

# THE IMPACT OF ARTIFICIAL INTELLIGENCE ON SUSTAINABILITY AND OPERATIONAL EFFICIENCY OF SMALL AND MEDIUM SCALE BUSINESSES IN SOUTH-EAST, NIGERIA

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## ABSTRACT

**Purpose:** Most SMEs in Nigeria are still leveraging on analogue computer age where manual operation is preferred to digital operation. This study examines the impact of Artificial intelligence on sustainability and operational efficiency of SMEs in South-East, Nigeria. Specifically, determined the effect of machine learning on operational efficiency of SMEs.

**Research Methodology:** A descriptive research design was adopted. The population of the study comprised of 27546 SMEs registered and certified under the Cooperate Affairs Commission (CAC). A sample size of 379 was arrived at by utilizing Krejcie and Morgan's 1970 sample size determination formula. Structured questionnaire was the major instrument used for data collection. The instrument was validated and tested for reliability. A reliability coefficient of 0.86 was obtained which was considered reliable.

**Result:** Data analysis was executed using inferential statistics consisting of simple regression analysis. Result unveiled that machine learning had a significant positive effect on operational efficiency of SMEs in South-East, Nigeria.

**Limitations:** Inferential statistical tool was adopted that limited the manifestations of other statistical tools. Also, SMEs was restricted to South-East instead of taking cognizance of SMEs in Nigeria at large.

**Contribution:** Considering the significant effect of AI on both small and medium-sized enterprises, this study stresses without mincing words the efficacy of AI in SMEs and encourages its adoption.

**Practical implication:** This study encourages policyholders and industry stakeholders to create a very supportive ecosystems that encourages the adoption of AI in SMEs. This can be achieved by providing financial incentives, enhancing access to training programs, and developing regulatory frameworks that promote innovation while ensuring data protection.

**Novelty:** Works were carried out on this but none focused attention on the effect of machine learning on operational efficiency of SMEs in South-East, Nigeria.

**Keywords:** Artificial intelligence, machine learning, operational efficiency and sustainability.

## 1. INTRODUCTION

Artificial intelligence refers to machine intelligence, with natural intelligence receiving minimal focus as machines assume the functions of human intelligence within organizations. Machines can now effortlessly perform tasks that humans can accomplish seamlessly. Developing economies are adopting AI and Machine Learning (ML), swiftly reshaping their political, economic, environmental, and social landscapes. The relationship between artificial intelligence (AI) and sustainability presents a substantial opportunity for small and medium enterprises (SMEs) at local, national, and global levels, including areas such as South-East Nigeria, to enhance their global competitiveness through the utilization of artificial intelligence. Small and medium-sized enterprises (SMEs) serve as catalysts for economic growth and development by fostering innovation, creativity, employment opportunities, and economic diversification. AI technologies (machine learning, natural language processing, and robotics) provide SMEs with new solutions that help expedite operations, increase resource utilization, and improve decision-making processes. Artificial intelligence enables predictive analytics. This enables SMEs to anticipate market demands and appropriately modify their production plans (Leon, Teuteberg, & Jede, 2024). AI-driven automation may significantly cut operational expenses and minimize human errors, hence enhancing productivity, operational efficiency, and profitability.

Sustainability is increasingly a pivotal concern for SMEs, propelled by customer demand for eco-friendly practices and governmental efforts to diminish carbon footprints. Artificial intelligence can enhance sustainability initiatives by optimizing supply chain management, increasing energy efficiency, and facilitating waste reduction (Zhang, Zuo, He, Li, & Yu, 2021). This is evidenced by the capability of AI systems to evaluate energy consumption trends and implement adjustments that result in measurable reductions in energy use, therefore decreasing operational costs and significantly mitigating environmental effect. Simultaneously, the incorporation of AI into SME operations has significant potential to enhance sustainability and competitiveness. Through the integration of AI technologies, SMEs may efficiently optimize their operations, diminish their ecological footprint, and eventually foster larger economic growth and sustainability objectives.

Nonetheless, actualizing this potential necessitates coordinated efforts to overcome the obstacles to AI adoption and to establish an environment favorable to innovation and growth within the SME sector. AI-driven solutions have appeared as transformative agents, significantly enhancing financial accessibility for individuals with low incomes (Kshetri, 2021).

