

ARTIFICIAL INTELLIGENCE: AN OPPORTUNITY OR A THREAT FOR AFRICA?

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Abstract: Artificial intelligence (AI) is poised to transform various sectors globally, including Africa. This paper investigates whether AI represents Africa's opportunity or threat, considering the continent's unique internet challenges, economic constraints, and infrastructural limitations. By examining AI's potential benefits and risks within the African context, this study aims to provide a balanced analysis. The findings suggest that while AI offers significant economic growth and social development opportunities to users capable of taking advantage, it presents challenges that must be strategically managed and may exponentially contribute to the digital gap, drawing a line between advanced and developing countries.

Keywords: Artificial intelligence; African development; Developing countries; Cyber security; Database; Electricity innovation

1 INTRODUCTION

Artificial intelligence (AI) transforms industries worldwide, promising enhanced efficiency, innovation, and economic growth. However, some requirements, such as the quality and availability of electricity, the Internet, and data, are necessary to take full advantage of that innovative technology. AI can be both an opportunity and a threat for developing countries, depending on how it is implemented and managed. Therefore, the effects of adopting AI in developed countries differ, particularly in developing countries and Africa. In a global environment driven by capitalism, cybersecurity threats, and strategic interests where AI will potentialize the development of already developed countries, while not fully accessible by developing countries, the concern is to assess if AI presents significant opportunities or threats for Africa, a continent characterized by rapid population growth and diverse socioeconomic landscapes: This paper explores AI's dual role in Africa, analyzing its potential benefits and risks, especially concerning the continent's electricity and internet connectivity challenges in a bipolar global environment.

2 AI OPPORTUNITIES IN AFRICA

2.1 Economic Growth and Job Creation

Artificial intelligence has the potential to enhance economic development by optimising productivity across several industries. Technological advancements in certain activities conserve human resources for more complicated and creative tasks, resulting in innovation and structural diversification. Utilising AI and adopting predictive analytics can optimise global supply chains, hence reducing costs and improving competitiveness in the worldwide market [1]. AI has the potential to enhance the economy of the African continent if it is utilised. McKinsey stated that AI might contribute up to \$13 trillion to the global economy by 2030 [2]. In the African area, the application of AI in automation and innovation can enhance productivity and generate employment opportunities across various sectors, including agriculture, healthcare, and finance.

2.2 Agriculture

Artificial intelligence possesses the capacity to significantly transform industrial agriculture by forecasting crop yields, meteorological conditions, and insect issues. Precision farming technologies can optimise resource utilisation and inputs in agriculture, resulting in heightened yields. The Food and Agriculture Organisation (FAO) has projected that AI-enhanced precision agriculture might increase crop yields by up to 30 percent.

2.3 Healthcare

Artificial Intelligence (AI) has the potential to revolutionise health care service delivery through better diagnosis, effective treatment, and early disease forecasting. For example, AI applications can explain illness onset manifesting in diagnoses or

enhance diagnosis using images. For example, AI can be useful in diagnosing a condition like malaria and tuberculosis; in addition, it can minimise mortality rates and improve the standard of living [3]. The WHO [4] states that increased use of AI tools in diagnostics can reduce diagnostic errors by 50%.

2.4 Finance

Artificial intelligence can facilitate mobile banking and digital payment systems to enhance financial accessibility. The credit score system, aided by AI algorithms, can facilitate credit access for under-represented populations. The World Bank estimates that digital financial services may add as much as \$300 billion to Africa's GDP by the conclusion of 2025 [5]. AI has the capacity to augment the development of financial services for underserved populations, particularly the unbanked demographic. For example, it can use thin file characteristics such as mobile phone usage or social media activity to assess creditworthiness and extend loans to clients who do not qualify based on conventional data. This can promote entrepreneurship and economic development in these communities [6]. AI enables platforms to offer microfinancing, mobile money, and credit ratings to individuals, hence enhancing access to the traditional formal economy [7].

