

Artificial Intelligence Adoption and Marketing Performance among SMEs: Examining Technological, Organizational, and Environmental Barriers through the TOE Framework

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ABSTRACT. Artificial Intelligence (AI) has emerged as a strategic technology capable of enhancing organizational competitiveness and marketing effectiveness. However, many Small and Medium Enterprises (SMEs), particularly in emerging economies, continue to face significant challenges in adopting AI technologies. This study aims to examine the influence of technological barriers, organizational barriers, and environmental barriers on AI adoption and their implications for marketing performance among SMEs in Banyumas Regency, Indonesia. The study adopts the Technology–Organization–Environment (TOE) framework as the theoretical foundation for explaining AI adoption behavior within SMEs. A quantitative research approach was employed using survey data collected from 100 SMEs in Banyumas. The data were analyzed using Partial Least Squares Structural Equation Modeling (PLS-SEM). The findings reveal that technological barriers and environmental barriers significantly influence AI adoption, whereas organizational barriers do not significantly affect AI adoption. Furthermore, AI adoption significantly influences marketing performance. The results indicate that SMEs adopting AI technologies experience improvements in sales growth, customer satisfaction, customer loyalty, digital campaign effectiveness, market responsiveness, and competitive advantage.

Keywords: Artificial Intelligence Adoption; Marketing Performance; Barrier; Organizational; TOE Framework;

JEL Classification: MM2

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INTRODUCTION

Artificial Intelligence (AI) has emerged as one of the most transformative technologies in the digital economy, fundamentally reshaping how firms create value, interact with customers, and sustain competitive advantage. AI enables organizations to automate decision-making, personalize customer experiences, improve predictive analytics, and optimize marketing strategies through intelligent data processing. Consequently, AI adoption has increasingly become a strategic necessity for organizations seeking to improve marketing performance in highly competitive and technology-driven markets. Recent studies demonstrate that firms implementing AI technologies experience improvements in customer engagement, market responsiveness, sales effectiveness, and overall business performance.

In the context of Small and Medium Enterprises (SMEs), AI adoption is particularly important because SMEs frequently operate under conditions of limited resources, intense competition, and rapidly changing customer demands. In emerging economies such as Indonesia, SMEs play a dominant role in economic growth and employment generation. However, despite the increasing availability of AI-based applications, many SMEs still face difficulties in adopting AI technologies effectively. The gap between AI potential and actual implementation remains substantial, especially among SMEs with limited technological capabilities and insufficient organizational support.

The Technology–Organization–Environment (TOE) framework proposed by Tornatzky and Fleischer (1990) has become one of the most widely utilized theoretical models for explaining organizational technology adoption. The TOE framework suggests that technology adoption decisions are influenced by technological, organizational, and environmental contexts. Recent AI adoption studies confirm that technological readiness, organizational capability, and environmental support significantly affect firms' willingness to adopt AI technologies.

Nevertheless, AI implementation among SMEs remains hindered by various barriers. Although organizations may possess readiness factors encouraging AI adoption, the existence of technological, organizational, and environmental barriers often inhibits successful implementation. Technological barriers include high implementation costs, cybersecurity risks, inadequate IT infrastructure, data quality problems, and system complexity. Organizational barriers involve resistance to change, lack of employee competence, insufficient managerial commitment, and financial limitations. Meanwhile, environmental barriers encompass regulatory uncertainty, lack of government support, weak digital ecosystems, and external market instability. These barriers substantially reduce the effectiveness of organizational readiness in translating into actual AI adoption.

Previous studies have widely investigated determinants of AI adoption using the TOE framework; however, several important research gaps remain unresolved. First, prior research primarily focuses on direct antecedents of AI adoption without adequately examining the inhibiting role of barriers. Most studies assume that readiness factors automatically encourage adoption, while empirical evidence indicates that SMEs frequently encounter substantial implementation obstacles that weaken adoption outcomes. Consequently, the moderating effect of barriers on AI adoption remains underexplored, particularly in developing-country SMEs.

Second, although AI adoption has increasingly attracted scholarly attention, relatively limited studies investigate its implications for marketing performance specifically. Existing AI studies predominantly focus on operational efficiency, innovation capability, or sustainable performance,

while marketing performance outcomes such as customer acquisition, customer retention, market expansion, sales growth, and brand competitiveness remain insufficiently examined. Yet, marketing performance represents one of the most critical indicators for SMEs striving to survive and compete in digital markets.

