

Perceived Data Privacy as a Moderator of AI-Personalized Recommendation and Digital Customer Empowerment on Customer Engagement in Shopee E-Commerce

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Abstract

Purpose: This study examines the effects of AI-Personalized Recommendation and Digital Customer Empowerment on Customer Engagement, and investigate the moderating role of Perceived Data Privacy, among Generation Z Shopee users in Semarang City, Indonesia.

Design/methodology/approach: A quantitative survey of 100 purposively selected respondents was analyzed using Partial Least Square – Structural Equation Modeling (PLS-SEM) with Two-Stage Moderation approach in SmartPLS 4, and hypotheses were tested via bootstrapping with 5,000 subsamples.

Findings: Digital Customer Empowerment is found to positively and significantly influence Customer Engagement, confirming that greater autonomy, control, and participation in the digital shopping experience meaningfully strengthen engagement. AI-Personalized Recommendation, however, shows no significant direct effect, suggesting that personalization alone does not yet translate into deeper engagement. Perceived Data Privacy does not significantly moderate either relationship, indicating that privacy perception neither strengthens nor weakens the influence of AI-personalized recommendation or digital empowerment on engagement. The proposed model nonetheless demonstrates adequate explanatory and predictive power.

Practical implications: Shopee is encouraged to strengthen empowerment-oriented features from transparent product reviews, responsive feedback channels, and participatory shopping tools, while improving algorithmic transparency and privacy communication to build the trust needed for AI-based personalization to succeed. Regulators are encouraged to accelerate the socialization of Indonesia's Personal Data Protection Law (UU No. 27 of 2022) among young digital consumers.

Originality/value: This study integrates AI-personalized recommendation, digital empowerment, and perceived data privacy within a single structural model grounded in Stimulus-Organism-Response Theory, the Technology Acceptance Model, and Privacy Calculus Theory, a combination rarely tested among privacy-sensitive Generation Z digital natives in Semarang City.

Paper type: Empirical

Keywords: AI-Personalized Recommendation, Digital Customer Empowerment, Perceived Data Privacy, Customer Engagement, Shopee E-commerce.

1. Introduction

The rapid expansion of Indonesia's digital economy has fundamentally reshaped consumer behavior, particularly among Generation Z with the range individuals born between 1997 and 2012 who have grown up fully immersed in an environment shaped by Artificial Intelligence (AI), digital assistants, and smart retail systems (Schultz, 2025). Indonesia now has more than 212 million internet users, representing an internet penetration rate of 74.6 percent (DataReportal, 2025), and Generation Z dominates shopping activity on e-commerce platform such as Shopee (We Are Social, 2025). As digital native, this generation expects fast, personalized shopping experiences and shows a strong preference for intelligent technologies (Huwaida et., Al 2024), yet this technological acceleration has been accompanied by growing concern over the security and ethics of personal data management.

AI-Personalized Recommendation has become one of the primary approaches e-commerce platforms use to increase product relevance through personalized recommendation, chatbots, and intelligent algorithms (Sadiq et al., 2025), improving customer experience and purchase conversion (Kumari et al., 2025). However, the effectiveness of AI-personalized recommendation systems is highly dependent on the balance between personalization and privacy protection; personalization that lacks transparency and user control can trigger privacy concerns that erode consumer trust in digital service (Teraiya & Krishnamurthy, 2025). AI adoption is also believed to enhance Digital Customer Empowerment, enabling consumers to control, influence, and actively participate in the digital consumption process (Rahman & Nasution, 2023), which in turn strengthens the customer's sense of ownership and long-term relationship with the platform (Park & Lee, 2022; Lähteenmäki et al., 2022). Nevertheless, empowerment without adequate data security guarantees can produce behavioral ambivalence, in which users wish to participate actively while remaining concerned about the potential misuse of personal data (Wunderlich et al., 2025).

This concern over data privacy is central to Customer Engagement, which reflects the degree of a customer's emotional, cognitive, and behavioral involvement with a brand (Han & Anderson, 2022; Abou-Shouk & Soliman, 2021). A preliminary survey conducted by the researchers among 50 Generation Z respondents in Semarang City found that Shopee was the most frequently used e-commerce platform (52 percent), followed by TikTok Shop (46 percent) and Lazada (2 percent). Despite this high preference, switching resistance, active participation, and word-of-mouth intention had not developed consistently, indicating that routine usage had not yet translated into strong behavioral engagement. This gap is presumed to be associated with users's perceived data privacy, as caution in disclosing personal information during product search and evaluation potentially affects long-term comfort and engagement.

