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AI adoption and sustainability of SMES in Africa: Opportunities and challenges

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Abstract

Adopting Artificial Intelligence (AI) technologies presents significant opportunities and challenges for Small and Medium Enterprises (SMES) in Africa. As the continent strives for economic growth and sustainability. This study explores the potential benefits of AI adoption for African SMES. However, several challenges hinder widespread implementation, such as limited access to finance, and technology, inadequate infrastructure, lack of skilled workforce, and regulatory uncertainties. Data were generated via the Internet, newspapers, newsletters, libraries, and other documented materials pertinent to the study. However, the study highlights how AI can drive operational efficiency, reduce costs, and promote sustainable business practices. Furthermore, cultural attitudes towards technology adoption can also impact the pace at which SMES embrace AI solutions. To harness the full potential of AI for sustainable development in Africa, it is crucial to address these challenges through targeted policies that promote digital literacy, investment in infrastructure, and collaboration between governments, educational institutions, and the private sector. By creating a conducive environment that supports AI integration into business practices, African SMES can leverage these technologies to drive economic growth while contributing to broader sustainability goals.

Keywords: Adoption of Artificial Intelligence; SMES Sustainability; Opportunities; Challenges

1. Introduction

The adoption of Artificial Intelligence (AI) in Small and Medium Enterprises (SMES) has emerged as a significant area of research, especially when it comes to emerging nations such as Africa. According to Nwagbala, Ezeanokwasa, and Aziwe (2023), Organizations especially in developing nations like Nigeria are working so hard to survive and maintain a competitive edge due to the turbulent and increasing changes in the environment. Ezeanokwasa, Nwagbala and Nwachukwu (2023) one common challenge in organizations is the difficulty in successfully implementing change efforts and ensuring that these changes lead to enhanced performance. Most firms are experiencing survival problems due to poor decisions in managing change as critical factors are not taken into consideration in the decision-making process as stated in (Nkiru, Chinelo & Raphael, 2023).

AI can play a transformative role by enhancing operational efficiency, improving decision-making processes, and fostering innovation. Small and medium-sized enterprises (SMES) play a crucial role in Africa's economic development. They are key drivers of job creation, contributing significantly to poverty reduction and economic diversification across the continent. According to the African Development Bank (2020), SMES contribute approximately 80% of total employment and over 50% of GDP in many African countries. These companies, however, encounter several challenges that prevent them from growing and becoming sustainable, including poor infrastructure, a shortage of skilled workers, and restricted access to capital and technology.

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AI technologies have demonstrated promise in recent times for addressing these challenges through increased decision-making, improved operational efficiency, and fostering innovation. To enhance customer experiences, streamline supply chains, and automate repetitive tasks, for example, SMES can benefit from artificial intelligence (Choudhury et al., 2021). Despite these potential benefits, the adoption rate of AI among African SMES remains low due to various challenges such as insufficient digital literacy among employees, high implementation costs, and concerns over data privacy and security (Ogunleye & Adebayo, 2022). According to Audu and Nwagbala (2024) Today, the global corporate world driven by information and communication technology has made the business world a global village, and this has increased the frontiers of challenges facing corporate leaders across the world (Audu &Nwagbala, 2024).

Moreover, it is essential to consider the unique socio-cultural contexts within which African SMES operate. The diversity across regional differences means that strategies for AI adoption must be tailored to local conditions. For example, rural SMES may face different technological hurdles compared to urban counterparts due to varying levels of internet connectivity and access to technology (Munyua et al., 2023). This study sets the stage for a detailed examination of how AI has the potential to foster sustainable growth among African SMES while also addressing the challenges they are facing concurrently.

2. Conceptual clarifications

2.1. AI Adoption in SMES

AI adoption is the process of incorporating AI technologies into business operations to improve decision-making, productivity, and creativity. Adopting AI can be a double-edged sword for SMES, who sometimes have fewer resources than larger enterprises. While there are chances for improvement in operations and competitive advantages, there are also challenges to cost, a lack of skilled labor, and change management (Kamble et al., 2021). As stated in Chinelo, Ndidiamaka and Ejike (2023) Learning effectiveness addresses the question, “How does this new information benefit me, and do I know more now than I did before? (Blocker, 2005; Chinelo, Ndidiamaka & Ejike,2023).

