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Harnessing the 4IR in SADC: Roles for Policymakers

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Abstract

This paper maps SADC countries' readiness for the Fourth Industrial Revolution from a strategic policy perspective. It focuses specifically on the digital connectivity and skills components of the 4IR, given their role in creating an enabling environment for industrial development in emerging markets. The paper undertakes three country case studies: South Africa, Lesotho and Malawi, examining supply-side policy related to information and communications technology service provision and regulation, and demand-side policy related to digital skills and innovation. The findings highlight priorities for the region, including policies and technologies to support affordable Internet service provision in rural areas, public sector capacitation and sensitisation, education and skills policy reform, and the creation of political and public buy-in for strong national visions of digital societies. From this analysis, the paper seeks to paint a picture of SADC countries' overall 4IR readiness, while also highlighting global best practice and offering recommendations on potential enabling roles for the SADC Secretariat.

Introduction

First popularised by the World Economic Forum (WEF) in 2015, the Fourth Industrial Revolution (4IR) or 'Industry 4.0' has become a catch-all term to describe imminent changes to global business, labour and education models stemming from the advent of 'cyber-physical systems'.[1] The general purpose technologies (GPTs)[2] driving the 4IR include big data, the Internet of Things (IoT), 3D printing, artificial intelligence (AI), blockchain, cloud computing, synthetic biology and advanced materials.

These advancements may appear less immediately relevant to emerging economies on the African continent that are still grappling with the challenges of the second and third industrial revolutions. However, African countries cannot afford to fall further behind the technological frontier, or to exacerbate the existing digital divides within their borders. Adopting new technologies will prove crucial for rapid and sustained productivity and economic growth. Policymakers must therefore strive to create an enabling environment that supports investment in emerging GPTs, while simultaneously placing primary focus on the necessary foundational improvements in information and communications technology (ICT) infrastructure. Data access and affordability, digital skills and innovation ecosystems are necessary building blocks for 4IR high-tech investments. Much of the global 4IR literature comes from developed countries and does not comprehensively integrate these elements.

1 Davis N, 'What is the 4th Industrial Revolution?', WEF (World Economic Forum), 19 January 2016, https://www.weforum.org/agenda/2016/01/what-is-the-fourth-industrial-revolution/, accessed 25 March 2019.

2 The *Handbook of Economic Growth* (2005) defines GPTs as 'a new method of producing and inventing that is important enough to have a protracted aggregate impact'. Durlauf SN & P Aghion, *Handbook of Economic Growth*, Elsevier BV, 2005.

Considering the aforementioned challenges (infrastructure, skills and costs of access), SADC has identified a need to take a strategic policy position on the 4IR.[3] It acknowledges that such a position must be informed by the economic realities of individual member countries and SADC's Industrialisation Strategy. Furthermore, the SADC ICT Subcommittee has highlighted the need for regional policies for accelerated deployment of technologies such as broadband, big data and cybersecurity.[4] This research sets out to support this objective by conducting a mapping of SADC countries' readiness for the 4IR from a strategic policy perspective.

The paper begins with a brief literature review unpacking the 4IR as a concept and its potential global significance, as well as where the region stands with respect to the digital transformation of society. It specifically focuses on digital connectivity and the required digital skills development elements of the 4IR. It outlines important roles for policymakers in driving improved connectivity, which creates an enabling environment for investments in cutting-edge technologies in the longer term. The paper then narrows to the continental and regional level, painting a broad picture of ICT infrastructure and policies, as well as innovation, digital skills and 4IR policies in the region. Various indices from the WEF, International Telecommunication Union (ITU) and African Development Bank (AfDB) supported this assessment.

The paper includes three in-depth case study countries in the region that represent differing levels of ICT development based on the AfDB's Africa Infrastructure Development Index (AIDI) for ICT. South Africa represents a top performer, Lesotho a mid-range performer and Malawi a low-range performer. The country case studies have three main objectives, namely to:

- examine supply-side 4IR readiness and policies, including policies to develop and improve affordable access to ICT infrastructure and services (ie, broadband access policies/statistics, national ICT policies, competition in the sector, data and cybersecurity policies);
- examine demand-side readiness and policies relating to digital literacy, research and development (R&D), innovation, and science, technology, engineering and math (STEM) skills; and
- highlight any innovations occurring in the case study countries relating to improving ICT access and affordability or with regard to the seven emerging GPTs identified, and how innovations in technology can be geared into socio-economic propellers.