Third, empirical findings regarding the relationship between AI adoption and marketing performance remain inconsistent. Several studies report that AI adoption positively influences marketing effectiveness through data-driven customer insights and automated personalization. Conversely, other studies argue that AI implementation does not automatically improve marketing outcomes unless organizations possess sufficient digital capability and strategic alignment. These inconsistencies indicate the existence of contextual factors influencing the effectiveness of AI implementation in SMEs.

Furthermore, studies integrating AI barriers and marketing performance within a single conceptual framework remain scarce. Existing literature tends to examine barriers independently from organizational outcomes, resulting in limited understanding of how barriers affect AI-driven marketing transformation. In particular, there is still insufficient empirical evidence explaining how technological, organizational, and environmental barriers influence AI adoption and subsequently affect marketing performance among SMEs in emerging economies.

To address these gaps, this study proposes an integrated research model examining the influence of technological barriers, organizational barriers, and environmental barriers on AI adoption, as well as the effect of AI adoption on marketing performance among SMEs. Unlike previous studies that predominantly emphasize readiness or enabling factors, this research focuses on barriers as critical determinants influencing AI adoption decisions. This perspective is particularly relevant for SMEs in developing countries where resource constraints and environmental uncertainty frequently hinder digital transformation initiatives.

This study contributes theoretically by extending the TOE framework through the incorporation of multidimensional barriers as predictors of AI adoption and by positioning AI adoption as a determinant of marketing performance. Additionally, this research contributes empirically by providing evidence from Indonesian SMEs, particularly in Banyumas Regency, where AI implementation remains relatively underexplored despite increasing digitalization pressure. Practically, the findings are expected to assist SME owners, policymakers, and technology providers in formulating effective strategies to overcome AI adoption barriers and improve marketing performance through AI-driven transformation.

Technology–Organization–Environment (TOE) Framework

The Technology–Organization–Environment (TOE) framework, introduced by Louis G. Tornatzky and Mitchell Fleischer (1990), is one of the most influential theories explaining organizational technology adoption. The TOE framework posits that the adoption of technological innovation is influenced by three major dimensions: technological context, organizational context, and environmental context. The technological context refers to internal and external technologies available to the firm; organizational context concerns organizational resources and capabilities; while environmental context includes industry characteristics, competition, and government support.

The TOE framework has been extensively applied in studies examining digital transformation, big data analytics, cloud computing, and Artificial Intelligence (AI) adoption. Recent studies suggest that TOE provides a comprehensive theoretical foundation for understanding AI adoption because AI implementation requires technological capability, organizational readiness, and

environmental support simultaneously. Therefore, TOE is considered highly suitable for explaining AI adoption among SMEs operating in uncertain and resource-constrained environments.

According to the TOE perspective, organizational readiness alone does not guarantee successful AI implementation. Firms often face technological, organizational, and environmental barriers that may inhibit the adoption process. Consequently, TOE has evolved from merely explaining enabling factors toward identifying constraints and barriers influencing innovation adoption decisions. In this study, TOE serves as the grand theory explaining how technological barriers, organizational barriers, and environmental barriers affect AI adoption and subsequently influence marketing performance.

Tornatzky and Fleischer (1990) argue that organizations adopt technological innovation when they perceive compatibility between technological capability, organizational resources, and environmental demands. In the context of SMEs, AI adoption becomes increasingly important because AI enables firms to improve decision-making, customer engagement, and marketing effectiveness. Thus, TOE provides an appropriate conceptual lens for understanding AI-driven marketing transformation.

Technological Barrier and AI Adoption

Technological barriers refer to technological constraints that hinder organizations from adopting and implementing AI systems effectively. These barriers include inadequate IT infrastructure, high implementation costs, cybersecurity risks, data quality issues, system incompatibility, and technological complexity. In SMEs, technological barriers become particularly critical because SMEs generally possess limited technological resources compared with large organizations.

