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Harnessing industrial AI for Africa's economic transformation: Opportunities, challenges, and policy pathways

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Highlights

- Industrial AI offers Africa a unique opportunity to drive inclusive economic transformation, enhance productivity in key sectors like manufacturing, energy, and mining, and prevent premature deindustrialization.
- The successful deployment of industrial AI depends critically on building reliable infrastructure, generating local data, developing skilled human capital, and fostering dynamic innovation ecosystems.
- Significant disparities in AI readiness across African countries require tailored strategies, prioritizing infrastructure development, education reforms, and policies that enable local innovation and responsible AI governance.
- A coordinated policy agenda — combining national AI strategies, investment in digital infrastructure, regional cooperation, and private sector engagement — is essential to harness AI's full potential for Africa's industrial growth.

Introduction

The field of Artificial Intelligence (AI) is not merely a passing trend in technology; rather, it is a transformative force that is profoundly impacting economies and societies around the globe. For the African continent, AI is regarded as a strategic asset with the potential to catalyze innovation, generate new industries and employment opportunities, and expedite the realization of development objectives (African Union, 2024). Of particular note is the potential of industrial AI—defined as the application of AI in industrial sectors such as manufacturing, energy, agriculture, logistics, and mining—to contribute significantly to the economic future of the continent. This potential has been acknowledged by African leaders, as evidenced by the adoption of a Continental AI Strategy in 2024 by the African Union. This strategy endeavors to promote an Africa-centric and inclusive approach to AI, with the objective of leveraging its benefits for development while addressing potential risks (African Union, 2024). As Dr. Akinwumi Adesina, President of the African Development Bank, has observed, the African continent possesses significant potential to transition into an AI-driven future, circumventing conventional impediments and directly adopting the technologies of tomorrow (Ukoha, 2024). This policy brief explores the manner in which AI can catalyze industrial growth across Africa, the opportunities and challenges associated with this process, and the policies and investments necessary to actualize the potential of AI for the benefit of all Africans.

Despite the pervasive optimism, the landscape of AI readiness in Africa exhibits significant disparities. A select group of nations, including Mauritius, Egypt, Tunisia, and South Africa, have demonstrated leadership in AI preparedness by allocating resources to infrastructure development and cultivating skilled talent. In contrast, numerous other countries have yet to make significant progress in this domain (Azeroual, 2024). The continent is confronted with persistent structural challenges, ranging from digital divides to skills gaps, that must be addressed for the potential of AI to be realized for all (Azeroual, 2024). The dissemination of the benefits of industrial AI will not occur automatically; deliberate action is required to ensure that the growth driven by AI is inclusive and sustainable. This brief adopts a Pan-African perspective, emphasizing significant sectors in which AI has the potential to generate substantial impact. Concurrently, it underscores the necessity for cross-cutting considerations in infrastructure, human capital, and governance.

Industrial AI and Africa’s ambition to industrialize

The Fourth Industrial Revolution, marked by the convergence of digital, physical, and biological technologies, is profoundly impacting various industries around the globe (Mittal et al., 2018). A significant catalyst for this transformation is the integration of industrial AI (IAI), which involves the application of AI within industrial domains such as manufacturing, energy, and mining, with the aim of automating processes, enhancing production efficiency, and stimulating innovation. For the African continent, which has aspired to industrialize and generate employment opportunities on a substantial scale, the emergence of industrial AI signifies both an opportunity and a challenge. The African Development Bank's "Industrialize Africa" initiative, for instance, established an ambitious objective to enhance Africa's industrial GDP by 130% (from \$2.2 trillion to \$4.6 trillion) by 2025 (Runde, 2019), thereby emphasizing the pivotal role of industrial growth in the continent's development agenda.

