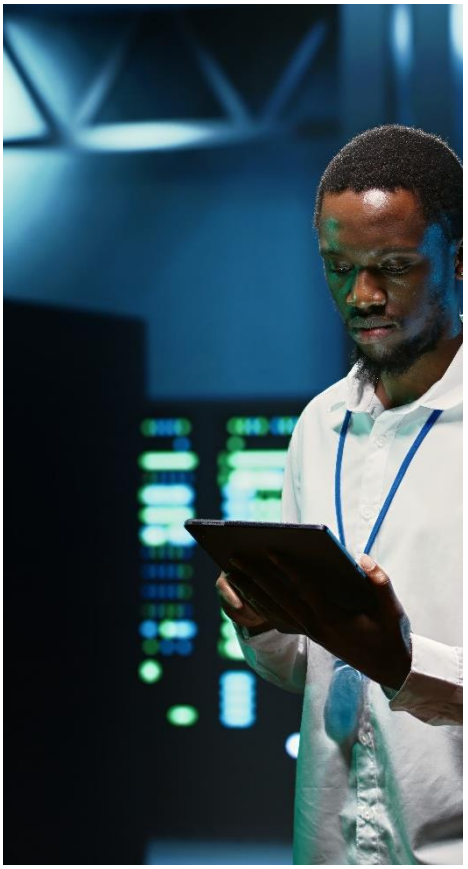
Deloitte.

AI for Inclusive Development in Africa – Part II: Data and Digital Infrastructure

Introduction

Artificial intelligence (AI) algorithms, particularly those used in machine learning and deep learning, rely on powerful and highly scalable computing infrastructure, as well as large datasets of structured or unstructured data, to identify patterns and make predictions.



In many African countries, however, data and infrastructure challenges stand in the way of harnessing AI's potential for economic growth. The vast data deficit in public statistics, such as basic population censuses and economic household surveys,[1] coupled with a lack of digitization of government services and processes[2] by African governments, companies, and individuals, leaves AI developers with limited African-centric, traditional datasets. Data security and protection regimes in Africa have gaps that can engender mistrust in data collection efforts.[3]

According to the Oxford Insights 2023 Government AI Readiness Index, Sub-Saharan Africa has the least ready AI infrastructure globally, due to the relatively high cost, low quality, and low availability of the internet.[4] Even countries like South Africa and Rwanda, which have the most AI-ready infrastructure, still have capacity levels well below the global average for electronic infrastructure development.

These discrepancies are partly attributed to the digital divide, where connectivity across geographies and socio-economic groups are unevenly distributed. For example, in 2021, Africa reached 50% urban internet connectivity across the continent, while rural communities only reached 15%.[5] This uneven connectivity landscape is embedded in AI development on the continent through data collection gaps and reverberates across AI models and their implementation. [6]

National governments and their international partners have already prioritized basic digital infrastructure and bridging the digital divide on the continent, which will benefit Africans aiming to use AI solutions for socio-economic advancement. Yet, for the continent to take advantage of AI as it becomes more widespread and sophisticated globally, these governments and their partners must both intensify their foundational digital investments. In addition, making a strategic push for AI-specific enabling infrastructure, such as high-performance data centers, high-throughput storage solutions, graphics processing units (GPUs) and tensor processing units (TPUs).

These investments should focus on 1) strengthening foundational connectivity; 2) accelerating digital transformation to generate and collect data; 3) improving, securing, and publishing datasets; and 4) enhancing computational power.

Digital divide: urban vs. rural areas

50% of urban communities in Africa have internet access, compared to 15% of rural communities

Data and Digital Infrastructure

Strengthening Foundational Connectivity

Enhanced AI development and integration requires readily available, consistent internet access to retrieve datasets, use cloud computing tools, train, and test AI models, and integrate Application Programming Interfaces (APIs), which is essential for systems-to-systems data exchanges.[7] Internet connectivity, however, is unevenly distributed across Africa, with most regions "lack[in] sufficient infrastructure, resources, and data-management."[8]

Foundational connectivity gaps have a compounding negative effect on AI development in Africa: low connectivity inhibits digital and AI use by the public, governments, and businesses, which in turn impacts Africans' ability to create data needed to fuel local AI solutions. Low bandwidth constrains AI computation capacity in data centers, which in turn limits governments and businesses from deploying accurate, impactful AI solutions to improve services for Africans. Furthermore, low bandwidth impedes the public from accruing the benefits of directly using AI platforms such as ChatGPT.[9]

In Sub-Saharan Africa, only 36% of the population has access to broadband internet, and across the continent basic data plans can cost up to three times more than in regions with advanced digital infrastructure.[10] Connectivity and internet coverage in Africa varies significantly depending on the region. While Central Africa has a coverage gap of 36%, other sub-regions fall between 11% to 14%.[11]

Internet speed and stability in Africa are also low compared to other regions.[12] Internet bandwidth, which is necessary for the most advanced AI computations, is the lowest of any region in the world, at one-third of the global average.[13] Broad coverage and internet use in Africa is low, at 33% compared to 59% globally (see Figure 1). Even in countries like South Africa, which tops the rankings for digital quality of life on the continent, individuals and firms face challenges with loadshedding—a deliberate electricity shutdown to distribute power —and slow internet speeds and connectivity.[14] Internet shutdowns across Africa also jeopardize reliable internet needed for AI. In 2023, internet shutdowns in Sub-Saharan Africa totaled over 30,785 hours and affected 84.8 million users.[15]

