Artificial Intelligence (AI) Deployments in Africa: Benefits, Challenges and Policy Dimensions

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Abstract

The deployment of artificial intelligence (AI) technologies is proliferating on the African continent, but policy responses are still at their early stages. This article provides an overview of the main elements of AI deployment in Africa, AI's core benefits and challenges in African settings, and AI's core policy dimensions for the continent. It is argued that for AI to build, rather than undermine, socio-economic inclusion in African settings, policymakers need to be cognisant of the following key dimensions: gender equity, cultural and linguistic diversity, and labour market shifts.

Keywords
artificial intelligence (AI), Africa, automated decision-making (ADM), natural language processing (NLP), inclusion, gender, linguistic diversity, labour, policy, policymaking

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1. Introduction

There is a dearth of data on all aspects of artificial intelligence (AI) in Africa, and much of the available information is thus anecdotal (Oxford Insights & IDRC, 2019). Meanwhile, there is a need for African policy responses, at the national, regional, continental and international levels, aimed at ensuring that the continent's innovators, enterprises, communities, governments, and other actors are able to reap AI's benefits and mitigate its threats. Sound policy approaches will be needed to enable African nations to build ecosystems that are inclusive, socially beneficial, and adequately integrated with on-the-ground realities.

Smith and Neupane (2018) define AI as "an area of computer science devoted to developing systems that can be taught or learn to make decisions and predictions within specific contexts" (2018, p. 10). The European Commission defines it as "systems that display intelligent behaviour by analysing their environment and taking actions—with some degree of autonomy—to achieve specific goals" (EC, 2018). The Organisation for Economic Co-operation and Development (OECD) defines AI as "a machine-based system that can, for a given set of human-defined objectives, make predictions, recommendations, or decisions influencing real or virtual environments. AI systems are designed to operate with varying levels of autonomy" (OECD, 2019b, p. 7). The Institute of Electrical and Electronics Engineers (IEEE) favours the term "autonomous and intelligent systems (A/IS)" over AI (IEEE, n.d.).

Among the core elements of AI are algorithmically controlled automated decision-making (ADM) systems, or decision-support systems, which are socio-technological frameworks that comprise decision-making models and the algorithms that translate the models into computable code (Penner, 2019). ADM systems are increasingly used as part of decision-making processes in the public and private sectors. Public authorities use them to improve efficiency, implement complex processes, and support evidence-based policymaking, in areas such as public sector procurement (which is a major source of business for many companies). They make material decisions regarding financial, health, and even liberty outcomes. Accordingly, they can have far-reaching impacts involving the weakest members of society, with potentially significant negative consequences for individuals, organisations, and society as a whole (Penner, 2019).

While AI technologies and applications have the potential to address many of humanity's most pressing problems—through, for example, fostering a world that is less sick, less hungry, more productive, better educated, and better prepared to thwart the effects of climate change—this promise comes with risks of entrenched and amplified social inequality (Hagerty & Rubinov, 2019). AI grounded in non-representative or biased data can entrench existing social and economic inequities, with AI systems reproducing the representation gaps and biases of the data sets on which they are trained (see Powles & Nissenbaum, 2018). AI can be used by already-dominant technology firms to further entrench their economic and social power, or by governments to violate the privacy and other human rights of citizens. AI's negative consequences can be compounded by a lack of transparency and accountability as such systems are scaled up (see Gwagwa, n.d.; Koene et al., 2019).

AI's potential risks are particularly acute in the developing world, where, in the words of Hamann (2018), "the new technologies […] may build upon and exacerbate existing inequalities—both within developing countries as well as between developing and more developed regions". As Smith and Neupane (2018) warn, in respect of developing nations, "if we continue blindly forward, we should expect to see increased inequality alongside economic disruption, social unrest, and in some cases, political instability, with the technologically disadvantaged and underrepresented faring the worst" (2018, p. 12).

In contemporary African settings, both the benefits and risks of AI are readily apparent. Brandusescu et al. (2017) provide examples of innovative AI use in Kenya, Nigeria, and South Africa to address needs in health, agriculture, fintech, public transportation, and language translation. Smith and Neupane (2018) provide examples from these same three countries, as well as Uganda and Ethiopia, of beneficial AI use in point-of-care diagnostics, government service delivery, wildlife conservation, crop monitoring, water management, enterprise development, and financial services. UN Global Pulse has published findings from its testing of AI natural language processing (NLP) tools to identify Somali social media postings with a bearing on peacebuilding and Ugandan radio content that portends social conflict (UN Global Pulse, 2018). In Accra, Google's AI Laboratory is experimenting with compressed algorithms that can run on the computing power of mobile phones (Adeoye, 2019). IBM's mobile open source Hello Tractor platform is providing AI-based on-demand tractor access to Nigerian farmers (Assefa, 2018).