2.5 Education and Skill Development

AI can improve education in Africa by providing learner-centred education, increasing access and quality, and mitigating the shortage of teachers. The integration of AI-based systems in education can facilitate an intelligent learning process for pupils and accommodate individualised learning paces. UNESCO indicates that AI has the potential to mitigate educational inequality in Africa, where 60% of children and adolescents are unable to read or perform basic arithmetic [8].

2.6 Public Services and Governance

Centralized AI has the potential of increasing effectiveness, eliminating the rife corruption, and facilitating sound policymaking within public entities within Africa. AI-dependent systems can optimally facilitate terms of public services, reduce the level of corruption, and enhance the quality of services offered. For instance, AI is applicable in the interpretation of big data in the formulation of policies and planning of resource reallocation. With the help of AI, it is possible to design an efficient urban environment, transportation system, and public services the outcome of which will be of high quality. AI enabled city schemes that apply intelligent action can improve traffic and saving energy, and improve public services such as management and public safety [1]. For instance, AI can be applied for purposes of forecasting flow of traffic, hence ensuring that the traffic signals are adjusted so as to ease the flow of traffic in the country. Automated waste management systems means of collection and disposal can thus be effectively implemented by embracing artificial technologies meaning efficiency is enhanced hence sustainability of the environment [3].

3 ELECTRICITY AND INTERNET CHALLENGES IN AFRICA

3.1 Electricity Supply and Infrastructure

A reliable electricity supply is crucial for consistent internet access. In many developing countries, frequent power outages and limited electricity infrastructure hinder internet connectivity. Nearly 1 billion people in developing countries lack access to electricity, severely limiting their ability to use the internet [9]. Figure 1 below displays the direct implications of electrical needs and data center locations among 1600 data centers surveyed from 63 markets [10]. The map only shows one data center in Africa and most in developed countries. Frequent electricity outages and unreliable power supply are significant barriers to effective AI implementation in Africa. Many regions face inconsistent electricity availability, which hampers the operation of AI systems that require stable and continuous power [1]. This issue affects various sectors, including healthcare and education, where AI technologies depend on uninterrupted power to function optimally. Additionally, poor infrastructure, such as inadequate internet connectivity and outdated technological frameworks, further limits the effective deployment of AI. For example, intermittent power and slow internet speeds in rural areas can undermine the use of AI-based educational tools and telemedicine services [6].

