

Adoption of Artificial Intelligence (AI) in Small and Medium Enterprise E-Commerce to Improve Marketing Performance

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ABSTRACT

This study investigates the key determinants influencing the adoption of Artificial Intelligence (AI) by Small and Medium Enterprises (SMEs) in the e-commerce sector and examines its impact on marketing performance. The research integrates the Technology-Organization-Environment (TOE) framework and the Technology Acceptance Model (TAM) to explain the relationships among technological readiness, organizational support, environmental pressure, perceived usefulness (PU), perceived ease of use (PEOU), and AI adoption level. A quantitative approach employing Partial Least Squares-Structural Equation Modeling (PLS-SEM) was conducted on 155 e-commerce SMEs operating in Jakarta, Indonesia. Empirical results reveal that technology, organization, and environment significantly affect perceived usefulness, which in turn strongly drives AI adoption. Perceived usefulness is identified as the most powerful determinant of adoption, whereas perceived ease of use exerts an indirect influence via usefulness perception. Furthermore, AI adoption has a positive and significant effect on marketing performance, particularly in enhancing digital campaign effectiveness, product innovation, and customer loyalty. The findings emphasize that internal readiness and external competitive pressures jointly foster AI-driven digital transformation within SMEs. The study provides both theoretical validation of the TOE-TAM integration and practical guidance for policymakers and business owners to design effective, ethical, and sustainable AI adoption strategies.

KATA KUNCI

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ABSTRAK

Penelitian ini bertujuan untuk menganalisis faktor-faktor yang memengaruhi adopsi kecerdasan buatan (*Artificial Intelligence/AI*) oleh Usaha Mikro, Kecil, dan Menengah (UMKM) dalam sektor *e-commerce*, serta dampaknya terhadap kinerja pemasaran. Model penelitian mengintegrasikan dua kerangka teoretis, yaitu *Technology-Organization-Environment* (TOE) dan *Technology Acceptance Model* (TAM), untuk menjelaskan hubungan antara kesiapan teknologi, dukungan organisasi, tekanan lingkungan, persepsi kegunaan (PU), persepsi kemudahan penggunaan (PEOU), dan tingkat adopsi AI. Penelitian menggunakan pendekatan kuantitatif dengan metode *Partial Least Squares-Structural Equation Modeling* (PLS-SEM) terhadap 155 UMKM *e-commerce* di Jakarta. Hasil penelitian menunjukkan bahwa faktor teknologi, organisasi, dan lingkungan secara signifikan memengaruhi persepsi kegunaan AI, yang pada gilirannya meningkatkan tingkat adopsi. Persepsi kegunaan terbukti menjadi determinan paling kuat terhadap keputusan adopsi, sedangkan kemudahan penggunaan berpengaruh tidak langsung melalui persepsi manfaat. Selain itu, adopsi AI berpengaruh positif dan signifikan terhadap kinerja pemasaran, terutama pada efektivitas kampanye digital, inovasi produk, dan loyalitas pelanggan. Temuan ini menegaskan pentingnya sinergi antara kesiapan internal dan tekanan eksternal dalam mendorong transformasi digital berbasis AI pada UMKM, sekaligus memberikan implikasi praktis bagi pembuat kebijakan dan pelaku bisnis untuk mengembangkan strategi adopsi AI yang efektif, etis, dan berkelanjutan.

1. Introduction

The development of Artificial Intelligence (AI) has created a fundamental transformation in digital business strategies, including for the Small and Medium Enterprise (SME) sector. In the era of data-driven economies, AI has become a foundational

technology for automating marketing processes, analyzing consumer behavior, and personalizing customer services [1]. The adoption of AI by SMEs—particularly within e-commerce—is not merely a strategic choice but a necessity to maintain competitiveness in an increasingly dynamic and digital

market [2]. In the Indonesian context, SMEs play a vital role as the backbone of the national economy, contributing over 60% of the Gross Domestic Product (GDP) and employing more than 97% of the workforce Ministry of Cooperatives and SMEs of the Republic of Indonesia, 2023. However, the adoption rate of advanced technologies such as AI among SMEs remains relatively low due to limitations in resources, digital knowledge, and risk perception [3].

