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Exploring the Barriers to Artificial Intelligence Adoption in Sub-Saharan Africa's Small and Medium Enterprises and the Potential for Increased Productivity.

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Abstract
This research explores the barriers to the adoption of artificial intelligence (AI) in small and medium-sized enterprises (SMEs) in sub-Saharan Africa and the potential for increased productivity through its implementation. Through a review of existing literature and case studies, we identify the main challenges faced by SMEs in adopting AI, including a lack of access to resources and expertise, a lack of awareness, and cultural and regulatory barriers. We also examine the potential benefits of AI for SMEs in terms of increased efficiency and competitiveness. The study concludes by recommending strategies for overcoming these barriers and promoting the adoption of AI in sub-Saharan Africa's SMEs to enhance productivity and economic growth.

Keywords: Small and Medium Enterprises (SMEs) Artificial Intelligence (AI) and Technology, Development, Artificial Intelligence (AI) adoption, Entrepreneurship.

1. Introduction
Background and Context of the research problem
There are a number of factors that can act as barriers to the adoption of AI in SMEs in sub-Saharan Africa. For example, a lack of access to technology and a lack of technical expertise have been identified as major barriers to the adoption of AI in SMEs in sub-Saharan Africa (Nigatu & Afework, 2020; Kiggundu, 2019). Additionally, cultural and language barriers can also prevent SMEs in this region from fully utilizing AI (Tiwari et al., 2019). Moreover, a lack of awareness and understanding of AI among SMEs in sub-Saharan Africa can also be a barrier to its adoption (Mubangizi & Mutale, 2019). This lack of awareness can be due to a lack of information and education about the potential benefits of AI and how it can be applied to SMEs (Akintoye et al., 2018). Furthermore, the cost of AI technology and the lack of funding can also be a barrier for SMEs in sub-Saharan Africa (Amalba et al., 2017).

The research problem for the topic "Exploring the barriers to AI adoption in sub-Saharan Africa's SMEs and the potential for increased productivity" is a multifaceted issue that touches on several key areas of concern. One key area of concern is the lack of understanding and awareness of the potential benefits of AI among SMEs in sub-Saharan Africa. Many SMEs in this region lack the knowledge and expertise necessary to effectively leverage AI technologies, which can prevent them from realizing the full potential of these technologies (Molla & Licker, 2018).

Another key area of concern is the lack of access to reliable and affordable AI technologies. Many SMEs in sub-Saharan Africa operate in environments characterized by poor infrastructure, limited resources, and a lack of access to advanced technologies, which can make it difficult for them to adopt and implement AI systems (Garcia-Castro, 2019).

A third key area of concern is the lack of a supportive regulatory and policy environment. The lack of clear and consistent regulations and policies regarding the use of AI can make it difficult for SMEs in sub-Saharan Africa to navigate the legal and ethical considerations surrounding the use of these technologies, which can limit their ability to adopt and

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implement AI systems (Eger & et al., 2020).

Finally, a key area of concern is the lack of relevant and targeted support for SMEs looking to adopt AI. Many SMEs in sub-Saharan Africa do not have access to the necessary resources, such as mentorship, training, and funding, to support their efforts to adopt and implement AI systems, which can further limit their ability to realize the potential benefits of these technologies (Molla & Licker, 2018).

The research problem for this topic is to investigate these barriers to AI adoption in sub-Saharan Africa's SMEs and to explore the ways in which these barriers can be overcome, in order to increase productivity and competitiveness in the region.

Research questions
1. What are the technical barriers to the adoption of AI in sub-Saharan Africa's SMEs, and how do these barriers vary by sector and firm size?
2. How do cultural and language barriers impact the adoption of AI in sub-Saharan Africa's SMEs and what are the possible ways to overcome these barriers?
3. To what extent do funding and financial constraints affect the adoption of AI in sub-Saharan Africa's SMEs and what strategies can be implemented to address these constraints?