With respect to the process of industrialization, African countries can be broadly categorized into three distinct groups. The first category comprises fragile states—namely, those nations that are conflict-affected or institutionally weak—which constitute a substantial proportion of the continent's nations. A notable example is that 35 out of the 59 globally identified fragile states are located in sub-Saharan Africa (Runde, 2019). These states encounter significant challenges in developing fundamental industrial capabilities due to prevailing instability. Second are the Least Developed Countries (LDCs), which include over thirty African nations that rank lowest in income and human development

(African School of Economics, 2024). LDCs such as Malawi and Burkina Faso have experienced only limited industrialization to date. A select group of emerging or frontier economies (e.g., South Africa, Nigeria, Egypt, Morocco, Tunisia and Kenya) have demonstrated notable advancements in their industrial bases and tech ecosystems. This combination of factors contributes to an uneven state of 4IR readiness across African nations, with some countries demonstrating the capacity to swiftly adopt new technologies, while others face the potential to be left further behind.

Alarmingly, Africa has witnessed a period of stagnant or declining industrial activity in recent decades. In 2013, the manufacturing sector constituted approximately 10% of the GDP in sub-Saharan Africa, a figure that has remained consistent with the levels observed in the 1970s. However, Africa's contribution to global manufacturing output has declined, with the share falling below 2% (Newman et al., 2017). In summary, the African continent has not yet experienced a comparable manufacturing surge that has been instrumental in propelling development in other regions. Continued progression of this trend may result in premature deindustrialization in Africa, defined as the loss of industrial capacity or the inability to develop it in the early stages of income. This risk is exacerbated by the global trend of "reindustrialization," which is driven by the integration of advanced technologies. The advent of automation and the conceptualization of smart factories has precipitated a resurgence of manufacturing activities in higher-income countries, thereby reducing the dependency on low-cost foreign labor. East Asia has already begun to incorporate robotics and AI into its high-value manufacturing processes, positioning itself as a global leader in this technological domain. For the African continent, the failure to engage in the process of industrialization at this particular juncture could result in the exclusion from global value chains, as machines and algorithms exhibit superior performance in comparison to the low-wage, low-tech manufacturing model that has historically been pursued by African economies. In summary, the 4IR has the potential to exacerbate the technological gap between Africa and industrialized regions, unless Africa employs AI to achieve a significant technological advancement.

On a positive note, African leaders have acknowledged the significance of this pivotal moment. The African Union's Agenda 2063 places significant emphasis on inclusive growth through technology-driven industrialization. Across the continent, there is growing awareness that industrial AI has the potential to be a transformative catalyst for African economies. The integration of AI can enhance productivity, foster the emergence of new industries, and mitigate the continent's potential exclusion from the fourth industrial revolution (4IR). The ensuing sections delve into the potential of AI to transform Africa's industrial sector, the prerequisites necessary for such a transformation to occur, and the policies that must be implemented to ensure the success of this endeavor.

The potential of AI in Africa’s industrial sector

The potential of AI to transform Africa's primary economic sectors, particularly manufacturing, energy, and mining, is considerable. These sectors stand to benefit from increased productivity, innovation, and resilience. Global estimates demonstrate the magnitude of the opportunity: According to African Union (2020), the implementation of 4IR technologies (i.e., AI, robotics, the Internet of Things, etc.) is projected to generate up to $3.7 trillion in value for manufacturing firms on a global scale. It is imperative for Africa to capitalize on the potential of industrial AI to achieve substantial economic growth and development. One analysis by the UN Development Programme, citing PwC, suggests that AI could contribute approximately $1.2 trillion to Africa's economy by the year 2030 (Balogun, 2024), representing a roughly 5-6% increase in the continent's GDP. Optimistic projections extend even further, with Google's African executives anticipating an impact reaching up to $1.5 trillion by the year 2030 (Balogun, 2024). While a considerable portion of this value would stem from advancements in agriculture and services, a substantial share is contingent on AI-driven gains in the industrial sector.