Artificial Intelligence in e-commerce marketing can enhance strategic decision-making effectiveness through predictive analytics, natural language processing, and recommendation algorithms. Studies show that AI implementation can increase marketing performance by up to 30% through offer personalization and customer management efficiency [4]. Within the Technology–Organization–Environment (TOE) and Technology Acceptance Model (TAM) frameworks, factors such as technological readiness, organizational support, and competitive pressure are the main determinants of adoption decisions [5]. Recent studies integrate both frameworks to explain AI adoption behavior in the SME sector, emphasizing the roles of Perceived Usefulness (PU) and Perceived Ease of Use (PEOU) as key mediators [6].

Nevertheless, there remains an empirical gap between AI's potential and its actual implementation in small and medium businesses within developing countries. Most previous studies have focused on large enterprises with advanced digital infrastructure [7], while the SME context has been relatively neglected. In Indonesia, barriers such as limited digital literacy, high initial investment costs, and uncertainty about adoption outcomes remain significant [8]. Moreover, trust issues related to AI-based systems and ethical concerns also influence business owners' perceptions [9]. Therefore, understanding the factors that drive and hinder AI adoption holistically is crucial to ensure that SME digitalization strategies are both effective and sustainable.

From a digital economy perspective, e-commerce serves as the primary medium for SMEs to expand their markets and improve operational efficiency [10]. Platforms such as Tokopedia, Shopee, and Lazada provide large-scale data ecosystems that enable the use of AI algorithms for market segmentation, customer sentiment analysis, and supply chain management [11]. Hence, AI adoption in e-commerce not only strengthens marketing capabilities but also creates data-driven competitive advantage [1]. However, this transformation requires organizational readiness in terms of human resources, innovation culture, and digital infrastructure [12].

Globally, numerous studies affirm that AI adoption among SMEs is positively correlated with product innovation, customer satisfaction, and revenue growth

[13]. Conversely, research in developing countries indicates that the perceived complexity of technology and the costs of adoption often hinder implementation [14]. Therefore, a research model integrating TOE and TAM is expected to provide a more comprehensive understanding of the determinants of AI adoption in Indonesia's e-commerce SMEs [15]. By identifying the roles of technological, organizational, and environmental factors, this study also offers policy recommendations for government agencies and SME support institutions to accelerate inclusive digital transformation.

Based on the discussion above, this research aims to: (1) analyze the factors influencing AI adoption among e-commerce SMEs in Indonesia; (2) assess the effect of AI adoption on marketing performance; and (3) examine the mediating roles of Perceived Usefulness (PU) and Perceived Ease of Use (PEOU) in the relationship between TOE factors and adoption level. The main contribution of this study lies in expanding the application of the TOE–TAM framework to the digital economy context of developing nations while providing practical implications for SMEs to optimize AI-based marketing strategies. Moreover, the findings are expected to serve as references for policymakers in designing effective and contextual SME digitalization programs.

Practically, understanding the determinants of AI adoption is crucial for SMEs in formulating digital transformation strategies oriented toward marketing performance improvement. For policymakers, the findings can inform efforts to strengthen digital infrastructure and technological literacy. For academics, this research enriches the literature by providing new empirical evidence on the relationship between AI adoption and marketing performance in the SME e-commerce sector. Thus, the study contributes not only to theoretical advancement but also to practical and policy dimensions relevant to the era of sustainable digital economy.

The Technology–Organization–Environment (TOE) framework developed, provides a holistic structure for analyzing technological innovation adoption at the organizational level. It comprises three core dimensions—technology, organization, and environment. The technology dimension concerns the availability and perceived suitability of a given technology, including its relative advantage and complexity [16]. The organizational dimension relates to firm size, managerial support, and human resource capabilities [17]. Meanwhile, the environmental dimension includes market competition, government support, and external infrastructure [18].

In the SME e-commerce context, TOE explains how AI adoption is influenced by digital readiness, innovation culture, and environmental pressure to remain competitive [19]. Managerial commitment and

competitive pressure are key drivers accelerating AI integration among small firms [20]. Hence, TOE serves as a comprehensive analytical tool for understanding contextual determinants of AI adoption decisions.

