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AI-Driven Personalization in E-Commerce: Impact on Customer Engagement and the Role of Privacy Concerns

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Keywords: AI-Personalization; Customer Engagement; E-Commerce; Privacy Concern.

Abstract

This study addresses the gap in understanding the effects of different AI-driven personalization strategies on customer engagement in e-commerce, particularly considering the moderating role of privacy concerns. The purpose is to analyze how product recommendations, AI-driven customer service, and automated personalized promotions influence customer engagement, and how privacy concerns affect these relationships. A quantitative approach was applied using survey data collected from 258 e-commerce users. Data were analyzed using Partial Least Squares Structural Equation Modeling (PLS-SEM). The results show that automated personalized promotions significantly enhance customer engagement, while product recommendations and AI-driven customer service do not have a significant impact. The findings suggest that privacy concerns play a critical role in moderating the effectiveness of AI personalization. This study contributes to e-commerce marketing strategies by highlighting the importance of privacy considerations and targeted personalized promotions to increase customer engagement. Future research should explore privacy concern mitigation and test findings across diverse e-commerce platforms.

Kata Kunci:

E-commerce; Kekhawatiran Privacy; Keterlibatan Konsumen; Personalisasi AI.

Abstrak

Penelitian ini mengisi kekosongan pemahaman tentang pengaruh berbagai strategi personalisasi berbasis AI terhadap customer engagement dalam e-commerce, dengan mempertimbangkan peran moderasi dari kekhawatiran privasi. Tujuan penelitian ini adalah menganalisis bagaimana rekomendasi produk, layanan pelanggan berbasis AI, dan promosi personalisasi otomatis memengaruhi customer engagement serta pengaruh moderasi kekhawatiran privasi. Pendekatan kuantitatif digunakan dengan data survei dari 258 pengguna e-commerce, dianalisis menggunakan PLS-SEM. Hasil menunjukkan promosi personalisasi otomatis berpengaruh signifikan terhadap customer engagement, sementara rekomendasi produk dan layanan pelanggan berbasis AI tidak signifikan. Temuan ini menegaskan pentingnya kekhawatiran privasi sebagai faktor moderasi dalam efektivitas personalisasi AI. Studi ini memberikan kontribusi pada strategi pemasaran e-commerce dengan menekankan pentingnya pertimbangan privasi dan promosi personalisasi yang tepat sasaran untuk meningkatkan customer engagement. Penelitian selanjutnya disarankan mengeksplorasi mitigasi kekhawatiran privasi dan menguji temuan di berbagai platform e-commerce.

INTRODUCTION

The advancement of Artificial Intelligence (AI) technology has brought a significant revolution to the e-commerce industry by enabling more sophisticated and efficient data-driven personalization (Raji et al., 2024). AI allows e-commerce platforms to gain a deeper understanding of customer preferences through behavioral analysis, purchase history, and digital interactions (Zhang et al., 2024a). One of the most significant implementations of AI in this industry is personalization (Ingriana & Rolando, 2025), which includes more relevant product recommendations (Nimbalkar & Berad, 2021), automated customer service through chatbots (Inavolu, 2024), and promotions tailored to individual customer needs (Mandagie & Kristaung, 2025). This technology not only enhances the shopping experience but also has the potential to increase customer engagement, a crucial factor in the sustainability of e-commerce businesses (Rahman et al., 2025).

However, despite its benefits, AI-driven personalization also presents critical challenges, particularly regarding privacy concerns (Paliński et al., 2025). As AI increasingly collects and analyzes customer data, many consumers feel uneasy about how their personal information is used for marketing purposes (Saxena & Thakur, 2024). Previous studies indicate that the higher the level of privacy concerns, the lower the likelihood that customers will engage with AI-driven personalization experiences (Amil & Midaoui, 2024). Such concerns may lead to resistance against personalization efforts and even decrease customer engagement on e-commerce platforms. Therefore, it is crucial to understand how the balance between the benefits of AI personalization and privacy concerns affects customer engagement.