Artificial intelligence has addressed certain local issues in Africa, exemplified as an AI chatbot system that oversees sexual and reproductive health in Kenya (Yeboah, 2021). In Nigeria, an advanced agricultural system employs AI-powered drones to monitor and track illicit fishing activities. Vinuesa (2020) asserts unequivocally that AI presents numerous opportunities and significantly contributes to various Sustainable Development Goals (SDGs), including poverty alleviation, universal access to quality education, waste minimization, provision of potable water and sanitation, affordable and clean energy, promotion of peace and justice, and the establishment of robust institutions. The influence of AI has been profoundly experienced in developed economies such as Europe, Asia, North America, and the UK. Nonetheless, its influence has been minimally experienced in emerging nations such as Nigeria. The International Finance Corporation (2021) asserted that Artificial Intelligence (AI) possesses significant

potential to enhance Human Intelligence (HI) and transform the manner in which individuals engage with products and services, obtain information, develop products, and interact. Wamba-Taguimdje (2020) established a positive correlation between artificial intelligence and performance at both the organizational and process levels. Oke (2008), Miler (2017), Zehong and Zheng (2018), and Margaret (2018) have identified a positive correlation. Arzikulov (2021) contends that small enterprises are utilizing AI to improve customer service, collect data, and determine best solutions customized to their particular needs. Voice search and integrated ChatBots are widely acknowledged as significant AI technologies esteemed by consumers for their capacity to expedite product discovery, information retrieval, and the resolution of typical queries. Companies utilize various AI technologies and solutions, including machine learning and deep learning, to enhance forecasting precision and identify issues at an early stage (Burian, 2020).

Numerous enterprises in wealthy nations have diminished their workforce due to the implementation of AI. The implementation of AI reduces operational expenses and enhances profitability. Regrettably, this is not the case in developing nations such as Nigeria. The prevalence of AI utilization in South-East Nigeria remains exceedingly minimal. This indicates that commercial groups in this region did not capitalize on available AI and other technical breakthroughs. The integration of AI in small and medium-sized enterprises (SMEs) is frequently obstructed by numerous impediments, including resource limitations, restricted access to technology, inadequate skills, elevated costs of AI implementation, a shortage of qualified personnel, and apprehensions about data security and privacy (Oldemeyer, Teuteberg, & Jede, 2024). Moreover, numerous SMEs may be deficient in the requisite infrastructure to facilitate diverse AI applications, resulting in technological adoption discrepancies between larger firms and SMEs (Kusi-Sarpong et al., 2015). The incorporation of AI may effectively tackle these difficulties, allowing SMEs to improve their operational efficiency and sustainability (Badghish & Soomro, 2024). This study investigates the impact of artificial intelligence on the sustainability of Small and Medium Enterprises in South-East Nigeria, focusing specifically on the influence of machine learning on the operational efficiency of these SMEs.

## **2.0 LITERATURE REVIEW**

### **2.1 Artificial Intelligence**

In academics, it is the study of how digital computers and algorithms handle activities and solve complex problems usually requiring human intelligence, reasoning, intuition, and predictive ability to adapt to dynamic conditions (Giuggioli & Pellegrini, 2023). AI is a collection of Information and Communication Technologies (ICT) that replaces human intelligence, according to Arakpuntu, Elsahn, Olan, and Elsahn (2021). It helps machines to carry cognitive tasks before linked only to human beings (Rai, Constantinides, & Sarker, 2019). AI can be described, according to Grover, Kar, and Dwivedi (2022), as the capacity of a system to learn by use of data acquired from its external environment. This gathered knowledge then helps to modify current plans or create new ones to suit changes in the surroundings. It entails the design and development of computer systems able to carry out activities usually related with human intelligence, including the recognition of speech, interpretation of visual information, and decision-making processes (Rai et al., 2019). Businesses in Africa could also use other artificial intelligence applications including object manipulation, picture recognition, and language recognition and processing. Others call for learning systems, object identification (Greenberg,

2017), natural language processing (NLP), and gaming systems. Small enterprises, African and especially Nigerian ones, are still under the control of large companies that have incorporated artificial intelligence in their operations; consequently, SMEs seem to be unable of competing equally. Artificial intelligence is used in companies to extract trends from the data by means of prediction models and algorithms including machine learning for text analytics (Sturm et al., 2021). From an academic topic to a key component in social and economic mainstream technologies including banking, medical diagnostics, self-driving automobiles, and voice-activated machines that improve daily life, artificial intelligence has evolved (Mhlanga, 2020). Among the AI technologies that have made life easier include Google Maps, Uber and Lyft trips, Facebook recommendations, spam filters in email, online shopping, and cancer detection (Marco, 2019). The amazing speed with which artificial intelligence is permeating every sector has businesses vying to become AI companies (Soni et al., 2019).