Prior studies on the relationships among digital technology, AI-personalized recommendation, customer empowerment, perceived data privacy, and customer engagement have produced inconsistent findings. Regarding the AI-Personalized Recommendation – Customer empowerment relationship, several studies report a significant positive effect, whereas Yin et al. (2025) found that this effect diminishes and may even turn negative when personalization lacks transparency or is perceived as overly aggressive. Regarding Digital Customer Empowerment, Giang et al. (2024) confirm a significant positive effect on engagement through the mediating roles of service innovation and platform trust, although other empowerment research cautions that excessive empowerment may instead trigger choice overload and reduce engagement. The most pronounced inconsistency concerns the moderating role of Perceived Data Privacy: some studies report that a well-protected privacy environment strengthens engagement, while Suryati et al. (2023) found the moderating effect of privacy-related variables to be insignificant, a pattern consistent with the privacy-paradox phenomenon.

This inconsistency underscores a research gap that remains unresolved, particularly in the Indonesian digital market. This study therefore positions Perceived Data Privacy as moderating variable in the relationship between AI-Personalized Recommendation and Digital Customer Empowerment on Customer Engagement among Generation Z Shopee users in Semarang City, a segment recognized as highly digital-native and privacy-sensitive, yet still under-examined in a single, comprehensive moderation model. The novelty of this study lies in three contributions: first, it integrates three key concepts which AI-personalization, digital empowerment, and perceived data privacy within one structural model grounded in Stimulus-Organism-Response (S-O-R) Theory, the Technology Acceptance Model (TAM), and Privacy Calculus Theory, a combination rarely tested in the Indonesian digital market; second, it positions Perceived Data Privacy as the moderator that determines the strength of both stimulus-response path simultaneously; and third, it extends the empirical context specifically to Generation Z Shopee users in Semarang City. Beyond its theoretical contribution, the study offers practical guidance for designing digital market strategies that are more ethical, personalized, and privacy-conscious within Indonesia's e-commerce ecosystem.

Based on this background, the study addresses four research questions: (1) Does AI-Personalized Recommendation significantly affect Customer Engagement? (2) Does Digital Customer Empowerment significantly affect Customer Engagement? (3) Does Perceived Data Privacy moderate the relationship between AI-Personalized Recommendation and Customer Engagement? And (4) Does Perceived Data Privacy moderate the relationship between Digital Customer Empowerment and Customer Engagement? Accordingly, the study aims to analyze the direct effects of both stimulus

variables on Customer Engagement and to examine the moderating role of Perceived Data Privacy in strengthening or weakening those relationships.

2. Literature Review and Hypotheses Development

Theoretical Foundation

This study is grounded in three complementary theories. Stimulus-Organism-Response (S-O-R) Theory, first proposed by Mehrabian and Russell (1974), explains how external stimulus are processed internally by an organism before producing a behavioral response and recent studies have applied this framework to explainable AI adoption (Dalvi-Esfahani et al., 2023), fast-fashion mobile application usage (Pop et al., 2023), personalized recommendation and reward effects (Jeong et al., 2022), and augmented reality experiences (Yang et al., 2024), consistently showing that relevant and valuable digital stimulus increase positive emotion, trust, and engagement (Hollebeek et al., 2024). In this study, AI-Personalized Recommendation and Digital Customer Empowerment act as stimulus, Perceived Data Privacy represents the internal organism, process, and Customer Engagement is the behavioral response.

The Technology Acceptance Model (TAM) was developed by Fred D. Davis (1985) to explain the cognitive mechanisms within perceived usefulness and perceived ease of use, that determine whether users accept or resist AI-based technology (Choubey et al., 2024; George et al., 2022; Zhang et al., 2024). TAM is integrated into the boarder S-O-R framework to explain why, not merely whether, technological stimulus translates into customer engagement. Privacy Calculus Theory, introduced by Laufer and Wolfe (1977) and elaborated by Dienlin (2023), posits that individuals rationally weigh the perceived benefits against the perceived risk of disclosing personal data. Empirical extensions show that this calculus is shaped by trust and perceived social value (Fan et al., 2021; Fehrenbach & Herrando, 2021), by the interaction between risk and benefit rather than either factor alone (Kezer et al., 2022), and by algorithmic transparency and user control (Cloarec et al., 2024). Privacy Calculus Theory provides the conceptual basis for treating Perceived Data Privacy as moderator that can strengthen or weaken the effect of AI-driven stimulus on engagement.