Previous studies indicate that technological complexity significantly reduces firms' willingness to adopt AI technologies. SMEs frequently perceive AI systems as difficult to integrate into existing business operations due to insufficient technical expertise and lack of infrastructure readiness. Additionally, high investment costs associated with AI implementation often discourage SMEs from adopting advanced digital technologies.

According to the TOE framework, technological context strongly determines innovation adoption decisions. When organizations perceive technological barriers as excessively high, the likelihood of AI adoption decreases substantially. Recent studies by Badghish and Soomro (2024) found that inadequate technological infrastructure and system complexity negatively influence AI adoption among SMEs. Similarly, Zavodna et al. (2024) identified data security concerns and implementation costs as major technological obstacles limiting AI diffusion in SMEs.

Therefore, technological barriers are expected to negatively influence AI adoption because higher technological constraints reduce firms' capability and willingness to implement AI technologies effectively.

Organizational Barrier and AI Adoption

Organizational barriers refer to internal organizational constraints inhibiting AI adoption. These barriers include employee resistance to change, insufficient managerial support, lack of employee competence, inadequate financial resources, and weak organizational culture toward innovation.

The successful implementation of AI requires strong organizational commitment and strategic alignment. However, SMEs often face difficulties in developing human resource capability and digital culture necessary for AI integration. Employees may perceive AI technologies as threatening existing jobs or increasing work complexity, resulting in organizational resistance. Moreover,

limited managerial understanding regarding AI benefits frequently prevents organizations from making strategic investments in AI systems.

Within the TOE framework, organizational context represents organizational readiness and capability to support technological innovation. Firms possessing weak organizational structures and limited managerial support are less likely to adopt AI successfully. Prior studies indicate that organizational resistance and lack of digital skills significantly inhibit AI adoption among SMEs.

Research conducted by Sánchez et al. (2025) demonstrates that managerial capability and employee competence are essential predictors of successful AI implementation. Furthermore, Dwivedi et al. (2024) emphasize that organizational barriers constitute one of the primary reasons behind AI adoption failure in developing economies.

Therefore, organizational barriers are predicted to negatively affect AI adoption because internal organizational limitations reduce firms' readiness and capability to implement AI technologies effectively.

Environmental Barrier and AI Adoption

Environmental barriers refer to external environmental constraints that hinder AI adoption. These barriers include regulatory uncertainty, insufficient government support, lack of external technological ecosystems, limited vendor support, competitive uncertainty, and inadequate digital infrastructure at the industry or national level.

Environmental conditions play an important role in organizational technology adoption because firms operate within broader institutional and competitive environments. SMEs in developing countries frequently encounter weak regulatory frameworks and insufficient governmental incentives for digital transformation. Furthermore, limited collaboration among stakeholders within digital ecosystems often constrains SMEs' access to technological resources and expertise. The TOE framework suggests that environmental context significantly influences firms' innovation decisions. Favorable environmental conditions encourage technology adoption, whereas unfavorable environments create uncertainty and increase perceived risk. Previous studies indicate that regulatory support and competitive pressure positively influence AI adoption, while environmental instability negatively affects adoption decisions.

Zavodna et al. (2024) found that weak governmental policies and limited external support constitute major barriers preventing SMEs from implementing AI technologies. Similarly, recent studies highlight that inadequate digital ecosystems and uncertainty regarding AI regulation significantly reduce SMEs' intention to adopt AI.

Consequently, environmental barriers are expected to negatively influence AI adoption because unfavorable external environments increase uncertainty and reduce organizational confidence in AI implementation.

Artificial Intelligence Adoption

Artificial Intelligence adoption refers to the extent to which organizations implement and utilize AI technologies in business processes and decision-making activities. AI adoption includes the use of machine learning, predictive analytics, intelligent automation, chatbots, recommendation systems, and customer analytics to improve organizational effectiveness.

AI adoption has increasingly become a strategic capability enabling firms to gain competitive advantage through enhanced efficiency, innovation, and customer engagement. In marketing activities, AI technologies facilitate personalized communication, customer segmentation, market prediction, and real-time decision-making.

According to the TOE framework, AI adoption is influenced by technological, organizational, and environmental contexts. Organizations possessing adequate technological capability, organizational readiness, and environmental support are more likely to implement AI successfully. However, technological, organizational, and environmental barriers may inhibit this process. Recent studies indicate that AI adoption positively contributes to organizational performance, innovation capability, and sustainable competitiveness. In SMEs, AI adoption enables firms to optimize marketing activities despite limited resources by automating customer interactions and improving data-driven decision-making.