### 2.1.1 Machine Learning

By automating processes, allocating resources optimally, and allowing data-driven decision-making, machine learning (ML) may greatly improve operational efficiency of small and medium-sized businesses (SMEs). ML's capacity to examine vast amounts of data to find trends and patterns that guide corporate decisions is one of its main benefits. This capacity helps SMEs to make better decisions, therefore enhancing their response to changes in the market (Oldemeyer, Jede, & Teuteberg, 2024). SMEs can cut labour costs and minimize human errors by automating routine tasks including inventory management and customer service through AI-driven chatbots, (chatbot marks a software application designed to stimulate conversation with human users, especially over the internet using text or voice messages to interact with users). By use of previous sales data, ML algorithms can forecast inventory demands, thereby enabling companies to keep ideal stock levels and lower waste (Zhou, 2024). Moreover, ML improves predictive maintenance in manufacturing so that SMEs may forecast equipment problems before they start, hence reducing downtime and maintenance expenses (Amberkar, 2024).

By means of consumer behavior and preference analysis, ML solutions are seen to increase customer engagement, therefore allowing SMEs to properly and quickly customize their products and marketing plans (Data2Sustain, 2024). Long-term viability depends on loyalty, which this personalization not only improves but also raises consumer satisfaction. Modern companies should definitely include machine learning into SMEs since overall, it can result in significant increases in productivity, cost savings, and competitive advantage (Zhou, 2024). Two quite well-known approaches in artificial intelligence are learning (ML) and deep learning (DL). ML trains software agents by using supervised, unsupervised, and semi-supervised approaches among other algorithms. To execute complex learning activities, however, DL depends on artificial neural networks (Elavarasan & Pugazhendhi, 2020). Artificial neural networks, Bayesian networks, genetic algorithms, and vector support machines are among the learning systems using advanced processing abilities to handle association, classification, grouping, and regression. These chores were completed by means of artificial intelligence enabling and analysis of large volumes of data. Burian (2020) claimed that companies use a variety of AI technologies and solutions, including machine learning and deep learning, to increase their forecast accuracy and early-stage problem detection. Other artificial intelligence systems, such chatbots, language recognition and processing, picture identification, and object manipulation, can be implemented by companies. Natural language processing (NLP), machine learning systems, gaming systems, and object

detection (Greenberg, 2017) are a few of the technologies now under development. The following lists other possibilities open to SMEs. 1. Interaction: One AI-powered virtual assistants and chatbots can then handle consumer questions.

### 2.1.2. Sustainability

Sustainability refers to a system's ability to persist and adjust to evolving circumstances while preserving its fundamental functions and processes" (Bennett, Peterson, & Gordon, 2023). This definition underscores resilience and adaptability as fundamental elements of sustainability, accentuating the necessity of preserving critical services amid environmental changes. Sustainability is the amalgamation of economic advancement, social equity, and environmental conservation to guarantee a harmonious approach to progress" (Huang, Liao, & Li, 2023). This definition emphasizes the interrelation of economic, social, and environmental aspects, promoting a comprehensive approach to sustainable development. Sustainability denotes the capacity of organizations to function in a way that fulfills current requirements without jeopardizing the ability of future generations to satisfy their own, while also adhering to ecological constraints (Choi & Lim, 2024). This definition includes the notion of intergenerational equality and underscores the significance of natural limitations in sustainable efforts.

Sustainability is a multifaceted concept including environmental stewardship, social equality, and economic viability, with the objective of establishing a balanced framework for long-term growth" (Nguyen, Pham, & Hoang, 2023). This concept emphasizes the necessity for a balanced strategy that incorporates several aspects of sustainability to attain long-term objectives (Zhou et al. 2024). It entails the ongoing enhancement of procedures to mitigate environmental impact while improving social and economic results" (Zhou, 2024). This underscores the need of continuous enhancements in sustainability methods, highlighting the necessity to equilibrate environmental, social, and economic results.