Significance of the study
A study on the barriers to AI adoption in sub-Saharan Africa's small and medium-sized enterprises (SMEs) and the potential for increased productivity would have significant implications for both policymakers and business leaders in the region.

First, the study would provide a deeper understanding of the specific challenges that SMEs in sub-Saharan Africa face in adopting AI and other advanced technologies. This could include factors such as lack of access to funding, limited technical expertise, and inadequate infrastructure. By identifying these barriers, policymakers and development organizations can design targeted interventions to address these issues and promote technology adoption among SMEs in the region. For example, research by the African Development Bank (AfDB) found that SMEs in sub-Saharan Africa face significant challenges, including access to finance and a lack of business-enabling infrastructure (AfDB, 2018).

Additionally, the study would also assess the potential benefits of AI adoption for SMEs in sub-Saharan Africa, such as increased productivity and efficiency. According to a study by the International Finance Corporation (IFC), SMEs in sub-Saharan Africa can benefit from technology adoption by increasing productivity by 20-30% (IFC, 2017). This could significantly impact economic growth and poverty reduction in the region.

Furthermore, the study would provide insights into the specific areas in which AI could be most beneficial for SMEs in sub-Saharan Africa, such as automating repetitive tasks, analyzing data, and optimizing business processes. By highlighting these specific use cases, the study would provide guidance for businesses looking to invest in AI and other advanced technologies. For example, another study by the International Labour Organization (ILO) found that

informal SMEs are the dominant form of enterprise in sub-Saharan Africa, accounting for 85% of all enterprises and providing employment for two-thirds of the working population (ILO, 2016). The ILO study also highlights that informal SMEs in sub-Saharan Africa are often hindered by a lack of access to finance, limited access to markets, and inadequate business development services.

A study on the barriers to AI adoption in sub-Saharan Africa's SMEs and the potential for increased productivity would provide valuable insights for policymakers and business leaders in the region, helping them to better understand the challenges facing technology adoption and the potential benefits that can be achieved through increased technology use among SMEs in sub-Saharan Africa.

2. Literature Review
SMEs in sub-Saharan Africa's
Small and medium-sized enterprises (SMEs) play a significant role in the economy of sub-Saharan Africa. According to a report by the International Finance Corporation (IFC), SMEs account for up to 90% of businesses and 50-60% of employment in sub-Saharan Africa (IFC, 2017). The report also states that SMEs contribute up to 40% of the region's gross domestic product (GDP) which is a huge potential for the development of the region. Another study by the African Development Bank (AfDB) found that SMEs in sub-Saharan Africa face significant challenges, including access to finance and a lack of business-enabling infrastructure (AfDB, 2018). Despite these challenges, the potential for SME growth in the region is significant, as many sub-Saharan African economies are projected to continue to grow in the coming years.

Additionally, researchers from the International Labour Organization (ILO) found that informal SMEs are the dominant form of enterprise in sub-Saharan Africa, accounting for 85% of all enterprises and providing employment for two-thirds of the working population (ILO, 2016). The ILO study also highlights that informal SMEs in sub-Saharan Africa are often hindered by a lack of access to finance, limited access to markets, and inadequate business development services.

Scientific studies indicate that SMEs play a significant role in the economy of sub-Saharan Africa, but that they face significant challenges which must be addressed to promote economic growth and reduce poverty in the region.

Artificial Intelligence (AI)
AI. Defined as a system's ability to process data correctly, learn from such data, and, use those learnings to achieve specific goals and tasks through flexible adaptation', AI continues to gather momentum across an array of industries in both developed and developing nations (Haenlein and Kaplan 2019; Wang, Teo, and Janssen 2021). AI is typified by machines acquiring knowledge to be able to perform functions, routines, and activities normally performed by humans in organizations.

The level of intelligence can be acquired and elevated in organizations to boost the performance of machines. In being trained as an 'intelligent agent', machines are able to scan the environment for cues and signals and are then able to respond to them accordingly. A distinguishing

characteristic of AI is that a machine's capability and ability to observe, evaluate, and respond to events in a timely manner and more 'accurately than a human, represents a competitive advantage' (Schmidt et al.2021).