AI Adoption and Marketing Performance

Marketing performance refers to the effectiveness of organizational marketing activities in achieving strategic objectives such as sales growth, customer acquisition, customer retention, market share expansion, and brand competitiveness.

The Resource-Based View (RBV) suggests that technological capabilities such as AI can become strategic organizational resources generating sustainable competitive advantage. AI adoption enhances firms' marketing performance by improving customer insights, personalization capability, predictive analytics, and marketing efficiency.

AI technologies enable organizations to analyze customer behavior more accurately, identify market trends, optimize pricing strategies, and improve customer relationship management. Consequently, firms adopting AI are better positioned to respond to market changes and customer preferences effectively.

Previous empirical studies consistently demonstrate a positive relationship between AI adoption and marketing performance. Chatterjee et al. (2024) found that AI-driven customer analytics significantly improve customer engagement and marketing effectiveness. Similarly, Soomro et al. (2025) reported that AI adoption positively affects business performance through enhanced operational and strategic capability.

Nevertheless, the effectiveness of AI adoption depends on firms' ability to integrate AI into marketing strategy and organizational processes. SMEs possessing limited digital maturity may experience difficulties translating AI adoption into superior marketing outcomes. Therefore, AI adoption is expected to positively influence marketing performance because AI enables firms to improve marketing efficiency, customer engagement, and competitive responsiveness.

Based on the Technology–Organization–Environment (TOE) framework and prior empirical findings, the following hypotheses are proposed:

H1 Higher technological barriers significantly reduce SMEs' adoption of Artificial Intelligence technologies.

H2 Organizational barriers significantly hinder Artificial Intelligence adoption among SMEs.

H3 Environmental barriers significantly inhibit SMEs from adopting Artificial Intelligence technologies.

H4 Artificial Intelligence adoption significantly improves marketing performance among SMEs.

H5 Technological barriers significantly reduce marketing performance among SMEs.

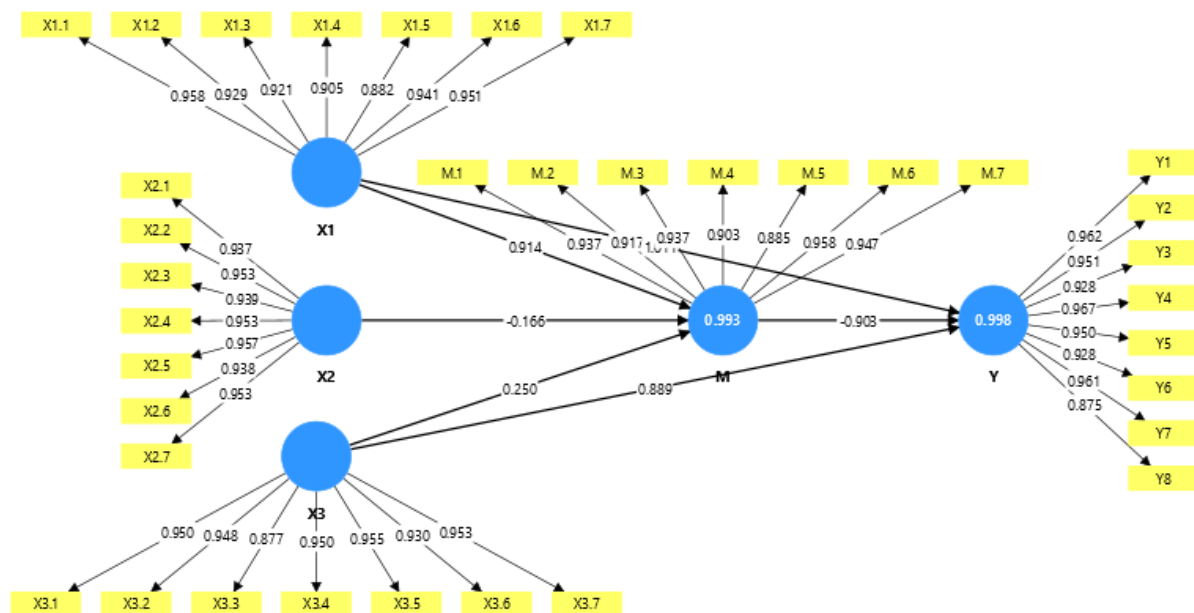
H6 Organizational barriers significantly reduce marketing performance among SMEs.