Manufacturing: The application of AI has the potential to transform the manufacturing sector in Africa, enhancing efficiency, quality, and flexibility in production processes. Smart factories, equipped with AI-driven automation and robotics, exhibit the potential to operate with greater efficiency and reduced error rates. This enhances the competitiveness of African-made products in global markets. For instance, AI-powered predictive maintenance systems leverage sensors and machine learning algorithms to anticipate equipment failures in industrial settings. This innovation enables manufacturers to proactively address and rectify malfunctions before they result in unplanned downtime, thereby significantly minimizing operational disruptions. A multitude of studies on a global scale have demonstrated that the implementation of predictive maintenance methodologies can result in a reduction of machine downtime by up to 50%, as well as an extension of the equipment's lifespan by 20% to 40%. In Africa, where numerous factories encounter frequent outages and maintenance issues, the implementation of these AI solutions has the potential to be transformative. These solutions could minimize costly production interruptions and enhance output. The utilization of AI in the realm of quality control has proven to be a highly effective tool. Computer vision systems, for instance, have demonstrated a remarkable capacity to detect defects on assembly lines with a level of accuracy that significantly surpasses that of the human eye. Similarly, the application of AI in supply chain optimization has yielded notable advancements, particularly in the domain of supply-chain planning, inventory management, and vendor collaboration.

Energy: Reliable and sustainable energy is the foundation of industrial development (Arouri et al., 2012; Ben Youssef and Dahmani, 2024), and AI is poised to significantly enhance Africa's energy sector. Numerous African countries encounter electricity-related challenges, including power shortages in Nigeria and load shedding in South Africa, which adversely impact industrial sectors. The utilization of AI has the potential to offer assistance in a variety of domains. In the domain of traditional energy, the integration of AI-driven controls has the potential to enhance the efficiency of power plants and grids. In South Africa, for instance, AI is being utilized in the field of predictive maintenance at coal-fired facilities. The implementation of AI has been shown to facilitate the early detection of equipment issues, thereby reducing operational downtime and enhancing overall performance (Shankar, 2024). This approach has the potential to reduce operational costs and even mitigate emissions by ensuring that industrial facilities operate with optimal cleanliness (Shankar, 2024). AI algorithms have been demonstrated to facilitate more precise forecasting of energy demand, enabling utilities to optimize supply management and mitigate the risk of blackouts (Shankar, 2024). It is noteworthy that AI is being utilized to address South Africa's well-known intermittent power outages. Through the analysis of extensive data sets, AI can predict areas where power shortages are likely to occur and assist grid operators in mitigating the adverse effects of load shedding (Shankar, 2024).

In the domain of renewable energy, AI has emerged as a pivotal catalyst for the integration of solar, wind, and other renewable energy sources into Africa's electrical grid. Renewable energy sources are inherently variable, as demonstrated by the intermittent nature of sunlight and wind. However, AI has the capacity to effectively manage these fluctuations. Machine learning models predict weather patterns and adjust grid distribution in real time, ensuring the optimal utilization of renewable power when available and its storage or supplementation when unavailable. This is of paramount importance as nations such as Kenya, Morocco, and Ethiopia are undertaking ambitious initiatives to expand their renewable energy generation. Additionally, AI has the potential to enhance the efficiency of energy storage systems and the maintenance of solar farms and wind turbines, as it can predict when a turbine requires repair. In general, the implementation of AI within energy systems has the potential to enhance reliability for industrial sectors and expedite Africa's transition to sustainable energy sources (Shankar, 2024; Mutiso, 2024). This ensures that industrial facilities, such as factories and mines, are equipped with the necessary infrastructure to support the integration of AI.