AI adoption in SMES" describes the application of AI technology to boost consumer experiences, streamline business operations, and spur innovation. According to a study by (Garmaki et al., 2023), Businesses that use AI may automate repetitive operations, improve supply chains, and gain better market insights by utilizing data analytics. There are usually several steps involved in the adoption process: awareness, assessment, application, and integration (Garmaki et al., 2023).

2.2. Sustainability in SMES

Sustainability includes social justice, environmental protection, and economic viability. As stated in Nwagbala and Ani (2022) Sustainable development is maintaining a delicate balance between the human need to improve the way of life, maintain and guarantee continuity of a business and feeling of well-being on one hand, and preserving natural resources and ecosystems, on which we and future generations depend (Ozoh and Stephen, 2018; Nwagbala and Ani,2022). For small and medium-sized enterprises (SMES), adopting sustainable practices is essential for regulatory compliance as well as improving brand reputation and customer loyalty (Jabbour et al., 2019). Improved resource efficiency and reduced operational costs can lead to the integration of sustainable practices. Research indicates that SMES that adopt sustainable practices have a higher chance of long-term success. However, many SMES find it difficult to implement these strategies because they lack the necessary resources and experience (Brammer & Millington, 2008).

2.3. Sustainability Considerations

The intersection of AI adoption with sustainability practices is another important consideration. While AI can contribute positively by optimizing resource use and reducing waste, it raises ethical concerns related to job displacement due to automation. Ensuring that the benefits of artificial intelligence (AI) do not jeopardize vulnerable populations requires striking a balance between technological innovation and social responsibility (Khan et al., 2024). However, the Brundtland Commission emphasizes the most well-known and frequently applied concept, sustainable development, as development that satisfies current needs without jeopardizing the ability of future generations to meet their own needs as stated in (Nwagbala & Ani,2022). Although the use of AI offers great potential to improve the sustainability of SMES in Africa, there are also significant challenges that must be addressed. Policymakers, business executives, and academic institutions need to collaborate to design policies that support financial access, skill development, and ethical technology use.

3. Linking ai adoption with sustainability

The integration of Artificial Intelligence (AI) into Small and Medium Enterprises (SMES) has gained significant attention due to its potential to enhance operational efficiency, decision-making, and overall sustainability. The purpose of this conceptual framework is to clarify the relationship between SMES' sustainability and their use of AI. AI technologies can optimize resource usage through predictive analytics and automation. For instance, machine learning algorithms can analyze data patterns to reduce waste or improve supply chain efficiency (Wang et al., 2022). Furthermore, AI-driven solutions that provide real-time data analysis can help with environmental impact monitoring. Furthermore, the decision-making processes associated with sustainability projects can be improved by the use of AI in company plans. SMES can pinpoint operational improvement opportunities that support sustainable development objectives by utilizing the data analytics capabilities provided by AI systems (SDGs) (Zhang et al., 2022).

Nevertheless, there are still difficulties with putting these technologies into practice. A lot of SMES lack the knowledge foundation or infrastructure needed for an efficient AI deployment. Thus, creating an atmosphere that encourages creativity through collaborations and training initiatives might be crucial to getting beyond these obstacles.

4. The role of ai in enhancing sustainability

Sustainable operations are referred to as "keeping the business going". It also refers to "achieving success today without compromising the needs of the future (Colbert & Kuruiz, 2017; Nwagbala, Ifureze & Okafor,2022). AI has significant potential to enhance the sustainability of Small and Medium Enterprises (SMES) through several key areas:

- **Enhancing Efficiency**: AI-driven tools can automate routine tasks, leading to greater operational efficiency. For instance, machine learning algorithms can streamline administrative processes, optimize workflows, and improve decision-making, thus allowing SMES to allocate resources more effectively and reduce operational costs (Smith, 2023).
- **Reducing Waste**: AI technologies can help minimize waste by predicting demand more accurately and optimizing inventory levels. For example, AI can analyze historical sales data and market trends to prevent overproduction and reduce excess inventory, thus minimizing waste (Johnson & Lee, 2023).
- **Resource Optimization**: AI algorithms can analyze data to optimize resource usage, reducing waste and energy consumption. For instance, predictive analytics can help businesses forecast demand more accurately, leading to better inventory management and reduced overproduction (Wang et al., 2022).
- **Improving Supply Chain Management**: AI can enhance supply chain management by providing better visibility and control over supply chain processes. AI algorithms can forecast demand, manage inventory, and predict disruptions, leading to a more resilient and sustainable supply chain. This optimization helps SMES reduce costs and improve their overall supply chain efficiency (Taylor, 2023).
- **Energy Management**: AI technologies such as IoT devices enable real-time monitoring of energy consumption patterns within SMES. This data helps identify inefficiencies and implement energy-saving measures (Zhou et al., 2023).