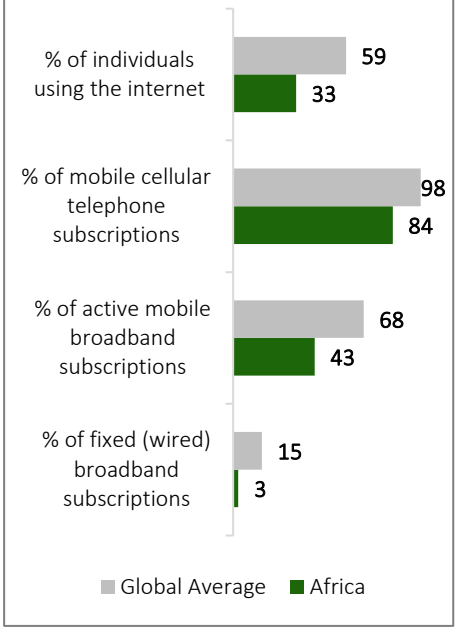
Beyond internet connectivity, AI systems need a powerful, reliable energy supply that can be up to four times greater than other commercial digital technologies.[16] Data centers and the hardware needed to run AI algorithms, such as central processing units (CPUs) and GPUs, can use massive amounts of power to process datasets and cool hardware.[17] [18] Inconsistent power can result in system crashes or data loss, lead to hardware malfunctions, decelerate processing speeds, and interrupt AI model training. While most data centers use backup power to prevent data loss, these systems are often too costly to make the investment viable, particularly in regions with limited resources.

Access to internet in Sub-Saharan Africa

Only 36% of the population has access to broadband internet,

Up to 3x higher cost for basic data plans than other regions in the world

Figure 1: 2022 Broadband Coverage in Africa Compared to Global Average[14]



Several large public-private initiatives are helping strengthen Africa's connectivity infrastructure gaps through undersea and land fiber optic cables. The 2Africa subsea project, for example, aims to connect forty-six landing stations across 33 countries, aiming to serve over 1.3 billion people. 2Africa requires fair and equitable access to the system, aiming to facilitate broadband at reasonable prices.[19]

The partnership includes major technology players like Meta and telecommunications companies like Telecom Egypt, Orange, and Vodafone, with various governments facilitating regulatory and infrastructure support.[20] *Terrestrial fiber optic cables are further extending this connectivity to landlocked countries. This partnership model can marshal funds, coordinate regulations, and disperse risk across parties for expensive connectivity infrastructure.* [21]

While access to electricity in Sub-Saharan Africa has grown substantially over the last two decades, only half of the population has access today[22] and 77% of firms experience electrical outages, at an average of over eight times a month.[23] Meanwhile, corporations leading in global AI are expected to consume more annual electricity[24] than lower-energy-consuming countries in Africa, like Rwanda[25] or Senegal.[26] Some mobile network operators are incorporating renewable energy solutions, including on-site renewables and battery storage. However, high costs and lack of physical space are substantial barriers to implementation.[27]

Access to electricity

77% of firms experience electrical outages, at an average of over eight times a month

Improving basic digital infrastructure is already a priority investment area for regional institutions such as the African Development Bank (AfDB) and the African Union (AU), as well as multi- and bilateral development partners like the U.S. Agency for International Development (USAID). China has also been heavily investing in Africa's connectivity infrastructure through the Belt and Road Initiative and has been the top exporter of AI-driven technologies to Africa.[28]

Some African countries, like Togo, have expanded public access to basic and higher quality broadband by encouraging competition in the telecommunications sector, facilitating infrastructure sharing for network operators, reforming spectrum management, and offering tax breaks to companies that invest in rural areas and critical infrastructure like fiber optic networks.[29] These strategic public sector investments in digital infrastructure can lay the foundation for broader AI use and AI development.

Opportunities for Consideration

- **Use public-private partnerships to increase fiber deployments to and within urban areas to improve network infrastructure**. Target fiber build outs in urban hubs that have the highest near-term growth potential for AI development and integration. Develop policies and partnerships that aim to increase redundancy of the land and undersea fiber optic cable routes that connect urban centers, improving the reliable internet access needed for scaling AI development and ensure accurate mapping of fiber infrastructure to avoid disruptions and optimize network expansion. By ensuring redundancy through mesh networks and multiple data pathways, telecommunications entities reduce the risk of a single point of failure, thereby enhancing the robustness and reliability of the network infrastructure.

- **Streamline licensing processes for private power generation projects that are accessible to AI developers and businesses to reduce the environmental footprint of AI.** Facilitate private investment in energy projects, particularly those focused on renewable energy, battery storage, and grid expansion, to benefit technology hubs with AI development and reduce their environmental footprint. This could include providing clear guidance on build requirements in specific climates to ensure resilience to rainy and harmattan seasons and expediting review and licensing renewal processes for quicker project execution. Given the heavy power and water consumption of multimodal AI and GenAI in particular, tie licensing agreements to public reporting requirements on AI environmental footprints.