Mining: The mining sector of Africa, a fundamental component of numerous economies, is currently undergoing a high-tech transformation that is driven, in part, by the integration of AI into various facets of the industry. The continent's abundant mineral deposits, ranging from gold and diamonds to cobalt and rare earths, can be more efficiently explored and extracted through the application of AI-driven techniques. Exploration and resource mapping have been shown to be of significant benefit. The utilization of AI algorithms facilitates the analysis of geological data, encompassing satellite imagery, geophysical surveys, and drilling data, to expedite and enhance the precision of identifying mineral-rich zones. This approach surpasses the efficacy of conventional methodologies. This approach has been demonstrated to reduce exploration costs and increase the probability of successful outcomes. In the mining sector, companies are leveraging AI to identify new mineral deposits and enhance production efficiency. For instance, in 2024, a mining firm initiated a nationwide AI-based exploration initiative in Botswana. Within months, the AI system identified promising deposits of minerals such as zinc, copper, and platinum group metals that were previously unknown. Consequently, the company initiated the application process for new prospecting licenses with the objective of developing these discoveries. A similar initiative is underway in Zambia, where the startup KoBold Metals, supported by prominent global investors, is employing AI to assess and develop one of the world's most substantial untapped copper reserves. KoBold's AI models meticulously analyze geological datasets to identify optimal drilling locations, thereby contributing to Zambia's objective of tripling copper production by 2031(Energy Capital & Power, 2025). Beyond the realm of exploration, AI plays a pivotal role in the optimization of extraction and processing methodologies. The integration of smart sensors on equipment, in conjunction with AI analytics, facilitates the real-time monitoring of equipment operations, including trucks, drills, and crushers. This real-time monitoring capability enables the adjustment of operational settings, with the objective of enhancing yield and optimizing energy efficiency. The utilization of AI in the mining industry holds considerable potential for enhancing safety and efficiency. For instance, AI can predict machinery failures in mines, thereby facilitating the development of maintenance schedules. Additionally, AI can identify risks, such as tunnel instability or hazardous conditions, thereby mitigating potential accidents. The utilization of autonomous vehicles and drilling rigs, guided by AI, has become increasingly prevalent in contemporary mining operations.

When considering the broader context, it is evident that the implementation of industrial AI holds the potential to facilitate the industrialization process in Africa in a manner that is both environmentally sustainable and inclusive. By optimizing resource use, AI has the potential to reduce waste and carbon emissions in various industrial sectors. For instance, AI can assist in reducing energy waste in factories and minimizing water usage in mining operations. It has the potential to facilitate the emergence of novel business models, such as on-demand manufacturing or mass customization. These models can generate opportunities for small and medium enterprises to engage with industrial supply chains. It is important to acknowledge the prevailing concerns regarding the potential impact of automation on the displacement of low-skill jobs in the manufacturing sector. However, in contrast to the situation in more economically developed regions, the majority of African economies currently exhibit an insufficiency of industrial employment opportunities rather than an excess. The net effect of industrial AI in Africa is expected to be the creation of new jobs and the upskilling of the workforce. For instance, the role of maintenance technicians may evolve into that of digital supervisors for AI-driven systems; the field of data analysis will experience significant demand as industrial data is managed; and entirely new industries, such as AI software services, sensor manufacturing, and drone-based mineral surveys, can emerge. One estimate suggests that by 2030, the implementation of AI could potentially enhance Africa's labor productivity to a considerable extent, thereby generating a substantial number of new employment opportunities, particularly if accompanied by substantial investments in educational institutions and digital infrastructure.

In summary, the potential of AI in Africa's industrial sector is enormous. The potential impact of this initiative on Africa's existing industries, particularly manufacturing, energy, and mining, is significant. It is hypothesized that the initiative will enhance the competitiveness of these industries and facilitate the emergence of new growth opportunities, including the establishment of high-tech startups that will serve these sectors. However, it should be noted that this realization does not occur automatically. In order for Africa to experience a flourishing of industrial AI, there are several prerequisites that must be met.

Prerequisites for AI success in industry: infrastructure, data, skills, and ecosystems

The implementation of AI in industry necessitates a multifaceted approach that extends beyond the mere utilization of algorithms. In order to establish a solid foundation, it is imperative that four fundamental elements be in place: infrastructure, data, skills, and a supporting ecosystem. The African continent is confronted with deficiencies in each of these domains. Addressing these gaps is of paramount importance to capitalize on the opportunities presented by the 4IR.

