



Artificial Intelligence in Africa: Emerging Challenges

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INTRODUCTION

The adoption and use of Artificial Intelligence (AI) are rapidly increasing (Borenstein and Howard 2021) around the world. In Africa, AI creation and implementation are transforming our lives and cultures in a variety of ways including economically, socially, and politically (Luan et al. 2020; Roos 2018). These developments are always difficult to comprehend and predict, and they are only becoming more so as the COVID-19 pandemic continues (Borenstein and Howard 2021). According to a research report, increasing the adoption of AI in Africa requires the development of vibrant ecosystems based on five stakeholders who form the foundation of building AI success including policymakers, universities, large companies, start-ups, and multi-stakeholder partnerships (Schoeman et al. 2021).

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AI refers to a set of technologies that allow machines to function intelligently and mimic human sensing, comprehension, and action (Li et al. 2018; Hamet and Tremblay 2017; Adamopoulou and Moussiades 2020). The technology will have a significant impact in almost all areas where human intelligence is involved. It can be used by businesses and institutions to personalise activities, optimise operations, promote innovations, and empower and supplement staff (Schoeman et al. 2021). Essentially, AI changes the way people function, allowing for more efficient resource allocation, which leads to increased productivity and allows better government service delivery to the public (Borenstein and Howard 2021; Roos 2018). Specifically, the application of AI in education, health care, agriculture, commerce, and governance is showing a significant impact on their various activities.

AI is a rapidly growing technical field that has the potential to change every aspect of human social interactions (Pedro et al. 2019). AI-powered services pervade many aspects of human life across the globe; however, adoption rates vary between developed and developing nations (Francesc et al. 2019). It is evident that AI is penetrating the African social system through various operations (Schoeman et al. 2021; Marino Garcia and Kelly 2020). Chatbots in Kenya, for example, now provide healthcare services to people without visiting doctors, and a data-driven platform called Zenvus in Nigeria delivers insights to farmers (Francesc et al. 2019). Finance and other sectors are not excluded; AI-powered technologies are changing the ways of operations in these sectors. In *South Africa*, *Mama Money* and *Mukuru* enable easy and quick transfer of money across different countries in Africa. Kudi is a Nigerian AI-powered Chatbot that aims to provide financial services to underprivileged people (Kudi 2018). Other online shopping facilities are: TakeAlot (South Africa) and Konga (Nigeria).

Because of the widespread adoption of mobile technologies in Africa, there is an optimism that AI technologies will be the next wave of technologies to receive wide acceptance. However, with the exception of a few nations (such as South Africa, Nigeria, Ethiopia, Kenya, and Ghana), widespread adoption of AI applications in Africa is not yet a reality (Gadzala 2018). The crucial factors needed for technology adoption are sadly lacking across most of Africa, and many countries in Africa are still lacking the necessary infrastructure, governance, data ecosystem, STEM education, and other factors necessary for AI.

The purpose of this paper is to explore the challenges facing a widespread adoption of AI across African regions. Therefore, the research question is, “what are the challenges facing the design, development, deployment and application of AI in Africa?”. To achieve this aim, a desk research to review literature (including reports) on AI in Africa was conducted. AI technologies are increasingly and significantly currently being developed, deployed, and applied more widely in the developed countries of the world than in Africa. This is as a result of contextual factors that can be conceptualised as barriers that require attention so as to improve AI capacities. This chapter highlights these barriers/challenges and makes recommendations that can improve the development, deployment, and usage of AI technologies in Africa.

This chapter starts with an overview of the meaning and nature of AI followed by the examination of the emerging challenges to AI in Africa. Section “[Emerging Challenges to AI Adoption in Africa](#)” discusses the implications of the challenges, while section “[Addressing AI Adoption Challenges](#)” suggests possible ways to address these issues. Section “[Discussion](#)” makes some practical suggestions and recommendations for diverse stakeholders, and finally, section “[Conclusions](#)” concludes the chapter.

OVERVIEW OF ARTIFICIAL INTELLIGENCE

Artificial Intelligence (AI) is a branch of science that studies and develops intelligent machines (Luxton 2016). This field of science was established in the 1950s, and by that time, AI was described as a new science which would methodically examine the phenomenon of “intelligence”. Computer simulations of intelligent processes were to be used to achieve this goal (Brey and Søraker 2009). The authors further explained that in AI, intelligence is viewed as a broad mental skill that incorporates a variety of more specialised abilities, including reasoning, planning, problem-solving, concepts understanding, use of language, and learning. To test computer intelligence, in 1950, Turing and Haugeland (1950) introduced the *Turing Test* which is still invoked though with some criticism (Hayes and Ford 1995).