Research Constructs

AI-Personalized Recommendation refers to the extend to which AI-driven algorithms generate product recommendations that are relevant, accurate, and useful to individual users, based on machine-learning analysis of browsing and transaction history (Yin et al., 2025; Hassan et al., 2025; Roy et al., 2023). In this study it is measured through four dimensions; relevance, accuracy, usefulness, and personalization perception, also operationalized as the independent variable expected to shape Customer Engagement on the Shopee platform.

Digital Customer Empowerment reflects the degree of autonomy, control, and participation consumers exercise when using digital technology to interact with, decide on, and co-create value with a company (Giang et al., 2024; Shahid & Qureshi, 2022; Roy et al., 2023). It is measured through self-efficacy, perceived control, participation, and influence, and represents the second independent variable in the model.

Perceived Data Privacy denotes consumers belief that their personal data is processed, stored, and used securely, transparently, and in line with their ethical expectations (Yin et al., 2025; Hassan et al., 2025). Rooted in Privacy Calculus Theory, it is measured through data control, data protection, data transparency, and data usage awareness, and serves as the moderating variable in this study.

Customer Engagement is the psychological state reflected in a customer's attention, emotional involvement, and active behavior when interacting with and e-commerce platform (Han & Anderson, 2022; Roy et al., 2023), operationalized through cognitive, emotional, and behavioral engagement dimensions, and treated as the dependent variable of this study.

Table 1. Theoretical Research Framework

Theoretical Component	Research Variables	Conceptual Relationship	Key Theoretical Basis
Stimulus (S)	AI-Personalized Recommendation (X1)	Relevant AI-based recommendations increase	Park & Lee (2022); Shahid & Qureshi

Theoretical Component	Research Variables	Conceptual Relationship	Key Theoretical Basis
		perceived usefulness and shape the customer experience.	(2022); Roy et al. (2023)
Stimulus (S)	Digital Customer Empowerment (X2)	Digital empowerment encourages active participation and control over consumption decisions.	Dienlin (2023); Giang et al. (2024)
Organism (O)	Perceived Data Privacy (Z) – Moderator	Perceived security and control over personal data shape willingness to accept digital personalization.	Asante et al. (2024); Hollebeek et al. (2024); Yang et al. (2024)
Response (R)	Customer Engagement (Y)	The level of customer's affective, cognitive, and conative involvement when interacting with the digital platform.	Hassan et al. (2025); Teraiya & Krishnamurthy (2025)

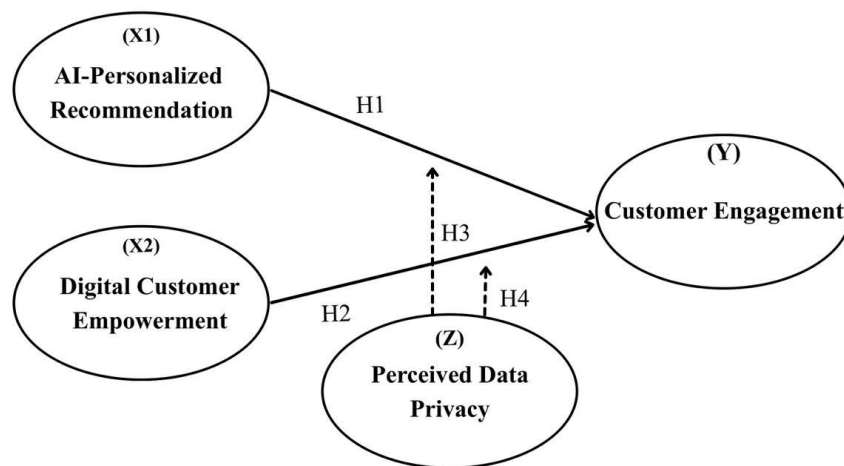


Figure 1. Conceptual Research Framework

Source(s): developed by the authors (2026), based on Park & Lee (2022), Shahid & Qureshi (2022), and Dienlin (2023).