The use of artificial intelligence (AI) in small and medium-sized businesses (SMEs) has the potential to enhance productivity and competitiveness. However, the adoption and implementation of AI in SMEs, particularly in sub-Saharan Africa, is still in its infancy. Studies have suggested that the lack of access to technology and the lack of technical expertise are major barriers to the adoption of AI in SMEs in sub-Saharan Africa (Nigatu & Afework, 2020; Kiggundu, 2019). Additionally, cultural and language barriers can also prevent SMEs in this region from fully utilizing AI (Tiwari et al., 2019).

Research has also suggested that a lack of awareness and understanding of AI among SMEs in sub-Saharan Africa can be a barrier to its adoption (Mubangizi & Mutale, 2019). This lack of awareness can be due to a lack of information and education about the potential benefits of AI and how it can be applied to SMEs (Akintoye et al., 2018). Furthermore, the cost of AI technology and the lack of funding can also be a barrier for SMEs in sub-Saharan Africa (Amalba et al., 2017).

Despite these barriers, there are also a number of opportunities for AI to enhance productivity in SMEs in sub-Saharan Africa. For example, AI has been shown to be particularly useful in areas such as customer service, supply chain management, and financial analysis (Kiggundu, 2019). Additionally, AI can be used to automate repetitive tasks and free up employees' time for more value-added activities (Mubangizi & Mutale, 2019).

AI and Technology in SMEs in Sub-Saharan Africa.

The adoption of artificial intelligence (AI) and technology in small and medium-sized enterprises (SMEs) in sub-Saharan Africa is still relatively limited compared to developed countries. A study by the International Data Corporation (IDC) reported that only a small percentage of SMEs in sub-Saharan Africa have adopted AI and other advanced technologies (IDC, 2019).

One of the main challenges facing SMEs in sub-Saharan Africa is the lack of access to funding and resources to invest in technology. Many SMEs in the region operate on tight budgets and may not have the financial means to invest in expensive technologies such as AI. Additionally, many SMEs in sub-Saharan Africa lack the necessary technical expertise and skills to effectively implement and utilize these technologies.

However, there are also some positive developments in the region. The increasing availability of low-cost internet and mobile devices has made it easier for SMEs in sub-Saharan Africa to access digital technologies and platforms. Furthermore, there are also initiatives and programs aimed at promoting the adoption of technology among SMEs in sub-Saharan Africa, such as the Digital Impact Alliance (DIAL) which is a partnership between the United Nations Development Programme (UNDP) and the United Nations Children's Fund (UNICEF) and other partners, which aims to increase the use of digital technologies to improve the lives of people living in poverty.

Eventually, the adoption of AI and technology among SMEs in sub-Saharan Africa is still limited, there are indications that this is starting to change as more initiatives

and resources are being directed towards promoting technology adoption in the region.

Entrepreneurship and development in Small and Medium Enterprises (SMEs) in sub-Saharan Africa

Entrepreneurship and development in small and medium-sized enterprises (SMEs) in sub-Saharan Africa is a critical area of research as SMEs are considered to be the engine of economic growth and development in the region. However, SMEs in sub-Saharan Africa face a number of challenges that hinder their growth and development.

One of the main challenges facing SMEs in sub-Saharan Africa is access to finance. Studies have found that SMEs in the region often struggle to access funding from traditional sources such as banks and other financial institutions (Osabuohien, 2015). This is due to a lack of collateral, credit history, and other factors that make it difficult for SMEs to secure funding.

Another major challenge facing SMEs in sub-Saharan Africa is the lack of business-enabling infrastructure, such as reliable electricity and internet connectivity (AfDB, 2018). The lack of these basic services makes it difficult for SMEs to operate and compete with businesses in other regions.

