



Customer Loyalty Formation in Medical Device E-Commerce: The Role of Value Co-Creation, Brand Image, and E-Service Quality through Customer Satisfaction

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Abstract

Background: Online sales have widened access to personal-use medical devices in Indonesia, but repeat purchasing is difficult to sustain because buyers must judge safety, authenticity, service reliability, and provider credibility at the same time. How these judgments combine to create loyalty remains insufficiently resolved.

Objective: The study tested whether value co-creation (VCC), brand image (BI), e-service quality (ESQ), and customer perceived value (CPV) explain customer satisfaction (CS) and customer loyalty (CL), and whether CS carries any of those effects to CL.

Methods: Survey data from 301 Indonesian consumers who had bought personal-use medical devices at least twice during the previous six months were analyzed with PLS-SEM in SmartPLS 3.0.

Results: VCC ($T = 2.341$; $p = 0.019$) and BI ($T = 2.206$; $p = 0.027$) were associated with CS; CPV ($T = 0.617$; $p = 0.541$) and ESQ ($T = 1.836$; $p = 0.064$) were not. CL was associated with CS ($T = 2.857$; $p = 0.004$), ESQ ($T = 2.852$; $p = 0.004$), VCC ($T = 5.386$; $p < 0.001$), and BI ($T = 3.255$; $p = 0.001$), but not CPV ($T = 1.377$; $p = 0.168$). All four CS-mediated paths were non-significant.

Conclusion: In this market, loyalty is explained more convincingly by direct relational, brand, and service effects than by a common satisfaction-mediated mechanism. Customer participation, brand credibility, and dependable digital service therefore deserve managerial priority.

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INTRODUCTION

Customer retention is unusually consequential in medical-device e-commerce because repeated transactions occur in a category where commercial convenience is inseparable from perceived health risk. A buyer deciding whether to return to the same seller weighs not only satisfaction but also confidence in the brand, the quality of digital interaction, perceived value, and opportunities to participate in shaping the service (Choi et al., 2019; Cronin et al., 2000).

The Indonesian market provides a timely setting for this question. Digital channels are taking a larger role in medical-device distribution, while projections cited by the Indonesian Ministry of Health and Grand View Research (2023) place the market near USD 3.2 billion by 2028. Unlike routine online retail, however, medical-device purchases require customers to assess authenticity, regulatory compliance, safety, and seller competence, which can make loyalty harder to secure (Buccioli et al., 2020).

Value co-creation captures one relational route to loyalty. Customers who provide feedback, evaluate products, request service adjustments, or otherwise participate in the

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exchange may perceive the provider as more responsive to their needs. Such participation can strengthen the experience itself and may increase both satisfaction and relational attachment (Assiouras et al., 2019; Scuotto et al., 2017; Vega-Vazquez et al., 2013).

This mechanism is particularly plausible for health-related products, where buyers often need clearer information and greater reassurance than in ordinary online purchases. Interactive contact can reduce uncertainty and give customers a stronger sense that the provider understands the functional and safety requirements attached to the product (Zarei et al., 2019; M. Zhang et al., 2020).

Customer satisfaction is treated in this study as a possible, rather than assumed, transmission mechanism. Expectation-Confirmation Theory links post-use evaluation to continued behavior, while Relationship Marketing Theory views favorable exchange experiences as foundations for enduring relationships (Oliver, 1999; Morgan & Hunt, 1994). The unresolved issue is whether satisfaction actually carries the effects of value, co-creation, brand image, and service quality into loyalty in medical-device e-commerce.

Brand image may operate differently because it can serve as a pre-purchase risk cue. A credible brand gives customers a basis for inferring quality, reliability, and accountability when the product cannot be fully evaluated before use. This can reduce uncertainty and support both favorable evaluations and repeat purchasing (Gensler et al., 2015; Mohammed & Rashid, 2018).