H7 Environmental barriers significantly reduce marketing performance among SMEs.

H8 Artificial Intelligence adoption mediates the negative relationship between technological barriers and marketing performance.

H9 Artificial Intelligence adoption mediates the negative relationship between organizational barriers and marketing performance.

H10 Artificial Intelligence adoption mediates the negative relationship between environmental barriers and marketing performance.



METHODS

Research Design

This study employed a quantitative research approach using a cross-sectional survey design to examine the relationships between technological barriers, organizational barriers, environmental barriers, Artificial Intelligence (AI) adoption, and marketing performance among Small and Medium Enterprises (SMEs). The study aimed to investigate the influence of multidimensional barriers on AI adoption and the subsequent impact of AI adoption on marketing performance.

The conceptual model was developed based on the Technology–Organization–Environment (TOE) framework and tested using Partial Least Squares Structural Equation Modeling (PLS-SEM). PLS-SEM was selected because it is suitable for predictive research models, mediation analysis, complex latent constructs, and relatively small sample sizes.

Population and Sample

The population of this study consisted of SMEs operating in Banyumas Regency, Indonesia. Banyumas was selected because SMEs in this region are increasingly encouraged to adopt digital technologies while still facing various technological and organizational challenges.

The sampling technique used in this study was purposive sampling. The respondents were SME owners or managers who:

1. Operate active SMEs in Banyumas,
2. Have utilized digital technology in business activities,
3. Possess basic understanding of AI-related technologies or digital marketing tools.

A total of 100 SMEs participated in this study. The sample size is considered adequate for PLS-SEM analysis because Hair et al. (2022) suggest that PLS-SEM can effectively handle small-to-medium sample sizes and complex structural models.

Data Collection Procedure

Primary data were collected through a structured questionnaire distributed directly and online to SME owners and managers in Banyumas. The questionnaire used a five-point Likert scale ranging from:

1	=	Strongly	Disagree
2	=		Disagree
3	=		Neutral
4	=		Agree
5		Strongly Agree	

The questionnaire items were adapted from previous studies related to TOE, AI adoption, and marketing performance and modified according to the SME context.

Measurement of Variables

Technological Barrier (TB)

Technological barriers refer to technological limitations that hinder AI implementation within SMEs.

Code Measurement Items

- TB1 High cost of AI implementation
- TB2 Complexity of AI technology
- TB3 Incompatibility of AI with existing systems
- TB4 Inadequate digital infrastructure
- TB5 Poor data quality and availability
- TB6 Lack of data security and privacy
- TB7 Difficulty integrating AI with business platforms

Organizational Barrier (OB)

Organizational barriers represent internal organizational constraints that inhibit AI adoption.

Code Measurement Items

- OB1 Lack of top management support
- OB2 Low AI-related human resource competence
- OB3 Lack of AI training programs
- OB4 Employee resistance to change
- OB5 Organizational culture does not support innovation
- OB6 Limited organizational budget
- OB7 Lack of strategic vision toward AI

Environmental Barrier (EB)

Environmental barriers refer to external environmental constraints affecting AI adoption.

Code Measurement Items

- EB1 Unclear AI regulations
- EB2 Lack of government support
- EB3 Limited availability of reliable AI vendors/partners

Code Measurement Items

- EB4 Limited digital ecosystem
- EB5 High uncertainty in digital markets
- EB6 Intense competitive pressure
- EB7 Low external technological collaboration

Artificial Intelligence Adoption (AIA)

AI adoption refers to the extent to which SMEs implement AI technologies in business operations and marketing activities.

Code Measurement Items

- AIA1 Intensity of AI usage
- AIA2 Integration of AI into business processes
- AIA3 Use of AI in marketing activities
- AIA4 Use of AI for customer analytics
- AIA5 Use of AI in customer service
- AIA6 Commitment to AI investment
- AIA7 Use of AI for decision-making

Marketing Performance (MP)

Marketing performance refers to the effectiveness of marketing activities in achieving organizational objectives.