The Technology Acceptance Model (TAM), introduced by [5], remains the cornerstone for predicting technology acceptance at both individual and organizational levels. It emphasizes two primary constructs: Perceived Usefulness (PU) and Perceived Ease of Use (PEOU). PU refers to the extent to which users believe technology improves job performance, while PEOU reflects the degree of effort required to use the system.

In SME AI adoption, these constructs mediate the relationship between TOE factors and actual adoption [21]. The more beneficial and easier AI is perceived to use, the more likely it is to be implemented for digital marketing operations [2]. Furthermore, TAM has evolved through integrations with models such as UTAUT and DOI to account for contextual and behavioral influences [22]. The TOE–TAM integration thus provides a robust theoretical base for analyzing both contextual and perceptual determinants of technology adoption.

Artificial intelligence in marketing refers to the application of intelligent algorithms that analyze customer data to improve decision-making, personalization, and engagement [23]. AI-driven tools enable automated customer segmentation, predictive analytics, and personalized recommendations, thereby enhancing marketing performance and customer loyalty. AI integration can improve SME marketing performance by up to 40% when data-driven insights are effectively leveraged. Marketing performance, therefore, extends beyond sales growth—it encompasses brand awareness, digital engagement, and innovation capabilities [1].

Within this study, AI adoption acts as a mediating construct connecting organizational and environmental readiness with marketing performance outcomes, highlighting the transformative power of digital intelligence. Synthesizing previous research, integrating TOE and TAM provides a multi-level theoretical lens linking external enablers, perceptual mediators, and performance outcomes. The technological dimension influences PU and PEOU, which drive adoption; organizational and environmental contexts reinforce these relationships. AI adoption subsequently enhances marketing performance through operational efficiency and customer analytics. This theoretical structure contributes to existing knowledge by contextualizing digital adoption in emerging economies, particularly among SMEs in Indonesia. It bridges the gap between adoption intent and realized performance, offering implications for policymakers, practitioners, and

scholars in digital transformation and AI-based marketing.

2. Research Method

This study adopts a quantitative explanatory approach to examine the causal relationships among TOE factors, perceived usefulness (PU), perceived ease of use (PEOU), AI adoption, and marketing performance of Indonesian SME e-commerce firms. PLS-SEM was employed via SmartPLS 4.0 to test the hypothesized model, as it suits predictive models with reflective constructs and moderate sample sizes [24]. The population includes e-commerce SMEs operating in Jakarta that have implemented at least one AI-based tool (e.g., chatbots, recommendation systems). Sampling followed purposive techniques with criteria: (1) micro to medium-sized firms, (2) operational ≥ 1 year, (3) at least one AI-driven marketing tool adopted. A total of 155 valid responses were collected via online survey (January–March 2025). The sample meets the minimum requirement of 10 times the maximum number of structural paths in the PLS model [25].

Table 1 Operationalization of Variables

Variable	Indicators / Dimensions	Scale
Technology Context (T)	T1. Technological compatibility	Likert 1–5
	T2. Complexity	
	T3. Infrastructure readiness	
Organization Context (O)	O1. Top management support	Likert 1–5
	O2. Employee competency	
	O3. Innovation culture	
Environment Context (E)	E1. Competitive pressure	Likert 1–5
	E2. Government support	
	E3. Customer pressure	
Perceived Ease of Use (PEOU)	PEOU1. Easy to learn PEOU2. Easy to operate PEOU3. Flexible to use	Likert 1–5
Perceived Usefulness (PU)	PU1. Improves efficiency PU2. Enhances decision quality PU3. Speeds market response	Likert 1–5
AI Adoption (ADOP)	ADOP1. Usage intensity	Likert 1–5
	ADOP2. Integration into business process	
	ADOP3. Investment commitment	
Marketing Performance (MP)	MP1. Sales growth	Likert 1–5
	MP2. Digital campaign effectiveness	
	MP3. Customer loyalty	
	MP4. Product innovation	