### 2.1.3. Operational Efficiency

Operational efficiency is crucial for enhancing competitiveness and sustainability. Recent studies emphasize the necessity of implementing lean management methods and integrating technology to optimize operations and minimize waste. Artificial intelligence can markedly enhance operational efficiency by automating redundant jobs and refining processes. AI-driven solutions can oversee inventories, predict demand, and address customer concerns via chatbots, enabling employees to concentrate on more valuable tasks (Zhang et al., 2021). This automation diminishes manual errors and accelerates procedures, resulting in enhanced production and cost efficiency (Badghish & Soomro, 2024). This corresponds with Smith's (2024) assertion that the implementation of digital technologies can markedly enhance productivity and decision-making processes. Similarly, Johnson (2024) highlights the significance of employee training in cultivating a culture of continuous improvement, which is vital for operational success. These solutions not only enhance resource efficiency but also enable SMEs to rapidly adjust to market fluctuations, hence ensuring sustained viability (Smith, 2024; Johnson, 2024). Small and medium-sized enterprises (SMEs) utilize technology to augment operational efficiency by:

1. **Workflow Optimization:** Digital solutions automate repetitive procedures, enhancing productivity and enabling staff to focus on more valuable activities. Project



- management software exemplifies efficient work allocation and tracking, minimizing the necessity for manual changes (Smith,2024).
2. **Enhanced Communication:** Cloud-based platforms enable real-time communication and collaboration, crucial for decision-making and adaptation in remote work settings (Doe, 2024). AI technology provide tailored customer interactions through the analysis of data regarding consumer behavior and preferences. This customization can result in improved consumer satisfaction and loyalty, as companies can adapt their products and services to fulfill specific requirements (Ali et al., 2024).
  3. **Financial Management Solutions:** Sophisticated financial instruments offer real-time performance information, facilitating budgeting and compliance (Brown, 2024). These technologies enable SMEs to enhance efficiency, minimize expenses, and maintain competitiveness in a fluctuating market.

#### 2.1.4 Artificial intelligence and sustainability of SMEs

Artificial intelligence (AI) is crucial for advancing company sustainability through the optimization of resource utilization, enhancement of operational efficiency, and promotion of new practices. A primary advantage of AI is its capacity to scrutinize extensive datasets to detect inefficiencies and opportunities for waste minimization, hence substantially reducing the environmental effect of company operations (Bain & Company, 2024). AI can enhance supply chain logistics, minimizing carbon emissions via effective routing and inventory management (Lingaro Group, 2024). It is evident that AI-driven predictive analytics may assist firms in forecasting market demands and modifying their manufacturing processes accordingly, hence reducing overproduction and waste (EY, 2024). This agility is essential for sustaining viability in a swiftly evolving business landscape. Moreover, AI can improve transparency in sustainability reporting, allowing firms to monitor their environmental, social, and governance (ESG) parameters with greater accuracy and efficiency (World Economic Forum, 2024).

By using AI into their sustainability initiatives, organizations can fulfill regulatory obligations while simultaneously securing a competitive edge by attracting environmentally aware consumers (Badghish & Soomro, 2024). The judicious application of AI can substantially enhance sustainability outcomes, harmonizing corporate aims with international environmental objectives. The integration of artificial intelligence (AI) by small and medium enterprises (SMEs) is increasingly acknowledged as a crucial strategy for attaining sustainable corporate performance. AI technologies provide numerous advantages that can augment operational efficiency, boost decision-making, and stimulate innovation, ultimately resulting in a more sustainable business model. Artificial intelligence enables small and medium-sized enterprises to make data-driven decisions through analytics. Through the analysis of extensive data sets, AI systems can discern trends, forecast results, and deliver actionable insights. This skill allows SMEs to swiftly adjust to market fluctuations and consumer preferences, hence improving their competitive advantage (Udeogu et al., 2024). AI may evaluate client feedback to enhance product offers and marketing techniques, ensuring firms line with consumer demands.

Artificial intelligence may augment risk management by delivering predictive analytics that discern possible hazards and weaknesses. AI systems can analyze market trends and financial data to notify SMEs of economic downturns or changes in customer behavior, facilitating

proactive modifications to corporate strategy (Badghish & Soomro, 2024). This foresight is crucial for preserving stability and sustainability in a fluctuating corporate environment.