Code Measurement Items

- MP1 Sales growth
- MP2 Effectiveness of digital campaigns
- MP3 Customer loyalty
- MP4 Customer satisfaction
- MP5 New customer acquisition
- MP6 Market response speed
- MP7 Product/service innovation
- MP8 Increased market share

Data Analysis Technique

This study employed Partial Least Squares Structural Equation Modeling (PLS-SEM) using SmartPLS software for data analysis. PLS-SEM was chosen because it effectively analyzes complex relationships among latent variables and accommodates predictive-oriented research models.

The analysis procedure consisted of two stages:

Measurement Model Evaluation (Outer Model)

The outer model evaluation included:

Convergent validity using factor loadings (>0.70) and Average Variance Extracted ($AVE >0.50$), Discriminant validity using the Fornell-Larcker criterion and HTMT ratio,

Reliability using Cronbach's Alpha and Composite Reliability (>0.70).

Structural Model Evaluation (Inner Model)

The inner model evaluation included:

Coefficient of determination (R^2), Predictive relevance (Q^2), Effect size (f^2), Hypothesis testing using bootstrapping procedures, Path coefficient significance using t-statistics and p-values.

A hypothesis is accepted when: t-statistic > 1.96 , p-value < 0.05 .

Furthermore, mediation analysis was conducted to examine the indirect effects of AI adoption on the relationships between technological, organizational, and environmental barriers and marketing performance.

Participation in this study was voluntary, and respondents were informed that all information would remain confidential and used solely for academic purposes. Respondents provided informed consent before completing the questionnaire.

RESULT AND DISCUSSION

Results

Respondent Profile

This study involved 100 SMEs operating in Banyumas Regency, Indonesia. The respondents consisted of SME owners and managers who had experience using digital technologies in their business activities. The SMEs represented various sectors, including food and beverage, fashion, retail, services, and creative industries. The majority of respondents had operated their businesses for more than three years, indicating that the participating SMEs possessed sufficient operational experience to evaluate AI adoption and marketing performance.

Measurement Model Evaluation (Outer Model)

The measurement model evaluation was conducted to assess convergent validity, discriminant validity, and construct reliability.

Convergent Validity

Convergent validity was assessed using factor loadings and Average Variance Extracted (AVE). According to Hair et al. (2022), factor loadings above 0.70 and AVE values above 0.50 indicate adequate convergent validity.

The results demonstrated that all indicators had outer loading values exceeding 0.70, ranging from 0.875 to 0.967, indicating excellent convergent validity.

Specifically:

- Technological Barrier indicators ranged from 0.882 to 0.958,
- Organizational Barrier indicators ranged from 0.937 to 0.957,
- Environmental Barrier indicators ranged from 0.877 to 0.955,
- AI Adoption indicators ranged from 0.885 to 0.958,
- Marketing Performance indicators ranged from 0.875 to 0.967.

Furthermore, all AVE values exceeded the recommended threshold of 0.50:

- AI Adoption = 0.859,
- Technological Barrier = 0.860,
- Organizational Barrier = 0.897,
- Environmental Barrier = 0.880,
- Marketing Performance = 0.885.

These findings confirm that all constructs possess satisfactory convergent validity.

Discriminant Validity

Discriminant validity was assessed using cross-loading analysis and the Fornell–Larcker criterion. The results indicated that each indicator loaded more strongly on its respective construct than on other constructs, confirming adequate discriminant validity.

The HTMT values and discriminant validity matrix further demonstrated acceptable construct separation among all latent variables.

Reliability Analysis

Construct reliability was evaluated using Cronbach's Alpha and Composite Reliability (CR). Hair et al. (2022) recommend values above 0.70 to indicate acceptable reliability.

The results showed exceptionally high reliability values:

- Cronbach's Alpha ranged from 0.972 to 0.981,
- Composite Reliability ranged from 0.977 to 0.984.

These results indicate that all constructs possess excellent internal consistency reliability.

Structural Model Evaluation (Inner Model)

Coefficient of Determination (R^2)

The coefficient of determination (R^2) was used to evaluate the explanatory power of the structural model.