- **Collaborate with telecommunications companies to build out fixed wireless networks or low earth orbit (LEO) satellites as alternatives to last mile connectivity.** In the short term, provide subsidies to expand access to fixed wireless or LEO, particularly to rural communities. While fixed broadband services through fiber buildouts promise lower latency and higher throughput, the near-term capital expenditures for governments and the private sector can be daunting, particularly when trying to reach geographically dispersed customers with lower incomes than urban areas. Fixed wireless networks and LEO are two ways to increase connectivity, with greater data throughput at lower cost—allowing more people to access technologies like AI and generate data.[30] Furthermore, international partners advocating for AI could promote the allocation of national spectrum to telecommunications companies willing to serve technology hubs focused on AI, with higher throughput and lower latency requirements than other commercial sites.

- **Promote the development of AI-solutions within the telecom sector to address connectivity and bandwidth challenges.** Encourage telecom providers to develop automation tools and advanced customization capabilities, such as deploying massive multiple-input multiple-output (MIMO) and beamforming, to improve connectivity for tech hubs that are developing AI for other sectors.

Accelerating Digital Transformation to Create and Collect Data

Large datasets facilitate AI algorithm training and curation, improving accuracy and comprehensiveness.[31] AI developers can ingest structured and/or unstructured data from a range of sources, including government agencies, internal systems of private enterprises, public web pages, and even third-party data collectors.[32]

Yet most government services[33] and private sector firms[34] in Africa have not incorporated advanced digital tools into their data collection and management processes, leading to a dearth of traditional data on the continent. These data deficits inhibit AI developers and integrators looking to quickly build Africa-focused algorithms, forcing them to rely on data sets that are smaller, synthetic, or originating from the global north.[35]

Consistent and thorough public sector data collection across the continent is challenging, even at the basic level. Collecting "big data" digitally at scale, with high volume, velocity, and variety to train advanced AI, is even more difficult.

In many cases, government data collection is still recorded manually, reducing data reliability, and embedding inefficiencies in the data cleaning process.[36] While entities like the AfDB and USAID have promoted open data platforms and enhanced the capacity of some National Statistical Offices, there is still comparatively low public data availability on the continent, even on basic vital statistics and civil registration.[37]

While e-government capabilities vary across Africa and many countries have made improvements, 50 out of 54 governments have lower digital use than the global average, representing 95% of the continent's population.[38] There are disparities in e-government capacity across the continent, with South Africa, Mauritius, Seychelles, and Tunisia leading in capacity (see Figure 2). This digital gap in African governments persists across capabilities such as e-procurement and digital invoicing,[40] as well as within services in social protection, education, and employment.[41] E-government initiatives, optimized by AI, have the potential to accelerate the creation of public databases by digitizing census, survey and geospatial data, and by standardizing metadata management across agencies.[42]

Meanwhile in Africa's private sector, digital adoption is growing with increased access to the internet and widespread mobile phone usage, particularly for firms in middle-income countries with large urban centers.[43] Yet according to the World Bank, only 7% of microenterprises – the typical business size in Africa – use smartphones and computers.[44] Of the larger firms that have adopted digital technologies within their businesses, over half do not use these technologies intensively.[45] By not using digital technologies, these private firms in Africa are not producing digital datasets that AI developers could use, let alone harnessing the benefits of AI for their own business goals.

Africa's data deficit is worsened by low levels of data generated from individual digital use—a deficit which also embeds existing socioeconomic divides across gender, geography, and age. Urban residents are 1.7x more likely to use the internet than rural residents[46] and men are 11 percentage points more likely than women to use the internet.[47] The reasons for these widespread internet use gaps are manifold, and include the prohibitive cost of devices and data, low digital literacy, and a lack of content in local languages.[48]

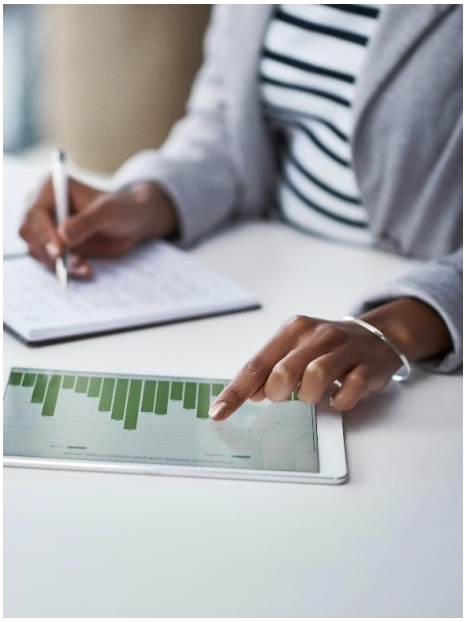
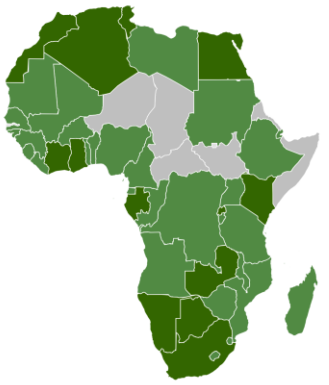


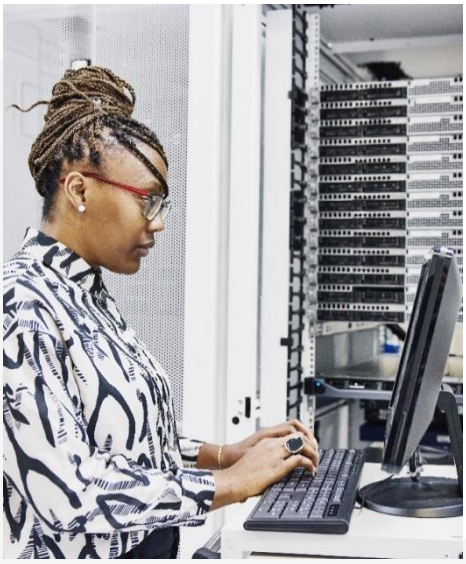
Figure 2: Africa E-Government Digital Index Scores (2022)[39]