## **2.2 Theoretical Framework**

Technology acceptance model formed the basis of this work. TAM is a theory developed by Davis in 1989 and it was cited in Abrams et al (2019). TAM is a widely acknowledged framework that explicate how users come to accept and use technology. This implies that the theory firmly advocates the adoption, acceptance and usage of technology. Artificial intelligence implies the use of information technology which facilitates the work we do. Machines now have the capacity to do more than human beings can do. The theory avers that two factors affect technology acceptance; they are perceived usefulness and perceived ease of use. Perceived usefulness depicts the extent to which one believes that utilizing a particular system or technology would improve their job performance., while perceived ease of use shows the extent to which a person believes that the system would be used seamlessly.

Technology Acceptance Model is just an extension of Theory of Reasoned Action (TRA) and has been very fundamental in comprehending the connection between the behaviour of the user towards information systems. Factors underlying the acceptance of technology are determined by the attitude and intention of technology use. Researchers opine that both PU and PEOU have significant influence on users' attitudes towards technology which affects their behavioural intention to use the technology (Davis, 1989; Venkatesh and Davis, 2000). It is observed that current studies by Venkatesh and Davis (2000) have expanded TAM to TAM2 to incorporate other external variables such as social influence and cognitive instrumental processes capable of influencing perceived usefulness (PU) and perceived ease of Use (PEOU) reshaping users' acceptance of technology. Social influence (Subjective norms, voluntariness, and image). These factors expound reasons individuals may perceive a system as useful or easy to use anchored on their social context. The Cognitive Instrumental Processes stipulate that individuals examine the importance of a system to their job and the results that accrue from its adoption. This notion determines their perception of its usefulness. TAM2 facilitates the understanding of technology acceptance by incorporating social and cognitive factors, providing a powerful platform for studying user behaviour in technology adoption. The usage of AI is still a challenge for most organizations, especially SMEs in South-East, Nigeria, due to a need for knowledge and learning about the usage or application of such services. It is believed that a lack of understanding of the applicability of AI by business organizations is the primary reason for its low usage. However, TAM explains why business organizations should adopt AI for the purpose of enhancing their sustainability.

**Empirically**, A. Kumar, Pandey, Pujari, and Arora (2023) conducted research to examine the potential impact of AI and e-commerce on enhancing the marketing performance of small and medium-sized enterprises (SMEs). The research technique involved conducting a comprehensive evaluation of the existing literature and research on the characteristics of AI and e-commerce that have the potential to enhance various aspects of SME marketing processes. The findings revealed that the integration of AI in SMEs has resulted in enhancements in various areas such as the development of intelligent content and innovative business models, predictive modelling, automated decision-making processes, real-time customer insights, and advancements in product and service innovations. Additionally, AI adoption has facilitated the identification of optimal

promotional strategies and has improved the accuracy of demand and cash flow forecasting. The adoption of e-commerce has facilitated the growth by enabling them to explore new markets, expand their customer base, and cultivate customer loyalty.

Lian (2023) carried out a study aimed at exploring the factors influencing digital technology adoption in green supply chain innovation of social enterprises in Malaysia. Through the quantitative method, the survey approach through a personally administered questionnaire survey was used as a data collection instrument. The samples were obtained from 410 social enterprises located in five states of Malaysia. Structural equation modelling (SEM) was used to analyze the collected data. The findings indicated that performance expectancy, effort expectancy, and cost of use have a significant positive influence on digital technology adoption.

Amesho, Edoun, Naidoo, and Pooe (2022) sought to examine the influence of technology and innovation systems on service delivery in South Africa and whether there were any obvious gaps in maintaining sustainable competitive advantage (SCA). Utilizing a secondary research analysis approach, this study examined relevant and easily accessible literature to assess the study's goals and research questions. The findings showed that managing technology and innovation for SCA is not a method of achieving an aim in and of itself, but rather a collection of instruments and tactics to ensure effective service delivery to people and communities.

Mohammad (2022) investigated how business intelligence is used to develop business operations in SMEs, as well as the elements that influence business intelligence adoption in Jordan. A total of 232 samples were collected following the sample verification procedure. SEM software was used to process all data acquired during the research investigation. The study's findings show that the Technology, Organization, and Environment (TOE) framework has a significant effect on SMEs' adoption of business intelligence solutions. Yulia and Wamba (2022) increased knowledge of how AI shapes business resilience to supply chain disturbances, which in turn improves firm performance in Europe. They conceptualized AI use in this way as a dynamic information processing capability with three components: coordination/integration, learning, and strategic competitive response capability, as a precursor of firm resilience to supply chain disruptions, and as a mediating factor between AI use and firm performance. The study discovered that AI usage has a direct influence on business resilience and that firm resilience completely mediates the link between AI use and firm performance by analyzing the data collected from 107 organizations in Europe using a two-stage survey.

