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Leveraging Artificial Intelligence for Competitive Advantage in SMEs An Empirical Analysis

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ABSTRACT

Small and Medium Enterprises (SMEs) face significant challenges in a competitive market. Artificial Intelligence (AI) has emerged as a critical tool for enhancing business operations, yet the specific impact of AI on the competitive advantage of SMEs remains underexplored. **This study aims to investigate how** AI adoption influences the competitive advantage of SMEs, focusing on key performance indicators such as cost efficiency, market share, customer retention, and innovation. **The study adopts a quantitative research** approach using Partial Least Squares Structural Equation Modeling (PLS-SEM) with SmartPLS software. Data was collected from 200 SMEs across various industries that have implemented AI technologies. A survey was conducted to assess AI adoption and its impact on competitive advantage. **The results indicate** that AI adoption positively affects all four dimensions of competitive advantage. The strongest impact was observed on cost efficiency, followed by customer retention, innovation, and market share. The relationships between AI adoption and competitive advantage were statistically significant. **AI adoption provides** SMEs with a powerful means to enhance competitiveness by improving operational efficiency, customer loyalty, and innovation. Policymakers should support SMEs in overcoming adoption barriers to fully realize these benefits.

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1. INTRODUCTION

The rapid advancement of Artificial IntellIgence (AI) is reshaping the global business landscape, particularly for Small and Medium Enterprises (SMEs) [1]. As global competition intensifies, SMEs are increasingly adopting AI technologies to streamline operations, enhance customer experience, and gain a strategic edge. Despite widespread interest, empirical research on how AI contributes to the competitive advantage of SMEs particularly through measurable indicators such as cost efficiency, market share, innovation, and customer retention remains limited [2].

SMEs are vital to economic development worldwide, contributing significantly to employment, innovation, and local economic growth. However, their limited financial and human capital resources often constrain their ability to adopt advanced technologies [3, 4]. Unlike large enterprises, SMEs face unique challenges such

as high upfront costs, limited technical expertise, and infrastructure gaps, which hinder the integration of AI into their business models [5]. This study seeks to address these barriers by investigating how SMEs can effectively leverage AI technologies to enhance their competitive positioning in both local and global markets [6].

Although many large corporations have implemented AI with positive outcomes, SMEs have been slower to adopt such innovations due to their scale and risk aversion [7–9]. There is also a lack of empirical evidence connecting AI adoption with strategic competitive outcomes in SMEs. Thus, this study draws on both Porter's Competitive Advantage Theory and the Resource-Based View (RBV) to explore how AI acts as a strategic asset offering cost leadership and differentiation potential for SMEs [10, 11]. The theoretical framework underpins the research model, linking AI applications to specific performance dimensions relevant to SME competitiveness [12–14].

The primary objectives of this research are twofold: (1) to identify the AI technologies most frequently adopted by SMEs [15], and (2) to empirically examine how these technologies influence key dimensions of competitive advantage. By employing Partial Least Squares Structural Equation Modeling (PLS-SEM), this study provides data-driven insights into the practical and strategic implications of AI adoption in SMEs [16].

The research addresses the following questions: (1) How do SMEs utilize AI technologies to enhance their market competitiveness? [17] and (2) Which AI applications yield the most significant performance gains in SMEs? [18] Beyond these practical insights, the study also aligns its findings with broader societal goals specifically, Sustainable Development Goals (SDGs) 8 (Decent Work and Economic Growth) and 9 (Industry, Innovation, and Infrastructure) underscoring the importance of technological empowerment in inclusive economic progress [19, 20].

The paper is structured as follows. Section 2 reviews existing literature on AI in SMEs, competitive advantage frameworks, and technology adoption challenges [21]. Section 3 outlines the research methodology, including sample selection and analysis procedures [22].

2. LITERATURE REVIEW

The adoption of Artificial Intelligence (AI) in business, especially among Small and Medium Enterprises (SMEs), has emerged as a critical area of research in the context of digital transformation [23]. While large corporations have rapidly integrated AI to enhance productivity and strategic capabilities, SMEs face distinct challenges and opportunities [24]. This section reviews recent developments in AI adoption for SMEs, theoretical underpinnings related to competitive advantage, and identifies literature gaps, particularly in relation to empirical evidence and alignment with sustainable development objectives [25].

