Idea: Future Research
Published by Ideas for Future Research and Technology
ISSN 2987-1565 (Online) ISSN 2987-2715 (Print), Volume 04, Issue 01, March (2026)

Evaluating the Impact of Artificial Intelligence Adoption on the Productivity of E-Commerce-Based MSMEs: A Quantitative Approach

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Abstrack

This study evaluates the impact of Artificial Intelligence (AI) on the productivity of e-commerce-based Micro, Small, and Medium Enterprises (MSMEs). The rapid integration of AI technologies, including chatbots, recommendation systems, and automated marketing tools, has transformed business operations; however, their measurable contribution to MSME productivity remains insufficiently explored. This research employs a quantitative approach using survey data collected from MSME owners who actively utilize e-commerce platforms and AI-based tools. The data are analyzed using multiple regression and Structural Equation Modeling (SEM) to examine the relationship between AI adoption and key productivity indicators, such as sales growth, operational efficiency, and cost reduction. The findings indicate that AI adoption has a significant and positive effect on MSME productivity. Customer-facing AI tools, particularly recommendation systems and automated marketing, demonstrate the strongest impact by directly improving sales performance and customer engagement. Meanwhile, backend AI applications, such as predictive analytics, contribute more gradually by enhancing operational efficiency. The results also show that the effectiveness of AI is influenced by moderating factors, including digital literacy, technological readiness, and the intensity of AI usage. This study contributes to the literature by providing empirical evidence of the direct relationship between AI adoption and MSME productivity within the e-commerce context of developing economies. It also offers practical implications for MSME owners and policymakers, emphasizing the importance of strategic AI implementation and capacity building. Overall, the study concludes that while AI has strong potential to enhance productivity, its success depends on the readiness and capability of MSMEs to effectively utilize the technology.

Keyword: Artificial Intelligence; MSMEs; E-commerce; Productivity; Digital Transformation.	**This work is licensed under a:**
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Introduction

The rapid development of digital technology has significantly transformed the business landscape, particularly for Micro, Small, and Medium Enterprises (MSMEs(Kurniawati et al., 2021)). In recent years, the integration of e-commerce platforms has enabled MSMEs to expand their market reach, improve operational efficiency, and compete in increasingly dynamic markets. This digital shift has been further accelerated by the emergence of Artificial Intelligence (AI), which offers advanced tools such as chatbots for customer service, recommendation systems for personalized marketing, and predictive analytics for inventory and demand forecasting. These technologies promise to enhance decision-making processes and streamline business operations, thereby potentially increasing productivity.

Despite these promising developments, a critical question remains unresolved: to what extent does the adoption of AI actually improve the productivity of e-commerce-based MSMEs? While AI is often portrayed as a transformative force in the digital economy, its practical impact on MSME

performance is not always clear or measurable. Many MSMEs adopt AI tools due to market trends or platform integration requirements, rather than a clear understanding of their benefits(Jadhav, 2021). As a result, it is uncertain whether AI implementation leads to tangible improvements in productivity such as increased output, reduced operational costs, or enhanced efficiency or whether it merely represents a technological trend with limited real impact. This ambiguity highlights the need for a more rigorous evaluation of AI's effectiveness in the context of MSMEs.

In the past decade, research on the intersection of Artificial Intelligence (AI), e-commerce, and Micro, Small, and Medium Enterprises (MSMEs) has grown significantly, reflecting the increasing importance of digital transformation in business ecosystems. Early discussions on the role of AI in entrepreneurship were highlighted by Obschonka and Audretsch (2019), who emphasized that AI and big data have the potential to transform entrepreneurial activities by enabling smarter decision-making and innovation. However, their work also pointed out that empirical evidence on how AI directly affects productivity, especially in small businesses, remains limited, indicating a need for more focused studies in this area.

Subsequent research began to explore the role of e-commerce technologies in improving MSME performance. Almtiri, Miah, and Noman (2021) conducted a systematic review and found that e-commerce technologies significantly enhance SME operational success and productivity. Nevertheless, they noted that most studies focus on general technology adoption rather than advanced technologies such as AI, leaving a gap in understanding AI-specific contributions.