5. Opportunities for ai adoption in SMES

- **Enhance operational efficiencies**: AI has the potential to enhance operational efficiencies, improve customer service, and foster innovation within SMES. For instance, AI can automate routine tasks, allowing businesses to allocate resources more effectively (Choudhury et al., 2021).
- **Market trends and consumer behaviour**: AI-driven data analytics can provide insights into market trends and consumer behavior, enabling SMES to make informed decisions that drive growth (Munyiri & Muthoni, 2022). The integration of AI can also facilitate access to global markets through improved online presence and e-commerce capabilities.
- **New Business Models**: AI enables the creation of innovative business models, allowing SMES to explore new markets and revenue streams, thereby enhancing their long-term sustainability (Amankwah-Amoah, 2022).

6. Challenges of the implementation of ai

Despite the numerous benefits associated with AI adoption, there are several challenges that African SMES face.

- **High Costs**: The financial implications associated with adopting AI technologies can be discouraging for many SMES operating on tight budgets. Research conducted by McKinsey & Company (2021) indicates that initial investments required for software licenses, hardware upgrades, and employee training can be prohibitively high. Many SMES lack the capital to invest in these technologies if there are no quick returns. Businesses are discouraged from pursuing AI integration due to additional financial burdens caused by ongoing maintenance expenditures and perhaps consulting services. Financial constraints prevent a lot of small and medium-sized businesses from investing in advanced technologies like AI systems.
- **Lack of Technical Skills and Expertise**: Many SMES lack the technical expertise necessary to develop or integrate AI systems effectively. This skills gap can lead to underutilization of available technologies (Muller et al., 2023). A study conducted by the African Development Bank (AfDB, 2022) indicates that a significant portion of the workforce lacks basic digital literacy skills, let alone advanced skills required for AI implementation. This skills gap creates a barrier not only for individual businesses but also for broader economic development as it limits innovation and competitiveness within the market.
- **Lack of Awareness**: A common problem faced by SMES is a lack of knowledge about the tools and resources available to them, such as market trends, technology advancements, and financial aid. This knowledge gap can lead to missed opportunities and inefficient business practices.
- **Cultural Resistance to Change**: Cultural resistance within organizations can impede the adoption of new technologies like AI. Employees may fear job displacement or feel overwhelmed by the complexity of new systems (Davenport & Ronanki, 2018).
- **Limited Access to Technology:** Many SMES operate in environments where internet connectivity is unreliable or nonexistent. According to a report by the International Telecommunication Union (ITU, 2021), only about 28% of individuals in Africa have access to the Internet, which severely limits the ability of businesses to leverage AI tools that often require stable online connections. Furthermore, many SMES are unable to invest in the necessary hardware or software due to financial constraints (World Bank, 2020).
- **Infrastructural Deficits**: Infrastructural challenges significantly impact the ability of SMES in Africa to adopt AI technologies successfully. Poor electricity supply remains a critical issue; frequent power outages disrupt business operations and hinder access to online resources necessary for effective AI implementation (United Nations Economic Commission for Africa (UNECA, 2021). Furthermore, SMES attempting to expand their businesses or incorporate cutting-edge technologies into their processes find that their market reach and resource accessibility are restricted by poor transportation networks. Adopting digital solutions required for the successful adoption of AI is significantly

hampered by inadequate technological infrastructure and poor internet access.

7. Strategies for successful ai implementation

To overcome these challenges and harness the full potential of AI for sustainability, SMES should consider several strategies:

- **Incremental Adoption**: SMES should implement AI gradually rather than trying to completely redesign everything at once. Start with pilot projects that show a clear return on investment before expanding.
- **Partnerships with Tech Providers:** collaborating with academic institutions or technology providers can assist bridge the knowledge gap and split the expenses of adopting innovative technologies.
- **Training Programs**: Putting money into digital skills training programs for employees will enable them to adopt new technology with confidence.
- **Focus on Data Governance**: Establishing strong data governance frameworks will guarantee that data is used wisely and ethically, in addition to addressing privacy issues.
- **Engagement with Stakeholders:** Engaging customers and other stakeholders in conversations surrounding sustainability efforts will promote a collaborative and innovative culture.