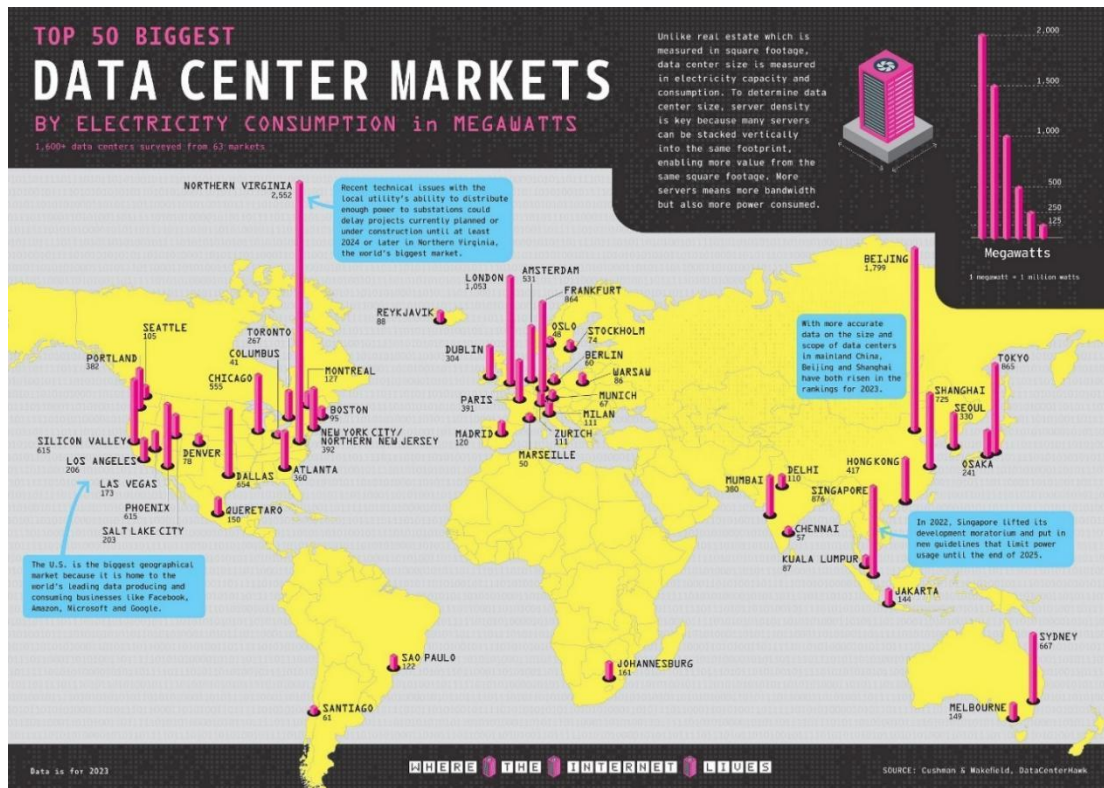


Figure 1 Top 50 Biggest Data Center Electricity Consumption and Location

3.2 Technological Obsolescence and Maintenance

The training of AI systems becomes hard due to the rapidly expanding global technology. African people encounter challenges in keeping abreast of the latest AI technology developments due to insufficient funding for investments in new technological offerings and services, along with elevated costs for equipment updates and upkeep [11]. Organisations encounter challenges in managing and updating their proprietary AI, hence impacting their competitiveness in acquiring and utilising AI technologies. To tackle this difficulty, it is essential to implement sustainable technology management techniques and promote ongoing maintenance and updates [7].

3.3 Limited Connectivity

Internet connectivity remains a major problem in Africa. ITU data recommends that in 2021, purely African Internet users were at 28.2% as contrasted with 60% of the universal total [12]. This digital divide presents a major challenge of how the full potential of AI can be realised.

3.4 Limited Fiber Optic Networks

The deployment of fiber optic networks, essential for high-speed internet, is minimal. For instance, only 15% of the population in Sub-Saharan Africa has access to fixed broadband networks [13].

3.5 Mobile Broadband Reliance

Developing countries heavily rely on mobile broadband due to the lack of fixed broadband infrastructure. In South Asia, mobile broadband subscriptions grew by 10% in 2020, but average download speeds remain significantly lower than the global average [14].

3.6 Infrastructure Deficits

Many African countries have inadequate digital infrastructure, including limited broadband coverage, unreliable electricity, and outdated technology. The World Bank reports that sub-Saharan Africa needs investments of approximately \$100 billion annually to bridge its infrastructure gap [15].

3.7 Affordability Issues

One of the primary challenges to AI adoption in Africa is the high cost associated with the technology. The initial investment required for AI infrastructure such as advanced computing systems, data storage, and software can be prohibitively expensive for many African nations [1] moreover, ongoing maintenance, updates, and skilled personnel costs further strain financial resources. For instance, the deployment of AI-driven healthcare solutions, while potentially transformative, demands substantial upfront capital that many healthcare systems in Africa cannot easily afford [7]. The cost of internet access in Africa is prohibitively high for many people. The Alliance for Affordable Internet (A4AI) notes that the average price of 1GB of mobile data in Africa is 7.1% of monthly income, far above the UN's target of 2% [16]. High costs limit the widespread adoption of digital technologies and AI.

3.8 Device Affordability

Internet-enabled devices like smartphones and computers are often prohibitively expensive. Only 45% of the population in Sub-Saharan Africa owns a smartphone [17]. Prices related to device acquisition are challenging for users, as well as maintenance and software needed since most of those devices are manufactured out of the continent and subject to international taxes and transportation costs.

3.9 Data Costs

High data costs exacerbate the affordability issue. In Africa, the cost of 1GB of data varies widely, with some countries experiencing costs as high as 20% of the average monthly income [16]. Data necessary for device updates and information processing remains expensive and hardly affordable for most users. Online storage and application usage are challenging for most users who prefer locally installed software (See Figure 2).