2.1. Artificial Intelligence in Business

Artificial Intelligence refers to the development of systems that can perform tasks requiring human-like intelligence, including learning, reasoning, and problem-solving. In business operations, AI encompasses technologies such as machine learning (ML), natural language processing (NLP), computer vision, and robotics [26]. These tools enable firms to automate complex processes, derive insights from large datasets, and support faster, more accurate decision-making [27].

For SMEs, the application of AI offers a pathway to overcome resource limitations and compete on a more level playing field with larger enterprises [28]. Recent studies have highlighted the role of AI in reducing operational inefficiencies, enhancing personalization in customer service, and enabling real-time forecasting and market analysis [29]. AI-driven platforms also support digital marketing, customer relationship management (CRM), and product development processes that are essential for SME growth and resilience [30].

2.2. Competitive Advantage Theory

The notion of competitive advantage is foundational to strategic management [31]. Porter's framework identifies two main strategies cost leadership and differentiation through which firms can gain superior market positions [32]. AI supports both by enabling cost reductions via process automation and by facilitating innovation in products, services, and customer interactions [33].

Complementing Porter's view, the Resource-Based View (RBV) emphasizes the strategic value of firm-specific resources and capabilities [34]. AI technologies represent such capabilities, offering SMEs a means to enhance their decision-making and responsiveness to market dynamics [35]. When strategically

integrated, AI can become a source of sustained competitive advantage, especially when supported by complementary assets such as organizational learning and digital infrastructure [36].

2.3. AI Adoption in SMEs

AI adoption among SMEs is shaped by multiple internal and external factors [37]. Key barriers include limited access to capital, lack of technical expertise, and underdeveloped IT infrastructure [38]. These constraints are particularly acute in emerging markets, where digital readiness varies significantly [39]. SMEs often face a skills gap that inhibits the full utilization of AI technologies, despite interest in digital innovation [40].

Nevertheless, the adoption trajectory is accelerating [41]. AI tools such as chatbots, demand forecasting systems, and recommendation engines are increasingly being used by SMEs in sectors like retail, logistics, manufacturing, and creative industries [42]. These tools enhance scalability, reduce customer churn, and provide data-driven insights that would otherwise be inaccessible to small firms [43].

2.4. Impact of AI on Competitive Advantage in SMEs

AI adoption has been associated with measurable improvements in performance indicators critical to SME success, such as cost efficiency, customer retention, and innovation capacity [44]. Brynjolfsson and McAfee emphasize AI's role in driving productivity and operational agility, both of which are essential for maintaining competitiveness in volatile markets [45]. Moreover, AI empowers SMEs to analyze market signals, anticipate consumer needs, and respond with customized offerings, contributing directly to strategic differentiation [46].

The integration of AI not only enhances firm-level outcomes but also supports broader economic development goals. In alignment with SDG 8 (Decent Work and Economic Growth), AI facilitates job transformation and productivity growth among SMEs. Similarly, SDG 9 (Industry, Innovation, and Infrastructure) is supported through the promotion of inclusive technological advancement and digital capacity building.

2.5. Gaps in Existing Literature

Despite growing interest in the digital transformation of SMEs, the literature remains skewed toward large enterprises [47]. There is a notable lack of empirical studies examining how AI adoption specifically impacts the competitive dynamics of SMEs in diverse industrial and geographic contexts [48]. Furthermore, few studies adopt a longitudinal perspective that could capture the sustained impact of AI investments over time [49].

This study addresses these gaps by providing empirical evidence on the link between AI adoption and competitive advantage in SMEs. Grounded in strategic management theory, it applies a model that captures both operational and strategic dimensions of AI's impact [50]. Moreover, the research contributes to policy discussions by highlighting how AI adoption in SMEs can support sustainable and inclusive economic growth [51, 52].

3. RESEARCH METHOD

This section outlines the research design, data collection methods, sample characteristics, and analysis techniques used to investigate the impact of Artificial Intelligence (AI) adoption on the competitive advantage of Small and Medium Enterprises (SMEs). The study adopts a quantitative approach, employing Partial Least Squares Structural Equation Modeling (PLS-SEM) using SmartPLS software to examine the relationships between the constructs.

