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Adoption of AI Marketing Tools Among SMEs: Insights from Technology Scale Validation in Malaysia

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Abstract

(AI) has emerged as a key driver of competitiveness for small and medium-sized enterprises (SMEs). Despite the benefits of AI marketing tools, including operational efficiency, enhanced customer engagement, and improved decision-making, adoption among SMEs remains limited. This study, grounded in the Technology-Organization-Environment (TOE) framework, investigates how two technological factors, relative advantage and compatibility, influence AI marketing tool adoption among Malaysian SMEs. Data was collected from 226 SMEs and analyzed using Structural Equation Modeling (SmartPLS). The results reveal that both relative advantage ($\beta = 0.280$) and compatibility ($\beta = 0.353$) significantly affect adoption, with the model explaining 20.8% of the variance in adoption ($R^2 = 0.208$). These findings indicate that SMEs are more likely to implement AI tools when they offer clear benefits and align with existing business processes and infrastructure. The study provides practical guidance for policymakers and practitioners on designing support initiatives and implementing AI tools to enhance competitiveness. It underscores the critical role of technological fit and perceived benefits in driving AI adoption, supporting SMEs' digital transformation in the evolving digital economy.

Keywords: Relative Advantage; Compatibility; Adoption of AI Marketing Tools

1. Introduction

The Industrial Revolution has progressed through four significant stages, each profoundly influencing industries, economies, and societal structures. The initial two revolutions were marked by mechanization, mass production, and technological innovation, while the third revolution, driven by the advent of the internet, revolutionized communication, business practices, and global connectivity (Ashton et al., 1948; Mokyr, 1998; Smith, 2001). Currently, in the era of the Fourth Industrial Revolution (IR 4.0), characterized by digital transformation, automation, and the integration of intelligent technologies into business processes. At the core of this shift is Artificial Intelligence (AI), which facilitates automation, data-driven decision-making, and improved customer engagement. For small and medium-sized enterprises (SMEs), AI presents promising opportunities to enhance operational efficiency, reduce costs, and improve marketing effectiveness, thereby providing a competitive edge in the digital economy (Sohrabpour et al., 2021; Dwivedi et al., 2021).

In Malaysia, national policies emphasize digital adoption as a strategic priority to enhance productivity and bolster economic resilience. The Twelfth Malaysia Plan (RMK-12) emphasizes the importance of SMEs

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adopting digital tools, supported by initiatives such as the Malaysian Digital Catalyst Grant and the Malaysia National AI Roadmap 2021–2025, which aim to promote AI integration across various sectors (Manda & Dhaou, 2019; SME Corp, 2021). Despite these efforts, the rate of AI adoption among Malaysian SMEs remains relatively low, with only about 25–30% incorporating AI tools into their operations. Challenges such as high implementation costs, technical complexity, and limited digital expertise are key barriers (Govori et al., 2023; Rawashdeh et al., 2023). Regional comparisons indicate that Malaysian SMEs are somewhat behind their counterparts in ASEAN and East Asia, where digital maturity and AI adoption are advancing more rapidly, emphasizing the need for targeted support (Bernama, 2024; ISIS, 2021).

A crucial factor shaping AI adoption is how SMEs perceive its relative advantage and compatibility with their existing systems. While AI has the potential to improve business outcomes, many SMEs view it as costly, technically demanding, and challenging to integrate with existing technology and workforce skills (Ab Rani, 2019; Kant & Johannsen, 2022). Infrastructure issues, system integration challenges, and workforce readiness are particularly acute among rural SMEs (Lu et al., 2022; NST, 2024). Although policy initiatives and scholarly research are increasingly focusing on digital transformation, there is limited empirical evidence on how technological factors, such as perceived advantage and compatibility, influence AI marketing adoption among Malaysian SMEs. Specifically, few studies have employed validated technology adoption scales and sophisticated statistical methods, such as PLS-SEM, to better understand SMEs' adoption behaviors in this context.

This study aims to fill these gaps by exploring the technological factors that influence the adoption of AI marketing tools among Malaysian SMEs, with a particular focus on perceived relative advantage and compatibility. By offering empirical insights and practical recommendations, the research seeks to contribute to academic understanding and inform policy efforts, ultimately supporting SMEs in their digital transformation, enhancing competitiveness, and integrating more effectively into IR 4. 0.