1. Hard infrastructure: Electricity and connectivity

Industrial AI systems have two fundamental requirements: power and connectivity. The absence of reliable electricity and internet precludes the operation of advanced factories and mines that rely on AI-driven processes. Regrettably, infrastructure continues to represent a significant vulnerability. According to the Pan African Climate Justice Alliance (2024), the current population of Africans without access to electricity is estimated to be over 640 million, representing approximately 43% of the African population. Moreover, many of those with access to electricity encounter frequent power outages. This energy deficit has a detrimental effect on industrial activity, as it renders machinery inoperable and data centers unable to function on diesel generators alone. The expansion of the electric grid, along with the development of off-grid solutions, is a foundational element of this approach. It is imperative for the African continent to prioritize the development and modernization of its industrial sectors prior to the implementation of automation technologies. Furthermore, digital connectivity is constrained. According to Balogun (2024), as of 2023, approximately 37% of Africans utilize the Internet, with even lower rates of broadband access. A significant number of manufacturing facilities in Africa have not yet been equipped with industrial internet or IoT sensors due to the limited availability of network infrastructure and the high cost associated with implementation. To enable AI, African nations must invest in information and communication technology (ICT) infrastructure, including fiber-optic networks, 5G wireless in industrial zones, data centers, and cloud services. Concurrently, mobile connectivity has exhibited a marked improvement, with nearly 800 million mobile subscriptions recorded in sub-Saharan Africa in recent years (Runde, 2019). Furthermore, several countries have initiated the deployment of 4G/5G networks and the installation of fiber cables. However, rural areas and industrial parks frequently experience limitations in bandwidth capacity, which hinders the efficient transfer of substantial data volumes. In order to cultivate intelligent industries, it is imperative that Africa address the fundamental infrastructure deficit, namely the necessity of ensuring that manufacturing facilities are equipped with uninterrupted power sources and high-speed internet connectivity. This may entail the implementation of innovative solutions, such as solar micro-grids for industrial parks, satellite internet for remote mining sites, and public-private partnerships to expand broadband access. In essence, the capacity for AI to function effectively is contingent upon access to data and continuous connectivity. Consequently, infrastructure development is the primary prerequisite for the implementation of industrial AI.

2. Data – local data and digital foundations

The capacity of AI to perform tasks is contingent upon the quality, quantity, and relevance of the data from which it is trained. At present, African industries are confronted with a relative dearth of data. A significant number of AI models utilized in Africa, which are frequently imported from regions such as the United States or Europe, are trained on data originating from foreign countries. Consequently, these models may not accurately represent local realities, potentially leading to inaccuracies or biases in their applications. This phenomenon can result in unintended consequences that may appear absurd to the uninitiated. To illustrate, an AI-powered application designed to monitor cattle health in Africa initially diagnosed a significant proportion of the bovine population as malnourished. However, upon further analysis, it was determined that this misdiagnosis was due to the algorithm's training dataset, which was exclusively composed of European cattle, known for their higher average body mass. In reality, the African cows were healthy but simply leaner on average. These illustrations underscore the potential for data bias when African data is limited. To ensure the effective integration of AI within the African industrial landscape, it is imperative to emphasize the generation and utilization of African-specific data. This encompasses data pertaining to local consumer preferences, sensor readings from African machinery, and geodata detailing African terrain.

This prerequisite has several dimensions: First, it is imperative for African firms to adopt fundamental digital systems, such as Enterprise Resource Planning (ERP) software and digital production monitoring tools, to initiate the collection of data. A significant number of African factories continue to predominantly operate using analog or manual processes, resulting in a paucity of recorded data. Government entities and industry associations are capable of encouraging the implementation of digital record-keeping and instrumentation in the manufacturing and mining sectors. For instance, the implementation of smart meters in power grids or sensors in agriculture silos initiates the process of data collection. Second, it is imperative for nations to allocate resources toward the development of data centers and cloud services within the continent. This strategic initiative will facilitate the local storage and processing of industrial data, thereby reducing latency and enhancing autonomy from external servers. Recent advancements have been observed in the field, as evidenced by the establishment of new data centers in South Africa, Kenya, and Nigeria, as well as the presence of regional cloud nodes provided by prominent service providers. The enhancement of data security and privacy frameworks is also expected to foster trust among companies, thereby facilitating the sharing of data. The concept of "open data" is predicated on the notion of collaboration. Governments have the capacity to incentivize corporations to engage in the practice of sharing.