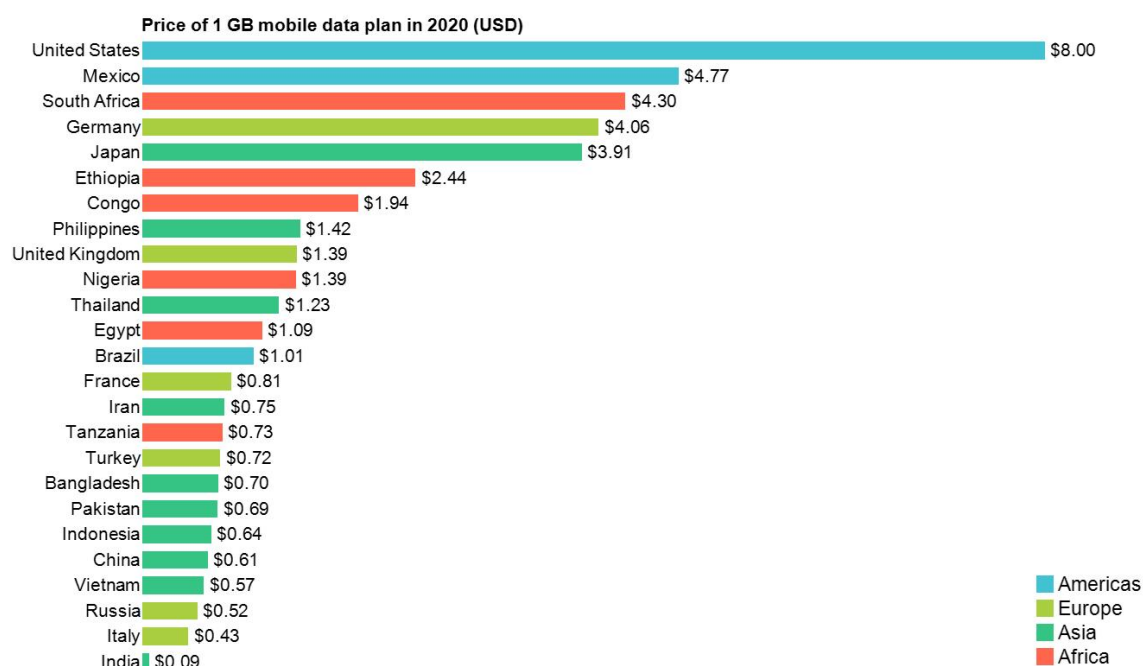


Figure 2 Price of 1GB Mobile Data Plan in 2020

4 CONSEQUENCES OF INTERNET CHALLENGES ON AI DEVELOPMENT AND ADOPTION

4.1 Limited Access to AI Technologies

Limited internet access restricts developing countries' ability to leverage AI technologies for development. The digital gap and challenges to access to high speed internet hampers access to AI-driven tools and services, widening the gap between developed and developing countries. The difference between both environment will exacerbate the divide in the technology landscape, making one side very advanced and the other side significantly less competitive and fragile. The digital gap would allow developed countries to be more efficient and productive and make the information available more relevant to their

reality. The lack or weak contribution to AI's database enrichment will enhance AI to be more accurate with developed countries in opposition to developing countries.

4.2 Healthcare

AI can enhance healthcare delivery through telemedicine, predictive analytics, and diagnostic tools. However, limited internet access prevents many healthcare facilities in developing countries from utilizing these technologies. Only 15% of healthcare facilities in low-income countries have reliable internet access [17]. The healthcare access limitation to AI enhances the lack of data collection necessary for AI optimization or utilization, preventing African researchers and health professionals from taking full advantage of the technology.

4.3 Education

AI-powered educational tools can provide personalized learning experiences and improve academic outcomes. However, the digital divide in education restricts access to these tools. During the COVID-19 pandemic, only 40% of students in low-income countries had access to remote learning, compared to 90% in high-income countries [18]. The limited access to technology, exacerbated by the related cost, prevents most African students from taking advantage of AI in opposition to developed countries where AI is part of most tools and software proposed by schools. That disparity constitutes a break for developing countries while acting as a catalyst for advanced countries.