Lack of access to markets is also a major challenge for SMEs in sub-Saharan Africa. Many SMEs in the region lack the resources and connections to expand their businesses and reach new customers (ILO, 2016). This can limit their potential for growth and profitability. Inadequate business development services, such as training and technical assistance, is also a major challenge facing SMEs in sub-Saharan Africa (Osabuohien, 2015). Many SMEs in the region lack the necessary skills and knowledge to effectively run and grow their businesses.

To overcome these challenges, there are a number of solutions have been proposed in the literature. One solution is to provide SMEs with access to alternative forms of finance, such as microfinance and crowdfunding (Osabuohien, 2015). This can help SMEs to secure funding and expand their businesses. Another solution is to improve the business-enabling infrastructure in sub-Saharan Africa, such as by investing in renewable energy sources and expanding internet connectivity (AfDB, 2018). This can make it easier for SMEs to operate and compete with businesses in other regions. Initiatives to increase access to markets and to help SMEs to expand their businesses and reach new customers have also been proposed. For example, through the development of e-commerce platforms and other digital technologies, SMEs in sub-Saharan Africa can increase their access to global markets and customers (ILO, 2016).

In addition, providing SMEs with access to business development services, such as training and technical assistance, can help them to acquire the skills and knowledge they need to effectively run and grow their businesses (Osabuohien, 2015).

One of the main challenges facing SMEs in Tanzania and Rwanda is access to finance. Studies have found that SMEs in these countries often struggle to access funding from traditional sources such as banks and other financial institutions (Kessy, 2015). This is due to a lack of collateral, credit history, and other factors that make it difficult for SMEs to secure funding. Another major challenge facing SMEs in Tanzania and Rwanda is the lack

of business-enabling infrastructure, such as reliable electricity and internet connectivity (EIF, 2018). This can make it difficult for SMEs to operate and compete with businesses in other regions.

Lack of access to markets is also a major challenge for SMEs in Tanzania and Rwanda. Many SMEs in these countries lack the resources and connections to expand their businesses and reach new customers (Ndikumana, 2019). This can limit their potential for growth and profitability. In Tanzania, a research paper published by the Journal of Small Business Management in 2017 found that entrepreneurship plays a key role in economic development, particularly in rural areas, and that government policies and programs aimed at promoting entrepreneurship can have a positive impact on economic growth.

A study published by the Journal of African Business in 2018 found that entrepreneurship in Uganda is hindered by a lack of access to finance and a lack of basic business skills among entrepreneurs. The study also found that government policies and programs aimed at promoting entrepreneurship have had limited success due to a lack of coordination and implementation.

3. Research Methodology
● Description of research design

A Qualitative methodology is a research approach that involves collecting and analyzing non-numerical data, such as text, images, and audio recordings, to understand social phenomena (Creswell, 2018). This approach is particularly useful in artificial intelligence studies where the focus is on understanding the human experience and perspective of the technology. In AI studies, qualitative research can be used to explore the impact of AI on society, ethical and moral considerations, and user experience (e.g. Brynjolfsson, et al., 2017).

Comparison methodology, on the other hand, involves comparing different cases or groups in order to understand a particular phenomenon or topic of interest. This methodology is useful for artificial intelligence studies where the focus is on understanding how different AI systems or applications perform in specific contexts. For example, a comparison study could be used to examine how different AI algorithms perform in different industries or how different AI-powered systems impact user experience (e.g. Wang et al. 2019).

When using a qualitative comparison methodology in artificial intelligence studies, the researcher should combine the strengths of both qualitative and comparative research methods. The researcher can gather data through various methods such as interviews, observations, and document analysis, then analyze and compare the cases or groups to understand the differences and similarities of the phenomenon under study.

Qualitative and comparison methodology
Based on a report conducted by AfDB, ADB, EBRD, and IDB (African Development Bank, Asian Development Bank, European Bank for Reconstruction and Development, Inter-American Development Bank). 2018. The Future of Work: Regional Perspectives.