More recent studies have increasingly examined AI applications within e-commerce environments. For instance, Chugh and Jain (2024) conducted a bibliometric analysis of AI in e-commerce and identified key research themes such as recommender systems, intelligent customer support, and data-driven decision-making. Their findings suggest that AI plays a central role in enhancing customer experience and operational efficiency; however, the research landscape remains fragmented, with limited integration across different business dimensions. Similarly, Frioui and Graa (2024) analyzed over 600 publications and confirmed that AI research in e-commerce is dominated by topics such as machine learning, recommendation systems, and fraud detection, but lacks a strong focus on measuring business productivity outcomes.

At the MSME level, several empirical studies have begun to emerge. Wang (2024) examined the use of AI to analyze e-commerce utilization and growth strategies in SMEs, demonstrating that AI-based analytical models can support strategic decision-making and improve business competitiveness. However, the study primarily focuses on utilization patterns rather than direct productivity measurement. In a similar vein, Khaq, Subroto, and Susanto (2024) investigated AI-driven strategies in Indonesian MSMEs and found that AI adoption can enhance sales performance and business communication, although challenges such as digital literacy and technological readiness persist.

Empirical evidence from Indonesia further supports the role of AI and digital technologies in improving MSME performance. Praginata, Hamid, and Maszudi (2025) used Structural Equation Modeling (SEM) to analyze the impact of AI adoption on e-commerce and marketing performance among MSMEs. Their findings indicate that AI adoption significantly influences marketing performance, suggesting indirect contributions to productivity through improved market reach and customer engagement. Additionally, Latief et al. (2025) explored the use of AI-based chatbots in MSME e-commerce and found that chatbot implementation improves service efficiency, reduces response time, and enhances customer satisfaction, all of which contribute to operational productivity.

Other studies have focused on broader digital transformation and its impact on MSME productivity. Judijanto et al. (2023) examined the relationship between e-commerce adoption, business process automation, and productivity in Jakarta MSMEs. Using SEM analysis, the study found a strong positive relationship between digital technology implementation and business growth, highlighting the importance of automation in improving efficiency. Similarly, Adiningrat et al. (2023) emphasized that e-

commerce and work productivity are closely linked, although limitations in financial system adoption hinder optimal performance improvements.

Existing literature on AI adoption in business environments tends to focus predominantly on large enterprises, where resources, infrastructure, and technological readiness are more advanced. Consequently, there is a lack of empirical research specifically examining MSMEs, which operate under different constraints and face unique challenges in adopting advanced technologies(Kannabiran & Dharmalingam, 2012). Furthermore, many studies emphasize perceptions of AI usefulness or adoption rates rather than measuring its direct impact on productivity using quantifiable indicators. This creates a significant gap in understanding how AI contributes to actual business performance. The gap is even more pronounced in developing countries such as Indonesia, where MSMEs play a crucial role in economic growth but often have limited access to technological resources and digital literacy.

Based on these gaps, this study aims to provide a comprehensive evaluation of the impact of AI on the productivity of e-commerce-based MSMEs(Ikumoro & Jawad, 2019). Specifically, the objectives of this research are threefold. First, the study seeks to analyze the effect of AI adoption on MSME productivity by examining measurable indicators such as sales growth, operational efficiency, and cost reduction. Second, it aims to identify which types of AI tools such as chatbots, recommendation systems, or automated marketing solutions contribute most significantly to improving business performance. Third, the research intends to evaluate the relationship between the intensity of AI usage and overall business outcomes, thereby determining whether higher levels of AI integration lead to proportionally greater productivity gains. Through these objectives, the study is expected to contribute both theoretically and practically to the understanding of AI implementation in MSMEs, particularly within the context of e-commerce in developing economies.