3. Skills and talent

The possession of skilled human capital can be regarded as the most critical prerequisite. It is imperative to recognize that AI does not function on autopilot; rather, it necessitates the involvement of researchers who are tasked with the development of algorithms, engineers who are responsible for the implementation and maintenance of systems, and workers who possess the capacity to utilize and oversee AI-augmented tools. Presently, the African continent is grappling with a pronounced dearth of digital competencies. Educational systems frequently fail to align with the rapidly evolving technological landscape. While a considerable number of African universities offer courses related to AI or data science, many graduates still lack practical AI skills due to the outdated nature of curricula or their overly theoretical approach. Companies report difficulty finding employees proficient in areas such as AI programming, data analytics, or robotics integration. The issue is further exacerbated by the phenomenon of "brain drain," which refers to the migration of skilled professionals, particularly those in the field of AI, to employment opportunities outside of the continent. Many of these highly qualified individuals are drawn to positions or industries that offer more lucrative or appealing prospects.

Addressing this issue necessitates action on multiple levels. Education reform is imperative for African universities and technical institutes to modernize their engineering and computer science programs by incorporating contemporary AI, machine learning, and automation content, complemented by hands-on training. The advent of new interdisciplinary programs, such as the integration of mechanical engineering with AI or mining engineering with data science, holds the potential to produce graduates equipped with the necessary skills to apply AI in industry, and it is incumbent upon governments and accreditation bodies to collaborate with industry to ensure curricula align with defined competencies. In parallel, technical and vocational training must acknowledge that not all roles within the industrial AI field require a PhD in machine learning; there is an acute demand for technicians capable of installing and calibrating sensors, machinists adept in operating CNC machines guided by AI, and electricians skilled in servicing automated equipment, necessitating the integration of digital skills into vocational programs to create a robust pipeline of talent. Moreover, upskilling the current workforce is crucial, as factory workers, plant managers, and engineers will need on-the-job training opportunities to adapt to AI systems; public-private partnerships can establish on-site training and certification programs, with enterprises such as IBM, Google, and local startups already initiating AI bootcamps and online courses across Africa, efforts that could be further expanded through government incentives. Additionally, attracting and retaining talent is vital, and African governments have the capacity to establish incentives to encourage local AI professionals to remain and diaspora experts to return, such as funding research laboratories or centers of excellence offering competitive salaries, or requiring foreign technology investors to provide advanced training to local staff. Encouragingly, countries like South Africa, Senegal, Tunisia, Morocco, Nigeria, and Kenya are developing national AI strategies that incorporate talent development initiatives, and the African Union’s recently published Continental AI Strategy prioritizes reversing the AI brain drain. In essence, the development of human capital—ranging from leading AI researchers to skilled technicians and digitally proficient factory workers—is imperative, as the absence of a skilled workforce would render even the most advanced AI technologies effectively useless, impeding Africa's progress in the realm of industrial AI.

4. Digital ecosystems and innovation networks

Beyond individual factories or mines, Africa requires a thriving ecosystem that fosters innovation and supports the adoption of AI at scale. This collaborative effort encompasses a diverse array of entities, including nascent startup enterprises, technologically-oriented hubs, research institutions, industry associations, and government agencies that facilitate innovation. There are encouraging signs that the situation may be improving. A World Economic Forum analysis (Newman et al., 2017) notes that "more than 400 tech hubs have emerged across the continent, with Lagos, Nairobi, and Cape Town emerging as internationally recognized technology centers." These hubs play host to thousands of startups and incubators, with a subset of these entities specializing in the development of AI solutions for local issues. Notable success stories, such as South Africa's Aerobotics (AI for precision agriculture) and Nigeria's Mines.io (AI-driven fintech), demonstrate the capacity of African entrepreneurs to develop cutting-edge AI products.