E-service quality concerns the functioning of the digital encounter itself: dependable systems, clear navigation, secure transactions, timely responses, and accessible information. These attributes have been linked to trust and continued use in digital services, but their importance may be amplified when product information and transaction reliability have health implications (Barreda et al., 2020; Blut et al., 2023; Pengnate & Sarathy, 2017).

Prior studies usually examine perceived value, co-creation, brand perceptions, service quality, satisfaction, or loyalty in separate relationships. The resulting evidence does not establish whether the same causal sequence applies to a medically sensitive online product category. This study therefore evaluates these constructs jointly and, in particular, tests the proposition that satisfaction is the common bridge from the four antecedents to loyalty.

The empirical objective is to estimate the direct links of CPV, VCC, BI, and ESQ with CS and CL and to test four specific indirect paths through CS among Indonesian consumers of personal-use medical devices.

Its novelty lies in combining relational participation, brand signaling, digital-service performance, perceived value, satisfaction, and loyalty within one model tailored to a high-risk e-commerce context. This design also allows the conventional satisfaction-mediated account of loyalty to be challenged rather than presumed (Xu et al., 2023).

The practical value of the model is diagnostic: it identifies which levers deserve attention when an online medical-device provider seeks to retain customers, rather than assuming that increasing satisfaction alone is sufficient.

METHOD

A cross-sectional quantitative survey was conducted among Indonesian consumers who purchased medical devices online for personal use. Because a complete population list was unavailable, purposive sampling was used. Eligibility required at least two personal-use purchases during the preceding six months. Screening produced 301 usable responses. Descriptive variables included sex, residence, age, occupation, education, monthly spending on medical devices, and platform-use frequency.

Data were collected through Google Forms. A 30-person pre-test preceded the main survey. The final instrument contained 47 five-point Likert items: CPV used five items from Suchánek and Králová (2019); VCC and BI used 24 and five items from Shah and Olivia (2022); ESQ used six items from Rita et al. (2019); and CS and CL used three and four items from (Rahman et al., 2022). Full item wording is retained in the appendices.

SPSS 26 and SmartPLS 3.0 were used for analysis. Initial checks covered KMO and MSA. The PLS-SEM measurement model was evaluated using indicator loadings, AVE, CR, Fornell-Larcker, cross-loadings, and HTMT. The principal adequacy criteria were $CR \geq 0.70$ and $AVE \geq 0.50$ (Hair et al., 2022).

The structural model was assessed with R^2 , f^2 , Q^2 , model-fit statistics, and bootstrapped

path estimates. Statistical decisions used $p < 0.05$. Direct effects to CS and CL and the four specific indirect effects through CS were tested separately.

RESULTS AND DISCUSSION

The final sample contained 301 customers. Women accounted for 54% and men 46%; 38% lived on Java. The largest age group was 18-26 years (32%), students were the largest occupational group (28%), and 35% had senior-high/vocational education. A quarter reported monthly medical-device spending of IDR 500,000-1,000,000. Fifty-eight percent had used the application more than six times, and 30% had used it more than four times in the preceding month (Appendix 4B, Table 5).

All constructs satisfied the reported CR and AVE criteria: BI (0.949; 0.758), ESQ (0.946; 0.744), VCC (0.984; 0.726), CPV (0.942; 0.764), CS (0.929; 0.813), and CL (0.928; 0.762). Discriminant validity was less secure because several HTMT values exceeded 0.90; consequently, the structural estimates are interpreted cautiously.

The model yielded $R^2 = 0.672$ for CPV, 0.692 for CS, and 0.925 for CL. $VCC \rightarrow CL$ had $f^2 = 0.177$; other effects were small to moderate. No CS-mediated path was significant: $CPV \rightarrow CS \rightarrow CL$, $p = 0.571$; $VCC \rightarrow CS \rightarrow CL$, $p = 0.084$; $BI \rightarrow CS \rightarrow CL$, $p = 0.103$; and $ESQ \rightarrow CS \rightarrow CL$, $p = 0.134$.