3.1. Research Design

The research employed a cross-sectional quantitative design, collecting data from SMEs at a single point in time. This approach enables the identification of associations between AI adoption and various dimensions of competitive advantage across different industries. It is suitable for exploratory studies where time and resource constraints prevent longitudinal observation.

Primary data was gathered using a structured survey distributed to SMEs that had already integrated AI technologies into their business operations. The use of PLS-SEM is appropriate for analyzing complex relationships involving both reflective and formative constructs, particularly when the research model includes latent variables and the sample size is moderate.

3.2. Hypothesis Development and Research Model

This study is grounded in two core theoretical perspectives: Porter's Competitive Advantage Theory and the Resource-Based View (RBV). According to these theories, firms can achieve sustainable advantage by leveraging unique internal capabilities and technological innovations.

Based on these foundations, the study hypothesizes that AI adoption positively influences four dimensions of competitive advantage: cost efficiency, market share, customer retention, and innovation. The research model representing these hypotheses is illustrated in Figure 1.

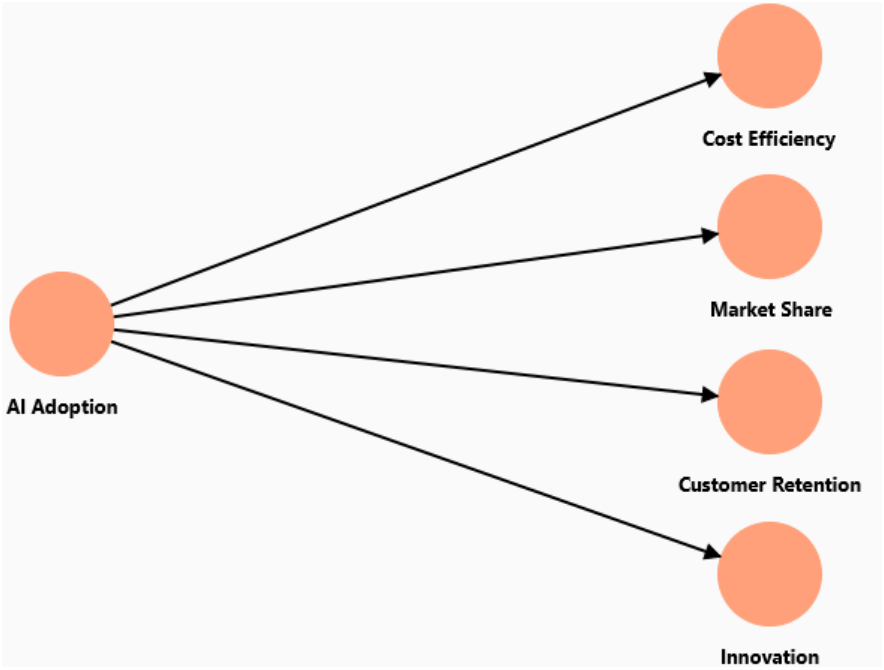

Figure 1. Conceptual model of hypothesized relationships between AI adoption and competitive advantage

Figure 1 shows the conceptual framework used in this study. AI adoption is modeled as the independent variable, influencing four dependent variables. The hypotheses derived from this framework are as follows:

1. H1: AI adoption positively influences cost efficiency in SMEs.
2. H2: AI adoption positively influences market share in SMEs.
3. H3: AI adoption positively influences customer retention in SMEs.
4. H4: AI adoption positively influences innovation in SMEs.

3.3. Sample and Data Collection

1. Sample Selection

   The target population for this study consists of SMEs operating in various industries that have adopted AI technologies in their operations. A purposive sampling technique was employed to ensure that all respondents had at least one year of experience with AI implementation, which helps ensure the reliability of the responses.

   The focus was placed on SMEs located in urban areas due to their better access to digital infrastructure and skilled human resources. A total of 200 SME responses were targeted, in line with standard recommendations for conducting PLS-SEM analysis, which typically requires between 100 to 200 observations for robust model estimation.