2. Literature Review

2.1. Relative Advantage

Relative advantage refers to the extent to which an innovation is regarded as superior to the idea or technology it replaces (Rogers, 2003; Rogers & Williams, 1983). It is seen as a key factor influencing the adoption of technology, as organizations tend to implement innovations when the anticipated performance improvements are clear and meaningful (Baker, 2012; Nimfa et al., 2020; Shahzad et al., 2023). In the realm of Artificial Intelligence (AI) for marketing, relative advantage includes better operational efficiency, cost savings, faster and more precise decision-making, enhanced customer engagement, and advanced predictive capabilities (Press, 2016; Mikalef et al., 2021). Empirical research generally indicates a positive relationship between relative advantages and the likelihood of adopting new technologies, suggesting that firms perceiving greater benefits are more likely to embrace innovations (Lin et al., 2011; Ramdani et al., 2020; Grandon, 2004). For small and medium-sized enterprises (SMEs), these benefits are particularly compelling, as limited resources make efficient tools vital for gaining a competitive edge (Asetoohy et al., 2019; Ezzaouia et al., 2020; Wong et al., 2020).

In the context of AI marketing, this can mean improved customer segmentation, personalized marketing campaigns, and more effective digital engagement strategies, all of which can positively impact firm performance (Pillai et al., 2020; Chen, 2021; Huang et al., 2021). Nonetheless, the literature also points to some inconsistencies. While many studies highlight strong positive effects of relative advantage on AI adoption, others suggest that small firms might overestimate benefits or struggle to measure outcomes, potentially dampening their motivation to adopt (Alsheibani et al., 2018; 2020). Moreover, differences in

research methods, such as cross-sectional surveys versus longitudinal studies, limit the ability to generalize findings across different sectors and regions. These gaps underline the importance of further empirical validation of the role of relative advantage specifically within AI marketing tools, as the performance benefits may vary from those of more general AI applications.

H1: Relative Advantage (RA) is significant relationship to the adoption of AI marketing tools among SMEs.

2.2. Compatibility

Compatibility refers to the extent to which an innovation aligns with an organization's existing values, culture, processes, and technological infrastructure (Rogers, 2003; Bhattacherjee & Lin, 2015). It is a crucial factor in technology adoption because innovations that integrate smoothly into current workflows are generally viewed as easier to implement and less likely to cause disruptions (Gibbs et al., 2007; Chatterjee et al., 2021; Katebi et al., 2022). In the realm of AI marketing, compatibility refers to the extent to which AI systems align with current marketing strategies, customer relationship management tools, digital platforms, and staff skills (Li et al., 2017; Tajudeen et al., 2020)

H2: Compatibility (COMP) has a significant relationship with the adoption of AI marketing tools among SMEs.

2.3. Adoption of AI Marketing Tools

Adopting Artificial Intelligence (AI) in marketing offers SMEs significant advantages, including enhanced decision-making, customer engagement, operational efficiency, and competitive positioning. AI enables real-time analytics, personalised offerings, and predictive insights that improve market responsiveness (Mikalef et al., 2021; Canhoto & Clear, 2020). Tools such as chatbots and automated customer journey mapping strengthen engagement and loyalty (Rawashdeh et al., 2023; Alsheibani et al., 2020), while automation reduces the burden of manual marketing tasks for resource-constrained firms (Hansen & Bøgh, 2021). Moreover, AI supports consistent branding and empowers SMEs to compete with larger firms through scalable personalisation and agility (Black & van Esch, 2020; OECD, 2021). However, successful adoption requires digital readiness, strategic alignment, and leadership commitment, as AI integration represents a technological upgrade and an organizational transformation (Kurniawanti et al., 2023; Harvard Business Review, 2023).

2.4 Conceptual Framework

Malaysia offers a compelling context for examining AI adoption among SMEs, as the nation has actively advanced digital transformation to strengthen competitiveness. With rising investments in technological infrastructure and increasing digital literacy, SMEs are encouraged to adopt AI-driven solutions to enhance efficiency and sustain growth in a competitive market environment. This study using a conceptual framework grounded in the Technology–Organization–Environment (TOE) perspective, emphasizing two technological factors, relative advantage and compatibility, as key drivers of adoption.