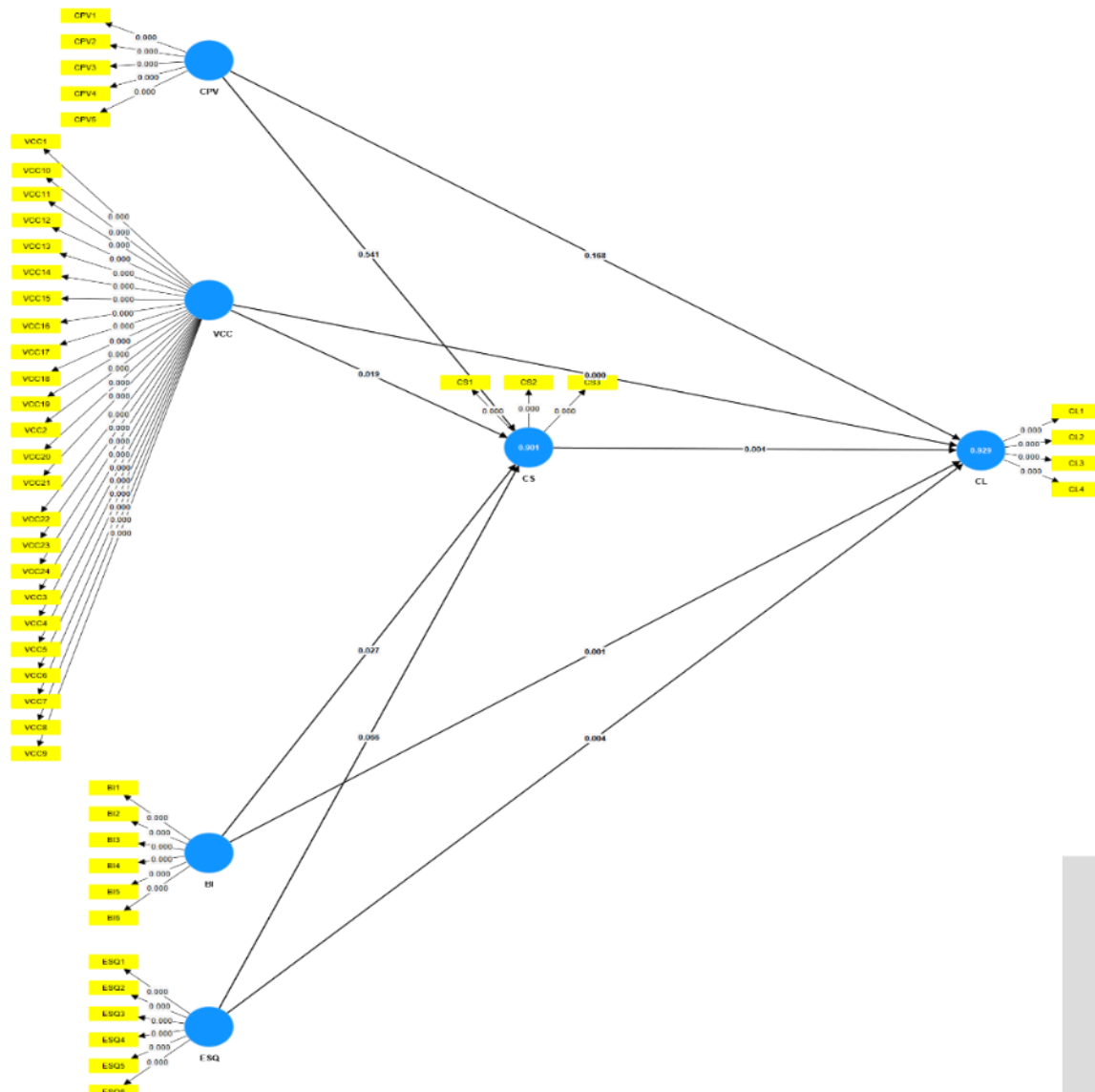


Figure 1. Path Diagram T- Value

Table 1*Hypothesis Test Research Model*

Hypothesis	Hypothesis Statement	T-Value	P-Value	Remarks
H1	CPV → CS	0.617	0.541	Not supported
H2	VCC → CS	2.341	0.019	Supported
H3	BI → CS	2.206	0.027	Supported
H4	ESQ → CS	1.836	0.064	Not supported
H5	CS → CL	2.857	0.004	Supported
H6	ESQ → CL	2.852	0.004	Supported
H7	CPV → CL	1.377	0.168	Not supported
H8	VCC → CL	5.386	0.000	Supported
H9	BI → CL	3.255	0.001	Supported
H10	CPV → CS → CL	0.566	0.571	Not supported
H11	VCC → CS → CL	1.731	0.084	Not supported
H12	BI → CS → CL	1.635	0.103	Not supported
H13	ESQ → CS → CL	1.502	0.134	Not supported

Six hypotheses were supported (H2, H3, H5, H6, H8, H9) and seven were not (H1, H4, H7, H10-H13). VCC and BI explained CS; CS, ESQ, VCC, and BI explained CL; CPV explained neither outcome. None of the four indirect effects through CS was significant.

Assessment of the Measurement Model

Before examining the hypothesized structural relationships, the measurement properties of the research constructs were evaluated. The assessment focused on construct reliability and convergent validity using Composite Reliability (CR) and Average Variance Extracted (AVE).

All six constructs exceeded the recommended CR threshold of 0.70 and AVE threshold of 0.50. Brand Image (BI) recorded a CR value of 0.949 and an AVE value of 0.758. E-Service Quality (ESQ) obtained a CR value of 0.946 and an AVE value of 0.744. Value Co-Creation (VCC) showed particularly high internal consistency, with CR = 0.984 and AVE = 0.726. Customer Perceived Value (CPV) recorded CR = 0.942 and AVE = 0.764. Customer Satisfaction (CS) obtained CR = 0.929 and AVE = 0.813, while Customer Loyalty (CL) recorded CR = 0.928 and AVE = 0.762.

These values indicate that the indicators used to represent the constructs demonstrated adequate internal consistency and convergent validity. Among the constructs, Customer Satisfaction produced the highest reported AVE value at 0.813, followed by Customer Perceived Value at 0.764, Customer Loyalty at 0.762, and Brand Image at 0.758. This means that, based on the reported AVE statistics, each construct captured more than half of the variance of its indicators.