4.4 Economic Impacts

The inability to adopt AI technologies limits economic growth and innovation in developing countries. AI can drive productivity, efficiency, and competitiveness, but internet challenges hinder these benefits. Limited internet access and AI have a massive impact on the analysis and synthesis of data necessary to understand and anticipate the needs of the economic landscape, the quality of work, and economic growth. In a global context, the lack of access to the internet will increase the challenge for developing countries in bridging the financial gap and competitiveness.

4.5 SMEs and Startups

Small and medium enterprises (SMEs) and startups in developing countries often struggle to leverage AI for innovation and growth. Limited internet access and frequent electricity outages restrict their ability to use AI tools for market analysis, customer engagement, and product development, impeding African startups and technology SME competitiveness in the international arena and a poor quality of service in the local arena.

4.6 E-Commerce

AI can optimize e-commerce platforms through personalized recommendations, demand forecasting, and customer service automation. However, e-commerce remains underdeveloped in many developing countries due to internet challenges. E-commerce accounts for less than 5% of total retail sales in Africa, compared to 18% globally [19].

4.7 Social and Developmental Impacts

Restriction of people's access to the Internet only deepens social injustice and hampers people's development. Despite the capacity that AI has to help meet developmental goals, internet hurdles confine it.

Social Inclusion: Social inclusion can be actualized through the enhancement the access of information, services and opportunities through AI. However, this kind of inequality keeps the marginalized groups from affording the opportunity to use these AI technologies. These groups of people are the most affected; women, those in the rural areas and the poor.

4.8 Public Services

The use of big data, intensive analytics, prescriptive decision making and robotics in public service delivery. However, denial of Internet access greatly hinders AI applications in governance, health care, education and other publicly relevant areas.

5 LIMITED ACCESS TO AI RESEARCH AND DEVELOPMENT

A significant challenge to AI development in Africa is the region's limited access to cutting-edge technology. The R&D resources obtained from various sectors are outlined below. Regrettably, most African nations lack a robust foundation in research, as well as the financial mechanisms and resources necessary to foster the advancement of AI [6]. Nonetheless, the majority of worldwide AI research papers, datasets, and cutting-edge R&D infrastructure remain

inaccessible due to physical, geographical, and economic factors. This constraint can hinder the participation of researchers and developers in Africa and their opportunity to engage with advancements in the field.

6 AI THREATS IN AFRICA

Most African nations have fragile IT frameworks and as such are ill-equipped to compel compliance with complicated security measures [20]. At the moment, there is an internet uptake in Africa at 28 % and this is based on the World Bank's statistics as compared to the global uptake of 60% [21].

6.1 Job Displacement

Application of AI to automate jobs is worrisome as many jobs are likely to be affected mainly in areas where low skill is highly prevalent. According to the ILO, the level of automatization adopted on sectors such as, industrial agriculture, mining, and manufacturing in Africa could amount to 85% [22]. Advancements in artificial intelligence applied to the workplace threaten to put a large share of employees out of work for instance in manufacturing and agricultural industries. A job losses situation sharpens the poverty and inequality crises and require concerted efforts to train and up-skill the workforce [1]. AI may deepen joblessness and some social-economic disparities if there are no mechanized retraining and reskilling.

6.2 Data Privacy and Security

AI systems are data-driven, however the problem of privacy and security arises here. The regulation of data protection in Africa is relatively young. African nations especially do not have well developed laws on data protection and as such are at high risk of data breach.

In an attempt to compare the efficiency of two laws in the protection of personal data I have decided to focus only on two nations. The generation and processing of personal data by AI systems are the key threats to privacy, therefore, the demand for strict regulations [6]. In their Vulnerabilities Global data protection index, the United Nations Conference on Trade and Development (UNCTAD) notes that only 19 of the African countries have complete data protection laws [23]. Lack of proper legislation complicates the ability to protect an individual's information and to curb its misuse. The growth of solutions, cyberattack tools, and the methodology of getting through to make Africa an easy target for advanced threats.