Access to e-Government services

95% of Africans have lower access to e-government services than the global average

Given that training some AI models, such as Generative AI, requires massive amounts of data scraped from content created by internet users on social media sites or web pages, the lack of widespread internet use in Africa poses a significant challenge. As AI developers try to use African datasets for their models, they must also actively add measures to tackle these data gaps and their embedded socioeconomic biases.



Some AI developers are attempting to fill the data deficit in Africa. Ghanian engineering company Bace Group developed AI facial recognition software focused on representing Black African faces.[49] By using a more diverse dataset, their software minimizes bias that is often common among Western developers. Other private sector efforts include Google's AI Research Centre in Ghana, which since 2019 has used satellite imagery and machine learning to quadruple Africa's built infrastructure visible on Google Maps.[50] Kenyan startup company Amini is focused on empowering the African agricultural sector by collecting and curating environmental data for widespread use.[51]

Several natural language processing initiatives across Africa are trying to bridge data gaps on local languages in training data. The Nigerian Government, for instance, recently launched its own pilot LLP with seed funding from the UN, multinational companies, and Nigerian universities.[52]

The Ghana NLP initiative aims to improve the quality of Ghanian and West African languages that are ingested in training data.[53] *This open-source initiative—a partnership with entities like Google, Microsoft and Harvard University—aims to adapt AI/ML techniques to work in lower-resource settings while it builds systems for local applications, having successfully supported 17 Ghanian languages to date.*[54]

Meanwhile, the Masakhane grassroots organization aims to increase the representation of African languages in technology through working across 30 countries to create datasets, train new models, and mentor NLP practitioners.[55]

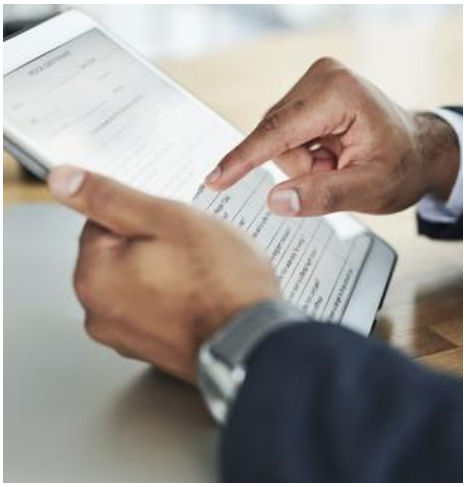
For AI models focused on African markets to develop accurately, impartially, and continuously, African governments and their partners must develop a digital ecosystem that can generate large, regionally-specific datasets.

Opportunities for Consideration

- **Increase coordination of national and regional data collection to standardize methods and increase ROI.** Increase investment in national statistical offices and empower them to be the coordinating focal point across sectoral data collection. This will avoid duplicative collection efforts and to increase returns on investments by exploring intersections across datasets (e.g., weather patterns, demographic trends by region, agriculture production levels, and health risks combined to provide a clearer picture of climate risks). Furthermore, encourage public-private initiatives to tackle priority AI use cases, through open innovation collaborations.

- **Invest in the digitization of data collection and hosting platforms to open data sharing to reduce the long-term costs of survey collection and increase data sources.** National

surveys, such as population and household surveys, are expensive and logistically challenging to conduct. Incorporating digital collection tools, like smart tablets and survey software, and conducting surveys via SMS can take advantage of the widespread mobile phone use in Africa. Furthermore, investments in data collection via internet of things (IoT) sensors and unmanned aerial vehicles (UAVs) could build out reliable data sources in sectors such as energy and resource use. African governments should invest in public-facing data hubs[56] that gather, clean, and manage data, which could facilitate AI-ready data[57] and reinforce data standards for AI models.



- **Enforce and raise awareness about best practices for the ethical collection of data to safeguard individuals.** Governments should establish policies and best practices for data collection and management, requiring licensed non-governmental organizations and private enterprises to confirm they have followed these standards when conducting data collection, particularly when it involves human beings. As digital tools become more widespread, individuals should also be educated about their rights and how their data is being collected.

- **Develop creative ways to generate data in both high and low fidelity digital contexts to address data scarcity problems across Africa.** Governments should consider investing in standardized efforts to capture and process data outside of traditional data sets, such as images, audio, and video formats. For example, governments could set standards on establishing data lineage and a single source of truth for non-traditional datasets to build towards trustworthy AI. Governments should also consider investing in processes to ingest paper-based data, potentially leveraging AI/ML mechanisms for automation. These efforts will improve data accuracy and efficiencies and help include populations currently less represented in traditional African data sets.

Improving, Securing, and Obtaining Datasets

Artificial Intelligence's often voracious data needs place an additional burden on entities to make data accessible, while also ensuring that the data is ethically sourced, the rights of entities represented in the data are protected, and the data is secured. While many African governments have adopted data protection policies, AI's exponential growth globally necessitates a reexamination of policies and standards to guide its responsible development. For deeper analysis of regulatory and ethical frameworks on the continent, please see *Part 1-Governance* of Deloitte's series.