Data analysis in this study was conducted through two main stages to ensure the robustness and validity of the research model. In the first stage, the measurement model (outer model) was evaluated to confirm the reliability and validity of the constructs used. Indicator reliability was assessed using the outer loading criterion, where all items with values greater than 0.70 were considered acceptable. Construct reliability was verified through Composite Reliability (CR) and Cronbach's Alpha, both exceeding the recommended threshold of 0.70, indicating internal consistency among indicators. Convergent validity was established by ensuring that the Average Variance Extracted (AVE) values were above 0.50, confirming that each

construct adequately captured the variance of its indicators. Discriminant validity was further tested using the Fornell–Larcker criterion and Heterotrait–Monotrait ratio (HTMT), with all HTMT values below 0.85, signifying that the constructs were empirically distinct from one another.

In the second stage, the structural model (inner model) was examined to evaluate the relationships between the latent constructs and to test the proposed hypotheses. Multicollinearity among predictor variables was assessed through the Variance Inflation Factor (VIF), and all values were below the critical level of 5, indicating the absence of multicollinearity. The significance of each path coefficient was tested using the bootstrapping procedure with 5,000 resamples, allowing for robust estimation of standard errors and t-values. The overall model fit was evaluated through the Standardized Root Mean Square Residual (SRMR), which yielded a value below 0.08, indicating an acceptable level of fit between the observed and predicted covariance matrices. The explanatory power of the model was assessed using adjusted R² values for each endogenous construct, while Q² statistics and the PLSpredict procedure confirmed the model's predictive relevance.

To ensure research integrity, a pilot test was conducted on 30 SME owners prior to the main data collection phase. The pilot results produced a Cronbach's alpha of 0.81, demonstrating strong internal consistency and the reliability of the measurement instrument. All

respondents participated voluntarily after providing informed consent, and confidentiality of responses was strictly maintained throughout the research process, in accordance with ethical standards for social science research.

3. Result and Discussion

This study involved 155 e-commerce SME owners based in Jakarta. The respondents were categorized into three business sizes: micro (45%), small (38%), and medium (17%). The majority of SMEs used well-known e-commerce platforms such as Tokopedia, Shopee, and Lazada, with 70% having adopted AI-driven technologies in their marketing processes, such as chatbots, personalized recommendation systems, and customer analytics. The respondents primarily represented sectors such as fashion (45%), electronics (30%), and household products (25%), reflecting the distribution of e-commerce sectors in Indonesia. This sample offers a comprehensive representation of SMEs that are integrating digital and AI-based marketing techniques into their operations.

The following Table 2 presents the hypothesis testing results using PLS-SEM (Partial Least Squares Structural Equation Modeling) via SmartPLS 4.0, with 5,000 resamples. The results indicate that the Perceived Usefulness (PU) of AI has the strongest direct effect on AI adoption ($\beta = 0.467$, $p < 0.001$), confirming the TAM framework, which posits that perceived benefits drive technology adoption decisions.

Table 2 Hypothesis Testing Results

Path Relationship	β (Path Coefficient)	t-value	p-value	Decision
Technology → PU	0.321	4.122	0.000	Supported
Organization → PU	0.198	2.345	0.019	Supported
Environment → PU	0.276	3.111	0.002	Supported
PU → AI Adoption	0.467	6.029	0.000	Supported
PEOU → PU	0.353	4.984	0.000	Supported
PEOU → AI Adoption	0.128	1.712	0.087	Not Supported
Organization → AI Adoption	0.209	2.458	0.014	Supported
Environment → AI Adoption	0.235	2.995	0.003	Supported
AI Adoption → Marketing Performance	0.521	7.642	0.000	Supported

The findings reveal that Technology, Organization, and Environment significantly influence Perceived Usefulness (PU), which subsequently drives AI Adoption. This is in alignment with the TOE theory, which highlights the crucial role of technological, organizational, and environmental factors in shaping technology adoption decisions. Specifically, organizational support and competitive pressure emerged as significant factors, supporting the importance of a resource-rich internal environment and external market pressures for driving innovation [26].