6.3 Cybersecurity Risks

Hackers can use artificial intelligence in order to carry out complex campaigns. Next, AI based malware, phishing attacks and deepfakes are some of the dangerous threats to cybersecurity. A study by the African Union Commission (AUC) revealed that there is a 55 % increase in cyber attacks in the African region in 2020 with the loss incurred amounting to \$ 3.5 billion [24]. To avoid such risks, cybersecurity should be stepped up so that it meets the needs of Artificial Intelligence's growing functionality. The relative absence of competitive advanced cybersecurity solutions within Africa can quickly turn this region into the launch base for cyberattacks and cybercharacters globally and weaken local cybersecurity systems .

6.4 Bias and Inequality

If not adequately addressed by its architects, AI systems can exacerbate biases and inequities at multiple levels, both locally and globally. The input of stored and gathered data into biased AI algorithms might result in conflicting outcomes, local infeasibility, inequitable usage, cybersecurity vulnerabilities in lending, and challenges in law enforcement management. This is due to the widely different socio-economic conditions prevalent in many regions of Africa, necessitating the integration of fairness, efficacy, and, above all, transparency into AI systems.

7 MITIGATION STRATEGIES

7.1 Investing in Infrastructure

These areas need considerable amounts of investment in order to narrow the digital divide that characterizes developing nations. To do this, tangible resources can be obtained from public-private partnerships and global cooperation.

Broadband Expansion: As for broadband expansion, only fiber optic and mobile broadband is required. Such calls as the World Bank's Digital Economy Initiative for Africa (DE4A) entail infrastructure advancement across Africa as well.

Energy Solutions: Enhancing surmises for electricity emitting structures from natural resources like water, wind, and sun. Internet can be made to improve through the promotion of renewable energy sources such as; solar panel, especially in areas that have most parts of Africa which has abundant sunshine. The decentralised electricity systems such as off-grid and mini-grid solutions can make a difference in remote and hard to reach areas.

7.2 Enhancing Internet Connectivity

It is important for Africa to upgrade its digital networks and support to help reduce the poor connectivity. It may be easier in webpage design but public-private partnerships and use of international collaboration can put the required logistics forward. Efforts such as the World Bank's Digital Economy Initiative for Africa (DE4A) are already being undertaken in an effort to boost development of the digital infrastructure in Africa.

7.3 Policies for the Formation of Regulatory Authorities

International and national guidelines and best practices are required when it comes to the ethical, legal and social impact of AI [25]. Governments of the Africa should ensure that data protection laws, cybersecurity regulations and ethical standards that govern Artificial intelligent use are enhanced. The African Union's Convention on Cyber Security and Personal Data Protection is already drafted, but more countries should ratify it and its implementation.

7.3.1 Promoting affordable access

The governments and other stakeholders need to put measures in place to fix the problem of affordability of the major components that support Information Systems infrastructure; the internet and the devices that support it. Ease of access in universities can greatly offset internet access challenges resulting in free access to the internet.

7.3.2 Subsidies and incentives

Similar to global warming or COVID-19 funding, developing countries can be subsidized and incentivized by worldwide organizations to allow internet service providers to lower the costs for consumers. Implementation of subsidies primarily for the low-income population allows increasing Internet accessibility.

7.3.3 Universal service funds

USF can help to build up infrastructure to areas that lack communication infrastructure and also assist the provision of internet services in most of the rural and remote areas.

7.3.4 Education and skill development for children

By improving the job market relevancy of education, Africans should be well-equipped to work in the emerging environment supported by artificial intelligence. There is a need to train young and old citizens with skills in Artificial Intelligence through partnership between governments, learning institutions, and private sector. One such institution which supports STEM education and research in Africa is the African institute for Mathematical Sciences: AIMS.