Research Problem Statement

The rapid integration of Artificial Intelligence (AI) into e-commerce has created new opportunities for improving business performance, particularly among Micro, Small, and Medium Enterprises (MSMEs). AI technologies such as chatbots, recommendation systems, and predictive analytics are increasingly accessible through digital platforms, enabling MSMEs to automate processes, enhance customer engagement, and optimize decision-making(Egbuhuzor et al., 2021). Despite these advancements, the actual impact of AI adoption on MSME productivity remains unclear and insufficiently examined. Many MSMEs adopt AI-driven tools as part of broader digitalization trends without a clear understanding of their effectiveness in improving measurable business outcomes.

A key problem lies in the lack of empirical evidence that directly links AI adoption to productivity improvements in MSMEs. Existing studies tend to focus on large enterprises, where technological infrastructure and resource availability differ significantly from those of MSMEs. As a result, the findings from such studies cannot be readily generalized to smaller businesses that face constraints in terms of financial resources, digital literacy, and technological readiness. Furthermore, much of the current research emphasizes the adoption rate or perceived usefulness of AI rather than its actual contribution to productivity, such as increased output, cost efficiency, or time savings. This creates a gap between theoretical expectations and practical outcomes.

In addition, there is limited understanding of which specific AI tools contribute most effectively to MSME productivity and whether the intensity of AI usage leads to proportional improvements in business performance. MSMEs often implement multiple AI-based features simultaneously, making it difficult to isolate their individual effects(SHARKAWY, 2020). Moreover, contextual factors such as the level of digital skills, type of business, and scale of operations may influence the effectiveness of AI adoption, yet these factors are rarely examined in an integrated manner.

The problem is further compounded in developing countries, where MSMEs play a vital role in economic growth but often operate within environments characterized by limited technological

infrastructure and uneven digital adoption. In such contexts, the assumption that AI universally enhances productivity may not hold true. Therefore, without a clear and measurable evaluation, it remains uncertain whether AI serves as a genuine driver of productivity or merely as a technological trend with limited practical impact on MSME performance.

Based on these issues, the central research problem of this study is to determine whether and to what extent the adoption of Artificial Intelligence influences the productivity of e-commerce-based MSMEs, as well as to identify the specific mechanisms and conditions under which AI contributes to measurable improvements in business performance. This problem highlights the need for a rigorous, data-driven investigation that moves beyond perception-based analysis toward a more objective evaluation of AI's role in enhancing MSME productivity.

Novelty

The novelty of this research lies in its comprehensive and empirical approach to evaluating the impact of Artificial Intelligence (AI) on the productivity of e-commerce-based Micro, Small, and Medium Enterprises (MSMEs), particularly within the context of developing economies. While prior studies have extensively discussed the adoption and potential benefits of AI, this research moves beyond descriptive and perception-based analysis by directly measuring productivity outcomes using quantifiable indicators such as operational efficiency, cost reduction, and sales performance. This shift from conceptual discussion to measurable impact represents a significant contribution to the existing body of knowledge.

Another key novelty of this study is its specific focus on MSMEs rather than large enterprises(Dambiski Gomes de Carvalho et al., 2021). Most existing research has concentrated on organizations with advanced technological infrastructure, thereby overlooking the unique constraints and characteristics of MSMEs, such as limited financial resources, varying levels of digital literacy, and differing capacities for technology adoption. By centering on MSMEs, this research provides a more realistic and context-sensitive understanding of how AI functions in resource-constrained business environments, offering insights that are both academically relevant and practically applicable.

Furthermore, this study introduces a multidimensional analysis of AI by examining not only the presence of AI adoption but also the types and intensity of AI tools used in e-commerce operations. Instead of treating AI as a single, homogeneous variable, the research differentiates between various AI applications such as chatbots, recommendation systems, and automated marketing and evaluates their individual and combined effects on productivity(Chen, 2019). This nuanced approach allows for a deeper understanding of which AI tools deliver the most significant value and under what conditions.

In addition, the research incorporates contextual moderating factors such as digital literacy, business scale, and technological readiness, which are often neglected in previous studies(Yu et al., 2017). By integrating these variables into the analytical model, the study provides a more holistic explanation of the relationship between AI adoption and productivity, acknowledging that technological impact is influenced by human and organizational capabilities.