AI refers to technology that can perform tasks that require a certain level of intelligence—that is, a machine or tool that has been trained to perform work like that of a human. AI is categorised into two basic types including weak and strong AI or narrow and general AI

(Chang 2020). Weak AI portrays AI as a problem-solving tool, whereas strong AI entails the creation of a “real” mind (Flowers 2019). AI portfolio involves Natural Language Processing (NLP), Robotics, Machine and Deep Learning, Cognitive Computing, and Reinforcement Learning (Chang 2020). The idea of AI as a science that examines the phenomena of intelligence has been somewhat overtaken in recent years by a perception of AI as an engineering discipline in which scholars focus on producing usable programmes and tools that operate in areas that ordinarily need intelligence (Brey and Søraker 2009). AI technologies are already in use all around us, in nearly every aspect of life. It can be used in a variety of corporate roles to help employees at work by reducing their workload and in areas such as commerce, education, agriculture, and finance. In addition, Artificial Intelligence is being used in transportation, automobiles, manufacturing, and weather forecasting.

As a technology, AI is still in its infancy. Today’s AI systems have only a rudimentary understanding of human expression, tone, emotion, and the intricacies of human interaction (Smith and Shum 2018). Before computers can truly act like humans, there is still a long way to go. While AI research has a long history of enthusiasm followed by extended disappointment, we are currently in the midst of an extraordinary period of technological innovation across multiple industries, which is fuelling the rise of AI. AI will have a big influence by enabling quicker and deeper advancement in practically every sector where (human) intellect plays a role. It may be used by businesses or organisations to engage customers, revolutionise product creation, optimise operations, and empower staff (Akerkar 2019). But, more crucially, AI can assist society in overcoming some of its most overwhelming challenges (Nishant et al. 2020).

AI solutions are being successfully deployed at scale in some African countries and especially in Kenya, Nigeria, Ghana, Ethiopia, and South Africa (Gadzala 2018). Most solutions currently target the financial services, agriculture, and healthcare sectors (Okonkwo and Ade-Ibijola 2021). South Africa leads the continent in AI adoption with a robust ecosystem that includes numerous technology hubs, research groups, and various. Many companies in South Africa are either integrating AI solutions into their existing operations or developing new solutions using AI (Ferrein and Meyer 2012; Gwagwa et al. 2020).

EMERGING CHALLENGES TO AI ADOPTION IN AFRICA

AI is a game-changing innovation with the potential to improve all sectors of the African social system. However, the adoption and use of AI applications in African society raise some issues including skills acquisition, ethics, programming, data integration, user attitude, government policy, and insufficient infrastructure and network connectivity. These challenges emerged from the review of AI-related literature and are presented and discussed in the subsequent sections.

Skills Acquisition

This entails learning the theoretical and practical skills required for the development, implementation, and use of AI applications. Technological advancement necessitates the acquisition of technical skills. Business and IT leaders in Africa agree that to achieve the adoption and use of AI technologies, the stakeholders' knowledge base must be changed or improved (Mzmkandaba 2019). One of the key essential competences in the era of the Fourth Industrial Revolution (4IR) is programming skills. Furthermore, Bianco (2021) reported that one of the major barriers to the adoption of this modern technology—AI—is skill. Any project requires the right expertise to succeed, and AI is no exception. Of all, AI skills are more difficult skills to master, and there is undoubtedly a demand–supply imbalance in the market.

AI, as a new and growing innovation, will improve existing jobs while also creating new ones, necessitating the acquisition of new skills. According to a Gartner research circle survey, 56% of participants believe that learning new skills would be essential to execute both existing and newly developed jobs. (Bianco 2021). In the development and implementation of an AI system, there is a need to incorporate expert knowledge (Abu-Alsaad 2019). Despite the fact that IT professionals (software developers and engineers) design and develop AI applications, they are not the primary users of AI. In developing markets such as the African market, a scarcity of AI-ready workers is a major issue (Ajadi 2020).

The development of AI involves machine learning and NLP processes which consist of complex algorithms; thus, programming skills are needed. The issue is “How can AI be programmed to perform accurate operations?”. For example, in an interaction with a Chatbot, a user's questions can come in various forms demanding the same answer. For

example, “What is the time” and “Could you check the time”. The Chatbot system may correctly answer the first question but incorrectly answer the second. According to Grosz (Grosz 2018), computational linguistics and NLP systems also raise some of the most serious potential issues, such as dialogue system failure, the impact of social Chatbots on how people communicate with one another, and system performance issues. As a result, ICT efficacy and programming competences are among the required skills for effective adoption and use of AI applications (Komarova et al. 2019).