Previous research has extensively examined the impact of AI-driven personalization on customer experiences in e-commerce (Celestin et al., 2024). Some studies suggest that effective personalization enhances customer retention and satisfaction (Khalik et al., 2023; (Celestin et al., 2024). AI-powered chatbots, as described in research by Zhang et al., (2024), can improve customer engagement through personalized service and smoother interactions. Furthermore, a study by Inavolu, (2024) highlights that while AI enhances customer service efficiency, significant challenges remain in terms of data privacy, algorithmic transparency, and integration with CRM systems.

Although many studies have explored the benefits of AI personalization and its impact on customer engagement (Kishen et al., 2021) (Rahman et al., 2025) , (Patil et al., 2024), several research gaps remain. First, most previous studies have focused on the effectiveness of AI personalization without thoroughly considering how privacy concerns may moderate this relationship. There is still a limited number of studies examining how customers respond to AI-driven personalization in the context of privacy concerns, particularly among specific populations such as younger generations or users with varying levels of digital literacy. Second, most research has concentrated on large e-commerce platforms, while the impact of AI personalization on customer engagement in small-scale or local e-commerce platforms remains underexplored. Third, studies addressing mitigation strategies for privacy concerns in AI personalization are still scarce.

Thus, the novelty of this research lies in examining the extent to which privacy concerns can weaken or strengthen the relationship between AI-driven personalization and customer engagement. By focusing on customers with different levels of digital literacy and small-scale

and local e-commerce platforms, this study will offer new perspectives that have not been widely discussed in previous research. Additionally, this study aims to identify strategies that e-commerce practitioners can employ to mitigate privacy concerns without compromising personalization effectiveness.

This research is expected to contribute significantly to understanding how AI-driven personalization affects customer engagement and how privacy concerns moderate this relationship. The findings of this study can provide insights for e-commerce platforms in implementing more effective and ethical personalization strategies while also assisting governments in developing better data protection policies. Consequently, the results of this research can offer long-term benefits to the e-commerce industry in developing more innovative, AI-based marketing strategies that prioritize customer satisfaction.

RESEARCH METHOD

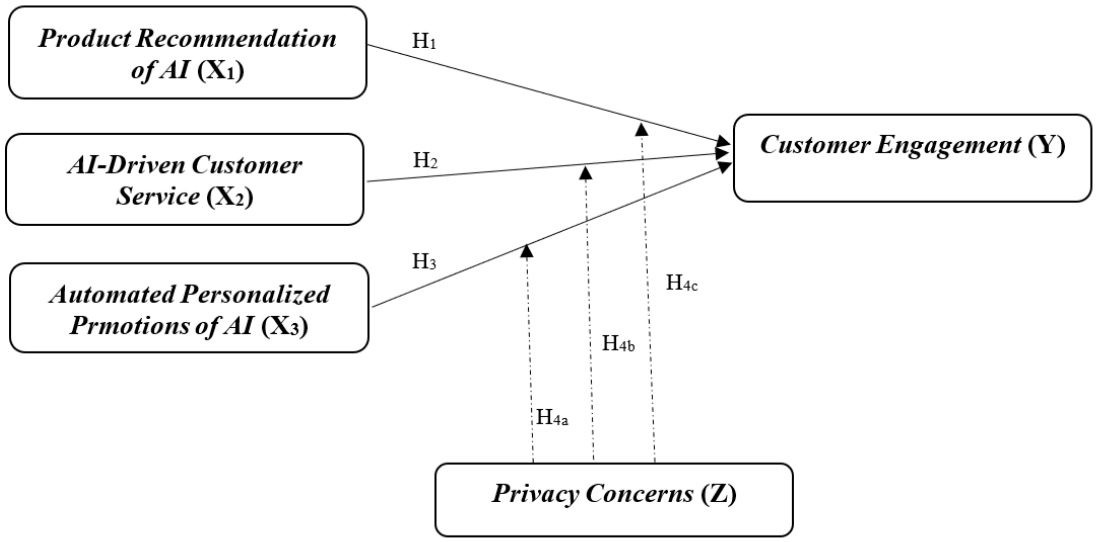
This study adopts a quantitative approach using a survey method to examine the influence of AI-driven product recommendations, AI-powered customer service, and automated personalized AI promotions on customer engagement, with privacy concerns acting as a moderating variable. The research design is causal, aiming to assess the relationships among independent, moderating, and dependent variables. The target population consists of e-commerce users who have experienced AI-based personalization features, such as product recommendations, chatbot-driven customer service, and tailored promotions. A **purposive sampling technique** is employed, with respondents selected based on the following criteria: (1) previous experience shopping on e-commerce platforms that utilize AI-driven personalization, (2) familiarity with AI-generated recommendations, AI-based customer service, or automated personalized promotions, and (3) at least 18 years old and actively using e-commerce platforms within the last six months.