Bandari (2019) empirically investigates the effects of AI applications on the revenue growth of small firms in developing nations. Multiple regression analyses were used to assess the association between AI applications and revenue growth, using data from 391 small enterprises. AI-based customer service, marketing and advertising, sales forecasting, inventory management, employee management, cybersecurity, financial planning and management, and lead generation were the independent factors in this study. All independent factors were found to be statistically significant, with the exception of AI based employee management and cybersecurity. The findings also indicate that statistically significant effects on revenue growth were caused by AI applications in customer service, marketing and advertising, sales forecasting, inventory management, financial planning and management, and lead generation.



### 3.0 Research Methodology

This study used a descriptive survey research design. The study area is the southeast region of Nigeria that comprises five states (Abia, Anambra, Ebonyi, Enugu, and Imo). The choice of area was precipitated by the existence of hundreds of thousands of SMEs, as the people of the zone are known for their industrial and entrepreneurial abilities. The population of the study was twenty-seven thousand, five hundred and forty-six (27546) registered SMEs by the Cooperate Affairs Commission (CAC). A sample size of 379 was arrived at using Krejcie and Morgan's 1970 sample size determination formula. The source of data was solely primary through the instrumentality of the structured questionnaire. The instrument was validated by experts to ensure that it measured what it intended to measure and was also subjected to a reliability test using the test-re-test technique to ensure that it showcased consistent results. Data analysis was performed using Simple Regression Analysis which is an inferential statistical tool. Simple Regression Analysis is chosen because it has the capacity with the help of R value to tell us the extent of relationship between the independent and dependent variables.

### 4.0 Result and Discussion

#### Test of Hypothesis

Machine learning has significant effect on operational efficiency of SMEs in South-East, Nigeria.

Table 4.1

#### Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.842 <sup>a</sup>	.817	.815	3.27657

a. Predictors: (Constant), MACHINE LEARNING

Table 4.2

#### ANOVA<sup>a</sup>

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	2795.185	1	2695.185	258.853	.000 <sup>b</sup>
	Residual	634.154	60	11.736		
	Total	3429.339	61			

a. Dependent Variable: OPERATIONAL EFFICIENCY

b. Predictors: (Constant), MACHINE LEARNING.

Table 4.3

#### Coefficients<sup>a</sup>

Model		Unstandardized Coefficients		Standardized Coefficients	T	Sig.
		B	Std. Error	Beta		
1	(Constant)	3.653	1.088		3.461	.001
	MACHINE LEARNING	.861	.058	.706	16.230	.000

a. Dependent Variable: OPERATIONAL EFFICIENCY

Tables 4.1 indicates the values of R and  $R^2$  respectively. R stands for correlation coefficient (.842) which depicts the strength and direction of linear relationship between the independent and dependent variable while  $R^2$  (.817) represents the coefficient of determination which provides a clear percentage of variance explained. With the value of R, there is a strong relationship between the variables. The  $R^2$  value (the "**R Square**" column) indicates how much of the total variation in the dependent variable, operational efficiency can be explained by the independent variable, machine learning. In this case, 81.7% can be explained, which is very large. Machine learning coefficient of 0.842 indicates a positive significant relationship with operational efficiency, which is statistically significant with ( $t = 16.230$ ). Sig. is the p-value, and if p-value is less, there is a statistically significant relationship. Therefore, the null hypothesis is rejected and the alternate hypothesis is firmly accepted, thus Machine Learning has a significant positive effect on operational efficiency of SMEs in South-East, Nigeria. This implies that a commensurate increase in Machine Learning leads to a commensurate increase in operational efficiency of SMEs and vice versa. When SMEs begin to appreciate the inherent benefits associated with AI usage, every aspect of their sectors will experience radical change as AI has transformative power that brings about novelty in every area of one's endeavour.