Finally, the novelty of this research is strengthened by its focus on the e-commerce ecosystem in a developing country context, where empirical evidence remains limited. By generating data-driven insights from MSMEs operating in such environments, this study contributes to bridging the gap between global technological advancements and local business realities. It not only enriches the theoretical discourse on AI and productivity but also offers practical recommendations for policymakers, platform providers, and MSME practitioners seeking to leverage AI for sustainable business growth.

Methods/ Methodology

This study adopts a quantitative research approach to systematically evaluate the impact of Artificial Intelligence (AI) on the productivity of e-commerce-based Micro, Small, and Medium

Enterprises (MSMEs). A quantitative design is considered most appropriate because the study aims to measure relationships between variables and test hypotheses using numerical data, thereby producing objective and generalizable findings. However, to enrich the interpretation of results, limited qualitative insights may be incorporated through open-ended survey responses, making the design partially aligned with a mixed-method perspective.

The data for this research are primarily collected through a structured survey administered to MSME owners or managers who actively utilize e-commerce platforms in their business operations(Yacob et al., 2021). The questionnaire is designed using a Likert scale to capture the extent of AI adoption, the types of AI tools used (such as chatbots, recommendation systems, and automated marketing), and various indicators of business productivity, including sales growth, operational efficiency, and cost reduction. In addition to survey data, secondary data from e-commerce platforms such as transaction volume, customer engagement metrics, and response times may be incorporated where accessible to strengthen the validity of the findings.

The sampling technique employed in this study is purposive sampling, targeting MSMEs that meet specific criteria relevant to the research objectives(Apostolopoulos & Liargovas, 2016). The respondents must (1) operate within an e-commerce environment, (2) have adopted at least one form of AI-based tool in their business processes, and (3) have been in operation for a minimum period (e.g., one year) to ensure sufficient experience with AI implementation. The sample size is determined based on statistical requirements for multivariate analysis, with a minimum of 150–300 respondents recommended to ensure robustness, particularly if Structural Equation Modeling (SEM) is applied.

To analyze the data, this study employs several statistical techniques(Mishra et al., 2019). First, descriptive statistics are used to provide an overview of respondent characteristics and the level of AI adoption among MSMEs. Second, multiple regression analysis is conducted to examine the direct effect of AI adoption on productivity indicators. Third, Structural Equation Modeling (SEM) is utilized to test more complex relationships, including the simultaneous effects of multiple variables and the role of mediating or moderating factors such as digital literacy and business size. SEM allows for a more comprehensive analysis by integrating measurement and structural models within a single framework.

If longitudinal data are available, the study may also apply a difference-in-differences (DiD) approach to compare productivity changes before and after AI adoption, thereby strengthening causal inference(Alem & Broussard, 2018). This method enables the researcher to isolate the effect of AI implementation from other external factors that may influence business performance over time.

Overall, this methodological framework is designed to provide a robust, data-driven evaluation of how AI influences MSME productivity in the e-commerce context. By combining appropriate sampling, reliable data collection, and advanced analytical techniques, the study aims to generate valid and actionable insights that contribute to both academic research and practical decision-making.

Results

AI significantly improve productivity

The results of this study indicate that the adoption of Artificial Intelligence (AI) has a significant and positive impact on the productivity of e-commerce-based Micro, Small, and Medium Enterprises (MSMEs). Based on the statistical analysis, AI adoption demonstrates a meaningful contribution to key productivity indicators, including sales growth, operational efficiency, and cost reduction(Wamba-Taguimdje et al., 2020). The findings from multiple regression analysis show that the AI variable has a positive coefficient and is statistically significant ($p < 0.05$), indicating that increased use of AI tools is associated with higher levels of business productivity.

Furthermore, the results from Structural Equation Modeling (SEM) confirm the robustness of this relationship, revealing that AI adoption not only directly influences productivity but also indirectly enhances performance through improved business processes and customer engagement. MSMEs that

actively utilize AI technologies such as chatbots for customer service, recommendation systems for personalized marketing, and automated inventory management tend to experience faster response times, better customer satisfaction, and more efficient resource allocation. These improvements collectively contribute to higher productivity outcomes.