Uncertainty

Although the adoption and use of AI applications are becoming common, it is still difficult for some business leaders to quantify the benefits associated with the technology. There are some well-known benefits of AI, such as instant response, time saving, medical advances, and revenue generation; other benefits like automation of process, enhanced learning, and customer experience are still hard for users in Africa to comprehend (Mzmkandaba 2019, Okonkwo and Ade-Ibijola 2021). Because these technologies mimic human intelligence, that is doing human jobs in a different manner, the question is therefore: Is the adoption of AI applications beneficial or not? While some business leaders and stakeholders believe and trust in this technology, others are afraid that implementation of AI may disrupt their traditional ways of working (Coetzee 2018; Smith and Neupane 2018). As a developing continent, Africa, the knowledge of AI is still at an early stage and the population is still not certain of the advantages. The fear of the unknown poses a great challenge to the adoption and use of AI in Africa.

Lack of Structured Data Ecosystem

AI initiatives rely on the quality and quantity of data contents to provide accurate information or responses to users in each situation. In many cases, an AI will fail if the data that is used to train the AI system does not reflect the demographic variables in the targeted population. A Chatbot system, for example, requires comprehensive information about its operations to provide correct responses to users; if the information requested by the user is not in the data bank, the system will fail. Data shortages in Africa are well known in the context of development, where

high-quality data are essential indicators of growth in relation to the Sustainable Development Goals (SDGs) and a key input for the development of modern technologies. The UN Economic Commission for Africa (UNECA) stated that African data ecosystems are at “nascent stages of the African data revolution and the private sector is increasingly becoming a critical and dynamic player within African data ecosystems” (UNECA 2016). Machine learning methods are only as good as the data they are given. AI algorithms include prejudices found in data or even in the individual who created the process, spreading social disparities. This is especially important in Africa, where users are more likely to import machine learning algorithms built and trained abroad using data that may not recognise or be biased against substantial parts of the African population (Kathryn Hume 2017). To enable researchers, developers, and users to adopt AI solutions, a deeper, larger, and more accessible pool of data is needed. In developing markets, particularly in unstable or conflict-affected areas, high-quality data is not always available or accessible (Ajadi 2020).

Lack of Relevant Government Policies

As AI-powered technologies are beginning to sweep over business, governance, and educational activities, there is a need for a policy on AI implementation strategies in African countries as seen in the developed countries such as Australia, China, France, and the United States (Pedro et al. 2019). Although some African countries, such as Mauritius, Egypt, Zambia, Tunisia, and Botswana, have recognised the potential of AI to boost GDP and have developed national AI strategies, and South Africa, Nigeria, and Kenya have passed data protection laws, all are still in their infancy (Pedro et al. 2019; Effoduh 2020). The African Union (AU) proposed the Promulgation of AI laws and regulations, called structured regulation of AI to manage the benefits of the technology for Africans (Effoduh 2020). Most of the African population is a late majority and laggard adopter of innovation; they take a “wait-and-see” approach to technology adoption (Okonkwo et al. 2020, 2021). AU needs to speed up to establish a well-structured adoption and implementation of AI-powered technology to boost its adoption among the African population. Overall, there is a general lack of relevant policies that can prioritise the design and implementation of AI as well as address the potential impacts on society.

Ethics

In terms of technology development, ethics refers to a set of principles based on public acceptance, religious beliefs, and cultural norms on the best behaviour that can be observed and followed during the development and deployment of innovative and emerging technologies. In Africa, ethics form the basis of human activities which can promote African cultures and help to build confidence in the development and applications of technologies in Africa (Dugbazah et al. 2021).

While AI has enormous potential, it also poses major difficulties for businesses and governments, notably in terms of ethics. The moral, economic, and social repercussions of the Second and Third Industrial Revolutions are still being debated in many African countries (Oosthuizen 2020). AI has already been implicated in several examples of ethical issues. Studies have revealed some major areas of AI possible implications on the African social world including accountability, data bias, transparency, and socio-economic risks (Ruane et al. 2019). AI technologies are systems that mimic human intelligence. AI undermines established moral and legal paradigms that place human agency solely in the hands of humans (Tegmark 2018). Using biased data, AI has been noted to create socio-economic inequality (Larsson et al. 2019). In addition, the design of AI systems involves some complex algorithms which in turn compromise trust and transparency. Data is used to train these algorithms. It has been claimed that there is a data scarcity in Africa (Microsoft 2018), and that the majority of acquired data does not correctly reflect the African experience, implying that many algorithms may not be appropriately adapted to the features of local populations (Mahomed 2018). To provide an acceptable basis for AI adoption in Africa, stakeholders must have open discussions on the ethical implications of AI and take necessary steps.