The framework in Figure 1 shows that AI-Personalized recommendation acts as a stimulus that is internally processed together with the Digital Customer Empowerment experience, the Perceived Data Privacy acts as an organism, which subsequently shapes Customer Engagement as the behavioral response. Based on this theoretical synthesis, four hypotheses are developed as follows.

AI-Personalized Recommendation and Customer Engagement

AI-based recommendation systems allow companies to deliver shopping experiences tailored to user preference. Relevant and accurate recommendations increase purchase intention and platform interaction (Yin et al., 2025), while personalization based on AI contributes positively to customer satisfaction and loyalty, both key components of engagement (Hassan et al., 2025). Under S-O-R Theory, AI-personalized recommendation functions as a digital stimulus that is cognitively processed by the user (organism) and can elicit engagement as a behavioral response. Under TAM, recommendations perceived as useful and easy to use increase positive attitudes toward the platform. However, Privacy Calculus Theory suggests that this stimulus may produce divergent responses whether strengthening engagement when perceived benefits are high, but weakening it when personalization is perceived as privacy-intrusive.

H1: AI-Personalized Recommendation has a positive and significant on Customer Engagement.

Digital Customer Empowerment and Customer Engagement

Digital Customer Empowerment reflects the extent to which consumers feel they possess control competence, and opportunity to participate in digital activity. Empowered consumers show higher engagement through increased trust in the platform (Giang et al., 2024), and those who feel digitally empowered tend to be more engaged with brand activities in omnichannel environments (Asante et al., 2024). From an S-O-R perspective, empowerment functions as a stimulus that is internalized as self-confidence, autonomy, and control (organism), which subsequently produces higher engagement (response); TAM further explains that users who can easily operate digital features and perceived tangible benefits develop a more positive attitude toward the platform, reinforcing interaction.

H2: Digital Customer Empowerment has a positive and significant effect on Customer Engagement.

Moderating Role of Perceived Data Privacy on AI-Personalized Recommendation and Customer Engagement

Trust in personal data protection strengthens the relationship between personalization and purchase intention, whereas users who feel their privacy is not safeguarded tend to restrict interaction even when the recommendations offered are relevant (Yin et al., 2025; Teraiya & Krishnamurthy, 2025). Under Privacy Calculus Theory, consumers with high perceived data privacy are more open to accepting AI recommendations, strengthening the AI-Personalized Recommendation on Customer Engagement relationship, whereas low perceived data privacy weakens or even reverses this influence, consistent with Cloarec et al. (2024), who shows that consumer responses to personalization are shaped by the evaluation of privacy benefits against privacy risks.

H3: Perceived Data Privacy moderates the effect of AI-Personalized Recommendation on Customer Engagement.

Moderating Role of Perceived Data Privacy on Digital Customer Empowerment and Customer Engagement

The success of digital empowerment in enhancing engagement depends substantially on consumers's sense of security when sharing personal data (Shahid & Qureshi, 2022), and trust in the platform is an important condition linking empowerment and engagement (Giang et al., 2024). Under TAM, a sense of data security increases the acceptance of digital technology, translating empowerment into a more positive attitude and higher engagement. However, Privacy Calculus Theory suggests that when digital activity is perceived as risky to personal data security, empowerment may instead trigger excessive caution and reduce the willingness to engage, consistent with Kezer et al. (2022), who found that the relationship between perceived benefit and self-disclosure is conditioned by privacy risk perception.

H4: Perceived Data Privacy moderates the effect of Digital Customer Empowerment on Customer Engagement.

3. Research Method

This study employs a quantitative, explanatory research design intended to test the causal relationships among AI-Personalized Recommendation (X1), Digital Customer Empowerment (X2), Perceived Data Privacy (Z) as moderator, and Customer Engagement (Y), following the S-O-R, TAM, and Privacy Calculus theoretical framework. All variables were measured using a five-point Likert scale (1 = strongly disagree to 5 = strongly agree). Table 2 summarizes the operational definitions of the research variables.