At the same time, AI's challenges and risks in African contexts are also potentially of great magnitude. In the wake of Nigerian online marketplace Jumia's public listing, during which most of its equity was transferred to foreign owners, there was a sentiment that such arrangements throttle Africa's homegrown tech industries (Madowo, 2020). A 2018 study of startups in East Africa found that 90% of funding had gone to the startups' foreign founders (Pilling, 2019). Foreign AI companies have been accused of using false African identities as marketing tools to raise capital and then eventually cashing out (Pilling, 2019). In the absence of significant AI R&D in Africa, the applications of AI deployed in Africa tend to originate from outside the continent and thus lack contextual relevance, particularly in respect of cultural and infrastructural factors (Oxford Insights & IDRC, 2019). And AI capabilities are in some cases being used by African governments to control citizens—for example, in Ethiopia (Gwagwa, 2018) and Zimbabwe (Chimhangwa, 2020). Instances of foreign-controlled and/or foreign-designed AI tools in African settings are increasingly being seen in neo-colonial terms, i.e., as elements of "algorithmic colonization" (see Birhane, 2019), "data colonialism" (see Couldry & Mejias, 2019), and "digital colonialism" (see Coleman, 2019).

If African nations are to build inclusive AI ecosystems, enlightened policymaking is essential. Yet the African AI policy discourse is still only embryonic. With this article, we seek to highlight some of the core AI opportunities, challenges, and policy dimensions requiring the attention of African policymakers.

2. Methodology and analytical framework

We reviewed literature on AI's manifestations and policy dimensions in both developed-world and developing-world settings. The literature included journal articles, books, chapters in edited volumes, electronic sources, conference papers, and reports by industry bodies and inter-governmental organisations. We organised the review findings in terms of an analytical framework drawing on two taxonomies: Calo's 2017 taxonomy for interrogating AI policy challenges (Calo, 2017); and Smith and Neupane's taxonomy of AI's potential risks in developing-world settings (Smith & Neupane, 2018). Our analysis of the literature was also broadly informed by findings from the on-the-ground situational analyses, in the form of case studies, which we and our research colleagues have conducted since 2015 under the auspices of the Open African Innovation Research (Open AIR) network (Open AIR, n.d.).

Calo's 2017 taxonomy of "key challenges" posed by "the contemporary policy environment around artificial intelligence" consists of the following five dimensions:

- "justice and equity;
- use of force;
- safety and certification;
- privacy and power; and
- taxation and displacement of labor" (2017, p. 403).

Calo's taxonomy has a developed-world focus. Accordingly, so as to ensure a proper consideration of developing-world dimensions, we also considered Smith and Neupane's proposed "proactive research agenda for the ethical and equitable application of AI in the Global South" (Smith & Neupane, 2018). Smith and Neupane identify the following "potential risks" posed by AI in developing countries:

- "fairness, bias and accountability";
- "surveillance and loss of privacy";
- "job and tax revenue loss through automation"; and
- "undermining democracy and political self-determination" (2018, pp. 11–12).

We found three areas of overlap between Calo's policy-challenges taxonomy and Smith and Neupane's potential-risks framework, as represented in the three rows of Figure 1.

Figure 1: Overlaps between Calo (2017) and Smith and Neupane (2018)

Calo (2017): Key policy challenges		Smith and Neupane (2018): Potential risks
justice and equity	⟺	fairness, bias, and accountability
privacy and power	⟺	surveillance and loss of privacy
taxation and displacement of labour	⟺	job and tax revenue loss through automation

Among the three areas of thematic commonality between the Calo taxonomy and the Smith and Neupane framework, we determined that the two themes most central to understanding the implications of AI in Africa, which we discuss in the next two sections of this article, are *equity* and *labour*. (Privacy and surveillance issues are also, in our view, important issues, but it is less clear that they require distinctly African policy approaches, whereas matters of equity and labour seem to certainly require attempts at Africa-appropriate responses.)

3. AI and equity in African settings

Among equity's numerous dimensions, the two we focused on, for the purposes of this study, are *gender equity* and *cultural and linguistic diversity*, each of which is now discussed.

AI and gender equity

A core equity dimension is gender, and there is evidence to suggest that African nations are experiencing a transformative "feminization" of technology entrepreneurship (Monehin, 2017). Vibrant startup ecosystems that support women are emerging in Kenya, Nigeria, and South Africa, with North Africa catching up. One example is Morocco's WaystoCap, an ambitious female-led tech startup based in Casablanca that provides a cross-border commerce platform (Toesland, 2018). According to the 2017 Mastercard Index of Women's Entrepreneurship (MIWE), Sub-Saharan Africa had the world's highest rate of female entrepreneurs (27%), and 34.8% of businesses in Uganda, and 34.6% in Botswana, were owned by women. The study describes this level of ownership as "significantly higher than in the United States, the United Kingdom and Germany, to mention a few" (Monehin, 2017). In Egypt, women are adopting AI technologies to engage in ride-sharing platform services as drivers. This is unprecedented in the country's male-dominated taxi driving culture, and it empowers the women, not only by improving their ability to provide for their livelihoods, but also by breaking down social taboos and using digital technologies to ensure their safety (Rizk et al., 2018).