Nevertheless, the discriminant validity assessment requires more cautious interpretation. Several HTMT values reportedly exceeded 0.90. This finding indicates that the empirical distinction among several constructs was not as strong as expected. Accordingly, although reliability and convergent validity criteria were satisfied, subsequent structural-model estimates should be interpreted with awareness of this limitation.

Structural Model and Explanatory Power

Following the evaluation of the measurement model, the structural model was examined to determine the explanatory capacity of the proposed relationships. The model produced an R^2 value of 0.672 for Customer Perceived Value, 0.692 for Customer Satisfaction, and 0.925 for Customer Loyalty.

The R^2 value of 0.692 for Customer Satisfaction indicates that the variables incorporated into the model accounted for 69.2% of the reported variance in Customer Satisfaction. Meanwhile, the R^2 value of 0.925 for Customer Loyalty indicates that 92.5% of the variance in loyalty was accounted for by the predictors included in the structural specification.

Among the reported effect-size statistics, the relationship between Value Co-Creation and Customer Loyalty yielded an f^2 value of 0.177. The manuscript reports that the remaining effects ranged from small to moderate. This finding is consistent with the hypothesis-testing results, in which the Value Co-Creation–Customer Loyalty relationship also produced the largest T-value

among the significant direct relationships with loyalty.

The path diagram presented in Figure 1 visually summarizes the structural relationships evaluated in the PLS-SEM model, including the relationships among Customer Perceived Value, Value Co-Creation, Brand Image, E-Service Quality, Customer Satisfaction, and Customer Loyalty. The figure therefore complements the hypothesis-testing results reported in Table 1.