User Attitudes

Another challenge facing the adoption of AI systems in Africa is the users' attitude. An adopter's attitude towards the adoption and rejection of an invention can be favourable, negative, and apprehensive (Okonkwo et al. 2019). According to (Wang et al. 2008), attitudes are a primary predictive factor impacting the adoption of a new product; hence, a better knowledge of attitudes in a well-defined manner is required. Africans are very sceptical in adopting and using new technology due to culture and social

influences. In a study on the adoption of AI in higher education, Chatterjee and Bhattacharjee (2020) revealed that individuals' behavioural intentions to use AI in higher education are influenced by their attitudes. Likewise, another research on the adoption of software engineering products proved that user attitude influences the adoption of software tools (Okonkwo et al. 2019). This leads to the conclusion that higher education authorities would find it useful and beneficial to mould stakeholders' attitudes to shape their intentions and behaviour (Chatterjee and Bhattacharjee 2020). As a result, if students have negative perceptions of Chatbot technology applications in education, they will be hesitant to adopt and use the technology. Positive perception of an innovation accelerates adoption.

Insufficient Infrastructure and Network Connectivity

Inadequate infrastructure and a dearth of network affordability are some of the major hurdles of AI adoption in Africa. The growth of infrastructural development as well as mobile technology network connectivity in Africa is slow (Marino Garcia and Kelly 2015). A good percentage of Africa's population are unconnected and not having access to the internet. Adoption of AI requires adequate availability of wireless network connectivity. In addition, African countries have the world's most expensive broadband. The Alliance for Affordable Internet (A4AI) reported that African countries inhabited nine of the ten least affordable spots in terms of internet access, with expenditures ranging from 12 to 44% of GDP (Marino Garcia and Kelly 2020).

ADDRESSING AI ADOPTION CHALLENGES

Adoption and use of any innovation including AI require the necessary competence. First and foremost, AI skill is much more difficult to perfect, and there is a greater demand for AI expertise. It is important to create a conducive environment in business, health, education, and public ecosystems and encourage the employees to have interests on the use of AI to perform their operations. This will make them learn the skills. There is a need to improve the educational curriculum to integrate the teaching of AI skills from the secondary level. Improving people's learning abilities in mathematics and computer programming will help them acquire the necessary AI skills. Because the use of AI systems is permeating all aspects

of life, the knowledge of AI is for all. Adding introductory programming and computer basics subjects to all fields of study may also aid in the acquisition of AI skills.

All stakeholders (citizens, policymakers, and technical experts) should be involved early in the architectural design process so that societal expectations, fears and concerns are taken into account and no patchwork is necessary later as an afterthought. This will improve users' knowledge of the system, which will reduce uncertainty or fear of the unknown. A responsible data management framework that takes into account data diversity is recommended for AI developers. The framework will make it easier to collect comprehensive data for system development and will improve the accuracy of AI system operations.

Ethical challenges are big concerns regarding adoption of AI systems in Africa. Many initiatives, including educational institutions, government agencies, non-governmental groups, and industry, have attempted to address the ethical and legal challenges that have arisen because of AI technology, but the impact of these efforts is still insignificant in Africa (Borenstein and Howard 2021). The selection, design, deployment, and usage of AI technology have ethical implications. We therefore agree with the recommendations made by Borenstein and Howard, (2021) that it is critical for developers to recognise that the technology they are creating is entwined with ethical dimensions, and that they have a critical role and obligation to engage with ethical considerations as developers. Making developers aware of their professional responsibilities and moral implications while developing will aid in reducing ethical issues. Also, government and other professional bodies should strengthen their ethics policies to guide the development process of AI.

Creating a conducive environment encourages innovative minds. African nations are still struggling on infrastructural development. Most government policies concentrate on urban development while rural areas suffer. Government should ensure that they extend their developments to rural locations, bringing stable and adequate network coverage across all areas. For example, most of the farming industries that need AI to boost their operations and increase productivity are in rural areas. In addition, the African Union and each respective African nation should establish AI strategies and policies that will be a foundation for the development and implementation of AI technologies.

Finally, Africa has developing economies that require technological advancements to accelerate growth. As a result, it is critical that the continent encourages the use of AI in a variety of ways to perform various tasks. Establishing various agencies that can assist in dealing with citizens' doubts and fears should be encouraged as part of an awareness campaign. These agencies should improve Africa's appreciation and adoption of AI and establish efficient ways of addressing societal impacts. Technology start-ups or tech hubs should be established to train the next generation of AI experts, and local technological innovations should be supported by the government and private sector.