Table 2. Operational Definition and Measurement of Variables

Variable	Dimensions	Operational Definition/ Indicators (illustrative items)
AI-Personalized Recommendation (X1)	Relevance, accuracy, usefulness, personalization perception (5 items)	Respondents' perception of the relevance, accuracy, and usefulness of AI-generated product recommendations, e.g. "Product recommendations on Shopee are relevant to my search and purchase history."
Digital Customer Empowerment (X2)	Self-efficacy, perceived control, participation, influence (3 valid items)	Respondents' perception of autonomy, control, and participation in the digital shopping process, e.g. "Product information and reviews on Shopee are easy for me to access and understand."
Perceived Data Privacy (Z)	Data control, data protection, data transparency, data usage awareness (6 items)	Respondents' belief that personal data is handled securely, transparently, and with adequate control, e.g. "I feel my personal data is safe when using Shopee."
Customer Engagement (Y)	Cognitive, emotional, behavioral engagement (5 valid items)	Respondents' level of attention, emotional involvement, and active behavior toward Shopee, e.g. "I am interested in paying attention to the information and features Shopee offers."

Source(s): develop by the authors (2026).

Population, Sample, and Sampling Technique

The population comprises Generation Z e-commerce users (aged 17-28) in Semarang City who had transacted online within the previous six month. Based on Badan Pusat Statistik Kota Semarang (2024) and the We Are Social (2025) report indicating that 86 percent of Indonesian Generation Z are active e-commerce users, the target population was estimated at approximately 289,000 individuals. The sample size was calculated using the Slovin formula with a 10 percent margin of error, $n = N / (1 + N\epsilon^2)$, yielding a minimum sample of 100 respondents, a size that satisfies the minimum requirement for PLS-SEM analysis. Respondents were selected through purposive (non-probability) sampling based on three inclusion criteria: (1) Generation Z digital users aged 17 – 28 years; (2) active users of the Shopee e-commerce platform; and (3) having made at least one purchase transaction on Shopee within the previous six month.

Data Collection

Primary data were collected through a structured online questionnaire distributed via Google Forms, comprising demographic questions, screening questions to confirm eligibility, and 23 original indicator items (5 for X1, 6 for X2, 6 for Z, and 6 for Y) measured on the five-point Likert scale described above. Secondary data, drawn from Scopus- and Sinta-indexed journals, industry reports, and news articles on AI-based e-commerce personalization and data privacy issues in Indonesia, where were used to strengthen the theoretical foundation and support instrument development. The questionnaire was distributed following instrument development, a pilot test, instrument revision, respondent screening and data cleaning before being exported for analysis in SmartPLS4.

Data Analysis Technique

Data were analyzed using Partial Least Square – Structural Equation Modeling (PLS-SEM) via SmartPLS4, chosen for its capacity to model complex relationships involving a moderating variable

without requiring strict multivariate-normality assumptions (Hair et al., 2021). Analysis proceeded in three stages: (1) descriptive statistical analysis of respondent characteristic and indicator-level means and standard deviations; (2) evaluation of the measurement model (outer model), comprising convergent validity (outer loadings > 0.70 , Average Variance Extracted/ AVE > 0.50), internal-consistency reliability (Cronbach's Alpha and Composite Reliability $\rho_c > 0.70$), and discriminant validity (Heterotrait-Monotrait Ratio/ HTMT < 0.90 and the Fornell-Larcker criterion); and (3) evaluation of the structural model (inner model) using the Two-Stage Moderation approach, comprising the coefficient of determination (R^2 and R^2 Adjusted), effect size (f^2), collinearity statistics ($VIF < 5.0$), predictive relevance ($Q^2_{predict}$ via the PLSpredict procedure), and hypothesis testing through bootstrapping with 5,000 subsamples at a 5 percent significance level (two-tailed), where a hypothesis is supported if the T-Statistic exceeds 1.96 and the p-value is below 0.05 (Hair et al., 2021).

4. Result and Discussion

Respondent Characteristics

Shopee is a mobile-first marketplace founded by Sea Limited and first launched in Singapore in 2015 (Sea Limited, 2023), operating in Indonesia since the same year and integrating social-commerce features, AI-based recommendation systems, and gamification mechanisms such as Shopee Games and Shopee Live to enhance user interaction (Zikry et al., 2024). A total of 100 valid responses were collected from Generation Z Shopee users in Semarang City who met the inclusion criteria. As shown in Table 3, respondents aged 21 – 24 years dominate the sample (75 percent), followed by the 17 – 20 age group (15 percent) and the 25 – 28 age group (10 percent), consistent with the profile of digitally mature Generation Z consumers who are accustomed to AI-based recommendation systems.