Another example of digitisation's potential benefits for African women emerges from African women engaging with code. When the African Girls Can Code Initiative (AGCCI) was launched in August 2018, 80 girls from 34 African countries signed up, within the first 10 days, to attend Coding Camp in Addis Ababa, Ethiopia (UN Women, 2018). SingularityNET, the startup that had the robot Sophia as one of its first use cases, is at the forefront of hiring and promoting African female engineers (Dishman, 2018). Code4CapeTown in South Africa invests in women coders and programmers, including running a coding programme for high school girls (Dishman, 2018).

At the same time, gender issues fall at the heart of inclusion paradoxes in respect of digital transformation and, as a subset of digital dynamics, AI dimensions (see, for example, UNESCO, 2020a). Women are typically disadvantaged by data and algorithm biases, which reflect and amplify inequities already in existence on the ground. AI algorithms are typically developed in the Global North, and trained on datasets representing realities that are significantly different from realities in African contexts—and thus may exclude certain communities, e.g., women, from particular services. Such "allocative harms" (Whittaker et al., 2018) can extend to decisions related to eligibility for bank loans or credit (Access Partnership, 2017). Also relevant are problems of facial recognition algorithms that can unduly exclude people of colour.

The potential of new technologies to magnify existing inequities becomes more challenging in contexts where inequality is multi-layered (Rizk, 2020). This tends to be the case in many African settings, where gender inequality is but one facet of complex and multidimensional inequalities that extend beyond income and that are rooted in various disparities—including disparities based on race, ethnicity, and social background. Such inequalities of opportunity are often aggravated by new technologies.

Multidimensional inequality is an entrenched reality for women in many African settings. For example, a 2018 Brookings Institution study found that 44% of women in Kenya were poor in terms of at least one dimension, and that women who lived in rural areas tended to be multi-dimensionally poor (Patel, 2018). In 2017, the employment gender gap reached nearly 80% in Algeria and 69% in Egypt (WEF, 2017). The digital divide is also gendered. Africa is the only continent whose digital gender gap has widened since 2013. Of the 60% of African women who own a mobile phone, only 18% have internet access, with over 200 million left unconnected (Majama, 2019).

In this context, women in Africa are likely to be marginalised by AI on more than one level. First, there is the inaccuracy of the data, AI's primary input. Inaccuracies are produced by the "data blur" (Rizk, 2020) as aggregation clouds out the detail present in disaggregated data, especially on gender-sensitive issues like health and employment. Data inaccuracy can also be an outcome of "data blindness" produced by top-down data collection methodologies which miss activities and communities that fall outside the radar of a formal lens (Rizk, 2020), e.g., informal workers, many of whom are women. In Sub-Saharan Africa, informal employment constitutes 92% of total female employment and 83% of total female non-agricultural employment (Bonnet et al., 2019).

Such invisibilities in data feed into biases in policymaking and other decision-making constructs based on AI algorithms fed by deficient data. An example is algorithm-based decision-making in the financial sector, where women constitute 60% of the 400 million people in Africa who lack access to digital financial services across the continent. In Sub-Saharan Africa, roughly 35 million women are excluded from financial services (World Bank, 2018), and in Egypt, 91.7% of women did not have bank accounts in 2014 (World Bank, 2016b).

The lack of ownership of a bank account can be traced to other female invisibilities. In Uganda, women's inability to provide formal documents, such as identity papers and utility bills, prevents them from opening bank accounts as they are unable to fulfil the know-your-customer (KYC) requirements (Musiitwa, 2018). The fact that these cohorts of women are absent from the official data apparatus, and thus are consequently absent from the algorithm, contributes to their exclusion from these financial services and indeed other social support instruments, especially when related to subsidies, housing, and social safety nets.

AI and cultural and linguistic diversity

As forcefully outlined by Kulesz (2018), AI can be expected to have profound impacts on the diversity of widely available cultural expressions in both the developed and developing worlds and, in the absence of strong policy interventions, the impacts have the potential to be starkly negative, particularly for the world's poor countries who are not home to the dominant AI and digital content firms.