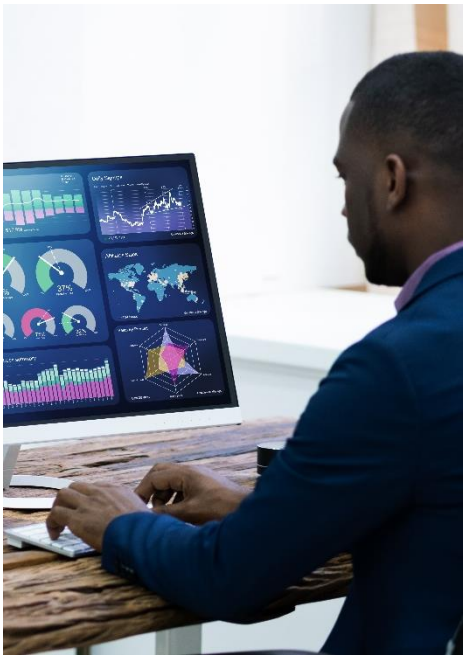
Data security in Africa

35 countries in Africa have adopted data protection regimes since 2001

> *"Africa's public and private sectors generate an abundance of data. But for African governments to develop meaningful AI use cases and deeply integrate AI into their services, they need to invest more in developing and linking structured datasets. USAID has supported several data and digital platforms for technologists and software developers in African countries to access new machine-readable datasets and tools more easily."*
>
> *– Olu Olutola, Senior Connectivity and Digital Advisor at USAID*

Standards to Improve Data

Given that data collection is not standardized across Africa's public and private sectors, AI developers must spend time cleaning the data by fixing or removing errors and identifying incomplete data within a dataset.[58] As the computer science axiom goes: "Garbage in, garbage out."[59] Without formal data quality standards, quality assurance frameworks and easily accessible cleaning tools that can be tailored to local contexts, entities generating data sets risk introducing inaccurate or biased data into AI algorithms.



Some African countries, like Botswana[60] and Tanzania,[61] have launched data quality efforts to guide their National Statistics Organizations in data production and dissemination. Botswana's Data Quality Policy, for instance, explicitly builds on United Nations, AU, and national legislative frameworks and principles, and provides clear definitions of quality dimensions.[62]

However, even for African countries with data quality policies, enforcement of these regulations and dissemination of guidance is uneven, perpetuating the generation of datasets with mixed reliability.[63] Given that data preparation can cost up to 60-80% of an analytics project and sometimes require advanced rare and expensive expertise,[64] governments must also ramp up efforts to raise awareness about affordable data quality tools and industry standards.

Securing and Protecting Data

AI models, particularly when customized on proprietary data, have the potential to "infer sensitive information, such as a person's location, preferences, and habits," as well as to facilitate "theft and unwarranted surveillance."[65] These models can pose significant risks to individual privacy, data security, and intellectual property.

As with data quality standards, African countries have a patchwork of policies on data protection, intellectual property (IP), trademarks, and copyright —many of which have not been updated since the global acceleration in AI development. Companies advancing AI across the continent currently must navigate 36 different sets of data protection regulations[66] or work in countries like Sierra Leone and Sudan that have no data protection legislation to adhere to.[67]

African countries that lack comprehensive legal frameworks on data protection, such as consumer safeguards, e-services, and oversight of online advertising, are at a distinct disadvantage in ensuring AI is developed & used responsibly.[68] Generative AI, in particular, has the ability to infringe on intellectual property rights, given its ability to ingest, analyze and mimic human inventions and art.[69] Governments with national data protections in Africa also face two underlying challenges as growing digital economies—enforcing regulations on cross-border data flows and ensuring widespread public awareness about data protections and rights.[70]

To ensure open, secure, and inclusive digital adoption, USAID launched the Digital Connectivity and Cybersecurity Partnership (DCCP). The DCCP focuses on expanding internet access in emerging markets, increasing digital regulation, promoting exports of U.S. ICT goods and services, and increasing the adoption of cybersecurity best practices.[71] A key initiative of the DCCP is the Cross Border Privacy Rules (CBRP) which increases knowledge and builds capacity of the Cross-Border Privacy Rules System to ensure greater cybersecurity and global cooperation.[72]

Countries like Kenya, Rwanda, and Morocco, have modeled their legal frameworks on the European Union's legislation,[73] such as the 2018 General Data Protection Regulation (GDPR), considered the strongest privacy and security law globally.[74] Given GDPR's extraterritorial reach and Europe's role in African economies, some African-based companies also have compliance obligations that will impact the level of data protection they will need if they adopt AI or develop solutions to be adopted internationally.[75]In addition to many national frameworks, IP in Africa has protection through two regional platforms, of which 39 out of 54 states are members.[76] These regional IP bodies could be empowered to help harmonize legal data protections on cross-border use for AI on the continent.