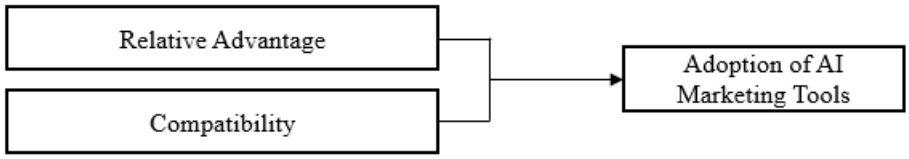

Fig 1: Conceptual Framework

3. Methodology

This study employed a quantitative, cross-sectional survey design to examine the factors influencing the adoption of AI marketing tools among SMEs in Malaysia. Data was collected from 226 respondents, primarily from top management and marketing departments, using a structured questionnaire adapted from validated instruments in prior research. A stratified random sampling method was used to ensure representation across SME sectors. Specifically, SMEs were first categorized by industry type (retail), and random samples were drawn proportionally from each state's stratum to reflect relative population sizes. In cases where sectoral participation was unequal, weighting adjustments were applied during analysis to mitigate over- or under-representation. Responses were gathered through a combination of online and offline distribution channels to maximize coverage.

All constructs were measured using multi-item Likert scales, and data analysis was conducted using Partial Least Squares Structural Equation Modeling (PLS-SEM) via SmartPLS. This approach is suitable for predictive research models that involve complex relationships and medium-sized samples. The analysis followed a two-step procedure: (1) assessment of the measurement model to evaluate reliability and validity, and (2) evaluation of the structural model to examine path coefficients, significance levels, and explanatory power.

4. Result

4.1 Descriptive Statistics

The study involved 226 SME respondents, with a nearly equal gender distribution between males (50.9%) and females (49.1%). Most participants were aged between 29 and 34 years old (36.7%) and 23 and 28 years old (36.3%). The largest educational group held a degree (30.1%), followed by those with master's qualifications (23.5%). Regarding job position, the majority were managers (40.7%), with executives making up 31.4%. Work experience was concentrated in the 1–10 years category (50.9%), and most firms were based in Selangor (19.9%), Johor (13.3%), and Melaka (14.6%). The largest share of firms employed 21–30 workers (35%), while almost all reported revenues between RM300,000 and less than RM3 million (93.8%). Retail sectors were led by fashion and apparel (30.1%) and food and beverage (28.3%). Regarding AI marketing tools, ChatGPT (60.2%) was the most widely used, followed by Canva (15%).

4.2 Measurement Model Assessment

Table 1: Measurement Model Assessment: Convergent Validity and Internal Consistency Reliability

Variable	Indicators	Factor Loadings	AVE	Composite Reliability (ρc)	Reliability ρA (rho_A)	Cronbach's Alpha
Relative Advantage (RA)	RA1	0.880	0.745	0.936	0.923	0.915
	RA2	0.875				
	RA3	0.882				

	RA4	0.856				
	RA5	0.822				
Compatibility (COMP)	COMP1	0.898	0.822	0.949	0.93	0.928
	COMP2	0.908				
	COMP3	0.917				
	COMP4	0.903				
Adoption of AI Marketing Tools (AAI)	AAI1	0.905	0.824	0.949	0.929	0.929
	AAI2	0.903				
	AAI3	0.904				
	AAI4	0.919				

The measurement model demonstrates excellent reliability and validity across all constructs. Relative Advantage (RA) has factor loadings ranging from 0.822 to 0.882, with an Average Variance Extracted (AVE) of 0.745, Composite Reliability (ρc) of 0.936, reliability rho_A of 0.923, and Cronbach's Alpha of 0.915. These results indicate that the indicators reliably capture the underlying construct of RA, and convergent validity is achieved. Compatibility (COMP) also shows strong measurement properties, with factor loadings between 0.898 and 0.917, an AVE of 0.822, ρc of 0.949, rho_A of 0.930, and Cronbach's Alpha of 0.928, suggesting a high degree of internal consistency and construct reliability. Similarly, Adoption of AI Marketing Tools (AAI) exhibits factor loadings from 0.903 to 0.919, an AVE of 0.824, ρc of 0.949, rho_A of 0.929, and Cronbach's Alpha of 0.929, confirming that the indicators effectively measure the construct. Overall, the results indicate that the measurement model is robust, with all constructs demonstrating strong convergent validity and internal consistency, supporting the reliability of subsequent structural model analysis.