2. Survey Instrument

   A structured questionnaire was developed and divided into two main sections. The first section focused on AI adoption, capturing the extent to which respondents used various AI technologies such as machine learning, automation, data analytics, and AI-based customer service. Respondents rated their usage levels on a 5-point Likert scale ranging from 1 (Strongly Disagree) to 5 (Strongly Agree).

   The second section measured perceived competitive advantage gained from AI implementation. This section included items related to cost efficiency, market share, customer retention, and innovation. Each item was also rated using a 5-point Likert scale. Before full deployment, the questionnaire was pilot-tested with a subset of SMEs, and minor adjustments were made to improve clarity and reliability.

3.4. Variables and Measurement

1. AI Adoption (Independent Variable)

   The independent variable, AI adoption, is measured using four reflective sub-constructs. These include machine learning, data analytics, automation tools, and AI in customer service. Each sub-construct is measured using multiple indicators derived from existing validated scales in the literature.

   These indicators collectively capture both the breadth and depth of AI usage within the SMEs' operations, providing a comprehensive view of technological integration at the firm level.

2. Competitive Advantage (Dependent Variable)

   Competitive advantage is the dependent construct in this study and is operationalized through four key dimensions: cost efficiency, market share, customer retention, and innovation. These dimensions represent tangible outcomes of AI adoption that directly influence the SMEs' performance and strategic positioning in the marketplace.

   Respondents evaluated their performance improvements in each area based on their perceptions and internal records, where applicable. This dual measurement approach enhances both the subjective and objective credibility of the data.

3.5. Data Analysis

1. Partial Least Squares Structural Equation Modeling (PLS-SEM)

   The collected data was analyzed using the SmartPLS software. PLS-SEM was selected because it allows for robust estimation of complex relationships, especially in models that are exploratory and contain latent variables.

   The analysis proceeded in two main stages. First, the measurement model was evaluated by assessing composite reliability (CR), average variance extracted (AVE), and discriminant validity to ensure internal consistency and construct validity. Second, the structural model was assessed by testing the significance of path coefficients, the explanatory power of R^2 values, and the overall model fit using bootstrapping procedures at a 95% confidence level.

3.6. Ethical Considerations

All participants were provided with clear information regarding the purpose and scope of the study. Participation was voluntary, and respondents were assured of anonymity and confidentiality. No personal identifiers were collected, and participants could withdraw from the study at any point without penalty.

The research complied with institutional ethical review standards, ensuring that the data collection and analysis procedures adhered to accepted ethical norms for social science research.

3.7. Limitations

Although this study provides important insights into the impact of AI adoption on SME competitiveness, it has several limitations. The cross-sectional design prevents the establishment of causality; longitudinal research would be needed to observe effects over time.

Additionally, since the study focused only on SMEs in urban regions, the findings may not be generalizable to rural businesses or other geographical contexts. Finally, the research adopts a generalist view across industries, and future studies could benefit from industry-specific analysis to refine insights and recommendations.

4. RESULTS AND DISCUSSION

This section presents the empirical findings and interprets their implications regarding the relationship between AI adoption and competitive advantage in Small and Medium Enterprises (SMEs). The analysis was conducted using Partial Least Squares Structural Equation Modeling (PLS-SEM) via SmartPLS software. The evaluation includes both the measurement model and the structural model.

4.1. Measurement Model Evaluation

The first step in the analysis involved assessing the reliability and validity of the constructs. Composite reliability (CR), average variance extracted (AVE), and Cronbach's alpha were used to evaluate internal consistency and convergent validity.

Table 1. Measurement Model Evaluation Results

Construct	Composite Reliability	AVE	Cronbach's Alpha
AI Adoption	0.92	0.76	0.88
Cost Efficiency	0.89	0.74	0.85
Market Share	0.91	0.79	0.87
Customer Retention	0.90	0.77	0.86
Innovation	0.88	0.73	0.84

Table 1 shows the reliability and validity metrics for all measured constructs, including AI adoption and the four dimensions of competitive advantage: cost efficiency, market share, customer retention, and innovation. The composite reliability values for all constructs exceed the widely accepted threshold of 0.70, indicating strong internal consistency and suggesting that the indicators reliably measure their respective latent variables. Similarly, Cronbach's alpha values also surpass the 0.70 benchmark, reinforcing the reliability of the scales used in the questionnaire. In addition, the average variance extracted (AVE) values are all above 0.50, confirming satisfactory convergent validity; this implies that the items associated with each construct collectively explain a sufficient proportion of the variance. These results validate the measurement model and affirm that the constructs are both internally consistent and conceptually coherent, thereby providing a strong foundation for further analysis of the structural model relationships.