Advancement of the Malabo Convention

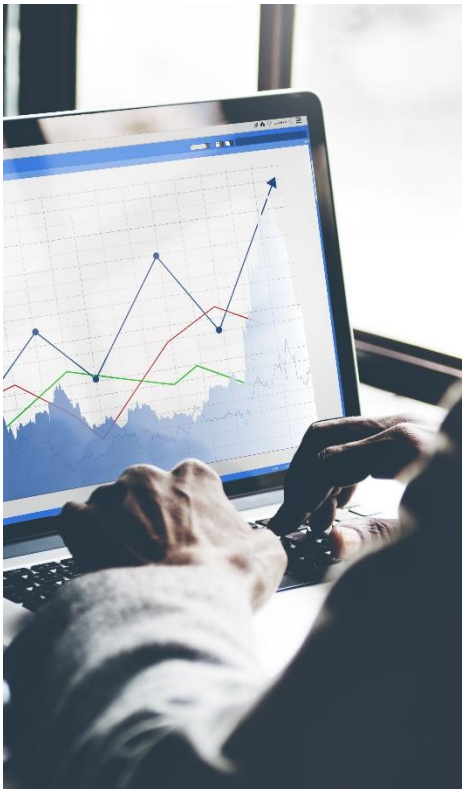
Only **15** countries in Africa have ratified the Convention on Cyber Security and Personal Data Protection

Yet enforcement of these legal frameworks remains a challenge. As of 2023, only 15 countries in Africa have ratified the Convention on Cyber Security and Personal Data Protection (the Malabo Convention), [77] which aims to standardize national data privacy efforts on the continent.[78] Among its framework content, the Malabo Convention introduces new requirements for data security, such as notification of data breaches, restriction of data transfers to countries with inadequate data protection laws, and upholding data subjects' rights to access, correct, and delete their data.

Expanding Access to Data

For AI to generate socioeconomic value in Africa, AI developers need broad and easy access to complete and accurate data for their AI systems to improve performance and relevance to African economies.[79] Given that the AI sector is currently dominated by a few companies in the Global North with access to proprietary data and systems,[80] opening African-based

data through targeted investments and the creation of standards could allow local AI developers to create more targeted local solutions.



While the open data movement has not yet gained broad traction in Africa, several technical and legislative initiatives aim to expand access to data at the national and regional levels in ways that could be valuable for AI developers. South Africa's Open Government Partnership (OGP) program and the South African Data Portal, for example, provide the public access to various government datasets.[81] Kenya has also made significant strides with the Kenya Open Data Initiative, which as of 2016 made over 800 datasets available to government sectors such as health, education, and infrastructure. Kenya's Data Protection Act also has protocols that facilitate data sharing platforms, aiming to increase the movement of data and reduce data collection costs.[82]

Regional open data initiatives, often supported by international development partners, have also pushed for publicly available data that could be ingested for AI models. The AU's platform, Open Data for Africa, is a large public collection of databases focused on socioeconomic trends and statistics, although it faces similar completeness challenges to national databases.[83] Other regional efforts include openAFRICA, a grassroots initiative supported by AWS and the World Bank, which currently provides over 6,000 datasets on an array of topics and geographies.[84]

Developing, maintaining, and publishing data sets, while also having high data quality and protection, can be expensive and time consuming.[85] Implementing open and free access to data also requires buy-in from those who control the data, which can be difficult to navigate in countries with weaker rule of law or limited experience in the process.[86] For instance, despite Tunisia's Open Data Strategy, many datasets are still not readily available due to capacity and coordination challenges, forcing AI enterprises and startups to buy or create their own datasets at great expense.[87]

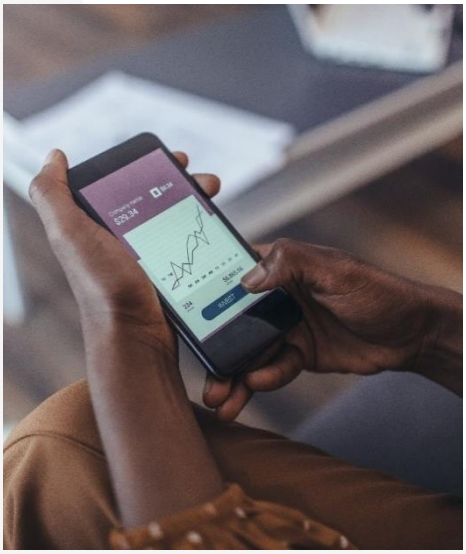
Opening data in Africa also comes with the risk of exacerbating existing inequalities in the global AI sector, in a form of "data colonialism" whereby Global North companies can use their established technical AI expertise and systems to extract and concentrate this newly opened data from African economies.[88] As some African governments seek to build datasets that can be accessed by the public, they must design its platforms so that Africans themselves can effectively use them.

Opportunities for Consideration

- **Establish partnerships with research centers both in Africa and globally to increase access to high-quality data and cross-border collection.** Develop joint AI-focused initiatives that can take advantage of existing, high-quality data stored at research centers, such as those at universities. These partnerships could be particularly helpful to establish frameworks that facilitate cross-border data collaboration and sharing, ensuring that data flows comply with relevant protection laws and promote mutual benefits for all participating countries.

- **Assess who is using government data to provide basic insights into data access efforts.** Derive insights into the types of individuals and organizations using publicly available data and digital services by tracking metadata associated with download requests. This could include asking users to state their occupation or country location, to help governments determine which sectors and regions are using open data. This can also help governments

refine data strategies and tailor any open data approach.



- **Fund data audits on government agencies to evaluate current-state data processes, storage, quality, and security.** Invest in national-level data audits to understand how different agencies are collecting and storing data. These results can identify gaps in data processes and capacities and establish a clear current state in data quality and security across public agencies, from which resources can be allocated. Prioritize audits for agencies that have promising AI use cases in priority sectors.