Kulesz (2018) sets out a worst-case scenario in which, in the "medium and long term", the dominant AI players (mostly American and Chinese companies) are able to "intervene simultaneously in all nodes of the creative chain and generate works based on user behaviour, in order to maximize consumption", resulting in the dominant firms creating "a 'perfect bubble' around users, which would lead to an unprecedented level of concentration in the creation, production and distribution of cultural goods and services" (2018, pp. 7–8). In this kind of future, Kulesz (2018) warns, "cultural expressions would have economic value, but they would convey neither identity nor meaning" (2018, p. 8), and the reality for cultural expression in the Global South could be as follows:

> The technological concentration and the "perfect bubble" [...] would see the artists and producers of the South gradually lose their autonomy and capability. If that were to happen, the future designers of African clothing would not be Cameroonian or Nigerian creators, but rather machine learning experts living in Silicon Valley or Tianjin. The North/South digital divide would then become an irreversible creative divide. (Kulesz , 2018, p. 10)

With respect to linguistic diversity, which is integral to cultural diversity, it is estimated that 17% of the world's languages, many of them in Africa, are "low resource languages" in the digital realm (Marivate et al., 2020), i.e., there are insufficient examples of use of the languages available online for the purposes of training NLP applications. These languages are marginalised by technology deployments, including AI deployments, developed in the Global North.

A key NLP project focused on African language preservation is the Masakhane community, which has more than 140 contributors from 17 African countries (Masakhane, n.d.). Masakhane outlines its mission in the following terms:

> Even in the forums which aim to widen NLP participation, Africa is barely represented—despite the fact that Africa has over 2000 languages. The 4th [i]ndustrial revolution in Africa cannot take place in English. It is imperative that NLP models be developed for the African continent […] In particular, for Africa to take part [in] the global conversation, we should be developing machine translation systems to translate the internet and [its] content into our languages and vice versa. (Masakhane, n.d.)

By February 2020, Masakhane members had developed and published 35 translation results for over 29 African languages online in an open access GitHub repository.[1] Training NLP systems in low resource African languages is highly complex because, as Orife et al. (2020) explain:

> African languages are of high linguistic complexity and variety, with diverse morphologies and phonologies, including lexical and grammatical tonal patterns, and many are practiced within multilingual societies with frequent code switching […]. Because of this complexity, cross-lingual generalization from success in languages like English [is] not guaranteed. (Orife et al., 2020, p. 1)

1 https://github.com/masakhane-io/masakhane-mt.

We now turn to a discussion of another area of thematic commonality identified above between the Calo (2017) taxonomy and the Smith and Neupane (2018) framework: labour.

4. AI and labour in African settings

A pioneering contribution to the debates on the impact of machine learning on employment is the 2013 paper by Frey and Osborne, which predicted that 47% of people working in the US at the time were at high risk (70% chance or greater) of having their jobs automated within a decade or so (Frey & Osborne, 2013). The World Bank's *World Development Report 2016: Digital Dividends*, through applying the Frey and Osborne (2013) methodology to developing countries—including African nations Nigeria, Ethiopia, and South Africa—also made alarming predictions, warning that "[t]he share of occupations that could experience significant automation is actually higher in developing countries than in more advanced ones, where many of these jobs have already disappeared" (World Bank, 2016a, p. 22).

Important caveats to this analysis are provided by studies that have focused on the automation of "tasks" rather than entire occupations. In this respect, Autor et al. (2003) make a distinction between routine and non-routine tasks. Historically, the increasing use of automation technologies, such as information and communication technologies (ICTs), led to job polarisation. Automation has driven the reduction of jobs requiring middle-level skills, such as clerks, craft workers and machine operators, compensated for by increases, in the shares of the labour force, of managers, professionals, and technicians—and also, paradoxically, increases in the shares of the lower-skilled categories composed of sales and service staff and the elementary trades. While previous industrial revolutions worked through "de-skilling" work into easier tasks to be accomplished by middle- to low-skilled workers, AI is "up-skilling" work by hollowing out the middle ground between high-skill jobs and low-paying jobs (Lee, 2018).

These patterns of job polarisation were evident in many low- and middle-income countries over the period 1995 to 2012 (see World Bank, 2016a, p. 22). For instance, in the period 1995 to 2012, South Africa experienced a sharp drop in the employment share of the middling groups; however, this was accompanied by a lesser decline in the share of low-skilled categories (World Bank, 2016a).

Within firms, the increased use of big data, sensors, and machine learning can generate drastic changes in the way work is organised, potentially furthering employers' ability to control employee behaviour, for instance, through increased monitoring and surveillance activities. This strengthens employers' ability to discourage union activity, deepened by employees' increasing employment insecurity as the employers' ability to outsource work to other countries with lower labour costs, such as to call centres in India, expands (Bajaj, 2011). These dynamics are significant in nations, such as those on the African continent, with large populations of unemployed or underemployed youth in urban areas, and the dynamics are often exacerbated by insufficient protections for those who become unemployed due to job displacement (Cyr, 2019).