The case studies and analysis were completed through a desktop policy review, as well as interviews with policy and industry experts. The resulting analysis seeks to paint a picture

3 'South Africa Draft Annotated Agenda', 19th Meeting of the Ministerial Task Force on Regional Economic Integration, Pretoria, 23 July 2018.

4 SADC, 'SADC ICT Sub-Committee (SCOM) Meeting SADC Headquarters, Gaborone, Botswana 4–6 July 2018', Media Release, https://www.sadc.int/files/5315/3139/7850/Media_Release.pdf, accessed 25 March 2019.

of SADC countries' overall 4IR readiness, identifying both policy strengths and weaknesses, while citing global best practice. The paper concludes with recommendations on the potential roles that SADC could play in developing enabling policy to accelerate digital connectivity, ICT infrastructure, service development and digital literacy to facilitate economic development in the region.

Harnessing the 4IR

The WEF places the so-called 4IR as a sequitur to the previous three industrial revolutions, which are all defined by major advances in resource utilisation and production (Figure 1). As with previous revolutions, the term 4IR is often used in an encompassing manner to describe a range of new applications of technologies. Specifically, the 4IR describes technological disruptions driven by *increased automation of labour* and *increased digital connectivity*. Chief among these changes is the use of machines to perform complex tasks formerly performed by humans, which is improving business efficiency and margins.[5] As a result, ICT processes are now an integral component throughout the business value chain, and a necessity for participation in the global economy and for improved public service delivery. The Sustainable Development Goals (SDGs) have therefore identified digital connectivity as a basic human right.[6] Reliable, secure and affordable digital connectivity is also an important component and core of 4IR technologies and services. Smart network technologies with variable quality of service demand are thus crucial to enable 4IR in emerging economies of Africa.

Figure 1 WEF characterisation of the four industrial revolutions

Revolution				
Year	1784	1870	1969	?
Information	• Steam • Water • Mechanical production equipment	• Division of labour • Electricity • Mass production	• Electronics • IT • Automated production	• Cyber-physical systems

Source: Davis N, 'What is the Fourth Industrial Revolution?', WEF (World Economic Forum), 19 January 2016, https://www.weforum.org/agenda/2016/01/what-is-the-fourth-industrial-revolution/, accessed 29 March 2019

5 Baweja B *et al.*, *Extreme Automation and Connectivity: The Global, Regional, and Investment Implications of the Fourth Industrial Revolution*, UBS (Union Bank of Switzerland), 2016, http://www.tadviser.ru/images/b/b7/Extreme_automation_and_connectivity_The_global%2C_regional%2C_and_investment_implications_of_the_Fourth_Industrial_Revolution.pdf, accessed 29 September 2019.

6 UN, 'Sustainable Development Goals', https://sustainabledevelopment.un.org/?menu=1300, accessed 12 May 2019.

Understanding the technologies driving these changes is essential to assessing their impacts and formulating policy responses. Although there is no formal list of 4IR technologies, below are short descriptions of some of the most potentially impactful emerging technologies:[7]

- big data/cloud computing: large amounts of data can be stored, processed and distributed instantly (ie, data that humans generate by browsing the Internet);
- the IoT: sensors that connect everyday products to the Internet (ie, the remote control of home appliances);
- 3D printing: computational design is used to complete processes of manufacturing, materials engineering and synthetic biology by 'printing' parts (this eliminates the need for mass production and is both faster and cheaper);
- AI: software algorithms able to complete processes traditionally completed by humans – ie, robots, autonomous (self-driving) vehicles and drones; and
- blockchain: decentralised, public ledger storing digital information that allows for payment transactions to be public to anyone with access to the network.

All of these technologies require reliable, secure and affordable broadband Internet connectivity as a baseline for their operation. The global commercial rollout of fifth-generation mobile technology (5G) is anticipated to begin in 2020 after standards are finalised by the ITU. 5G will allow for the Internet connectivity of billions of devices, thereby enabling the IoT, improved speed to allow the instant processing of large amounts of data, and ultra-reliable low latency for automation.[8] However, as digital technology expands daily, so have the tactics of cybercriminals targeting anyone active in cyberspace – often with irreversible damage.[9] Personal data can also freely be used and distributed by companies if it is not legally protected. This is especially damaging to financial systems in emerging African countries. People and businesses are afraid of using emerging ICT-based financial services if they suspect that their limited resources can be stolen when cybersecurity fails. Therefore, cybersecurity and data protection have become pressing threats that must be addressed along with emerging ICT.[10] At the same time, technological services with onerous security requirements necessitating a certain level of proficiency can also become barriers to use in emerging markets. Finding a balance is important.