- **Incentivize private sector data sharing to expand the scope of data available to African AI developers.** Introduce incentives for private companies to share non-sensitive data with the broader AI community, particularly public sector actors, educational institutions, and non-profit researchers. This could include tax breaks, grants, or recognition awards for companies that contribute valuable datasets to public repositories.

- **Adapt international standards to local contexts to enhance African competitiveness in the global AI sector.** Encourage the adoption of international data protection standards, such as the GDPR, where applicable. This can help African data protection regimes align with global best practices and enhance their competitiveness in the AI sector. Countries without existing data protection laws should consider pooling resources through investment in regional enforcement bodies, as well as researching how to effectively foster local compliance without limiting AI innovation.

Enhancing Computational Capacity

AI developers need access to scalable and high-performance computing infrastructure to develop, test, deploy and maintain AI solutions.[89] To maintain ultra-high processing speeds, large, highly complex AI systems, such as foundational models that process high volumes of data, require advanced supercomputing infrastructure.[90] This infrastructure uses clusters of multiple CPUs, facilitating up to 1 million times greater processing power than a laptop computer.[91]

Compute and storage capacity in Africa is extremely low—with only 1% of global data center capacity—severely restricting the advancement of AI development on the continent.[92] Any effort by African governments or companies to increase computational capacity places them squarely amid global competition for hardware, such as expensive specialized hardware accelerators that can cost US$40,000 per chip.[93] The demand for GPUs for AI development is a concern globally, even amongst the most influential computational service providers in the AI space.[94] While traditional applications can operate via a loose distribution of processors, Generative AI platforms in particular require an especially high volume of chips, sometimes up to 10,000 chips at a time.[95] When testifying before the U.S. Congress in 2023, OpenAI CEO Sam Altman stated, "We're so short on GPUs, the less people that use the tool, the better."[96]

Public and private sectors in Africa typically have two options to expand their compute capacity: supercomputer hardware or cloud platforms.

Supercomputer Hardware

Supercomputers are the most powerful computers globally, with standalone, highly specialized systems that accelerate processing for specific applications.[97] For African countries targeting specific research focus areas, such as genomics or agricultural land management,[98] or those that have concerns about retaining citizens' data within their borders, supercomputers have significant appeal.

> *"As the founder of a Tunisian AI startup that develops computer vision models, I had to invest in costly graphic cards to test and validate my AI model. Cloud and edge computing alternatives were too expensive. I believe that increasing the availability of local supercomputers for startups to test and validate models would accelerate the entire AI ecosystem"*
>
> *– Adnene Labidi, Founder of Instaware*

Yet these computers are almost prohibitively expensive to install and maintain in Africa—beyond the competition for chip procurement, supercomputers consume a massive amount of power that require extensive and reliable electricity and cooling mechanisms.[99] As such, few supercomputers have been installed across the continent that have globally competitive capacity, the largest of which are in Morocco[100] and South Africa.[101] None rank in the top 250 most powerful supercomputers globally.[102]

Other countries in Africa have made deliberate investments to improve their data storage and processing capacities via supercomputers. Senegal, for example, has upgraded its data

Low compute and storage capacity

Only **1%** Of global data centers capacity, including computing and storage, are in Africa.

infrastructure to acquire a supercomputer,[103] while Kenya has allocated industrial land and special economic zones to support data center development.[104]

Cloud Platforms

Cloud adoption in Africa is rising, but still far behind other regions, at 15% adoption compared to 71% in Europe as of 2022.[105] Cloud services for both governments and private firms are dominated by US-based platforms like Amazon Web Services (AWS), Google Cloud Platform (GCP), and Microsoft Azure, with most data centers located outside of the continent.[106] Seventy percent of government agencies in Nigeria store their data overseas, for example.[107]

This global power imbalance has elicited growing concerns about data sovereignty, as African governments and businesses are largely dependent on non-African big tech companies who host personal data of African citizens. Some countries, like South Africa, Nigeria, Kenya and Zimbabwe have adopted legislation requiring personal data to be stored locally and limiting the processing of personal data.[108] But they have few alternatives to reduce reliance on foreign companies—only 82 data centers exist on the continent, while analysts estimate that onshoring cloud computing would require a minimum of 700 data centers.[109]

Given the high latency, bandwidth constraints, and data privacy concerns of cloud computing, some African companies, particularly startups, are turning to edge computing to test their AI models to get to a minimum viable product. Zindi, a data science competition platform based in South Africa, is exploring edge computing to enable AI model training and inference on devices at the edge, reducing reliance on cloud infrastructure.[110]

Edge computing can reduce latency and lower bandwidth costs in low connectivity areas, while maintaining the data privacy offered by cloud—this enables advanced AI/ML closer to the data source.