To better anticipate the impact of AI on jobs in Africa, it is important to consider the distribution of the labour force. Approximately 54% of all workers in Sub-Saharan Africa are in the agricultural sector, and in some specific countries this figure surpasses 70% (Fuglie et al., 2019). In the agricultural sector, AI has two primary uses that are, or are expected to be, of significant impact and value (Walch, 2019). First, as with other sectors, AI has significant advantages in analysing data, and it is thus useful for predicting the weather, optimising planting and harvesting schedules, determining appropriate fertiliser needs, and the like. This use of AI has the potential to increase yields and overall land productivity or efficiency, and it is unlikely to negatively affect the African labour force in the agricultural sector. Indeed, by improving the ability to predict floods and drought, optimise land usage, and increase yields, AI may increase the need for workers in the agricultural sector. This use of AI is, therefore, not necessarily competitive with human labour, and could actually be complementary to it.

Second, AI-powered agricultural bots (robots) are known to, or are expected to, exceed human abilities for harvesting crops and picking weeds. Although this use of AI is, at least in part, competitive with human labour, the reality of African agricultural practices reduces the overall impact that AI is likely to have. Small farms, defined here as farms of two hectares or less, account for 40% (by area) of farmland in Sub-Saharan Africa, a substantially larger percentage of land than the percentage held by small farms in rich countries (Lowder et al., 2016). Furthermore, daily wages for farm labourers in Sub-Saharan Africa are substantially below those in highly developed countries. With a large percentage of relatively very small farms, and with an abundance of relatively inexpensive labour, there is less economic incentive in Sub-Saharan Africa than in developed-world settings to invest in agricultural bots. The negative impact of AI on farm labour could, therefore, be substantially less in Sub-Saharan Africa, compared with developed countries.

Another core attribute of Sub-Saharan African labour forces is the large number of people working in informal jobs. The International Labour Office has found that more than 85% of employment in Africa is informal (ILO, 2018). New forms of servitisation, facilitated by digital technologies, may open opportunities for developing countries, including in Africa. Uber and Airbnb provide examples of informal entrepreneurs finding niches in services facilitated by digital technologies and AI. And other examples are also emerging in manufacturing—involving 3D printing, digital platforms, and apps—where there could be room for informal actors to not only survive but also to thrive.

5. Policy dimensions

As demonstrated in the preceding sections of this article, it is clear that AI offers myriad potential benefits and potential challenges for African nations, regions, and the continent as a whole. Less clear, however, are the policy responses needed and the level or levels at which the policymaking needs to occur—e.g., the African national, regional, and continental levels, and the global level. In this section we look at some of the current sites of AI policymaking at each of these four levels.

At African national levels

According to Onuoha's African AI policy survey for the 2019 *Global Information Society Watch*, only 17 of the 55 African Union (AU) Member States had enacted "comprehensive data protection and privacy legislation": Angola, Benin, Burkina Faso, Cape Verde, Côte D'Ivoire, Gabon, Ghana, Lesotho, Madagascar, Mali, Mauritius, Morocco, Senegal, Seychelles, South Africa, Tunisia, and Western Sahara (Onuoha, 2019, p. 60).

Meanwhile, the top five African countries in the 2020 global *Government Artificial Intelligence Readiness Index* are Mauritius (45th in the world), South Africa (59th), Seychelles (68th), Kenya (71st), and Rwanda (87th) (Oxford Insights & IDRC, 2020; Sey, 2020). That same report cites recent government progress towards AI readiness in Tunisia and Egypt (Sey, 2020).

The African country credited with having the first fully formalised national AI strategy is Mauritius (Sey, 2020), which launched its Mauritius Artificial Intelligence Strategy, along with the Digital Government Transformation Strategy 2018–2022 and the Digital Mauritius 2030 Strategic Plan, in December 2018 (GIS, 2018; Government of Mauritius, 2018). The government has also announced that it will establish a Mauritius Artificial Intelligence Council (MAIC) (Sey, 2020). Another leading country on the continent in respect of AI is Nigeria, which in November 2020 launched its publicly-run Centre for Artificial Intelligence and Robotics in Nigeria (CFAIR) in Abuja (*FinIntell*, 2020).

Several other countries have established task forces mandated to develop a national AI strategy. Kenya established its Distributed Ledgers Technology and Artificial Intelligence Task Force in February 2018 (*Kenyan Wall Street*, 2018). In its final report published in July 2019, the task force focuses on the potential and realised impacts of AI on key development areas such as health care, food security, manufacturing, housing, and education. The report provides general arguments for and against targeted regulation of AI by governments, and also provides general policy recommendations (Mpala, 2019). However, the report is far from a policy document, and the government has since said little about any policymaking regarding AI.