The sample size is determined following the guideline by Hair et al. (2017), which recommends 5 to 10 respondents per indicator in Structural Equation Modeling (SEM). With a total of 25 indicators, a minimum of 250 respondents is deemed sufficient. Data is collected through an online questionnaire distributed via social media platforms such as WhatsApp and Instagram. The questionnaire consists of two parts: (1) respondent demographics (age, gender, and frequency of e-commerce usage), and (2) measurement of the research variables, including AI-driven product recommendations, AI-driven customer service, AI-driven personalized promotions, privacy concerns, and customer engagement. All items are rated using a 5-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). The research instrument was developed based on indicators adapted from previous validated studies and underwent a pre-test with 30 respondents to ensure clarity, validity, and reliability. Content validity was confirmed through expert judgment, while construct validity was assessed using Average Variance Extracted (AVE), and reliability was evaluated using Composite Reliability (CR). All constructs met the recommended thresholds (AVE > 0.5 and CR > 0.7), confirming that the instrument is suitable for this study.

The questionnaire items used in this study were adopted and adapted from previously validated research to ensure content relevance and measurement accuracy for each construct. Indicators for the variable **Product Recommendation of AI** were sourced from Zhang et al.

(2024) in their study titled *"Is AI Chatbot Recommendation Convincing Customer? An Analytical Response Based on The Elaboration Likelihood Model."* The items measuring **AI-Driven Customer Service** and **Privacy Concerns** were adopted from Saxena and Thakur (2024), whose research, *"Mediating Role of Trust and Privacy Concerns Between Web Assurance Mechanism and Purchase Intention of Online Products,"* provided a reliable basis for evaluating trust and privacy issues related to AI-based interactions. The indicators for **Automated Promotions of AI** were taken from Kronemann et al. (2022) in the study *"How AI Encourages Consumers to Share Their Secrets? The Role of Anthropomorphism, Personalisation, and Privacy Concerns."* Lastly, the measurement items for the **Customer Engagement** variable were adopted from Rahman et al. (2025) in their research titled *"How Do Omnichannel Customer Experiences Affect Customer Engagement? Theory and Empirical Validation."* These sources were selected based on their relevance to the AI personalization context in e-commerce and their alignment with the study's conceptual framework.

This study uses both primary and secondary data. Primary data is collected directly from respondents through the online survey, while secondary data is obtained from relevant literature, including academic journals, industry reports, and prior studies on AI applications in e-commerce personalization. Data analysis is conducted using Partial Least Squares Structural Equation Modeling (PLS-SEM)**,** which involves four key stages: (1) validity and reliability testing using AVE and CR, (2) assessment of the measurement model (outer model), (3) evaluation of the structural model (inner model), and (4) hypothesis testing using t-statistics and p-values to determine the significance of the relationships among variables. Informed consent is obtained from all participants before data collection to ensure adherence to research ethics, including anonymity, voluntary participation, and confidentiality of personal information.