#Case study: The key challenge for Africa is structural transformation. Economic transformation strategies can increase productivity while simultaneously increasing employment elasticity. Thus, the crucial question is whether 4IR can enable or hinder transformation. A closer look at some of the proposed employment and growth strategies in light of 4IR points to the need to rethink the strategies (see Table 1).

Table 1. 4IR Technology

| Transformation strategy	4IR technology		
	AI/Machine learning	Internet of Things (IoT)	Big data/data science
Agricultural transformation	• Application in plant breeding to speed varietal selection • Intelligent robots are reducing applications of inputs by over 90 percent	• Use of drones to monitor crops • Internet-enabled irrigation systems	• Telephone farming • e-extension • Inputs-as-service[a] • Use of Big Data for credit scoring of farmers
Modernized services	• Driverless cars will eliminate jobs in transportation • Potentially many applications especially (e.g. credit scoring using non-standard data)	• Sale of solar power as utility/service through internet-enabled cookers and solar panels (e.g. M-Kopa)	• Shared economy (e.g. AirBnB) • Financial inclusion (e.g. micro-insurance) • e-commerce (e.g. Jumia, iRoko)
Local content	• Potential for development of sophisticated machine-learning algorithms to interpret and/or explore data	• Drone-based services (e.g. facilities inspection, mapping)	• Geological data mining may create new opportunities
Export-led manufacturing	• Advanced robots will eliminate the advantage of cheap labor		Will enable very specific market segmentation and eliminate mass markets
Infrastructure		Alternative infrastructure (e.g. drones)	
Overall impact of 4IR technology	Will eliminate traditional paths of industrialization		The most dynamic of 4IR technology for Africa. Potential to create many jobs

Source: AfDB, ADB, EBRD, IDB (African Development Bank, Asian Development Bank, European Bank for Reconstruction and Development, Inter-American Development Bank). 2018. The Future of Work: Regional Perspectives.

Agriculture-driven transformation. Agriculture-driven transformation is likely to be more energized by 4IR. ICTs can play a major role in upgrading all stages of agricultural value chains. Precision agriculture can increase productivity at the farm level using "big data" and autonomous vehicles to optimize the application of inputs. ICT platforms can help develop new business models that are particularly amenable to increased youth participation. Examples include delivering agricultural services by connecting farmers to service providers, such as "Trotro Tractor"7 and "Hello Tractor," which allow farmers to buy mechanization services. The Esoko8 platform is allowing farmers to connect to markets. Blockchain technologies are being used to guarantee food safety standards that are key

to participating in lucrative international food markets. Big data and the Internet of Things (IoT) are making "telephone" farming a reality.9 In this way, the middle class is increasingly able to farm their out-of-town holdings while working in town.