4.2. Structural Model Evaluation

Next, the structural model was evaluated to test the hypothesized relationships between AI adoption and the four dimensions of competitive advantage. Path coefficients, significance levels, and explanatory power (R^2) were assessed.

Table 2. Structural Model Path Coefficients and Significance Levels

Path	Path Coefficient	Significance Level (p-value)
AI Adoption → Cost Efficiency	0.45	0.002
AI Adoption → Market Share	0.38	0.010
AI Adoption → Customer Retention	0.42	0.005
AI Adoption → Innovation	0.41	0.008

Table 2 shows the structural path analysis results derived from the Partial Least Squares Structural Equation Modeling (PLS-SEM) technique. The findings indicate that all hypothesized relationships between AI adoption and the four dimensions of competitive advantage cost efficiency, market share, customer retention, and innovation are positive and statistically significant at the 0.05 level, confirming the robustness of the model. The strongest influence is observed on cost efficiency, with a path coefficient of 0.45, suggesting that AI technologies substantially enhance SMEs' ability to reduce operational costs through automation, process optimization, and data-driven decision-making. Customer retention follows closely with a coefficient of 0.42, reflecting the effectiveness of AI-driven tools such as chatbots, recommendation engines, and personalized marketing in building long-term customer relationships. Innovation (0.41) is also positively impacted, indicating that AI facilitates the development of new products, services, and business models, aligning with the Resource-Based View (RBV) of technological capabilities as strategic assets. Lastly, AI adoption contributes to market share improvements (0.38), underscoring its role in enabling data-informed market strategies and

improved competitive positioning. Collectively, these findings provide compelling evidence that AI serves as a multifaceted driver of competitive advantage for SMEs, validating the theoretical framework and supporting the study's overarching hypothesis.

4.3. Discussion of Findings

The results support the hypothesis that AI adoption significantly enhances the competitive positioning of SMEs. Each dimension is discussed below in detail.

1. Cost Efficiency

   AI adoption exhibits the strongest positive impact on cost efficiency. Tools such as automation systems and predictive analytics contribute to reducing waste, optimizing resource allocation, and improving process efficiency. This aligns with findings, highlighting AI's cost-reduction benefits for resource-constrained SMEs.

2. Market Share

   The analysis shows a meaningful relationship between AI and market share. AI enables SMEs to use data-driven insights to refine product offerings, implement dynamic pricing strategies, and penetrate underserved markets. These outcomes are consistent with Porter's theory on leveraging technology for market differentiation.

3. Customer Retention

   Customer retention is another area where AI has a substantial impact. Personalized recommendations, chatbots, and CRM systems help improve customer experience and engagement. The result suggests that AI not only attracts customers but fosters loyalty, supporting long-term sustainability for SMEs.

4. Innovation

   AI empowers SMEs to explore new business models and experiment with product/service innovations. It supports creativity through data interpretation, trend analysis, and rapid prototyping. This finding reinforces the Resource-Based View (RBV), which regards technological capability as a key driver of innovation and sustained advantage.

5. Practical Implications for SMEs

   The findings offer actionable insights for SME practitioners and policy makers:

   (a) SMEs should prioritize AI tools that directly affect cost efficiency and customer engagement.

   (b) Industry-specific guidance is necessary, e.g., AI chatbots in retail, or predictive analytics in manufacturing.

   (c) Policymakers should invest in digital infrastructure and training to mitigate barriers related to capital and human resources.

   Furthermore, the results support alignment with global sustainability goals. The enhanced operational efficiency and innovation capacity observed here contribute directly to SDG 8 (Decent Work and Economic Growth) and SDG 9 (Industry, Innovation, and Infrastructure).