7.3.5 Promoting local innovation: encouraging indigenous AI technologies

In supporting the sustainable development of AI in Africa, deprived dependency on foreign AI solutions and herein promoted local innovations. Governments should spurn local development, and provide grants for indigenous AI R&D projects, innovation incubators, and incentives for start-ups. Developing AI capabilities in Africa will enable the nations of Africa, to design and implement AI solutions that meet needs and harness opportunities peculiar to their communities, and thus promote economic development as well as AI sovereignty. Outsourcing also improves the local competencies, and at the same time guarantee global appliance when adopting AI creativity.

7.4 United States of America Keen on All Inclusive AI Development

AI systems should grow to be fair, and should have characteristics of transparency together with inclusion. AI principles and frameworks with respect to ethical challenges should be adopted into African countries. Engagement with Intergovernmental organizations and technology firms can guarantee that the current and future AI systems are appropriate for the continent's purpose and environments.

Strategic Planning: Building End-to-End Strategies for AI

The African countries should therefore design their AI framework of development honestly fitting those countries. Strategic planning means considering which of the sectors AI will be most valuable, in particular – health care, education, agriculture. This makes it easier for government to align the development of the AI with the overall national development strategies, which makes inclusive access to AI technologies, African countries must invest in improving their digital infrastructure. This includes expanding internet connectivity, particularly in rural and underserved it easier for the government to ensure that any given AI project is in line with the over all national development frameworks. This also embraces building of the bridges between the governments, industries and the universities with regard to AI research and adoption.

7.5 Investment in Human Capital: Improving Educational and Training Curriculum

It is for this reason that an apprenticeship of an expert staff is needed in order to enable the adoption and deployment of the AI technologies. Thus, it is high time for the African countries to promote (accessibility of) education and training in areas related to Data Science techniques and Machine Learning, as well as software engineering disciplines. This can be done in the following ways; for instance, schools, universities and technical institutions must have an AI curriculum. Furthermore, training these existing pool of workforce for consecutive sessions will ensure them with new practices within the emerging

AI related positions at workplace. Other key activities include consultations with intergovernmental organizations and effective interactions with private stakeholders for co learning and capacity building.

7.6 Regulatory Frameworks: Developing Comprehensive Data Protection and Ethical Standards

In this article on the future of AI, we recognized the pressing necessity for constructing and applying effective regulatory measures about how to apply the technology more effectively but safely and equitably as well. All these ways imply that the African countries need to enact and implement laws governing data protection, privacy, and use of AI. These frameworks have to consider potential ethical concerns such as bias in algorithms with regard to the employment of AI and ensure that progression of AI is for the benefits of citizens during [their time]. Thirdly, there is an ability of the regulatory frameworks to ensure that implementation of AI will attract public acceptance within diverse sectors. On this basis, these regulations shall be subject to regular refinement and upgrade because of advance in technology.

7.7 Infrastructure Development: Improving Internet Connectivity and Digital Infrastructure

To fill the gap and guarantee proper At the same time, digital divides need to be overcome, new technologies need to be brought to the developed and developing areas, and the existing technological infrastructures should be revised to facilitate the implementation of AI. Stable electricity also plays the other ingredient of infrastructure to support the artificial intelligence system and strong and stable data centers. Governments can support the enhanced use of the technology in the benefit of people by focusing on infrastructure development.

8 CONCLUSION

The opportunities that artificial intelligence brings into Africa are vast On the other hand, there are risks associated with its implementation of artificial intelligence in the area too. AI can benefits society giving a social-economic growth, services, as well as knowledge progress but it has factors such as unemployment, data privacy and cyber insecurity. Solving these issues assumes investments in digital platforms, effective legislation, aid in training the population, and the creation of a progressive AI. Thus, it is possible to state that in taking a balanced approach to AI implementation African countries can unlock the use of Artificial Intelligence for the actualisation of development and socio-economic growth. These challenges can be addressed by the developing developing countries deploying digital platforms, increasing content that can be affordably accessed, improving digital literacy levels, overhauling rules and regulations as well as adopting AI technology. Therefore, sustainable and inclusive development can only be achieved by developing strategies that will help population of each region/group to integrate into the digital society of the future driven by AI.

CONFLICT OF INTEREST

The authors have no relevant financial or non-financial interests to disclose.

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