Descriptive Statistics

Descriptive statistics were computed for each variable using the interpretation range 1.00 – 1.80 (strongly disagree) to 4.21 – 5.00 (strongly agree). As presented in Table 4, all four variables fall within the “agree” category, with the Digital Customer Empowerment and AI-Personalized Recommendation showing the highest mean perceptions (3.937 and 3.968) and Perceived Data Privacy showing the lowest (3.728), indicating that although respondents generally view Shopee's AI recommendations and empowerment features favorably, their confidence in the platform's data-privacy practice remains comparatively moderate.

Table 3. descriptive Statistics of Research Variables

Variable	Mean	Std. Dev.	Category
AI-Personalized Recommendation (X1)	3.968	0.950	Agree
Digital Customer Empowerment (X2)	3.937	0.945	Agree
Perceived Data Privacy (Z)	3.728	0.901	Agree
Customer Engagement (Y)	3.940	0.953	Agree

Source(s): Primary data, processed by the authors (2026).

Measurement Model (Outer Model) Evaluation

Convergent validity was assessed through outer loadings and Average Variance Extracted (AVE). during initial evaluation, four indicators (DCE1, DCE2, DCE4, and CE1) showed loadings below the 0.70 threshold and were eliminated in accordance with Hair et al. (2021), leaving a final model of 19 valid indicators across the four variables, with loadings ranging from 0.742 to 0.902 (Table 5).

Table 4. Summary of Outer Loading Results (after indicator elimination)

Variables	Indicator Range (valid items)	Outer Loading Range
X1 – AI-Personalized Recommendation	AI1 – AI5 (5 items)	0.742 – 0.855

X2 – Digital Customer Empowerment	DCE3, DCE5, DCE6 (3 items, after eliminating DCE1/ DCE2/ DCE4)	0.754 – 0.866
Z – Perceived Data Privacy	PDP1 – PDP6 (6 items)	0.786 – 0.902
Y – Customer Engagement	CE2 – CE6 (5 items, after eliminating CE1)	0.743 – 0.859

Source(s): SmartPLS 4 output, processed by the authors (2026).

Table 6 shows that all variables achieved Cronbach's Alpha and Composite Reliability (rho_c) values above 0.70 (ranging from 0.744 to 0.941) and AVE values above 0.50 (ranging from 0.646 to 0.726), confirming adequate convergent validity and internal-consistency reliability for every variable.

Table 5. Variable Reliability and Validity

Variable	Cronbach's Alpha	Rho_a	Rho_c (CR)	AVE
X1 – AI-Personalized Recommendation	0.862	0.866	0.901	0.646
X2 – Digital Customer Empowerment	0.744	0.755	0.854	0.662
Z – Perceived Data Privacy	0.870	0.880	0.905	0.658
Y – Customer Engagement	0.924	0.929	0.941	0.726
Criterion	> 0.70	> 0.70	> 0.70	> 0.50

Source(s): SmartPLS 4 output, processed by the authors (2026).

Discriminant validity was examined using the Heterotrait-Monotrait Ratio (HTMT) and the Fornell-Larcker criterion. All HTMT values remained below the 0.90 threshold recommended by Hair et al. (2021), with the highest value (0.844) observed between Z_PDP and X2_DCE (Table 7), while the square root of the AVE for every variable (0.804 – 0.852) exceeded its correlations with others variables, confirming that discriminant validity was satisfied on both criteria.

Table 6. Heterotrait-Monotrait Ratio (HTMT) Result

	X1_AI Rec	X2_DCE	Y_CE	Z_PDP
X1_AI-Rec	-			
X2_DCE	0.789	-		
Y_CE	0.597	0.742	-	
Z_PDP	0.667	0.844	0.651	-

Source(s): SmartPLS 4 output, processed by the authors (2026).

Structural Model (Inner Model) Evaluation

As shown in Table 8, the model explains 43 percent of the variance in Customer Engagement ($R^2 = 0.459$; $R^2_{\text{Adjusted}} = 0.430$), a value that falls within the moderate category ($0.25 \leq R^2 < 0.50$) according to Hair et al. (2021), indicating that AI-Personalized Recommendation, Digital Customer Empowerment, Perceived Data Privacy, and the two interaction terms jointly explain 43 percent of the variation in Customer Engagement among Generation Z Shopee users in Semarang City, while the remaining 57 percent is explained by factors outside the model. All f^2 effect sizes (0.012 – 0.067) fall in the small category (< 0.15), indicating that each path contributes a modest yet meaningful share to the overall model.