Tunisia's Secretary of State for Research launched the country's AI task force in April 2018, with the process to be driven by a task force established by Tunisia's Agence Nationale de la Promotion de la Recherche Scientifique (ANPR), with support from the UNESCO Chair on Science, Technology and Innovation Policy (Future of Life Institute, n.d.; Mehrez, 2019). South Africa established the Presidential Commission on the Fourth Industrial Revolution in April 2019 (DTPS, 2019). Also in April 2019, Uganda launched its Expert National Task Force on Fourth Industrial Revolution Technologies (Masereka, 2019; Uganda Media Centre, 2019). Egypt's National Artificial Intelligence Council, tasked with developing the country's AI strategy, convened its first meeting in February 2020 (MCIT, 2020). In June 2020, Rwanda announced it was working towards the development of a National Emerging Technology Strategy and Action Plan (Lasry, 2020). Several of the above-listed entities have mandates to find ways to build national AI expertise—and, by extension, policy capacity.

University-driven national AI capacity-building programmes are present in numerous countries, including Egypt, South Africa, Cameroon, Morocco, Senegal, Lesotho, and Ethiopia (see Effoduh, 2020). South Africa's Centre for Artificial Intelligence Research (CAIR), established in 2011, links nine research groups from six universities—the University of Cape Town, the University of KwaZulu-Natal, North-West University, the University of Pretoria, Stellenbosch University and the University of the Western Cape. It is funded by the Department of Science and Innovation (DSI) and coordinated by the Council for Scientific and Industrial Research (CSIR) (CAIR, n.d.). One of the CAIR member institutions, the University of Pretoria, is also involved in a national AI policy engagement exercise. The university's Data Science for Social Impact research group participates in the the Policy Action Network (PAN), convened by South Africa's Human Sciences Research Council), which in 2020 published the AI and Data Series of brief guides to AI's interfaces with equity, crime prevention, education, cities and towns, migration management, and health (Data Science for Social Impact, n.d.; PAN, 2020). South Africa also hosts a Centre for the Fourth Industrial Revolution, established at the CSIR in 2017 as part of a global network of such centres supported by the World Economic Forum (WEF) (C4IR-SA, n.d.).

At African continental and regional levels

The key African continental instrument with relevance to AI is the 2014 AU Convention on Cyber Security and Personal Data Protection (AU, 2014). However, as of the middle of 2020, only eight AU Member States had signed, ratified, and deposited the convention (AU, 2020). In October 2019 in Sharm-El-Sheik, Egypt, AU ministers in charge of communications, ICTs, and postal services—convened as the AU

Specialised Technical Committee on Communication and Information Communication Technologies (STC-CICT)—called on Member States to:

> [e]stablish a working group on Artificial Intelligence (AI) based on existing initiatives and in collaboration with African Institutions to study:
> a. The creation of a common African stance on AI
> b. The development of an Africa wide capacity building framework
> c. Establishment of an AI think tank to assess and recommend projects to collaborate on in line of Agenda 2063 and SDGs. (AU STC-CICT, 2019)

The AU's Cybersecurity Expert Group (AUCSEG), at its inaugural meeting in Addis Ababa in December 2019, stated in its press release that "[a]s Africans, we need to articulate our own Philosophy, Ethics, Policy, Strategies and accountability frameworks for Cyberspace, Cybersecurity and Cognitive or Artificial Intelligence (AI)" (AUCSEG, 2019).

At regional level, the Economic Community of West African States (ECOWAS) has adopted the 2010 Supplementary Act on Personal Data Protection within ECOWAS, which is binding on the community's Member States. Other African regional economic bodies have also worked to produce non-binding instruments with relevance to AI—e.g., the East African Community's (EAC's) draft EAC Legal Framework for Cyber Laws, and the Southern African Development Community's (SADC's) Model Law on Data Protection in 2012 (Onuoha, 2019).

In respect of fostering African AI policymaking capacity, one key emerging continental initiative is the Artificial Intelligence for Development in Africa (AI4D Africa) programme funded by the International Development Research Centre (IDRC) and the Swedish International Development Cooperation Agency (Sida) (AI4D Africa, n.d.). In September 2020, AI4D Africa published a call for proposals for two AI policy research "think-and-do tanks"—one in Anglophone Africa, the other in Francophone Africa—to produce AI policy research that will "inform and facilitate the development of public policies and regulations that promote the inclusive benefits of AI, while mitigating the potential costs and risks" (AI4D Africa, 2020).

There is wide recognition on the continent that building robust African AI policymaking capacity also requires the development of a critical mass of AI skills. Accordingly, the AI4D Africa initiative has pledged to support not only the aforementioned policy research bodies, but also African AI networks, labs, and scholarships. At a 2019 workshop convened in Nairobi as part of the establishment of AI4D Africa, a core idea discussed by participants was how to mobilise collaboration between a network of African companies, universities, research centres, and public institutions to advance the AI4D Africa agenda (AI4D, 2019). The head of Google Ghana has pledged support for this idea by advocating for better AI education across the continent, and by encouraging African governments to see AI as a key priority and to support efforts to use AI for the good of humanity (Russon, 2019). One flagship initiative in the area of AI capacity development is the African Master's in Machine Intelligence (AMMI), which is being delivered by a pan-African consortium of centres of excellence collaborating under the banner of the African Institute for Mathematical Sciences (AIMS) (AMMI, n.d.; AIMS, n.d.).