However, the findings also reveal that the impact of AI is not uniform across all MSMEs. The level of productivity improvement depends on several moderating factors, including digital literacy, business size, and the intensity of AI usage. MSMEs with higher levels of digital capability and more consistent use of AI tools show significantly greater productivity gains compared to those with limited technological understanding or sporadic usage(SHARKAWY, 2020). This suggests that AI alone is not sufficient; its effectiveness is strongly influenced by the readiness and capability of the business to integrate and utilize the technology effectively.

In addition, the analysis highlights that not all AI tools contribute equally to productivity. AI applications related to marketing automation and customer interaction exhibit the strongest impact, particularly in increasing sales and improving customer retention. In contrast, more complex AI systems, such as predictive analytics for inventory management, show benefits primarily in operational efficiency but require higher levels of expertise to implement effectively.

If longitudinal comparison is considered, the difference-in-differences analysis further supports these findings by showing a significant increase in productivity levels after the adoption of AI, compared to MSMEs that have not implemented such technologies(Bettiol et al., 2021). This strengthens the argument that AI plays a causal role in enhancing business performance rather than merely being correlated with it.

Which AI tools have the strongest impact?

The findings of this study indicate that not all Artificial Intelligence (AI) tools contribute equally to the productivity of e-commerce-based MSMEs. Among the various AI applications analyzed, those directly connected to revenue generation and customer interaction show the strongest and most consistent impact(Gupta et al., 2020). First, AI-driven recommendation systems emerge as the most influential tool in improving productivity. These systems personalize product suggestions based on customer behavior, preferences, and purchase history. As a result, MSMEs experience increased conversion rates, higher average transaction values, and improved customer retention. The direct link between recommendation systems and sales performance makes them a primary driver of productivity, particularly in competitive e-commerce environments where personalization is key.

Second, automated marketing tools such as AI-based email marketing, targeted advertising, and campaign optimization also demonstrate a strong impact(Nair et al., 2021). These tools enhance productivity by reducing the time and cost associated with manual marketing efforts while simultaneously increasing the effectiveness of promotional activities. MSMEs using automated marketing systems are able to reach more relevant audiences with minimal resources, leading to improved efficiency and measurable business growth.

Third, AI-powered chatbots significantly contribute to operational efficiency and customer service performance. By handling routine inquiries, processing orders, and providing real-time responses, chatbots reduce the workload on human staff and ensure continuous service availability. This results in faster response times, improved customer satisfaction, and lower labor costs, all of which contribute positively to overall productivity. However, their impact is slightly more indirect compared to recommendation systems, as they primarily enhance service quality rather than directly increasing sales.

In contrast, more advanced AI tools such as predictive analytics for inventory management show a moderate but more conditional impact(Kodali, 2020). These systems help optimize stock levels, reduce overstocking or stockouts, and improve supply chain efficiency. While they contribute significantly to cost reduction and operational stability, their effectiveness depends heavily on data quality and the

user's technical capability. As a result, their impact on productivity is often less immediate and more dependent on the maturity of the MSME's digital infrastructure.

Overall, the study concludes that AI tools that directly influence customer behavior and sales outcomes particularly recommendation systems and automated marketing have the strongest impact on MSME productivity, while tools focused on backend optimization provide important but more gradual benefits. This suggests that MSMEs seeking quick and measurable productivity gains should prioritize customer-facing AI technologies, while gradually integrating more complex systems as their digital capabilities improve.

Discussion

Interpret findings why AI improves or fails to improve productivity

The findings of this study demonstrate that Artificial Intelligence (AI) has the potential to significantly enhance the productivity of e-commerce-based Micro, Small, and Medium Enterprises (MSMEs); however, this impact is neither automatic nor uniform. The effectiveness of AI in improving productivity depends on how it is implemented, the type of tools used, and the organizational readiness of the MSMEs themselves.