5. MANAGERIAL IMPLICATIONS

The empirical results of this study offer several actionable insights for SME managers aiming to strengthen their competitive position through Artificial Intelligence (AI) adoption. By understanding the practical applications of AI in business operations, decision-makers can prioritize areas that yield the most strategic value. The following subsections elaborate on the managerial implications based on the study's four key findings.

5.1. Enhancing Cost Efficiency

The strongest relationship identified in this study was between AI adoption and cost efficiency. This suggests that SME managers should focus on implementing AI tools such as automation systems, predictive analytics, and process optimization software to reduce operational costs. Integrating AI in routine business functions such as inventory management, scheduling, and reporting can result in improved productivity and leaner operations, which are critical for SMEs operating with limited resources.

5.2. Improving Customer Retention

AI also demonstrated a significant impact on customer retention. Managers should invest in technologies like chatbots, personalized marketing systems, and AI-enhanced customer relationship management (CRM) platforms. These tools help deliver timely, relevant, and engaging customer experiences, which foster loyalty and repeat business. Proactive use of AI to analyze customer behavior and feedback can also enable better service customization and faster issue resolution.

5.3. Fostering Innovation

AI enables SMEs to enhance their innovation capabilities by identifying emerging trends, analyzing market data, and supporting product development. Managers are encouraged to create cross-functional teams that combine domain knowledge with AI insights, promoting a culture of data-driven innovation. This approach can accelerate the ideation process, reduce development risks, and enable rapid testing of new concepts in response to market shifts.

5.4. Expanding Market Share

Finally, the positive relationship between AI adoption and market share indicates that SMEs can leverage AI for strategic market positioning. Managers should use AI-powered analytics to monitor competitors, identify new customer segments, and forecast market trends. These insights can guide decisions on pricing, distribution, and promotional strategies, allowing SMEs to differentiate themselves and expand their market presence effectively.

6. CONCLUSION

This study investigated the impact of Artificial Intelligence (AI) adoption on the competitive advantage of Small and Medium Enterprises (SMEs). The empirical findings indicate that AI adoption significantly enhances four key dimensions of competitiveness: cost efficiency, market share, customer retention, and innovation. Among these, cost efficiency showed the strongest relationship, underscoring the value of automation and data analytics in improving operational performance. The results affirm that AI can serve as a strategic enabler for SMEs to optimize operations, increase customer loyalty, and foster innovation-driven growth. Additionally, the study highlights how AI-driven decision-making processes contribute to more agile business responses and enhanced product or service customization, which are critical in today's rapidly changing markets. These insights provide valuable guidance for SMEs seeking sustainable growth through technology adoption.

Despite these benefits, SMEs often face substantial barriers to AI adoption, including financial constraints, limited access to technical expertise, and concerns about data security and privacy. To overcome these challenges, policymakers and ecosystem stakeholders should implement comprehensive support mechanisms such as specialized training programs, financial incentives, affordable and scalable AI tools, and collaborative platforms to share best practices. Such initiatives will not only facilitate broader AI diffusion among SMEs but also contribute to more equitable economic development. These efforts directly support the Sustainable Development Goals (SDG) 8 on decent work and economic growth and SDG 9 on industry, innovation, and infrastructure by fostering innovation ecosystems and inclusive digital transformation. Future research should focus on industry-specific AI adoption patterns, the role of organizational culture, and the longitudinal impact of AI integration on SME performance to provide deeper insights and actionable recommendations for stakeholders.

7. DECLARATIONS

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7.2. Author Contributions

Conceptualization: JF; Methodology: AA; Software: AL; Validation: JF and AA; Formal Analysis: AA and AL; Investigation: JF; Resources: AA; Data Curation: AA; Writing Original Draft Preparation: JF and AL; Writing Review and Editing: JF, AA, and AL; Visualization: AA. All authors, JF, AA, and AL, have read and agreed to the published version of the manuscript.

7.3. Data Availability Statement

The data presented in this study are available on request from the corresponding author.

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7.5. Declaration of Conflicting Interest

The authors declare that they have no conflicts of interest, known competing financial interests, or personal relationships that could have influenced the work reported in this paper.

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