactorThe Importance-Performance Map Analysis (IPMA) provides a fascinating perspective regarding the Assurance, Security & Privacy dimension, illustrating that Islamic banks currently deliver their highest operational performance within this specific privacy-security realm. Paradoxically, consumers perceive this dimension as having the lowest structural importance in formulating their overall satisfaction. The researchers interpret this statistical anomaly as concrete proof that modern consumers strictly view system security as a fundamental baseline (hygiene factor)—an absolute, undeniable standard that banking institutions must inherently possess, rather than an extraordinary value-added benefit. Thus, Islamic banks merely need to sustain their existing operational security protocols without heavily exploiting them as primary promotional or marketing materials.

Conversely, the IPMA accurately identifies critical operational gaps within the Efficiency & System Availability alongside the Responsiveness

& Reliability dimensions. Although customers attach exceptionally high urgency to these two technical elements, the actual performance delivered by Islamic banks in Bandung City currently falls short of expectations. Clients frequently experience sluggish application processing, repeatedly encounter unplanned maintenance downtimes, and suffer from painfully slow system responses during peak transactional hours. Executive banking management must urgently eradicate these performance gaps to prevent a severe erosion of future customer satisfaction levels.

Theoretically, this investigation significantly enriches the broader service marketing literature by proving that integrating symmetrical approaches (PLS-SEM and IPMA) with asymmetrical methodologies (NCA) successfully yields a vastly more comprehensive and profound understanding of digital service quality.

Managerially, the researchers formulate three actionable strategic recommendations for Islamic banking executives:

Banking management must aggressively allocate fresh investments toward reinforcing their server infrastructures to radically accelerate transaction processing times (boosting operational efficiency).

Islamic banks must intensively train their helpdesk personnel, empowering these frontline workers to resolve technical issues swiftly (responsiveness) while heavily employing an empathetic communication style firmly rooted in Sharia values.

Executives should refrain from unnecessarily burning excessive resources attempting to overhaul the security systems or price transparency mechanisms; instead, they should simply preserve these specific elements at their currently optimal, well-functioning operational standards.

Conclusion

Synthesizing the empirical outputs generated by the PLS-SEM, IPMA, and NCA frameworks, this study firmly concludes that digital-based Islamic banking service quality (SyarDigBankQual) exerts a positive, highly significant, and massive predictive impact on customer satisfaction across Bandung City. Specifically, the analysis reveals that while all six service

quality dimensions contribute validly to the model, customers resoundingly crown Empathy & Personnel Effectiveness as the ultimate determinant of their satisfaction. The Necessary Condition Analysis (NCA) rigorously corroborates this discovery, empirically proving that empathy operates as the sole large-effect absolute prerequisite (bottleneck condition) triggering straight from the earliest phases of service quality formation. Conversely, consumers perceive technical dimensions—particularly Security and Price Transparency—more as fundamental baseline standards rather than primary satisfaction drivers. Furthermore, the out-of-sample predictive evaluations (via PLSpredict and CVPAT) definitively establish that this structural model possesses exceptional relevance and accuracy for forecasting customer behaviors well beyond the observed data sample.

To translate these empirical findings into actionable managerial strategies, the researchers highly recommend that Islamic banking executives execute the following initiatives:

Prioritize Empathetic Training: Management must urgently conduct Sharia-value-based soft skills training for all customer service personnel—including the digital response and helpdesk teams—to ensure they deliver highly empathetic assistance. Failing to execute this humanistic touch will immediately bottleneck customers, preventing them from even reaching the foundational levels of satisfaction.

Bridge the Technical Gaps: Banks must rapidly allocate fresh capital and resources to eradicate the existing performance gaps within the Responsiveness & Reliability and Efficiency dimensions. Upgrading server infrastructures to aggressively minimize application downtime and accelerate transaction processing speeds must become the central focus of medium-term operational improvements.

Maintain Existing Strengths: Executive management should refrain from executing massive overhauls regarding the Assurance, Security & Privacy, and Tangibles dimensions. Instead, the institution simply needs to rigorously monitor and routinely maintain these specific features, ensuring they constantly meet the prevailing operational standards of the modern banking industry.

Despite delivering robust empirical and methodological contributions, the researchers acknowledge several inherent limitations within this study. Primarily, the geographical scope remains strictly confined to Islamic banking customers residing within the urban boundaries of Bandung City. The unique cultural and demographic characteristics of Bandung's urban society potentially heavily influence how these specific consumers perceive and define "empathy." Consequently, scholars cannot automatically generalize these findings to banking populations situated in rural territories or other provinces across Indonesia. Furthermore, this study executed a cross-sectional quantitative design; therefore, it cannot comprehensively capture the fluid behavioral dynamics or shifting technological satisfaction trends of consumers over an extended temporal trajectory.

To successfully overcome these limitations and continuously expand the financial services marketing literature, the authors propose several actionable pathways for future research. Subsequent investigations should broaden the sampling scope to a national level. Alternatively, researchers could execute comparative studies—utilizing Multigroup Analysis (MGA)—to contrast customer behaviors between Java and non-Java regions, thereby rigorously testing the cross-cultural stability of the empathy prerequisite.

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Conflicts Of Interest

The authors declare no conflict of interest. The funders had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript, or in the decision to publish the results.

Use Of Artificial Intelligence (AI)

The authors transparently disclose the use of AI Tool exclusively for the purpose of linguistic editing and grammatical refinement of the original draft. The authors maintain full responsibility for the manuscript's substantive content, data integrity, andfinal scientific conclusions.sion to publish the results.

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