Although the current ecosystem in Africa leans heavily toward finance and e-commerce, few startups tackle industrial challenges. To support Industrial AI, several elements must be strengthened. Research and Development Centers dedicated to AI in engineering and industrial applications are essential, with governments establishing centers of excellence like “AI in Manufacturing” or “Mining 4.0” to adapt global techniques to African contexts. Supporting startups with targeted financing is equally important, as industrial tech ventures often require more capital and longer development cycles; initiatives like the Africa Growth Platform are a step forward (Newman et al., 2017), but broader efforts such as industrial AI accelerators are needed. Traditional industries must also partner with tech startups to pilot AI solutions, with governments facilitating collaboration through innovation grants and matchmaking events. Additionally, digital platforms should democratize access to AI services for small and medium enterprises, while clear regulations on data, testing sandboxes, and updated standards will encourage safe adoption. The African Union’s AI strategy, alongside initiatives like globalcenter.ai, aims to align national approaches on ethics and governance. If these ecosystem components fall into place, they will create a virtuous cycle where talent flows into innovation, successful pilots attract investment, and local AI solutions scale across industries. Africa has already leapfrogged in sectors like mobile banking; with a strong enabling environment, it can do the same in industrial AI. In short, for AI to transform Africa’s industrial sector, the foundation—power, internet, data, skills, and innovation networks—must first be solidified.

Policies and a policy agenda for Africa's Industrial AI transformation

The attainment of an AI-driven industrial transformation on the African continent is not a spontaneous occurrence; rather, it necessitates deliberate and meticulously coordinated policy action. The government, in its various national and local iterations, in conjunction with regional bodies and the private sector, each possesses a pivotal role to fulfill. Fortunately, many African policymakers have become cognizant of the 4IR imperative, and some have initiated the formulation of AI and digital strategies. Capitalizing on this growing momentum, the following policy agenda has been formulated to support the integration of industrial AI in Africa's economic transformation. The development and implementation of national AI strategies with a focus on industry is imperative. It is imperative for each African nation to formulate a national AI strategy (if one has not already been developed) that identifies priority sectors (such as manufacturing, energy, and mining) for AI adoption and establishes a roadmap. To date, fewer than 10 African countries have published national AI strategies; however, this number is growing, as evidenced by recent adopters such as Kenya, Nigeria, South Africa, and Ghana. These strategies must be precise and include actionable plans such as the establishment of innovation hubs, the allocation of funds for research and development, the updating of curricula, and the incentivization of private sector investment in AI. It is imperative that industrialization objectives be integrated into AI strategies. For instance, establishing targets to enhance manufacturing productivity through AI or mandating the development of "smart factories" within special economic zones can serve as effective strategies. Ensuring policy coherence is imperative. It is imperative that AI initiatives complement industrial policies, such as those promoting manufacturing or mining value-addition. To that end, countries can establish inter-ministerial 4IR task forces to ensure that ministries of industry, ICT, education, and so on operate in accordance with a unified strategy.

It is imperative that public policy address infrastructure bottlenecks directly. This necessitates substantial investments in power and digital infrastructure, facilitated by donor and private partnerships. It is incumbent upon governments to prioritize electrification projects that power industrial zones and rural production centers, leveraging renewable energy and mini-grids where appropriate. Similarly, the expansion of broadband infrastructure to industrial areas, facilitated by initiatives such as fiber backbone projects, 5G spectrum allocation, and incentives for telecom operators, is imperative. It is recommended that policymakers consider the designation of "Industrial Innovation Zones," wherein companies are guaranteed access to high-quality power and internet (potentially through subsidies or specialized service agreements) in exchange for the implementation of advanced technologies. Development finance institutions (e.g., the World Bank, the AfDB) have been allocating increasing sums of money to the development of Africa's digital infrastructure. It is incumbent upon African governments to proactively leverage these resources for projects such as the establishment of national data centers or regional fiber loops. In essence, the viability of any subsequent plan is contingent upon the presence of electricity and connectivity, underscoring the imperative of regarding these as foundational industrial policy investments in the AI era. The development of human capital for industrial AI necessitates a multifaceted educational and workforce policy. The objective of such a policy is to cultivate the engineers, technicians, and analysts who will shape the future of this field. The enhancement of STEM education at all levels is imperative. This enhancement should encompass the introduction of coding and fundamental AI concepts in secondary schools, as well as the expansion of university seats in computer science, engineering, and data science. Governments have the capacity to provide financial aid in the form of scholarships or loan forgiveness for students who pursue academic studies related to AI and subsequently seek employment within their respective countries. Furthermore, there is a necessity for the refinement of vocational training programs to incorporate mechatronics, industrial IT, and data skills. To illustrate, a government could collaborate with a corporation such as Siemens or Huawei to establish a vocational training center that provides post-secondary education and training in industrial automation for high school graduates. This is yet another example of the phenomenon under consideration.