Other AI initiatives with relevance for African policymakers include the international Knowledge for All Foundation (K4A), which is mapping Africa's emerging AI ecosystem as part of its "Global South map of emerging areas" in AI, with a focus on "talents, players, knowledge and co-creation hot spots" (K4A, n.d.). Meanwhile, UN Global Pulse, spearheaded by the Office of the UN Secretary-General and with its African hub in Uganda (called Pulse Lab Kampala), is an "initiative on big data and artificial intelligence for development, humanitarian action, and peace" (Tatevossian, 2015; UN Global Pulse, n.d.). And the Global Network of Internet and Society Research Centers gave strong consideration to African voices at its 2017 Global Symposium on Artificial Intelligence and Inclusion in Rio (NoC, 2017).

There are also several active African machine-learning innovation and research communities. Deep Learning Indaba has held well-attended annual continental summits since 2017 (Deep Learning Indaba, n.d.). Data Science Africa has, since 2015, held continental events in Kenya, Uganda, Tanzania, Nigeria, Ghana, and Ethiopia (Data Science Africa, n.d.). Data Science Nigeria is also active (DSN, n.d.). AI research has also been undertaken by the Regional Academic Network on IT Policy (RANITP), sponsored by Microsoft and hosted by the Cape Town-based Research ICT Africa (RIA) network (RIA, n.d.) RANITP comprises researchers in South Africa, Nigeria, Uganda, Kenya, and Zimbabwe (RANITP, n.d.).

At global level

There are myriad international statements and declarations on AI, produced by civil society, private-sector, and public-sector actors. One of the most influential statements is the 2019 OECD Recommendation of the Council on Artificial Intelligence (OECD, 2019b), which was crafted with guidance from a multistakeholder expert group (OECD, 2019c). These OECD principles reflect many of the goals contained in The Public Voice's Universal Guidelines for Artificial Intelligence (UGAI) (The Public Voice, 2018). A key regulatory instrument is the EU General Data Protection Regulation (GDPR), which came into force in 2018 and which requires entities conducting transactions in EU Member States to observe high thresholds of protection for EU citizens' personal data and privacy (EU, n.d.). Though not specifically an AI instrument, the GDPR is of great significance to AI matters because many core practical and ethical AI matters include data protection elements.

One characteristic of certain AI policy discussions at high-level forums in the Global North has been the marginalisation or exclusion of Global Southern inputs. One example was the Global Forum on AI for Humanity, hosted by the Government of France in late 2019. Notably absent from this "global" forum were Global Southern voices, with no representatives based at institutions in Africa, Latin America, or Asia (apart from Japan) (Geist, 2019).

The International Telecommunication Union (ITU) and 36 other UN agencies and initiatives are engaging with AI matters, collaborating under the ITU's AI for Good Global Summit processes (ITU, 2019). One initiative falling under this umbrella that has a strong African focus is the aforementioned UN Global Pulse initiative, which is active in East Africa via its Pulse Lab Kampala data innovation hub established in 2015 (Tatevossian, 2015). With respect to the three domains of African AI benefits and challenges highlighted in this article—gender, linguistic diversity, and labour—perhaps the most relevant, and Africa-inclusive, global policy processes currently underway are those being carried out by UNESCO.

UNESCO convened a Forum on Artificial Intelligence in Africa in Morocco in December 2018. In its Outcome Statement, the forum called for, inter alia, "the African Union, in partnership with the RECs [regional economic communities], to develop a continental strategy for AI, which includes digital data management, and that is based on a multi-stakeholders approach and underpinned by [the AU] Agenda 2063" (UNESCO, 2018). Subsequently, in November 2019, at UNESCO's 40th General Conference, Member States mandated the UNESCO Director-General "to prepare an international standard-setting instrument on the ethics of artificial intelligence (AI) in the form of a recommendation" (UNESCO, 2019). In fulfilment of that mandate, UNESCO assembled an Ad Hoc Expert Group (AHEG) to prepare a draft text of recommendation, which was published in September 2020 as the *First Draft of the Recommendation on the Ethics of Artificial Intelligence* (UNESCO, 2020b). Among the myriad inputs considered by the AHEG were the inputs of the aforementioned 2018 Forum on Artificial Intelligence in Africa in Morocco and, in August 2020, a virtual UNESCO Regional Consultation for the Arab States Region hosted by Egypt's Ministry of Communications and Information Technology (MCIT) (Phillips, 2020).