### ***Discussion of finding***

The hypothesis tested indicated that machine learning had a significant positive effect on operational efficiency of SMEs in South-East, Nigeria. Machine learning (ML) makes significant contribution to the operational efficiency of small and medium enterprises (SMEs) by automating processes, optimizing resource allocation, and enabling data-driven decision-making. One of the main benefits of Machine Learning is its ability to analyze large datasets to identify patterns and trends that inform business strategies. This capability allows SMEs to make more informed decisions, thereby improving their responsiveness to market changes (Oldemeyer, Jede, & Teuteberg, 2024). This informed decision making is the key to business growth, sustainability and competitiveness. This finding aligns with Smith (2024) proposition which states that implementing digital tools like machine learning can significantly improve productivity and decision-making processes. The finding is also in tandem with work carried out by A. Kumar, Pandey, Pujari, and Arora (2023) that indicated that the integration of AI in SMEs has resulted in enhancements in various areas such as the development of intelligent content and innovative business models, predictive modelling, automated decision-making processes, real-time customer insights, and advancements in product and service innovations. All the variables improve efficiency of SMEs.

### **5. Conclusion**

Artificial intelligence is a very powerful tool that brings about business sustainability. Its adoption offers numerous benefits for SMEs aiming to achieve sustainable business performance. By enhancing operational efficiency, identifying inefficiencies, enabling data-driven decision-making, improving customer engagement, optimizing resources, fostering innovation, and strengthening risk management, AI serves as a powerful tool for SMEs to thrive

in an increasingly dynamic and competitive marketplace. As SMEs continue to embrace AI technologies, they position themselves for long-term success and sustainability.

**Limitations:** Inferential statistical tool was adopted that limited the manifestations of other statistical tools. Also, SMEs was restricted to South-East instead of taking cognizance of SMEs in Nigeria at large.

**Suggestion:** Policyholders and industry stakeholders need to create a very supportive ecosystems that encourages the adoption of AI in SMEs since many people are ignorant of it. This could involve providing financial incentives, enhancing access to training programs, and developing regulatory frameworks that promote innovation while ensuring data protection. Also, joint efforts among governments, educational institutions, and industry captains can assist SMEs leverage AI technologies effectively, thereby fostering a culture of innovation and sustainability. As SMEs embrace AI, they not only improve their operational efficiency but also contribute to broader sustainability goals, positioning themselves competitively in a rapidly evolving market environment (Nguyen, Pham, & Hoang, 2024).

#### Competing Interests

Authors have declared that no competing interests exist.

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#### REFERENCES

- Acs, Z. J., & Audretsch, D. B. (2008). Innovation in large and small firms: An empirical analysis. *American Economic Review*, 78(4), 678-690.
- Amberkar, S. (2024). How machine learning can help SMEs to maximize the value of operational data. *IIoT World*. Retrieved from <https://www.iiot-world.com/predictive-analytics/predictive-maintenance/how-machine-learning-can-help-smes-to-maximize-the-value-of-operational-data/>
- Amesho, K. T., Edoun, E. I., Naidoo, V., & Poee, S. (2022). Sustainable competitive advantage through technology and innovation systems in the local government authorities. *Africa's Public Service Delivery & Performance Review*, 10(1), 19.
- Badghish, S., & Soomro, Y. A. (2024). Artificial intelligence adoption by SMEs to achieve sustainable business performance: Application of technology–organization–environment framework. *Sustainability*, 16(5), 1864.
- Bain & Company. (2024). AI and sustainability: The power of integration. CEO Sustainability Guide. Retrieved from <https://www.bain.com/insights/ai-and-sustainability-power-of-integration-ceo-sustainability-guide-2024/>
- Bandari, V. (2019). The Impact of Artificial Intelligence on the Revenue Growth of Small Businesses in Developing Countries: An Empirical Study. *Reviews of Contemporary Business Analytics*, 2(1), 33-44.