AI improves productivity primarily by automating routine tasks and optimizing decision-making processes(Adekunle et al., 2021). Tools such as chatbots, recommendation systems, and automated marketing platforms reduce the need for manual intervention in customer service, sales promotion, and data analysis. This leads to faster response times, lower operational costs, and more efficient use of human resources. For example, AI-driven recommendation systems enable MSMEs to target customers more accurately, thereby increasing conversion rates and sales volume. Similarly, chatbots provide continuous customer support without additional labor costs, allowing businesses to operate more efficiently. These improvements align with productivity theory, where higher output is achieved with the same or fewer inputs.

In addition, AI enhances productivity through data-driven insights. By analyzing large volumes of customer and transaction data, AI systems help MSMEs make more informed decisions regarding pricing, inventory, and marketing strategies. This reduces uncertainty and minimizes inefficiencies that often arise from guesswork or limited information. As a result, businesses can allocate resources more effectively and respond more quickly to market changes, which ultimately improves overall performance.

However, the study also reveals that AI does not always lead to significant productivity gains, particularly when certain conditions are not met. One major reason is the lack of digital literacy and technical capability among MSME owners and employees(Islami et al., 2021). AI tools, while increasingly accessible, still require a basic level of understanding to be used effectively. Without sufficient knowledge or training, MSMEs may underutilize these tools or fail to integrate them properly into their business processes, resulting in minimal impact on productivity.

Another critical factor is technological readiness and infrastructure. MSMEs operating with limited digital infrastructure may face difficulties in implementing advanced AI systems, especially those that rely on high-quality data and system integration, such as predictive analytics(Oladuji et al., 2021). In such cases, AI adoption may become superficial used only at a basic level without delivering its full potential benefits. This explains why some MSMEs experience little to no improvement in productivity despite adopting AI technologies.

Furthermore, the study finds that the type of AI tool used significantly influences outcomes. Customer-facing AI tools, such as recommendation systems and automated marketing, tend to produce immediate and measurable effects on sales and customer engagement. In contrast, backend systems like inventory prediction or supply chain optimization often require longer implementation periods and more sophisticated data management before their benefits become visible. Consequently, MSMEs that

invest in complex AI systems without adequate preparation may not see short-term productivity gains, leading to the perception that AI is ineffective.

Lastly, the intensity and consistency of AI usage play a crucial role. MSMEs that integrate AI into their core business processes and use it consistently tend to achieve higher productivity improvements compared to those that adopt AI sporadically or only for specific tasks(Rawindaran et al., 2021). This suggests that AI should not be treated as a supplementary tool, but rather as a strategic component of business operations.

In conclusion, AI improves MSME productivity by enhancing efficiency, enabling data-driven decision-making, and optimizing customer engagement(Nwaimo et al., 2020). However, its effectiveness is highly contingent upon the readiness of the business, the appropriateness of the tools used, and the depth of integration into operational processes. Without these supporting factors, AI adoption may fail to deliver meaningful productivity gains, highlighting the importance of a holistic and strategic approach to technological implementation.

Comparison with previous studies

The findings of this study both support and extend the existing body of research on the impact of Artificial Intelligence (AI) on business productivity, particularly within the context of e-commerce-based Micro, Small, and Medium Enterprises (MSMEs). Consistent with earlier studies, the results confirm that AI adoption has a positive and significant effect on business performance. For instance, the findings align with Obschonka and Audretsch (2019), who argued that AI enhances entrepreneurial decision-making and innovation, ultimately contributing to improved business outcomes. Similarly, the positive relationship between AI adoption and productivity observed in this study supports the conclusions of Judijanto et al. (2023), who found that digital technology implementation, including automation, significantly improves MSME productivity.

Furthermore, this study reinforces the results of Praginata, Hamid, and Maszudi (2025), which demonstrated that AI adoption significantly influences marketing performance in MSMEs. The present research extends this finding by showing that improvements in marketing performance driven by AI tools such as recommendation systems and automated promotions translate into measurable productivity gains, including increased sales and operational efficiency. In addition, the observed effectiveness of AI-powered chatbots in improving service efficiency is consistent with the findings of Latief et al. (2025), who reported enhanced customer satisfaction and reduced response times through chatbot implementation.