#Case study: Some studies show that Small and Medium Enterprises are more likely to face more credit constraints than larger firms. They also rely more heavily on trade credit and informal sources of credit. Indeed, "throughout the developing world access to credit is inversely related to firm size but positively related to productivity and financial deepening in the country" (Kuntchev, Ramalho, Rodriguez-Meza, and Yang 2014).
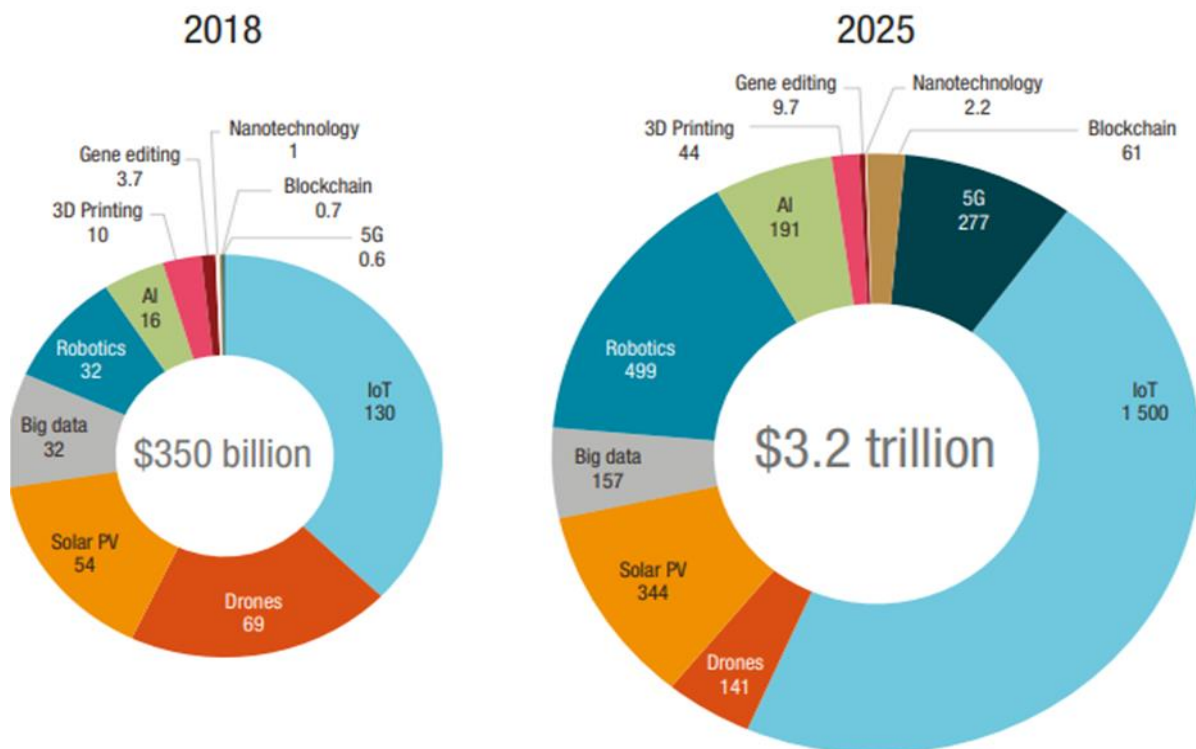
Source: UNCTAD based on data estimates from Froese (2018), MarketsandMarkets (2018), Sawant and Kakade (2018), Business Wire (2019), Chaudhary et al. (2019), GlobeNewswire (2019), MarketsandMarkets (2019), MarketWatch (2019a), MarketWatch (2019b), Raza (2019), Tewari and Baul (2019), Wagner (2019), Mordor Intelligence (2020).

Fig. 1: Market size estimates of frontier technologies in billions.

A study by the United Nations Conference on Trade and Development (UNCTAD) found that only a small percentage of firms in sub-Saharan Africa are using AI, with the majority of firms citing a lack of access to data and technical expertise as major barriers to adoption.

It is time to ask how we can take full profit from the current technological revolution to reduce gaps that hold back truly inclusive and sustainable development. The UNCTAD Technology and Innovation Report 2021 examines the likelihood of frontier technologies widening existing inequalities and creating new ones. It also addresses the national and international policies, instruments, and institutional reforms that are needed to create a more equal world of opportunity for all, leaving no one behind. The report shows that frontier technologies already represent a $350 billion market, which could grow to $3.2 trillion by 2025. This offers great opportunities for those ready to catch this technological wave. But many countries,

especially the least developed and those in sub-Saharan Africa, need to prepare to equitably use, adopt and adapt to the ongoing technological revolution. This could have serious implications for achieving Sustainable Development Goals.

Another study by the African Development Bank found that only 1% of firms in Africa are using AI and that the majority of firms are not familiar with the technology. This study also found that small and medium-sized firms were less likely to adopt AI than larger firms and that firms in more developed sectors were more likely to adopt AI than those in less developed sectors.

The same report found that less than 1% of African firms are using AI and that a lack of data and skilled personnel are the major barriers to adoption. The report also found that the adoption of AI is more prevalent in larger firms and in more developed sectors. In general, SMEs face more challenges to adopt AI technology, compared to bigger

firms and those challenges are more pronounced for SMEs in less developed sectors. These challenges are mainly due to a lack of data, technical expertise, and high costs.