The results showed:

- R^2 for AI Adoption = 0.993,
- R^2 for Marketing Performance = 0.998.

These findings indicate that technological, organizational, and environmental barriers explain 99.3% of the variance in AI adoption, while AI adoption and barrier variables explain 99.8% of the variance in marketing performance. According to Hair et al. (2022), these values indicate substantial predictive accuracy.

Effect Size (f^2)

The effect size analysis revealed varying contributions of each exogenous variable to endogenous constructs. Environmental Barrier demonstrated the largest effect on Marketing Performance ($f^2 = 8.289$), followed by Technological Barrier on AI Adoption ($f^2 = 2.879$).

These findings suggest that environmental factors play a dominant role in influencing SME marketing performance within AI-driven business environments.

Hypothesis Testing

Hypothesis testing was conducted using the bootstrapping procedure. A hypothesis is accepted when the t-statistic exceeds 1.96 and the p-value is below 0.05.

Direct Effects

Technological Barrier → AI Adoption

The results revealed that Technological Barrier significantly influences AI Adoption ($\beta = 0.914$, $t = 15.531$, $p = 0.000$).

Therefore, H1 is supported.

Organizational Barrier → AI Adoption

The relationship between Organizational Barrier and AI Adoption was not statistically significant ($\beta = -0.166$, $t = 1.724$, $p = 0.085$).

Thus, H2 is not supported.

Environmental Barrier → AI Adoption

Environmental Barrier significantly influences AI Adoption ($\beta = 0.250$, $t = 2.378$, $p = 0.017$).

Accordingly, H3 is supported.

AI Adoption → Marketing Performance

AI Adoption significantly influences Marketing Performance ($\beta = -0.903$, $t = 12.825$, $p = 0.000$). Therefore, H4 is supported.

Discussion

The Influence of Technological Barrier on AI Adoption

The findings demonstrate that technological barriers significantly affect AI adoption among SMEs. This result indicates that technological conditions play a critical role in determining whether SMEs adopt AI technologies. SMEs frequently encounter difficulties related to infrastructure readiness, AI complexity, integration challenges, and implementation costs.

From the TOE perspective, technological context represents one of the most influential determinants of innovation adoption. SMEs possessing stronger technological preparedness are generally more capable of integrating AI into business operations. This finding aligns with Badghish and Soomro (2024), who argued that technological capability strongly determines AI implementation success among SMEs.

Interestingly, the positive coefficient suggests that SMEs facing technological challenges may simultaneously become more aware of the strategic importance of AI technologies, thereby increasing their motivation to adopt AI solutions.

The Influence of Organizational Barrier on AI Adoption

The results indicate that organizational barriers do not significantly influence AI adoption. This finding suggests that internal organizational limitations such as employee resistance, lack of managerial support, and insufficient AI competence may not constitute the primary determinant of AI adoption among SMEs in Banyumas.

One possible explanation is that SMEs tend to adopt AI incrementally and pragmatically without relying heavily on formal organizational structures. In many SMEs, decision-making processes are centralized within owners or managers, reducing the impact of organizational bureaucracy on technology adoption decisions.

This finding contrasts with several prior studies emphasizing the importance of organizational readiness in AI implementation. However, it also highlights the contextual uniqueness of SMEs in emerging economies where external pressures and technological necessity may outweigh internal organizational constraints.

The Influence of Environmental Barrier on AI Adoption

Environmental barriers significantly influence AI adoption among SMEs. This finding confirms the importance of external environmental conditions in shaping AI adoption decisions.

SMEs operating in uncertain digital ecosystems often depend heavily on external support such as government assistance, technological vendors, digital infrastructure, and market stability. The significant relationship indicates that environmental conditions strongly shape firms' confidence and capability to implement AI technologies.

This finding supports the TOE framework, which argues that environmental context substantially affects innovation adoption. The result also aligns with recent studies emphasizing the importance of governmental support and digital ecosystems in accelerating SME digital transformation.

The Influence of AI Adoption on Marketing Performance

AI adoption significantly influences marketing performance among SMEs. This finding demonstrates that AI technologies contribute substantially to improving sales growth, customer satisfaction, customer loyalty, digital campaign effectiveness, and market responsiveness.