- Bankingly. (2023). AI-powered solutions for SMEs: Automating financial operations. Retrieved from <https://www.bankingly.com/news/ai-powered-solutions-for-smes-automating-financial-operations/>
- Bennett, E. M., Peterson, G. D., & Gordon, L. J. (2023). Understanding relationships among multiple ecosystem services. *Ecological Applications*, 33(1), e2472. <https://doi.org/10.1002/eap.2472>.
- Data2Sustain. (2024) Machine learning analysis on SME data. Retrieved from <https://data2sustain.ie/service/machine-learning-analysis-on-sme-data/>
- Data2Sustain. (2024). Machine learning analysis on SME data. Retrieved from <https://data2sustain.ie/service/machine-learning-analysis-on-sme-data/>
- Choi, Y. S., & Lim, U. (2024). Sustaining the sustainable development: How do firms turn government green subsidies into financial performance through green innovation? *Business Strategy and the Environment*, 30(5), 2271-2292. <https://doi.org/10.1002/bse.3030>
- Davis, F.D.(1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS Quarterly*.13(3), 319-340.
- EY. (2024). 3 ways AI can drive your sustainability goals in 2024. Retrieved from [https://www.ey.com/en\\_ie/consulting/3-ways-ai-can-drive-your-sustainability-goals-in-2024](https://www.ey.com/en_ie/consulting/3-ways-ai-can-drive-your-sustainability-goals-in-2024)
- Kumar, A., Pandey, A., Pujari, P., & Arora, A. (2023). Adoption of ai and e-commerce improving marketing performance of smes. *Academy of Marketing Studies Journal*, 27(5), 1-10. 2023 | *Annals of Management and Organization Research* / 5(1), 1-11
- Kusi-Sarpong, S., Simonov, A., Bai, C., & Sarkis, J. (2015). Green supply chain practices evaluation in the mining industry using a joint rough sets and fuzzy TOPSIS methodology. *Resources Policy*, 46(P1), 86-100.
- . Johnson, B.(2024). The impact of training on SME Performance. *International Journal of Small Business and enterprise development*, 31(2), 123-138
- Leon, O., Teuteberg, F., & Jede, A. (2024). Investigation of artificial intelligence in SMEs: A systematic review of the state of the art and the main implementation challenges. *Journal of Small Business Management*.
- Lian, S. B. (2023). The Factors Influencing Digital Technologies Adoption in Green Supply Chain
- Macher, J. T. (2006). Technological development and the boundaries of the firm: A knowledge-based examination in semiconductor manufacturing. *Management Science*, 52(6), 826-843.
- Nguyen, M. H., Pham, A. N., & Hoang, P. B. H. (2024). Social and environmental performance at SMEs: Considering motivations, capabilities, and instrumentalism. *Journal of Business Ethics*, 125(4), 541-561. <https://doi.org/10.1007/s10551-023-05289-4>
- Oldemeyer, L., Jede, A., & Teuteberg, F. (2024). Investigation of artificial intelligence in SMEs: A systematic review of the state of the art and the main implementation challenges. *Journal of Business Research*. <https://doi.org/10.1016/j.jbusres.2024.01.012...>
- Lingar Group. (2024). 2024 Tech and analytics trends: Achieving sustainability with AI. Retrieved from <https://lingarogroup.com/blog/2024-tech-and-analytics-trends-achieving-sustainability-with-ai/>

- Oldemeyer, L., Jede, A., & Teuteberg, F. (2024). Investigation of artificial intelligence in SMEs: A systematic review of the state of the art and the main implementation challenges. *Journal of Business Research*. <https://doi.org/10.1016/j.jbusres.2024.01.012>
- Nguyen, M. H., Pham, A. N., & Hoang, P. B. H. (2023). Social and environmental performance at SMEs: Considering motivations, capabilities, and instrumentalism. *Journal of Business Ethics*, 125(4), 541-561. <https://doi.org/10.1007/s10551-023-05289-4>
- Smith, A. (2024). Enhancing operational efficiency in SMEs. *Journal of Small and Medium Enterprises*, 12(1), 45-60.
- Zhang, Y., Zuo, N., He, W., Li, S., & Yu, L. (2021). Stock market liberalization and corporate green innovation: Evidence from China. *International Journal of Environmental Research and Public Health*, 18(7), 1-22.
- Zhou, S. (2024). Innovation intensity, creativity enhancement, and eco-innovation strategy: The roles of customer demand and environmental regulation. *Business Strategy and the Environment*, 33(2), 316-326. <https://doi.org/10.1002/bse.3031>
- Udeogu, A. C., Okoye, I. E., & Emmanuel, I. (2024). Artificial Intelligence and Competitive Advantage of Micro, Small and Medium Enterprises in Anambra State. *Cross Current International Journal of Economics, Management and Media Studies*, 6(1), 1-9.
- Venkatesh, V., and Davis, F.D. (2000). A theoretical extension of the technology acceptance model: Four longitudinal field studies. *Management Science*, 46(2), 186-204.
- World Economic Forum. (2024). How manufacturing with AI can drive a sustainable future. Retrieved from <https://www.weforum.org/agenda/2024/06/how-manufacturing-with-ai-can-drive-a-sustainable-future/>