Picture 1. Research Model

RESULTS AND DISCUSSIONS

Table: 1
Respondent Demographics

	N	%		N	%
Gender			**Occupation**		
Male	116	46,40	Unemployed	10	4,00
Female	134	53,60	Student	77	30,80
Total	**250**	**100**	Employee	125	50,00
			Entrepreneur	21	8,40
Age			Professional/Expert	15	6,00
12 – 15 years old	26	10,40	Others	2	0,80
16 – 19 years old	51	20,40	**Total**	**250**	**100**
20 – 23 years old	78	31,20			
24 – 27 years old	54	21,60			
>27 years old	41	16,40			
Total	**250**	**100**			
Educational Backgroung			**Monthly Income**		
Elementary School (SD)	5	2,00	No Income	87	34,80
Junior High School (SMP)	27	10,80	Less than Rp 1.000.000	36	14,40
Senior High School (SMA)	82	32,80	Rp 1.000.000 - Rp 3.000.000	25	10,00
Bachelor's Degree(S1)	120	48,00	Rp 3.000.001 – Rp 5.000.000	84	33,60
Master Degree (S2)	16	6,40	More than Rp 5.000.000	18	7,20
Total	**250**	**100**	**Total**	**250**	**100**

Source: Processed by the Researcher

Table 1 presents the demographic characteristics of the 250 respondents who participated in this study. The gender distribution shows a slightly higher proportion of female respondents (53.60%) compared to male respondents (46.40%). This indicates a balanced representation with a slight dominance of females in the sample. In terms of age, the majority of respondents were between 20 to 23 years old (31.20%), followed by those aged 16 to 19 years old (20.40%) and 24 to 27 years old (21.60%). A smaller proportion of respondents were older than 27 (16.40%) and younger than 16 years old (10.40%). This distribution suggests that the sample primarily consists of young adults, which is relevant if the study focuses on youth or early adult behavior and preferences.

Regarding occupational status, 50% of respondents were employees, indicating that half of the participants are currently engaged in formal work. Students made up 30.80%, showing that a significant portion of respondents are still pursuing education. Other occupational groups include entrepreneurs (8.40%), professionals/experts (6.00%), and unemployed individuals (4.00%). Only a small number of respondents (0.80%) selected "Others," suggesting minimal occupation variation beyond the categories provided.

In terms of educational background, the highest proportion of respondents held a Bachelor's degree (S1) at 48.00%, followed by those with a Senior High School (SMA) education (32.80%). Respondents with a Master's degree (S2) accounted for 6.40%, while those who had completed only Junior High School (SMP) and Elementary School (SD**)** represented

10.80% and 2.00%, respectively. These results indicate that the sample is predominantly composed of individuals with relatively high educational attainment.

As for monthly income, 34.80% of the respondents reported having no income, which aligns with the substantial number of student respondents. Additionally, 33.60% earned between Rp 3,000,001 and Rp 5,000,000, while 14.40% earned less than Rp 1,000,000, and 10.00% reported earning between Rp 1,000,000 and Rp 3,000,000. A smaller group (7.20%) earned more than Rp 5,000,000. These figures suggest a diverse range of income levels among the participants, although a large portion may still be financially dependent.

Overall, the demographic profile indicates that the study's respondents are mainly young, educated individuals with varied occupational and income backgrounds, making them a suitable group for analyzing modern consumer behavior, preferences, or perceptions depending on the research focus.

Table : 2
Validity and Reliability

Variables	No. Items	CA	DG *rho*	CR	AVE	VIF
Product Recommendation	5	0,826	0,839	0,883	0,654	1,409
AI-Driven Customer Service	5	0,854	0,864	0,894	0,629	1,759
Automated Personalized Promotions	5	0,627	0,651	0,841	0,726	1,263
Customer Engagement	5	0,840	0,844	0,893	0,677	2,264

Note: DG rho: *Dillon-Goldstein's rho*; AVE*: Average Variance Extracted*, CA: *Cronbach's Alpha*; VIF: *Variance Inflation Factors*, CR: *Composite Reliability.*
Source: Author's data analysis.