Table 7. R-Square and F-Square Results

Path/ Variable	R^2 Adjusted	f^2
Y – Customer Engagement (R^2)	0.430	-

Path/ Variable	R ² Adjusted	f ²
X1_AI_Rec → Y_CE	-	0.027
X2_DCE → Y_CE	-	0.067
Z_PDP → Y_CE	-	0.036
Z_PDP × X1_AI_Rec → Y_CE	-	0.038
Z_PDP × X2_DCE → Y_CE	-	0.012

Source(s): SmartPLS 4 output, processed by the authors (2026).

Predictive relevance was assessed via the PLSpredict procedure. All indicators of Customer Engagement produced Q²predict values above zero (ranging from 0.027 to 0.224), and the variable-level Q²predict for Customer Engagement was 0.244, above the 0 threshold recommended by Hair et al. (2021), confirming the model's adequate out-of-sample predictive relevance. Regarding Table 9, Collinearity statistics (VIF) for all structural path ranged from 1.944 to 3.118, well below the 5.0 threshold, indicating no multicollinearity problem and confirming that the path coefficient estimates are unbiased and trustworthy.

Table 8. Collinearity Statistic (VIF) Result

Path/ Variable	VIF	Category
X1_AI_Rec → Y_CE	1.944	< 5.0
X2_DCE → Y_CE	2.383	< 5.0
Z_PDP → Y_CE	2.352	< 5.0
Z_PDP × X1_AI_Rec → Y_CE	3.118	< 5.0
Z_PDP × X2_DCE → Y_CE	3.065	< 5.0

Source(s): SmartPLS 4 output, processed by the authors (2026).

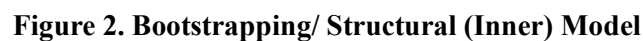
Hypothesis Testing

Hypotheses were tested through bootstrapping with 5,000 subsamples at a 5 percent significance level. As summarized in Table 10 and illustrated in Figure 2, Digital Customer Empowerment shows positive and significant effect on Customer Engagement ($\beta = 0.294$; $T = 2.759$; $p = 0.006$), supporting H2. In contrast, AI-Personalized Recommendation does not significantly effect Customer Engagement ($\beta = 0.169$; $T = 1.195$; $p = 0.232$), leading to the rejection of H1. Perceived Data Privacy does not significantly moderate either the AI-Personalized Recommendation and Customer Engagement relationship ($\beta = -0.165$; $T = 1.225$; $p = 0.221$; H3 rejected) or the Digital Customer Empowerment and Customer Engagement relationship ($\beta = 0.093$; $T = 0.677$; $p = 0.498$; H4 rejected).

Table 9. Hypothesis Testing Result (Bootstrapping 5,000 subsamples)

H	Path	β (O)	Std. Dev.	T-Stat.	p	Decision
H1	X1_AI_Rec → Y_CE	0.169	0.141	1.195	0.232	Rejected
H2	X2_DCE → Y_CE	0.294	0.106	2.759	0.006	Supported
–	Z_PDP → Y_CE (control path)	0.215	0.146	1.477	0.140	–
H3	Z_PDP × X1 → Y_CE	-0.165	0.135	1.225	0.221	Rejected

Source(s): SmartPLS 4 output, processed by the authors (2026).



Source(s): SmartPLS 4 output, processed by the authors (2026).

The rejection of H1 indicates that, although respondents generally hold a positive perception of Shopee's AI-recommendation system (mean = 3.968), this perception does not translate into a statistically significant increase in engagement. Respondents rated the relevance of recommendations to their search and purchase history highest (AI2, mean = 4.240), yet rated the recommendation's contribution to easing purchase decisions lowest (AI5, mean = 3.750), suggesting that AI recommendations function more as an information facility than as a decisive engagement driver for this segment. The finding aligns with TAM's premise that technology acceptance does not automatically translate into deep engagement unless users fully trust the underlying AI system (Zhang et al. 2024), and is consistent with Jayapal (2025) and Teepapal (2025), who found that AI-personalization affects engagement only indirectly, mediated by trust and perceived usefulness, in conditions not yet firmly established among the digitally mature 21 – 24 years old majority in this sample. The result contrasts with Hassan et al. (2025) and Yin et al. (2025), who found AI-recommendation to be a significant engagement driver, a divergence plausibly explained by differences in population digital-exposure levels between studies.