Direct Effects on Customer Satisfaction

Four direct relationships were tested with Customer Satisfaction as the endogenous construct. The results demonstrate that the four antecedent variables did not contribute equally to Customer Satisfaction.

Customer Perceived Value did not show a statistically significant relationship with Customer Satisfaction. The CPV → CS path produced $T = 0.617$ and $p = 0.541$. Because the p -value was above the 0.05 significance threshold, H1 was not supported.

In contrast, Value Co-Creation demonstrated a statistically significant relationship with Customer Satisfaction. The VCC → CS relationship obtained $T = 2.341$ and $p = 0.019$. Accordingly, H2 was supported.

Brand Image also demonstrated a statistically significant relationship with Customer Satisfaction. The BI → CS path yielded $T = 2.206$ and $p = 0.027$, resulting in support for H3.

E-Service Quality, however, did not reach statistical significance in explaining Customer Satisfaction at the 5% level. The ESQ → CS relationship produced $T = 1.836$ and $p = 0.064$. Although the p -value was relatively close to the conventional threshold of 0.05, it remained above the criterion used in the study; therefore, H4 was not supported.

Taken together, the results for Customer Satisfaction indicate that only two of the four proposed antecedents—Value Co-Creation and Brand Image—showed statistically significant relationships with satisfaction. Customer Perceived Value and E-Service Quality did not independently reach the specified significance threshold.

Direct Effect of Customer Satisfaction on Customer Loyalty

The relationship between Customer Satisfaction and Customer Loyalty was also statistically significant. The CS → CL path generated $T = 2.857$ and $p = 0.004$. Therefore, H5 was supported.

This result shows that Customer Satisfaction retained a significant direct association with Customer Loyalty within the estimated structural model. Importantly, however, this direct relationship must be distinguished from the mediation hypotheses evaluated later in the analysis. A significant CS → CL relationship does not by itself indicate that satisfaction mediates the effects of the other antecedent variables on loyalty.

Direct Effects of E-Service Quality, Customer Perceived Value, Value Co-Creation, and Brand Image on Customer Loyalty

The model further assessed four direct antecedent relationships with Customer Loyalty.

E-Service Quality demonstrated a statistically significant relationship with Customer Loyalty, producing $T = 2.852$ and $p = 0.004$. Consequently, H6 was supported.

Customer Perceived Value did not demonstrate a statistically significant relationship with Customer Loyalty. The CPV → CL path produced $T = 1.377$ and $p = 0.168$, resulting in the rejection of H7.

Value Co-Creation showed the strongest reported statistical evidence among the direct paths toward Customer Loyalty. The VCC → CL relationship produced $T = 5.386$ and $p < 0.001$. Accordingly, H8 was supported.

Brand Image also showed a statistically significant relationship with Customer Loyalty, with $T = 3.255$ and $p = 0.001$. H9 was therefore supported.

Comparing the reported T -values of the significant direct predictors of Customer Loyalty, Value Co-Creation produced the largest T -value at 5.386, followed by Brand Image at 3.255, Customer Satisfaction at 2.857, and E-Service Quality at 2.852. This comparison describes the relative statistical evidence of the reported paths and does not substitute for comparison of standardized path coefficients, which are not reported in Table 1.

Mediation Effect of Customer Satisfaction

Four mediation hypotheses were tested to determine whether Customer Satisfaction transmitted the relationships between the antecedent constructs and Customer Loyalty. Contrary to the proposed mediation framework, none of the four indirect effects was statistically significant.

The indirect relationship between Customer Perceived Value and Customer Loyalty through Customer Satisfaction produced $T = 0.566$ and $p = 0.571$. Consequently, H10 was not supported.

The indirect effect of Value Co-Creation on Customer Loyalty through Customer Satisfaction yielded $T = 1.731$ and $p = 0.084$. Although this p -value was closer to the significance threshold than several other indirect relationships, it remained above 0.05. Therefore, H11 was not supported.