Table 2 presents the results of the validity and reliability testing for the constructs used in this study: Product Recommendation, AI-Driven Customer Service, Automated Personalized Promotions, and Customer Engagement. All constructs demonstrated acceptable levels of internal consistency reliability, as indicated by Cronbach's Alpha (CA) and Composite Reliability (CR) values. According to established criteria, Cronbach's Alpha values above 0.7 indicate good reliability. In this study, all constructs met this threshold, except for Automated Personalized Promotions, which has a CA of 0.627. While slightly below the conventional cutoff, it still falls within an acceptable range for exploratory research. The Composite Reliability (CR) values for all constructs exceed 0.8, confirming strong internal consistency.

Dillon-Goldstein's rho (DG rho) values also exceeded the recommended threshold of 0.7 for all constructs, further supporting the reliability of the measurement model. The Average Variance Extracted (AVE) values for each construct are all above the 0.5 benchmark, indicating satisfactory convergent validity—that is, the items within each construct adequately explain the underlying latent variable. Furthermore, Variance Inflation Factor (VIF) values are all below the critical threshold of 3.3, suggesting that multicollinearity is not a concern in the measurement model. The construct Customer Engagement has the highest VIF value (2.264), but it remains within an acceptable range. In summary, the results confirm that the constructs used in this study exhibit good reliability, convergent validity, and no significant multicollinearity, thereby supporting the appropriateness of the measurement model for further analysis.

Table: 3
Deskriminan Validity

	Product Recommendation	AI Customer Service	Automated Personalized Promotions	Customer Engagement
Fornell Lacker Crietion				
Product Recommendation	0,808			
AI Customer Service	0,610	0,793		
Automated Personalized Promotions	0,665	0,641	0,852	
Customer Engagement	0,448	0,420	0,535	0,823
Heterotrait-Monotrai Ratio (HTMT)				
Product Recommendation				
AI Customer Service	0,722			
Automated Personalized Promotions	0,628	0,867		
Customer Engagement	0,520	0,484	0,728	

Source: Author's data analysis.

Table 3 shows the results of the discriminant validity analysis using two approaches: the Fornell-Larcker criterion and the Heterotrait-Monotrait Ratio (HTMT). Based on the Fornell-Larcker criterion, the square root of the AVE for each construct is higher than its correlations with other constructs, indicating good discriminant validity. For example, the square root of AVE for Product Recommendation is 0.808, which is greater than its correlation with AI Customer Service (0.610), Automated Personalized Promotions (0.665), and Customer Engagement (0.448). Similar patterns are observed for the other constructs, confirming that each variable is empirically distinct.

The HTMT values further support this result. All HTMT ratios are below the conservative threshold of 0.90, with the highest value observed between AI Customer Service and Automated Personalized Promotions (0.867). This demonstrates that the constructs are not only conceptually but also statistically different from one another. Thus, both tests provide strong evidence that the measurement model meets the requirement for discriminant validity, ensuring the variables used in the model represent distinct concepts.

Table: 4
Path Coeficient

Hypothesis	**Hubungan**	**Beta**	**t**	**p**	**r^2**	**f^2**	**Q^2**	**Keputusan**
H_1	PR → CE	0,082	1,156	0,248	0,369	0,005	0,232	Rejected
H_2	ACS → CE	0,103	1,379	0,168		0,009		Rejected
H_3	APP → CE	0,249	3,160	0,002		0,038		Accepted

Note: PR: Product Recommendation, ACS: AI Customer Service, APP: Automated Personalized Promotions, CE: Customer Engagement.

Source: Author's data analysis.

Table 4 – Path Analysis reveals the effect of three AI-driven personalization strategies Product Recommendations, AI Customer Service, and Automated Personalized Promotions on

Customer Engagement. Among the three tested hypotheses, only one (H3) was accepted, while two (H1 and H2) were rejected. First, Hypothesis 1 (H1), which proposed that AI-powered Product Recommendations affect Customer Engagement, was rejected (β = 0.082; p = 0.248). This indicates that AI-generated product suggestions do not significantly drive consumer involvement. One possible explanation is that the recommendation algorithms used may not yet be sufficiently personalized or context-aware. If users receive irrelevant or repetitive suggestions, they may perceive the feature as unhelpful or even intrusive. According to the Technology Acceptance Model (TAM), perceived usefulness is a critical factor in adoption. When consumers feel that the recommendations do not add real value to their shopping experience, their willingness to engage diminishes. Furthermore, Expectation-Confirmation Theory (ECT) suggests that if the performance of product suggestions fails to meet customer expectations, it results in dissatisfaction, which can lead to disengagement.