DISCUSSION

The adoption of AI technologies in Africa is facing some challenges including lack of technical skills, uncertainty, lack of structured data, lack of government policies, ethics, and user attitude. AI has the potential to improve productivity at a firm while also keeping competitive and gaining a deeper knowledge of their consumers. However, there are not enough individuals with the necessary expertise and abilities to operate these applications. A strong skill set is required to create an AI technology with good content, system, and service qualities, and adequate knowledge of how to use the product is required to use the technology effectively. These skills extend beyond basic technological knowledge and may address other difficulties such as a lack of adequate managerial knowledge or even development of business ideas. In terms of maintenance, AI tools require routine maintenance and upgrade, and this calls for expert knowledge of programming. In other words, a company that wants to employ the services of AI technologies needs an in-house engineer or trusted vendor for maintenance and services. As a result, business leaders, other stakeholders, and members of the public who may be engaged in the implementation and usage of any sort of AI must acquire the core skills required to adapt, learn, govern, and utilise the technology in their respective fields of work. This implies that all the stakeholders including the government should develop a means to incorporate the required skills into the people starting from the young age of primary education to professional level. Lack of technical skills hinders the adoption and use of technologies (Mtega et al. 2012).

The application of AI technologies raises some ethical concerns, particularly in the areas of role, privacy, transparency, trust, personality, and

culture. There are numerous ethical questions surrounding the adoption of AI: Are AIs job killers? How is data stored and utilised? Is AI smarter than humans? and so forth. These questions instil fear and scepticism in the adoption of AI technologies. For example, in the healthcare system, AI is being used to collect various forms of personal information from patients. Gathering user data generates several privacy concerns; some may have legal backing and are protected by data protection laws (Ruane et al. 2019). When incorporating AI into any aspect of life, it is critical to consider user privacy. As an intelligence machine that is not human, it is best to inform users of its AI status so that they can make informed decisions about how to interact with the system. The human-machine relationship differs from the human-to-human relationship. Knowing the nature of an AI system will increase the user's understanding and trust. To accommodate different users, user groups, interests, characteristics, and context should be considered during the design and development of AI tools. Culture plays an important role in ethics. It is concerned with the social behaviour of people in a specific area. African nations are multilingual and have diverse cultural backgrounds, which can have an impact on the adoption of technological innovation. Culture, according to research conducted in Nigeria and South Africa, is a determining factor in technological innovation (Bankole et al. 2011; Lekhanya 2013).

Individual beliefs and feelings should be considered when designing AI systems. The user's perceptions of a new technology influence its adoption. A positive perception encourages users to adopt and use AI systems, whereas a negative perception leads to rejection of the innovation. If users do not have sufficient information about an innovation, they will be sceptical of its usefulness, leading to uncertainty—fear of the unknown. Because most Africans are laggards and late majority adopters, they are uncertain of new technological innovations, and they employ a wait-and-see approach to adopting new innovations. The greater the level of uncertainty, the lower the adoption of AI in Africa. Developers and other stakeholders should always strive to make AI systems user-friendly to reduce the uncertainty associated with new technology. Governments should step up infrastructural development and expansion of network connectivity especially to rural locations in Africa. Furthermore, African governments and stakeholders, including the African mobile ecosystem, must establish well-structured guidelines and policies to ensure proper AI systems development, implementation, and adoption in Africa.

AI technologies are rapidly evolving and being used for a wide range of purposes, including education, business, politics, and social activities. In Africa, there is still a need for sustainable development, and the use of AI technologies may help to achieve this. Using AI technologies as supporting tools will be impossible if they are not properly adopted, and for AI to gain widespread adoption, these challenges must be addressed.

CONCLUSIONS

This chapter has highlighted some of the emerging challenges facing the effective design, development, adoption, and use of AI technologies in Africa. AI technologies have enormous potential to aid the growth of African economies and human flourishing. AI technology has the potential to alter business operations and performance, enhance productivity, and improve health care, education, and transportation in Africa. Without addressing these challenges or barriers, Africa will continue to lag behind countries in the global world. Stakeholders in Africa, especially policy-makers, need to establish robust governance structures and infrastructures to improve not only the design and development of AI but the adoption and use of AI technologies. In addition to policymakers, industry stakeholders also have a duty to focus on capacity development to ensure that adequate AI skills are acquired for the responsible use of AI to address African-specific needs and problems. It is therefore hoped that a proper understanding and appreciation of these challenges and recommendations will be had to ensure accelerated design, development, and adoption of AI, which will have a big influence on Africa's economy.

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