The acceptance of H2 confirms that Digital Customer Engagement is the only significant direct predictor of Customer Engagement in this model, reinforcing the view that empowerment and through accessible product information (DCE3, mean = 4.060) and to a lesser extent, the recognition of user opinions (DCE5, mean = 3.840), builds engagement more organically than algorithmic personalization. Under S-O-R Theory, empowerment features function as an environmental stimulus internalized as a sense of control (organism), producing active cognitive, emotional, and behavioral engagement (response), consistent with Hollebeek et al. (2024) and Giang et al. (2024), who found that trust-building empowerment mechanism are a more fundamental engagement driver than algorithmic stimulus alone.

The rejection of H3 shows that Perceived Data Privacy does not condition the (already insignificant) relationship between AI-Personalized Recommendation and Customer Engagement, suggesting that for this segment neither the AI stimulus nor privacy perception alone is currently strong enough to shape measurable engagement patterns. A pattern that echoes Suryati et al. (2023) regarding the insignificance of privacy-related moderating variables amid the broader privacy-paradox phenomenon, though it departs from studies in other contexts that found privacy protection to be a significant strengthening condition for engagement.

The rejection of H4 indicates that the positive effect of Digital Customer Empowerment on Customer Engagement is robust and does not depend on user's data-privacy perception, where the sense of digital empowerment already internalized by Generation Z respondents appears to operate independently of external contextual condition such as perceived data privacy. Because Perceived Data Privacy shows the lowest mean score among the four variables (3.728), Shopee is nonetheless encouraged to strengthen transparent privacy communication, as improved privacy perception could still enhance overall trust in the platform even where a direct moderating effect was not statistically confirmed in this sample.

5. Conclusion

This study examined the moderating role of Perceived Data Privacy in the relationships between AI-Personalized Recommendation and Digital Customer Empowerment on Customer Engagement among 100 Generation Z Shopee users in Semarang City, using PLS-SEM with a Two-Stage Moderation approach in SmartPLS 4. Four conclusions can be drawn. First, AI-Personalized Recommendation does not have a significant effect on Customer Engagement ($\beta = 0.169$; $p = 0.232$; H1 rejected), indicating that a positive perception of AI recommendations (mean = 3.968) does not automatically translate into higher engagement, and that digital empowerment appears to be the more dominant driver of engagement for this segment. Second, Digital Customer Empowerment has a positive and significant effect on Customer Engagement ($\beta = 0.294$; $p = 0.006$; H2 supported), confirming that greater perceived control, information access, and participation opportunity on Shopee directly increase user engagement. Third, Perceived Data Privacy does not significantly moderate the AI-Personalized Recommendation and Customer Engagement relationship ($\beta = -0.165$; $p = 0.221$; H3 rejected). Fourth, Perceived Data Privacy does not significantly moderate the Digital Customer Empowerment–Customer Engagement relationship either ($\beta = 0.093$; $p = 0.498$; H4 rejected), suggesting that the empowerment-engagement link operates independently of users' privacy perception.

Overall, Digital Customer Empowerment emerges as the key driver of Customer Engagement among Generation Z Shopee users in Semarang City. The model demonstrates adequate explanatory and predictive power (R^2 Adjusted = 0.430; Q^2 predict = 0.244 for Customer Engagement), while AI-Personalized Recommendation and the moderating role of Perceived Data Privacy remain unsupported in this context, pointing to opportunities for future research to explore mediating mechanisms, such as AI trust or perceived value of recommendation, that may better explain how AI personalization translates into engagement.

Practically, Shopee is encouraged to strengthen empowerment-based features such as transparent and accessible product-review systems, responsive user-feedback channels, and interactive participation tools, while also improving algorithmic transparency regarding how recommendations and personal data are used, which may in turn raise the currently moderate perceived-privacy score (mean = 3.728) and better position AI personalization as an engagement driver. Regulators, particularly Indonesia's Ministry of Communication and Digital Affairs, are encouraged to accelerate the implementation and public socialization of UU No. 27 of 2022 on Personal Data Protection, especially among young digital-native users. This study is limited to Generation Z Shopee users in a single city, so future research should extend the geographic and generational scope, test mediating variables such as AI trust or user satisfaction, consider alternative moderators such as digital literacy or platform-usage intensity, and consider mixed-methods designs to more deeply understand the psychological mechanisms underlying digital engagement in the AI era.

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