Next, Hypothesis 2 (H2), which examined the impact of AI-driven Customer Service (e.g., chatbots, virtual assistants) on Customer Engagement, was also rejected (β = 0.103; p = 0.168). While AI-based customer service tools are designed to provide fast and accessible support, they may lack emotional intelligence or contextual understanding compared to human agents. This gap may lead to user frustration, especially when chatbots provide generic answers or fail to resolve complex issues. Based on Service Quality Theory, customer satisfaction stems from empathy, assurance, and responsiveness qualities that AI may struggle to deliver convincingly. If users perceive these systems as impersonal or ineffective, it limits their willingness to further engage with the platform.

In contrast, Hypothesis 3 (H3) which tested the relationship between Automated Personalized Promotions and Customer Engagement was accepted (β = 0.249; p = 0.002), indicating a significant positive effect. This can be attributed to the high perceived relevance and timeliness of AI-driven promotions. By analyzing real-time customer data, AI can deliver targeted offers that align with a user's specific interests and purchase history. This aligns with the Stimulus-Organism-Response (S-O-R) Theory, which posits that external stimuli (e.g., tailored promotions) can evoke internal emotional responses (e.g., interest, excitement), ultimately resulting in positive behavioral outcomes (e.g., engagement). Additionally, consumers tend to perceive personalized promotions as more valuable, which enhances satisfaction and strengthens their bond with the platform.

Table: 5
Moderating Effect

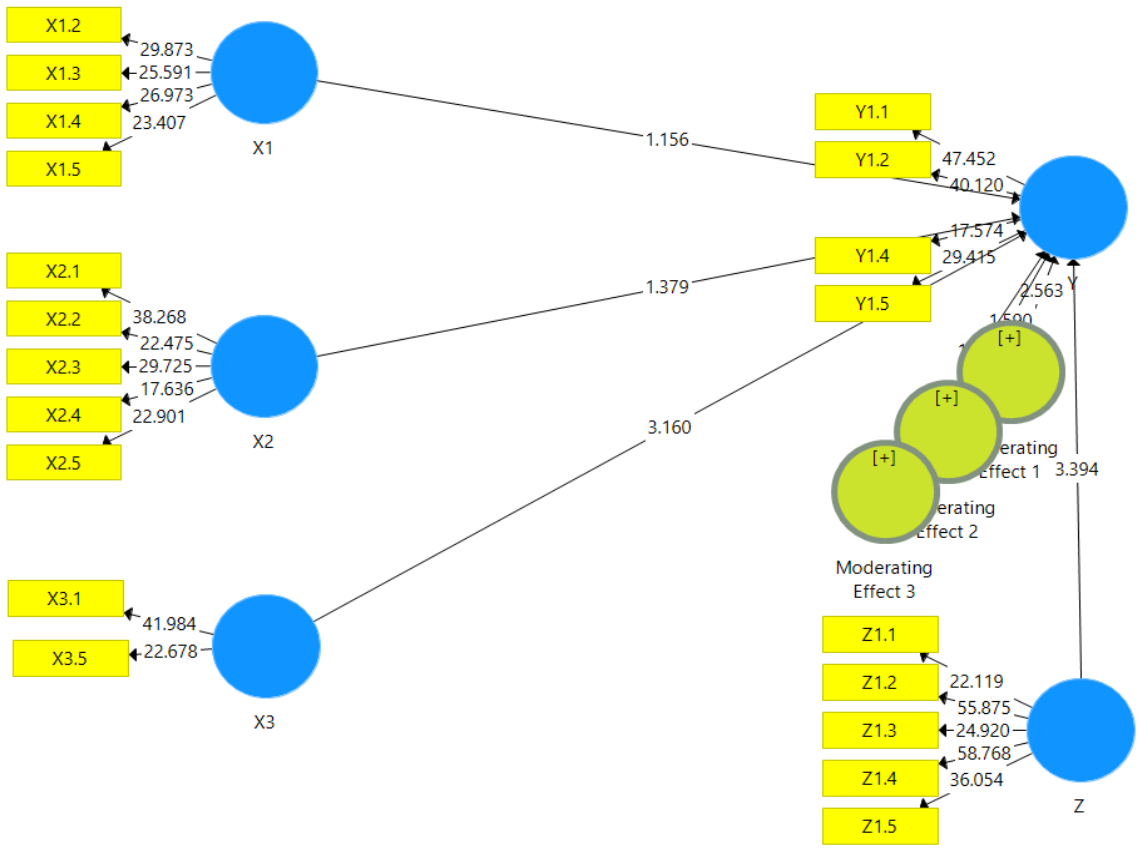
	Beta	T	p	Keputusan
PR → PC → CE	-0,201	2,563	0,011	Accepted
ACS → PC → CE	0,150	1,590	0,112	Rejected
APP → PC → CE	0,127	1,559	0,120	Rejected