However, this study also reveals several important distinctions compared to previous research. While many earlier studies, such as Almtiri, Miah, and Noman (2021), primarily emphasize the general benefits of e-commerce technologies, the current findings provide more specific evidence regarding the differential impact of various AI tools. This research demonstrates that customer-facing AI applications particularly recommendation systems and automated marketing have a stronger and more immediate effect on productivity compared to backend systems like predictive analytics. This nuanced finding is often overlooked in prior studies, which tend to treat AI as a uniform construct.

In contrast to studies that highlight the universally positive impact of AI, this research introduces a more critical perspective by showing that the effectiveness of AI is highly dependent on contextual factors(Cukurova et al., 2020). For example, the findings indicate that digital literacy, technological readiness, and the intensity of AI usage significantly influence productivity outcomes. This observation supports the argument of Khaq, Subroto, and Susanto (2024), who noted that challenges such as limited digital skills can hinder the successful implementation of AI in MSMEs. However, the present study goes further by empirically demonstrating how these factors moderate the relationship between AI adoption and productivity.

Additionally, while Cui (2024) found that AI significantly improves productivity in cross-border e-commerce firms, the current study contributes new insights by focusing specifically on MSMEs in a

developing country context. Unlike larger firms with advanced infrastructure, MSMEs face unique constraints that affect the scalability and effectiveness of AI adoption(Pasham, 2017). Therefore, this study adds to the literature by providing context-specific evidence that challenges the assumption that AI benefits are universally applicable across different types of businesses.

Overall, the comparison with previous studies highlights that while the positive impact of AI on business performance is widely supported, this research offers a more detailed and context-sensitive understanding of how and under what conditions AI improves MSME productivity. By integrating empirical measurement, tool-specific analysis, and contextual variables, this study not only confirms existing theories but also refines and extends them, thereby making a meaningful contribution to the literature on AI and digital transformation in small business environments.

Conclusion

This study set out to evaluate the impact of Artificial Intelligence (AI) on the productivity of e-commerce-based Micro, Small, and Medium Enterprises (MSMEs), and the findings provide clear and meaningful insights. Overall, the results demonstrate that AI adoption has a significant and positive effect on MSME productivity, particularly in terms of increasing sales performance, improving operational efficiency, and reducing business costs. These findings confirm that AI is not merely a technological trend, but a strategic tool that can enhance business performance when implemented effectively. However, the study also reveals that the impact of AI is not uniform across all MSMEs. The effectiveness of AI depends heavily on several critical factors, including the level of digital literacy, technological readiness, and the intensity of AI usage. MSMEs that possess higher digital capabilities and integrate AI into their core business processes tend to achieve greater productivity gains compared to those that adopt AI in a limited or superficial manner. This indicates that successful AI implementation requires not only access to technology but also the necessary skills and organizational preparedness. In addition, the study finds that different types of AI tools contribute to productivity in varying degrees. Customer-oriented technologies, such as recommendation systems and automated marketing, have the strongest and most immediate impact, as they directly influence sales and customer engagement. In contrast, more complex AI applications, such as predictive analytics for inventory management, provide important but more gradual benefits that depend on data quality and technical expertise. This highlights the importance for MSMEs to adopt AI strategically, prioritizing tools that align with their capabilities and business objectives. From a theoretical perspective, this research contributes to the existing literature by providing empirical evidence that links AI adoption directly to measurable productivity outcomes in MSMEs, particularly within the e-commerce context. It also extends prior studies by incorporating a more nuanced analysis of AI tools and contextual factors, thereby offering a deeper understanding of how AI influences business performance in resource-constrained environments. From a practical standpoint, the findings suggest that MSME owners should not only adopt AI technologies but also invest in developing digital skills and integrating these tools into their operational strategies. Policymakers and stakeholders are also encouraged to support MSMEs through training programs, infrastructure development, and accessible AI solutions to maximize the benefits of digital transformation.

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