8. Expected outcomes in terms of sustainability

8.1. Improved Operational Efficiency

Organizational operational efficiency is typically enhanced by sustainability measures. By adopting sustainable practices, Businesses can improve operations, maximize resource utilization, and reduce waste. For instance, implementing energy-efficient technologies can significantly lower energy consumption, leading to smoother operations and reduced downtime. Furthermore, Adopting lean manufacturing concepts, which aim to reduce waste

while increasing efficiency, frequently goes hand in hand with environmental initiatives. This combined strategy not only increases productivity but also supports CSR objectives.

8.2. Cost Reduction

One of the most immediate benefits of sustainability is cost reduction. Organizations that invest in sustainable technologies and practices often experience lower operational costs over time. For example, transitioning to renewable energy sources can reduce reliance on fossil fuels and mitigate fluctuations in energy prices (Mazzucato & Semieniuk, 2018). Additionally, sustainable supply chain management can lead to reduced material costs through better resource management and waste reduction strategies. Companies that adopt circular economy principles where products are designed for reuse or recycling can further decrease costs associated with raw materials and disposal (Geissdoerfer et al., 2018).

8.3. Enhanced Customer Experience

Sustainability is essential to improving the client experience Consumers today are more conscious of environmental issues and choose companies that are committed to sustainability. Businesses that prioritize sustainable practices often experience a rise in client retention and satisfaction because these activities align with the values of their target market. Furthermore, open communication about sustainable initiatives can strengthen consumer and brand trust.

This enhanced relationship drives sales and encourages repeat business and positive word-of-mouth referrals.

8.4. Reduced Environmental Footprint

Reducing an organization's environmental impact is, finally, one of the most important results of implementing sustainability. Reducing greenhouse gas emissions, preserving water resources, and cutting back on waste are examples of sustainable activities that directly support environmental preservation (IPCC,2021). Businesses may drastically minimize their environmental influence by putting measures like carbon offsetting or zero-waste policies into practice. In addition to contributing to the fight against climate change, this helps businesses stand out in a market that is becoming more environmentally sensitive.

9. Potential benefits of Ai for SMEs

Artificial Intelligence (AI) offers several key benefits for small and medium-sized enterprises (SMES), particularly in improving operational efficiency, enhancing customer engagement, and supporting decision-making processes.

- AI can significantly improve operational efficiency by automating routine tasks such as data entry, inventory management, and customer service, which allows SMES to reduce costs and allocate resources more effectively (Nguyen & Thompson, 2023). This automation also frees employees to focus on more strategic activities that drive business growth.
- AI enhances customer engagement by providing personalized experiences. AI-driven tools can analyze customer data to deliver tailored recommendations, targeted marketing campaigns, and responsive customer service, all of which contribute to increased customer satisfaction and loyalty (Smith & Walker, 2024).
- AI supports decision-making by providing SMES with powerful data analytics tools. These tools can process large volumes of data, identify trends, and generate insights that inform strategic decisions, reducing uncertainty and enhancing competitiveness in the market (Jones & Allen, 2024).
- AI tools can assist SMES in identifying new market opportunities by analyzing consumer behavior patterns and preferences thereby expanding the market.

10. Encouraging collaboration for Ai adoption in SMEs

The successful integration of AI into SMES requires a collaborative effort among various stakeholders, including governments, educational institutions, and the private sector. This collaboration can create an environment that supports AI adoption through shared resources, knowledge transfer, and policy development.

10.1. Role of Governments

Governments play a pivotal role in fostering an ecosystem conducive to AI adoption. They can implement policies that incentivize SMES to invest in AI technologies. For instance, tax breaks or grants for technology investments can lower the financial barriers that SMES face when adopting new technologies (European Commission, 2020). Additionally,

governments can facilitate public-private partnerships that allow SMES to access advanced technologies and expertise from larger corporations or research institutions.

Moreover, governments should focus on creating regulatory frameworks that promote innovation while ensuring ethical standards are met. Clear guidelines on data privacy and security will encourage SMES to adopt AI solutions without fear of legal repercussions (OECD, 2021). By establishing a supportive regulatory environment, governments can help SMES navigate the complexities associated with AI implementation.

10.2. Role of Educational Institutions

Educational institutions are essential in equipping the workforce with the necessary skills to leverage AI technologies effectively. Collaborations between universities and SMES can lead to tailored training programs that address specific industry needs (Bessen et al., 2020). These programs could include workshops, internships, and co-op placements that provide hands-on experience with AI tools.