AI technologies enable SMEs to analyze customer behavior more accurately, personalize marketing communication, automate customer service, and improve strategic decision-making. Consequently, SMEs implementing AI can respond more effectively to market dynamics and customer preferences.

This finding is consistent with the Resource-Based View (RBV), which suggests that technological capability constitutes a strategic organizational resource capable of generating competitive advantage and superior performance.

The result also supports previous studies by Chatterjee et al. (2024), who found that AI-driven marketing capability significantly improves organizational marketing effectiveness.

Theoretical Implications

This study contributes theoretically by extending the TOE framework through the integration of technological, organizational, and environmental barriers in explaining AI adoption among SMEs. The findings demonstrate that technological and environmental contexts remain dominant factors influencing AI adoption in emerging-market SMEs.

Additionally, this study enriches the AI adoption literature by empirically confirming the relationship between AI adoption and marketing performance within SMEs.

Practical Implications

The findings provide important managerial implications for SME owners and policymakers.

First, SMEs should strengthen technological infrastructure and improve digital capability to facilitate AI implementation. Second, policymakers should provide stronger regulatory support, AI training programs, and digital ecosystem development to accelerate SME digital transformation. Third, technology providers should develop affordable and user-friendly AI solutions tailored to SME needs. Improving AI accessibility and reducing technological complexity may substantially enhance marketing performance and competitiveness among SMEs in developing economies.

CONCLUSION

This study examined the influence of technological barriers, organizational barriers, and environmental barriers on Artificial Intelligence (AI) adoption and their implications for marketing performance among SMEs in Banyumas Regency, Indonesia. Using the Technology–Organization–Environment (TOE) framework and Partial Least Squares Structural Equation Modeling (PLS-SEM), the study provides empirical evidence regarding the role of multidimensional barriers in shaping AI-driven marketing transformation within SMEs.

The findings reveal that technological barriers significantly influence AI adoption among SMEs. This indicates that technological aspects such as infrastructure readiness, implementation costs, technological complexity, data quality, and system integration remain critical determinants of AI implementation. SMEs with stronger technological capability are more likely to adopt AI technologies effectively.

Furthermore, environmental barriers were found to significantly influence AI adoption. External environmental factors including government support, digital ecosystems, technological collaboration, and regulatory conditions play an important role in determining SMEs' readiness to implement AI technologies. This finding highlights the importance of supportive external environments in accelerating SME digital transformation.

In contrast, organizational barriers did not significantly influence AI adoption. This result suggests that SMEs in Banyumas tend to adopt AI pragmatically and flexibly, where organizational

formalities and internal structural limitations may not become dominant determinants of technology adoption decisions.

The study also confirms that AI adoption significantly influences marketing performance. AI technologies contribute to improving sales growth, customer satisfaction, customer loyalty, market responsiveness, digital campaign effectiveness, and competitive advantage among SMEs. Through AI-driven analytics and automation, SMEs can better understand customer behavior, optimize marketing strategies, and improve decision-making effectiveness.

Theoretically, this study extends the TOE framework by integrating multidimensional barriers into the AI adoption model and linking AI adoption with marketing performance outcomes. The findings enrich the literature on AI adoption within SMEs, particularly in emerging economies where empirical evidence remains limited.

Practically, the study provides important implications for SME owners, policymakers, and technology providers. SMEs should strengthen technological capability and digital readiness to facilitate AI implementation. Policymakers are encouraged to develop supportive regulations, improve digital infrastructure, and provide AI-related training programs for SMEs. Meanwhile, technology providers should design affordable and user-friendly AI solutions tailored to SME needs and capabilities.

Despite its contributions, this study has several limitations. First, the study focused only on SMEs in Banyumas Regency, limiting the generalizability of the findings to other regions or industries. Second, the cross-sectional design restricts the ability to capture long-term changes in AI adoption behavior. Future studies are recommended to employ longitudinal approaches, expand geographical coverage, and incorporate additional variables such as digital capability, innovation orientation, or competitive advantage to obtain a more comprehensive understanding of AI adoption and marketing performance.

Overall, this study demonstrates that AI adoption represents a strategic mechanism for improving SME marketing performance, while technological and environmental barriers remain critical factors influencing successful AI implementation in the digital economy.

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