This UNESCO process has clear policy relevance for the AI dimensions discussed in this article because the process is strongly focused on AI's ethical and sustainable development dimensions. The UNESCO AHEG *First Draft* document of September 2020 proposes Member State actions under the following 10 "Areas of Policy Action":

- ethical impact assessment;
- ethical governance and stewardship;
- data policy;

- development and international cooperation;
- environment and ecosystems;
- gender;
- culture;
- education and research;
- economy and labour; and
- health and social well-being (UNESCO, 2020b).

Among these 10 policy action areas outlined in the UNESCO AHEG *First Draft* document, the "gender", "culture", and "economy and labour" sections provide policy action ideas that directly address several of the African AI benefits and challenges discussed in this article. In the gender policy action area, the UN document states, inter alia, that

> Member States should ensure that gender stereotyping, and discriminatory biases are not translated into the AI systems. […]
>
> Member States should encourage female entrepreneurship, participation and engagement in all stages of an AI system life cycle by offering and promoting economic, regulatory incentives, among other incentives and support schemes, […]. (UNESCO, 2020b, paras. 92, 93)

In its section on the culture policy action area, the document strongly targets cultural heritage and endangered languages, stating that

> Member States are encouraged to incorporate Al Systems where appropriate in the preservation, enrichment, understanding, promotion and accessibility of tangible, documentary and intangible cultural heritage, including endangered languages as well as indigenous languages and knowledge, […]. (UNESCO, 2020b, para. 96)

Also, in the section on culture, the document focuses on the intersection between NLP and matters of linguistic diversity:

> Member States are encouraged to examine and address the cultural impact of AI systems, especially Natural Language Processing applications such as automated translation and voice assistants on the nuances of human language and expression. Such assessments should provide input for the design and implementation of strategies that maximize the benefits from these systems by bridging cultural gaps and increasing human understanding, as well as negative implications such as the reduction of use, which could lead to the disappearance of endangered languages, local dialects, and tonal and cultural variations associated with human language and expression. (UNESCO, 2020b, para. 96)

In its section on the economy and labour policy action area, the document points to the need for strong pro-competition measures, stating that, inter alia,

> Member States should devise mechanisms to prevent the monopolization of AI systems throughout their life cycle and the resulting inequalities, whether these are data, research, technology, market or other monopolies. Member States should assess relevant markets, and regulate and intervene if such monopolies exist, taking into account that, due to a lack of infrastructure, human capacity and regulations, LMICs, in particular LDCs, LLDCs and SIDS are more exposed and vulnerable to exploitation by large technology companies. (UNESCO, 2020b, para. 118)

Inputs on this UNESCO AHEG *First Draft of the Recommendation on the Ethics of Artificial Intelligence* are due by 31 December 2020, and a final draft recommendation is scheduled to be submitted to UNESCO's 41st General Conference in late 2021.[2] The final *Recommendation on the Ethics of Artificial Intelligence* that is eventually approved by UNESCO Member States is likely to be a valuable standard-setting tool for African policymakers to consult and reference as they take forward their efforts to craft policies that maximise AI's benefits and address its challenges.

6. Conclusion

From certain perspectives, it can be argued that there is a high level of diversity of AI deployment on the African continent. As revealed in this article, one aspect of diversity is in the types of problems that are being addressed by AI. From financial inclusion to combatting cultural and linguistic marginalisation, AI innovations are aimed at many different aspects of African society, economy, and government. Another form of diversity is in the people implementing AI solutions, and in this regard, the relatively high level of participation by women in African entrepreneurship is encouraging. Diversity of location is also noteworthy—while AI is clearly developing in countries that are well known as technology hubs (e.g., Kenya, Nigeria, and South Africa), there are also significant AI-focused activities in countries that are less frequently recognised for cutting-edge digital adoption (e.g., Uganda and Ethiopia). In contrast, government policy is an area where there is less diversity, as the vast majority of African countries lack a dedicated AI policy instrument.

AI has the potential to be as impactful in Africa as it is in other regions of the world, but as explained herein, the unique context will influence the depth and breadth of that impact. The labour force in Africa is very different from the labour forces in, for example, Europe and the United States, and, accordingly, the impact of AI on labour will likely also be quite different. This is similarly true for the financial sector and various aspects of inclusion. In many ways, the stakeholders responsible for the

2 At the time of finalising this article, the dates of UNESCO's 41st General Conference had not been set.

evolution and adoption of AI in Africa can be guided by the experiences of other nations and continents. At the same time, however, African AI stakeholders will ultimately chart a course that is substantially dictated by the unique characteristics of the continent. Future research should focus on the evolution of AI in Africa, from the development of the technologies through to the levels of acceptance by the people interacting with AI, and through to the ultimate impact of the technologies on society.

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