Similarly, the indirect pathway from Brand Image to Customer Loyalty through Customer Satisfaction produced $T = 1.635$ and $p = 0.103$, resulting in the rejection of H12.

Finally, the $ESQ \rightarrow CS \rightarrow CL$ pathway generated $T = 1.502$ and $p = 0.134$. H13 was therefore also not supported.

The mediation analysis thus provides a consistent pattern: Customer Satisfaction had a significant direct relationship with Customer Loyalty, but none of the proposed antecedent variables produced a statistically significant indirect relationship with Customer Loyalty through Customer Satisfaction.

Summary of Hypothesis Testing

Table 2

The complete hypothesis-testing results are summarized as follows:

Hypothesis	Relationship	T-Value	P-Value	Result
H1	CPV $\rightarrow$ CS	0.617	0.541	Not supported
H2	VCC $\rightarrow$ CS	2.341	0.019	Supported
H3	BI $\rightarrow$ CS	2.206	0.027	Supported
H4	ESQ $\rightarrow$ CS	1.836	0.064	Not supported
H5	CS $\rightarrow$ CL	2.857	0.004	Supported
H6	ESQ $\rightarrow$ CL	2.852	0.004	Supported
H7	CPV $\rightarrow$ CL	1.377	0.168	Not supported
H8	VCC $\rightarrow$ CL	5.386	<0.001	Supported
H9	BI $\rightarrow$ CL	3.255	0.001	Supported
H10	CPV $\rightarrow$ CS $\rightarrow$ CL	0.566	0.571	Not supported
H11	VCC $\rightarrow$ CS $\rightarrow$ CL	1.731	0.084	Not supported
H12	BI $\rightarrow$ CS $\rightarrow$ CL	1.635	0.103	Not supported
H13	ESQ $\rightarrow$ CS $\rightarrow$ CL	1.502	0.134	Not supported

The original manuscript reports six supported hypotheses—H2, H3, H5, H6, H8, and H9—and seven unsupported hypotheses—H1, H4, H7, and H10–H13.

Overall Empirical Findings

Overall, the empirical results reveal three notable patterns. First, Value Co-Creation and Brand Image were the only antecedent variables with statistically significant direct relationships with Customer Satisfaction. Customer Perceived Value and E-Service Quality did not reach the 5% significance threshold for Customer Satisfaction.

Second, Customer Loyalty was directly associated with a broader set of constructs. Customer Satisfaction, E-Service Quality, Value Co-Creation, and Brand Image all demonstrated statistically significant relationships with Customer Loyalty, whereas Customer Perceived Value did not. Among these relationships, Value Co-Creation produced the largest reported T-value.

Third, the mediation results did not support the proposition that Customer Satisfaction served as a common mediating mechanism. None of the indirect relationships involving CPV, VCC, BI, or ESQ through Customer Satisfaction reached statistical significance. Therefore, the statistical results distinguish between the direct role of Customer Satisfaction in Customer Loyalty and its proposed role as an intervening mechanism between the antecedent variables and Customer

Loyalty.

These findings provide the empirical foundation for the subsequent Discussion section, particularly for explaining why Value Co-Creation and Brand Image were associated with both Customer Satisfaction and Customer Loyalty, why E-Service Quality was related to Customer Loyalty but not significantly to Customer Satisfaction, why Customer Perceived Value was non-significant for both outcomes, and why the proposed satisfaction-mediated pathways were not supported. The existing discussion in the manuscript already begins addressing these patterns.

Discussion

The structural results do not support a single satisfaction-centered explanation of loyalty. Instead, customer participation, brand evaluation, digital-service performance, and satisfaction contribute in different ways. VCC was the most prominent direct predictor of CL, suggesting that an exchange in which customers can voice needs and influence the service may create attachment independently of a later satisfaction judgment (Chiu et al., 2015; Sohaib & Han, 2023).

H8 was supported (VCC → CL: $T = 5.386$; $p < 0.001$; $f^2 = 0.177$). The result gives co-creation practical relevance: feedback, product evaluation, educational interaction, and post-purchase dialogue may function simultaneously as information channels for the seller and relationship-building experiences for the buyer.