Perceived Usefulness (PU) emerged as the strongest predictor of AI adoption, with a path coefficient of 0.467 ($p < 0.001$). This suggests that SMEs are more likely to adopt AI technologies when they perceive that these technologies will enhance performance, such as increased efficiency and better decision-making. These

results corroborate with Davis's TAM model (1989), which identifies perceived usefulness as a key determinant in technology adoption.

On the other hand, Perceived Ease of Use (PEOU) did not have a significant direct effect on AI Adoption ($\beta = 0.128$, $p = 0.087$). This finding resonates with researcher, who argue that in resource-constrained environments, SMEs prioritize tangible benefits such as cost reduction, sales growth, and customer engagement over system usability factors [27]. Thus, in this context, the benefits outweigh the ease of use when SMEs consider adopting AI technologies.

The AI Adoption → Marketing Performance path was the most substantial ($\beta = 0.521$, $p < 0.001$), indicating that AI adoption positively impacts marketing performance. This confirms the findings of a study,

which state that AI enhances marketing outcomes by improving personalization, automating digital campaigns, and leveraging data analytics for more informed decision-making [1]. These outcomes are consistent with the global trend of AI-powered marketing, where firms witness significant improvements in customer loyalty and product innovation [2].

The study's findings have significant implications for both theory and practice. Perceived Usefulness (PU) is identified as the primary factor driving AI adoption, suggesting that SMEs in Indonesia are motivated by tangible performance improvements rather than the ease of using AI systems. Policymakers should focus on demonstrating clear AI benefits, such as cost savings, sales growth, and enhanced customer experience, to encourage AI adoption.

Although PEOU was not a significant predictor of AI adoption in this study, it remains important for developers and technology providers to improve usability as it can enhance user experience over time. Furthermore, the role of organizational readiness (e.g., managerial support, human resources) and external pressures (e.g., competitive market dynamics) cannot be overlooked when designing AI adoption strategies for SMEs. This research supports the TOE framework in the context of Indonesian SMEs, highlighting the importance of both internal preparedness and external market forces in enabling successful AI adoption. SMEs should leverage government programs aimed at improving digital infrastructure and enhancing digital literacy to accelerate AI adoption.

This study aligns with previous research that emphasizes Perceived Usefulness (PU) as the primary driver of technology adoption [2], [27]. However, it also adds value by showing that ease of use does not have a direct impact on AI adoption, which contrasts with studies in developed countries where user-friendly systems are emphasized [5]. Moreover, this study contributes to the literature by focusing on the Indonesian e-commerce SME context, which has often been overlooked in previous research that predominantly focuses on large firms and developed economies [28]. This research extends the existing literature by exploring how AI adoption in SMEs can contribute to improving marketing performance in a developing country context.

This study has several limitations, such as focusing solely on SMEs in Jakarta and relying on self-reported survey data, which may introduce bias. Future research could expand the sample to other regions and consider using objective performance data regarding marketing outcomes generated by AI adoption. Additionally, future studies could explore the specific role of AI technologies in influencing adoption and employ longitudinal studies to assess the long-term impacts of AI on business performance.

4. Conclusion

This study concludes that the adoption of Artificial Intelligence (AI) among Indonesian e-commerce SMEs is significantly influenced by technological, organizational, and environmental factors as conceptualized within the TOE–TAM framework. Empirical results confirm that Perceived Usefulness (PU) is the strongest predictor of AI adoption, while Perceived Ease of Use (PEOU) exerts an indirect effect through usefulness perception. Managerial support, human capital competence, and external competitive pressure jointly enhance adoption readiness, underscoring that both internal capabilities and environmental dynamics drive AI-based digital transformation in SMEs. Furthermore, AI adoption positively and significantly improves marketing performance, particularly through better digital campaign efficiency, product innovation, and customer loyalty. Therefore, AI adoption should be viewed not merely as a technological tool but as a strategic driver of value creation and competitive advantage. The study contributes theoretically by validating the TOE–TAM integration in an emerging economy context and practically by providing actionable insights for policymakers and SME practitioners to design effective, ethical, and sustainable AI adoption strategies.

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