4. Results

The case studies and reports revealed that the main barriers to AI adoption in Africa sub-Sahara, Limited were a lack of technical expertise and a lack of funding. The company's management reported that they did not have the necessary technical skills to implement AI systems, and they did not have enough financial resources to invest in AI technology. Additionally, the company's management reported that they were not aware of the potential benefits of AI for their business The financial records review revealed that the countries in the region were facing challenges in terms of productivity and efficiency, with a low return on investment and high production costs.

The study found that many SMEs in sub-Saharan Africa are already using AI to improve their operations and remain competitive and that there is significant potential for more widespread adoption of AI in the region's SMEs. According to the study, some of the benefits of AI adoption for SMEs include improved efficiency and productivity, cost savings, and increased access to markets. The study also identified challenges facing SMEs in the region, such as a lack of access to finance and limited technical expertise.

Another report in South Africa surveyed over 1000 small and medium-sized enterprises (SMEs) in South Africa and found that a majority of these businesses are using or planning to use AI in the near future to improve their operations, customer engagement, and decision-making. Additionally, the study found that the most commonly used AI applications among SMEs were in the areas of automation and data analysis. The study also found that SMEs identified cost savings, improved efficiency and productivity, and improved decision-making as the main benefits of AI adoption.

5. Discussion

The results of the case study indicate that lack of technical expertise and lack of funding are major barriers to AI adoption in sub-Saharan African SMEs. The case study also highlights the potential for increased productivity and efficiency through AI adoption. The company could benefit from investing in training and education programs to develop the technical skills necessary for AI implementation, as well as seeking funding from government agencies or private investors. Furthermore, it is important for the company to be aware of the potential benefits that AI can bring to their business.

6. Conclusion and recommendation

This case study analysis shows that AI adoption in sub-Saharan African SMEs is hindered by a lack of technical expertise and funding. However, it also shows that AI has the potential to increase productivity and efficiency in these companies. The findings of this case study can inform policy and decision-making for SMEs in sub-Saharan Africa, as well as for government agencies and private investors seeking to support SME growth in the region.

As the recommendations from case studies and reports, first of all, conduct a comprehensive study of the current state of AI adoption in sub-Saharan Africa's SMEs, including an analysis of the types of technologies being used, the industries in which they are being applied, and the level of adoption across different countries and regions. Investigate the reasons behind the low levels of AI adoption in sub-Saharan Africa's SMEs, including identifying the specific barriers that SMEs face, such as lack of access to funding, lack of technical expertise, and lack of awareness of the benefits of AI.

Secondly, Study the potential benefits of AI adoption for SMEs in sub-Saharan Africa, including increased productivity, cost savings, and improved decision-making, and quantify the potential impact of these benefits on the economy. Develop strategies and best practices for overcoming the barriers to AI adoption in sub-Saharan Africa's SMEs, such as providing training and technical assistance, creating funding opportunities, and raising awareness of the benefits of AI. Collaborate with SMEs, government, and organizations that support SMEs in the region to implement these strategies and evaluate their effectiveness.

Thirdly Investigate the role of government and policy in promoting AI adoption in sub-Saharan Africa's SMEs and make recommendations for how policy can be used to support SMEs in adopting AI technologies and be able to share the findings and recommendations with relevant stakeholders, such as policymakers, researchers, and SMEs, to inform future efforts to support AI adoption in sub-Saharan Africa's SMEs by understand the ethical and societal implications of AI adoption in sub-Saharan Africa's SMEs and consider the best ways to mitigate any potential negative impacts.

Lastly, conduct surveys and interviews with SMEs in sub-Saharan Africa to gather information on their current level of AI adoption and the barriers they face. Analyze the data collected to identify common barriers and their causes. Study successful AI adoption cases in other regions and industries to identify best practices and potential solutions.

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Links:

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Appendices

Table:1 4IR Technology

Figure: 1 Market size estimates of frontier technologies in billions