H2 was also supported (VCC → CS: $T = 2.341$; $p = 0.019$). Participation therefore appears to improve customers' evaluation of the transaction, possibly because it makes information and service delivery more responsive to individual needs. This interpretation is consistent with prior evidence on co-creation and participatory service experiences (Hau et al., 2017; Peng et al., 2022; Vega-Vazquez et al., 2013).

Brand image showed a second, distinct route. In medical-device e-commerce, the brand can act as shorthand for authenticity, competence, safety, and accountability. These signals matter because buyers cannot always verify technical quality before purchase and therefore use provider reputation to reduce uncertainty (Mohammed & Rashid, 2018; Rahi et al., 2021).

The BI → CL path was significant ($T = 3.255$; $p = 0.001$; H9 supported). A favorable brand evaluation was therefore associated with continued patronage even after the other constructs were considered.

BI also predicted CS ($T = 2.206$; $p = 0.027$; H3 supported). Brand-based expectations may frame how customers interpret product quality, service dependability, and the overall exchange, a pattern broadly consistent with earlier satisfaction research (Chang et al., 2009; Gounaris et al., 2010; Rita et al., 2019).

ESQ represents the functional side of the digital encounter. Reliable transactions, clear information, responsive support, and low-effort navigation can lower the time, uncertainty, and perceived risk attached to online medical-device purchasing (Almazrouei et al., 2020; Kurniawan & Suryani, 2023).

Yet ESQ did not reach the 5% threshold for CS ($T = 1.836$; $p = 0.064$; H4 not supported). This does not imply that digital service is irrelevant; it indicates that ESQ did not independently account for enough variation in satisfaction in the present specification. Satisfaction may instead depend more heavily on provider credibility and customers' involvement in the exchange.

CPV was likewise non-significant for CS ($T = 0.617$; $p = 0.541$; H1 not supported). Once VCC, BI, and ESQ were modeled simultaneously, a general benefit-versus-sacrifice evaluation added little explanatory value for satisfaction.

The CPV → CL path was also non-significant ($T = 1.377$; $p = 0.168$; H7 not supported). In this health-sensitive product category, continued patronage may therefore depend less on an overall value calculation than on confidence-building relational and service cues.

CS nevertheless had a direct association with CL ($T = 2.857$; $p = 0.004$; H5 supported). Among the significant direct predictors of loyalty, VCC produced the largest T-value, followed by BI, CS, and ESQ. Satisfaction matters, but it is not the sole mechanism through which the other predictors operate.

The mediation tests make that distinction explicit. CPV → CS → CL ($p = 0.571$), VCC → CS → CL ($p = 0.084$), BI → CS → CL ($p = 0.103$), and ESQ → CS → CL ($p = 0.134$) were all non-significant; H10-H13 were therefore rejected. Future models may obtain greater explanatory value from trust, perceived risk, engagement, or digital health literacy than from assuming a universal

satisfaction bridge.

CONCLUSION

The study shows that loyalty among Indonesian medical-device e-commerce customers is not organized around one dominant mediating pathway. VCC and BI were associated with CS; VCC, BI, ESQ, and CS were associated with CL; CPV was not significant for either outcome. VCC was the strongest direct predictor of loyalty. The four indirect tests through satisfaction were all non-significant, indicating that satisfaction contributes to loyalty without serving as the common mechanism linking the antecedent variables to CL.

The evidence favors investment in customer participation, brand credibility, and dependable digital service. Interpretation should remain bounded by purposive sampling, one national market, cross-sectional measurement, and incomplete discriminant validity. Longitudinal and comparative studies should test alternative mechanisms such as trust, perceived risk, engagement, and digital health literacy.

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AUTHOR CONTRIBUTION STATEMENT

Imam Subagyo and Rhian Indradewa jointly designed the study, developed the method, collected and analyzed the data, interpreted the results, drafted the article, revised its intellectual content, and approved the submitted version.

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