To that end, governments should enact policies that treat data as a strategic asset for development. This encompasses the formulation of legislation and regulations that promote data sharing and innovation while ensuring the protection of rights. Open data policies have the potential to facilitate access to government-collected data (e.g., weather, maps, industrial statistics) for innovators. In the contemporary business landscape, the need for data governance frameworks has become increasingly evident. These frameworks serve to provide businesses with the assurance that the sharing of data, even with competitors or nascent enterprises, can be done so securely. This assurance can be facilitated through the implementation of anonymization requirements or secure data exchanges. In the context of their digital economy plans, South Africa and Kenya have initiated the consideration of such frameworks. Furthermore, regulatory frameworks should be designed to promote the utilization of cloud services, thereby clarifying ambiguities regarding data residency issues. This would result in a reduction of costs for companies that adopt AI technologies. Conversely, governments are obligated to address concerns surrounding AI ethics, privacy, and security by adopting or adapting global guidelines to suit African contexts. The African Union Continental AI Strategy is poised to offer high-level guidance on AI governance for member states. National legislation may require updates, such as the revision of labor laws to encompass human-machine collaboration or the refinement of liability laws to address the potential failures of AI systems. By proactively establishing the regulatory framework, policymakers can foster a stable environment conducive to investment. Companies are more likely to adopt AI if they have a clear understanding of the legal parameters, as opposed to operating in a state of legal ambiguity.

Africa's regional organizations and partnerships play a significant role in the scaling of industrial AI. It is evident that no single nation can achieve all objectives independently; economies of scale and shared learning are indispensable. The capacity of Regional Economic Communities (RECs) (e.g., ECOWAS, SADC, EAC) to harmonize standards is of particular relevance in the context of AI. The potential exists for the export of AI solutions that have been proven effective in one country to other communities without significant difficulty. For instance, the establishment of shared standards for smart grid interoperability or industrial IoT communication on a global scale has the potential to expand the market for these solutions. The African Continental Free Trade Area (AFCTA) is a regional economic integration initiative that aims to promote trade, investment, and economic development across the African continent.

The private sector, comprising large corporations and startup entities, will be responsible for implementing a significant portion of the AI technology on the ground. Consequently, policy initiatives should proactively engage with these entities as collaborative partners. Governments have the capacity to utilize incentives as a means of promoting the adoption of AI and the 4IR technology within existing industrial sectors. For instance, the provision of tax credits or depreciation benefits to manufacturers who invest in automation and AI systems, or the allocation of matching grants to mining companies that implement AI for safety and environmental management purposes, are potential policy options. Another approach is public procurement, wherein governments can function as lead customers for AI solutions, such as the utilization of AI for public utilities or the procurement of locally manufactured technology for state-owned enterprises. This, in turn, contributes to the expansion of the market. In order to promote economic growth and innovation, it is imperative to facilitate the adoption of digital technologies by small and medium-sized enterprises (SMEs). Potential strategies to achieve this objective may include the provision of subsidized training programs, the facilitation of financing for technological upgrades, and the establishment of shared technology centers. These centers would provide smaller firms with access to advanced equipment and resources, such as government-run AI-enabled fabrication laboratories, which would be available to local manufacturers.

The establishment of collaboration platforms is imperative for the regular discussion of needs and obstacles by private sector players and policymakers. For instance, the formation of a "Manufacturing 4.0 Council" could facilitate a collaborative effort among factory owners, technology providers, worker unions, and government representatives, with the objective of developing a comprehensive roadmap for automation that is both productive and conducive to a favorable working environment. The presentation of success stories is a crucial aspect of this endeavor. For instance, if a Kenyan textile factory were to achieve a substantial increase in output through the implementation of AI-based inventory control methods, the dissemination of this information has the potential to serve as a source of inspiration for other entities operating within the same sector. Governments might also encourage corporate social responsibility (CSR) programs in which prominent technology firms establish training academies or incubators.

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