Other underlying challenges to cloud adoption in Africa concern currency fluctuation and capital controls. Cloud fundamentally shifts a firm's local capital expenditures to operational expenditures—with global firms that charge services in US dollars.[111] Even African countries with the most advanced compute capabilities, like Nigeria or South Africa, have experienced major currency volatility that has ballooned budgets for local companies relying on cloud infrastructure.[112] In African countries where foreign currency exchange is highly regulated and credit card access is limited, paying for international cloud services at scale can impede adoption.[113]

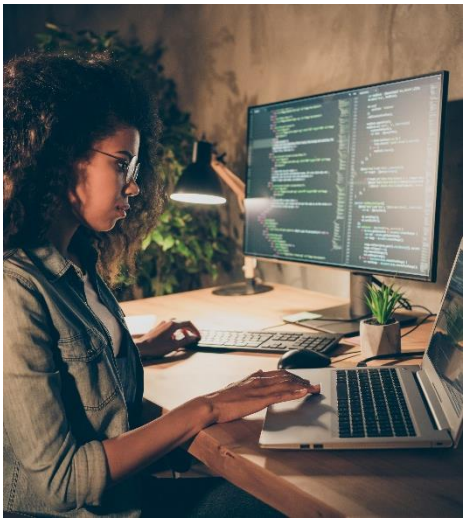
Cloud adoption in Africa

15%

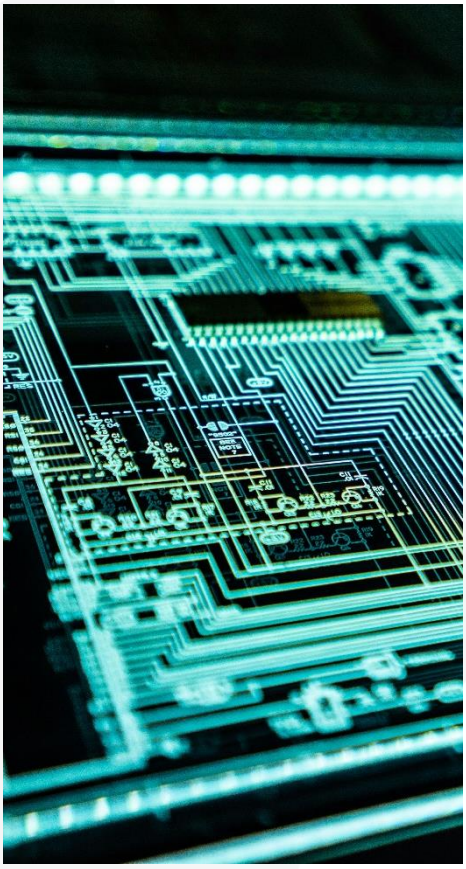
Of cloud adoption in Africa, compared to 71% in Europe in 2022

Edge computing localizes cloud computing, moving from a centralized point in a network towards the device

This reduces overall computing costs, reaction time and infrastructure needs, allowing for machine-learning algorithms to access relevant data with lower latency



Opportunities for Consideration



- **Pool regional infrastructure and harmonize policies to aggregate computing investments and promote effective resource distribution.** Concentrate investments in compute capabilities geographically, targeting hubs that are developing and integrating AI solutions. Consider public-private partnerships to coordinate licensing requirements and establish policies that can facilitate onshoring of data centers and create regional computing hubs to distribute resources effectively and encourage collaborative AI projects.

- **Provide credit to AI-focused startups for cloud services to reduce cost barriers that inhibit testing early models.** Emulating the financial support models of private sector cloud providers such as AWS, GCP, and Microsoft Azure, African governments should consider providing public financial support to AI startups purchasing cloud storage and compute. This will remove a costly barrier for innovative new African companies to access initial computational tools to test their early models.

- **Encourage the development of modular data centers that can be deployed rapidly and scaled efficiently**. These data centers can be designed for specific regions or industries, providing flexible and cost-effective solutions to the computational deficit. Modular units can be added as needed, supporting incremental growth aligned with AI development demands.[114]

- **Require AI use cases to be linked to national economic priorities for testing and development to optimize the use of publicly available compute infrastructure**. For countries with limited public compute infrastructure, establish clear criteria and require AI developers to link their AI use cases to existing national economic interests, such as their relevance to a priority industry or ability to impact multiple markets.

- **Offer tax incentives, reduce hardware import tariffs, and streamline data center regulations to incentivize cloud and edge computing adoption**. Work with cloud providers like AWS, GCP, and Microsoft Azure to offer localized billing and better pricing for AI deployment solutions, addressing currency fluctuation and capital control issues.

- **Invest in the development of local and regional cloud service providers to reduce dependency on foreign companies**. Improve data sovereignty by supporting these providers through land grants, tax incentives, and streamlined regulatory approvals, while leveraging regional cooperation frameworks like the AU's Digital Transformation Strategy and the Malabo Convention to create a cohesive, continent-wide approach to data sovereignty. Implement a national cloud strategy and governance model to supervise cloud infrastructure and ensure entities that manage data considered as sovereign data are properly regulated and supported.

Conclusion

Developing and deploying AI solutions at scale in Africa requires strategic investment in digital infrastructure and the generation and accessibility of high-quality data. Many challenges facing AI developers in Africa are magnified versions of the broader digital divides in these economies—from connectivity gaps to data quality.

Other AI infrastructure challenges, such as supercomputing for large sovereign use, compel African governments and international partners to consider new strategies to expand capacity on the continent.

While AI is not a panacea for development, maximizing AI's potential and minimizing its harms as it accelerates globally will mean advancing policies and incentives for stronger infrastructure, greater capacity and enforced data quality policies. Given the costly and often technically challenging nature of this infrastructure, African countries must align their AI investments with use cases in their priority development sectors and assess their needs for bandwidth, datasets, servers, and computational capacity.

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