4.3 Measurement Model Evaluation

Table 2: HTMT Discriminant Validity Analysis Result

Construct	AAI	COMP	RA
AAI	0.908		
COMP	0.36	0.906	
RA	0.288	0.025	0.863

The HTMT (Heterotrait–Monotrait) ratio of correlations was used to assess discriminant validity among the constructs. The HTMT values between constructs (AAI–COMP = 0.36, AAI–RA = 0.288, COMP–RA = 0.025) are all well below the conservative threshold of 0.90 (Henseler et al., 2015), indicating satisfactory discriminant validity. This confirms that each construct adoption of AI marketing tools (AAI), compatibility (COMP), and relative advantage (RA) is conceptually distinct and captures unique aspects of the model, ensuring that the measurement items reliably differentiate between the constructs. Consequently, the structural model can be interpreted with confidence, as multicollinearity between latent constructs is not a concern.

4.4 Model Performance Fits Evaluation

Table 3: Effect Size (f^2) Evaluation

Construct	f^2	Standard Error	t-value	p-value	Effect Size
RA → AAI	0.099	0.055	5.085	0.000	Small
COMP → AAI	0.158	0.059	5.996	0.000	Medium

The analysis of effect sizes (f^2) assesses the impact of each independent variable on the adoption of AI marketing tools (AAI) among Malaysian SMEs. Relative advantage (RA) exhibits a small effect ($f^2 = 0.099$, $t = 5.085$, $p < 0.001$), indicating that perceived benefits, such as operational efficiency and improved customer targeting, significantly influence adoption, although their overall contribution to explaining AAI variance is limited. Conversely, compatibility (COMP) demonstrates a medium effect ($f^2 = 0.158$, $t = 5.996$, $p < 0.001$), indicating that ensuring AI tools align with existing processes, systems, and business practices has a more pronounced impact on adoption decisions. Overall, these results emphasize that both perceived benefits and organizational compatibility are crucial, with compatibility having a stronger effect on SMEs' decisions to adopt AI marketing tools.

4.5 PLS SEM Prediction

Table 4: Predictive Relevance for the Endogenous Variable (Q^2)

Construct	Q^2predict	RMSE	MAE
AAI	0.187	0.91	0.737

The Q^2 predictive relevance analysis evaluates the model's ability to forecast the adoption of AI marketing tools (AAI) among Malaysian SMEs. A Q^2predict value of 0.187 indicates moderate predictive ability, implying the model has sufficient capacity to predict AAI outcomes. The prediction errors, with an RMSE of 0.91 and an MAE of 0.737, indicate that the model's predictions are reasonably close to the actual observations. Overall, these findings demonstrate that the structural model not only explains the variation in AI adoption but also provides valuable predictive insights, confirming its usefulness in understanding SMEs' adoption patterns

4.6 Path Analysis (Factors to Adoption of AI Marketing Tools

Table 5: Path Coefficient

Path	Coefficient (β)	SE	t	p	2.50%	97.50%
RA → AAI	0.280	0.055	5.996	<.001	0.177	0.393
COMP → AAI	0.353	0.059	5.085	<.001	0.237	0.467

**Remarks: RA: Relative Advantage, COMP: Compatibility*

	R-square
AAI (Adoption of AI Marketing Tools)	0.208

Table 4 shows that both Relative Advantage ($\beta = 0.280$, $t = 5.996$, $p < 0.001$) and Compatibility ($\beta = 0.353$, $t = 5.085$, $p < 0.001$) have a significant and positive effect on SMEs in Malaysia adopting AI marketing tools (AAI). This means SMEs are more likely to adopt AI when they see clear benefits, such as increased efficiency, cost reductions, or a competitive edge, and when the technology aligns with their existing systems, processes, and culture. The model's R^2 of 0.208 suggests that Relative Advantage and Compatibility together explain about 20.8% of the variation in AI marketing tool adoption among SMEs, indicating a low-to-

moderate explanatory power. For emerging technologies and SMEs, these values are meaningful because adoption is influenced by various organizational, environmental, and personal factors beyond technology alone (Hair et al., 2019; Dwivedi et al., 2021). While this emphasizes the importance of technological perceptions in decision-making, it also underscores the need to consider other organizational and environmental factors for a more comprehensive understanding of AI adoption in SMEs.

5. Discussion

The findings show that Relative Advantage (RA) significantly influences the adoption of AI marketing tools among Malaysian SMEs, supporting H1. SMEs that view AI as offering clear benefits, such as cost savings, increased efficiency, improved customer targeting, and more informed decision-making, tend to be more inclined to adopt these tools. This aligns with earlier research emphasizing the role of technological superiority in adoption (Nguyen et al., 2022; Shahzad et al., 2023). However, the impact of relative advantage was moderate ($R^2 = 0.208$), suggesting that perceived benefits alone are not enough. This reflects Malaysia's specific context, where SMEs often face financial limits, limited digital skills, and infrastructure challenges, which may weaken RA's influence compared to more resource-rich environments (Govori et al., 2023; Lu et al., 2022).