Note: PR: Product Recommendation, ACS: AI Customer Service, APP: Automated Personalized Promotions, CE: Customer Engagement, PC: Privacy Concerns.
Source: Author's data analysis.

Table 5 – Moderating Effect presents the analysis of Privacy Concerns (PC) as a moderating variable in the relationship between three AI-driven personalization strategies—

Product Recommendation (PR), AI Customer Service (ACS), and Automated Personalized Promotions (APP)—on Customer Engagement (CE). The result shows that Privacy Concerns significantly moderate the relationship between Product Recommendation and Customer Engagement, as indicated by a negative beta value (β = -0.201, p = 0.011). This suggests that when privacy concerns are high, the positive impact of AI-powered product recommendations on customer engagement weakens. This finding supports prior literature (Amil, 2024) which states that consumers who are highly sensitive about how their data is used may distrust personalized systems. Even if the product suggestions are relevant, concerns about surveillance, data misuse, or lack of transparency can reduce users' willingness to interact with the platform.

However, the moderating effects of privacy concerns in the relationships between AI Customer Service and Customer Engagement (β = 0.150, p = 0.112) and between Automated Personalized Promotions and Customer Engagement (β = 0.127, p = 0.120) are not statistically significant. These findings indicate that while privacy concerns may exist, they do not significantly alter how consumers respond to AI-powered customer service or automated promotions. A possible explanation is that users may view these features as less intrusive or more transactional in nature, thereby tolerating certain levels of data usage in exchange for faster service or relevant deals. This is consistent with the Privacy Calculus Theory, where users weigh the benefits of personalization against perceived risks, and may continue to engage when the utility is deemed worth the trade-off.



Picture 2. Path Analysis

CONCLUSION

This study examined the impact of AI-driven personalization strategies—product recommendations, AI-driven customer service, and automated personalized promotions—on customer engagement in e-commerce, with privacy concerns as a moderating factor. The findings indicate that only automated personalized promotions significantly enhance customer engagement, while product recommendations and AI-driven customer service do not show a statistically significant effect. This suggests that personalized promotions are more effective in capturing consumer attention, likely due to their direct appeal and perceived value. Additionally, the study points to the limitations of AI product recommendations and customer service tools, which may be seen as intrusive or irrelevant if not tailored appropriately to individual preferences. Privacy concerns remain a critical issue, highlighting the need for further research on how these concerns influence the effectiveness of AI personalization across different demographics and platform types. Overall, the research provides valuable insights into consumer behavior in e-commerce and underscores the importance for platforms to prioritize privacy and implement more context-aware, meaningful personalization strategies to foster sustainable customer engagement. Future studies are encouraged to investigate strategies for mitigating privacy concerns and to broaden the scope by including smaller or local e-commerce platforms.

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