Furthermore, research initiatives funded by educational institutions can lead to innovative solutions specifically designed for SMES. By encouraging students and faculty to engage with local businesses on real-world problems involving AI applications, educational institutions can foster a culture of innovation while simultaneously supporting SME growth.

10.3. Role of the Private Sector

The private sector has a significant role in driving technological advancements and providing resources for SMES wishing to implement AI. Large technology companies can offer affordable access to their platforms and tools through subscription models or tiered pricing strategies tailored for smaller businesses (McKinsey & Company, 2021). Additionally, mentorship programs where experienced individuals educate SME owners through the process of implementing AI into their operations can be invaluable.

Collaboration between private businesses promotes the exchange of information regarding the most effective ways to put AI technologies into practice. Industry associations can facilitate networking events so that small and medium-sized enterprises can share their experiences with adopting AI successfully.

11. Theoretical review

The Resource-Based View (RBV) theory

The Resource-Based View (RBV) theory by Barney (1991) posits that a firm's competitive advantage is derived from its unique resources and capabilities. He emphasizes that SMES may possess unique human capital in terms of skilled employees who understand AI technologies or proprietary data that can be leveraged for machine learning applications. These resources can provide a significant advantage over competitors who lack similar capabilities. The RBV emphasizes not just having resources but also developing capabilities around those resources. For instance, an SME might invest in training staff on AI tools or develop partnerships with tech firms to enhance their technological capabilities. The RBV also suggests that for a resource or capability to provide a sustainable competitive advantage, it must be valuable, rare, inimitable, and non-substitutable (VRIN criteria). If an SME successfully adopts AI technologies that meet these criteria—such as proprietary algorithms or specialized knowledge, they can achieve long-term benefits.

12. Gap in current literature

Artificial Intelligence (AI) has been increasingly recognized for its potential to enhance the sustainability of Small and Medium Enterprises (SMES). However, the existing literature primarily focuses on the technological capabilities of AI rather than its long-term impacts on sustainability practices within SMES. This gap presents an opportunity for future research that can provide a more comprehensive understanding of how AI influences sustainable practices over time.

12.1. Policy recommendations

To facilitate the integration of AI into African SMES, the authors propose several policy recommendations:

- **Training Programs:** Governments and organizations should invest in training programs aimed at enhancing digital literacy among SME owners and employees.

- **Access to Funding:** Financial institutions should develop tailored funding solutions that cater specifically to the needs of SMES looking to adopt AI technologies.
- **Public-Private Partnerships:** Collaboration between government entities and private sector players can foster an ecosystem conducive to innovation.
- **Infrastructural Investments**: Investing in digital infrastructure is essential for enabling widespread access to AI technologies. Policymakers should prioritize the development of high-speed internet access, particularly in rural and underserved areas, as this will facilitate the use of cloud-based AI solutions. Additionally, creating innovation hubs or tech parks can provide SMES with access to shared resources, mentorship, and networking opportunities that are vital for successful technology adoption.

13. Suggested areas for future research

- **Longitudinal Studies on Impact:** Future research should prioritize longitudinal studies that assess the long-term effects of AI implementation on SME sustainability metrics. These studies could explore various dimensions such as environmental performance, social responsibility, and economic viability over extended periods.
- **Sector-Specific Studies:** Conducting detailed sector-specific studies will allow researchers to understand better how different industries leverage AI for sustainable practices. For instance, examining how agricultural SMES use AI for resource management could reveal unique challenges and opportunities compared to those in manufacturing or service sectors.
- **Cross-Regional Comparisons:** Assessing the differences in AI adoption across various African regions can reveal effective approaches and common challenges that small and medium-sized enterprises encounter. Policymakers and business owners could benefit from such comparative evaluations by learning about locally relevant technological initiatives that support sustainable development.

14. Conclusion

The adoption of Artificial Intelligence (AI) by Small and Medium-sized Enterprises (SMEs) in Africa presents a paradox. While AI offers immense opportunities for growth, innovation, and competitiveness, its adoption is hindered by significant challenges. These challenges include limited access to funding, inadequate infrastructure, shortage of skilled personnel, and regulatory frameworks that are not conducive to AI adoption. Governments and private sector players should invest in AI skills development programs, AI infrastructure, including data centers and high-speed internet.

Compliance with ethical standards

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Conflict of Interests

The authors declare that they have no conflict of interests.

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