These results extend the Technology–Organization–Environment (TOE) framework by demonstrating that, for Malaysian SMEs, the technological aspect interacts with organizational and environmental factors, underscoring the need for multifaceted strategies that encompass not only benefits but also their implications. Compatibility (COMP) also significantly affects AI adoption, supporting H2, by emphasizing the importance of aligning new technologies with existing processes, structures, and culture. When AI is perceived as compatible, integration is easier, resistance decreases, and adoption becomes more achievable. This supports prior studies on the role of compatibility in innovation adoption (Badghish et al., 2024; Chong & Lim, 2022). Interestingly, the influence of compatibility was slightly stronger than that of relative advantage, suggesting that SMEs may prioritize ease of integration and process alignment over perceived benefits during the early stages of AI adoption. This detail highlights the practical challenges faced by SMEs, including legacy systems, limited technical skills, and workforce readiness issues. From a theoretical standpoint, it reinforces the technological component of the TOE framework, suggesting that compatibility may be a prerequisite for realizing the benefits of AI.

Implication for Research

These findings contribute to the literature by empirically validating the TOE framework in the Malaysian SME context, with a focus on AI marketing tools. They demonstrate that technological factors alone provide only moderate explanatory power, suggesting that future research should integrate organizational and environmental constructs, such as top management support, organizational readiness, competitive pressure, and government support, to capture a more comprehensive picture of adoption behavior. Additionally, the moderate effect of RA compared to COMP suggests that contextual factors moderate the strength of technological determinants, warranting further investigation.

For practitioners, the results suggest that SMEs should focus not only on recognizing the benefits of AI but also on ensuring that AI tools are compatible with existing processes and workforce capabilities. Policymakers and support agencies can facilitate adoption by providing training, technical assistance, and guidelines that emphasize both the value and integrability of AI solutions. By doing so, SMEs can more effectively leverage AI to enhance competitiveness, operational efficiency, and long-term growth

6. Conclusion

This study enhances understanding of AI marketing tool adoption among Malaysian SMEs by identifying relative advantage and compatibility as key technological drivers influencing adoption decisions. SMEs are more inclined to adopt AI when they see clear benefits, such as improved operational efficiency, cost reductions, and better customer targeting, especially when these technologies integrate smoothly with existing systems and organizational culture. By empirically confirming these relationships, the study contributes to the TOE framework, showing that the technological aspect effectively explains adoption behaviors in resource-limited SMEs within emerging economies.

However, the study has notable limitations. It primarily emphasizes the technological dimension of the TOE model, without exploring organizational factors (top management support and organizational readiness) or environmental influences (such as competitive pressure and government support), which may also impact adoption. Additionally, the reliance on self-reported data may introduce response bias. The cross-sectional design limits the ability to draw causal conclusions about adoption over time. Furthermore, the findings may not generalize well beyond Malaysia due to differences in policies, digital infrastructure, and SME characteristics in other countries.

Future research should address these limitations by adopting more comprehensive models that incorporate organizational and environmental factors from the TOE framework. Researchers may also investigate moderating variables, such as firm size, digital preparedness, and leadership support, to determine how these factors affect adoption. Longitudinal or mixed-method studies could better capture how adoption evolves and provide deeper insights into decision-making processes. Comparative research across ASEAN nations or other emerging markets could also clarify the contextual influences on AI adoption.

Practically, these findings offer valuable guidance for policymakers, industry groups, and SME leaders. Policymakers should promote Malaysia's National AI Roadmap 2021–2025 through targeted incentives, grants, and sector-specific digital training. Industry associations can foster knowledge sharing through mentorship programs, best-practice case studies, and collaborative platforms to demonstrate the business benefits of AI. SME leaders should align AI initiatives with strategic goals, cultivate an innovative-friendly culture, and invest in digital skills development to support sustainable digital transformation.

In summary, this study offers both theoretical and practical insights into how perceptions of technology influence the adoption of AI marketing tools among Malaysian SMEs. Focusing on relative advantage and compatibility, while addressing organizational and environmental challenges, can help SMEs boost competitiveness and drive Malaysia's digital transformation. Future efforts combining supportive policies, accessible technologies, and organizational readiness will be vital for Malaysian SMEs to fully leverage AI opportunities in the digital era economy.

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