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7 Montresor F, 'The 7 technologies changing your world', WEF, 19 January 2016, https://www.weforum.org/agenda/2016/01/a-brief-guide-to-the-technologies-changing-world, accessed 14 April 2019; Herweijer C *et al.*, 'Enabling a sustainable Fourth Industrial Revolution: How G20 countries can create the conditions for emerging technologies to benefit people and the planet', *G20 Insights*, May 2017, https://www.g20-insights.org/policy_briefs/enabling-sustainable-fourth-industrial-revolution-g20-countries-can-create-conditions-emerging-technologies-benefit-people-planet/, accessed 20 April 2019; PWC, 'Fourth Industrial Revolution for the Earth Harnessing the 4th Industrial Revolution for Sustainable Emerging Cities', November 2017, https://www.pwc.com/gx/en/sustainability/assets/4ir-for-the-earth.pdf, accessed 20 April 2019.

8 Personal interview, South African public research entity representative, Pretoria, 24 April 2019.

9 Etion, 'Playing catch-up', 12 September 2018, https://www.etion.co.za/2018/09/12/playing-catch-up/, accessed 3 May 2019.

10 Lund S *et al.*, 'Globalization in Transition: The Future of Trade and Value Chains', McKinsey & Company, January 2019, https://www.mckinsey.com/featured-insights/innovation-and-growth/globalization-in-transition-the-future-of-trade-and-value-chains, accessed 20 April 2019.

Global and continental implications

Charles Schumpeter's theory of 'creative destruction', dating back to the 1940s, remains applicable to technological development. Schumpeter postulated that technological advances would create new opportunities for growth and employment in emerging technologies and industries, but also cause a decline in employment opportunities in traditional industries.[11] This holds true in the African context. While the 4IR can deliver the widespread benefits of more efficient production to African countries, it also presents many risks, particularly from increased automation. Traditional paths to economic development have all followed a similar trajectory from the Second Industrial Revolution: manufacturing underpinned by low-cost, labour-intensive production, which creates mass employment. However, these growth paths are now threatened by the automation of low-skill activities. According to a 2019 McKinsey report, the importance of labour cost advantages in determining production locations has declined, and only 20% of goods production is currently based on labour–cost arbitrage.[12] Low-skill production outsourced to emerging markets is increasingly insourced closer to home markets, which impacts countries' industrial development strategies across many sectors.

Given the uncertainty inherent in future technological development, accurate predictions regarding the pace or extent of changes to employment are not possible, which increases the difficulty in preparing for such changes.[13] However, what is known is that competitive advantage is increasingly determined by connected, knowledge-intensive economies with high digital skill levels. The growth in demand for technological skills is projected to rise 55% by 2030.[14] This paper therefore primarily focuses on responding to the need for improved connectivity and skills, as it is a clearly defined way in which countries can and must prepare for global shifts. This should be coupled with more longer-term policies and strategies relating to the specific 4IR technologies mentioned above, although this extends beyond the focus of this paper.

African countries' standing

While some parts of North America, Europe and Asia are at the frontier of R&D and technological development, other regions, such as Africa, are often playing catch-up.[15] The digital divide on the African continent is stark: 24% of people in Africa accessed the Internet in 2018, compared to 80% in Europe and a 51% global average. This is despite the largest global growth in Internet usage coming from African countries.[16] The penetration

11 Schumpeter JA, 'The creative response in economic history', *The Journal of Economic History*, 7, 2, 1947, pp. 149–159.
12 Lund S *et al., op. cit.*
13 World Bank, *World Development Report 2019: The Changing Nature of Work*. Washington, DC: World Bank, 2019.
14 Lund S *et al., op. cit.*
15 Saunders M, 'Shaping the Future of Production in South Africa: Preliminary Country Readiness Results'. South Africa: CSIR (Centre for Science and Industrial Research), 2017.
16 Mumbere D, 'Digital in 2018: Africa's Internet users increase by 20%', *Africa News*, 6 February 2018, https://www.africanews.com/2018/02/06/digital-in-2018-africa-s-internet-users-increase-by-20-percent//, accessed 20 April 2019.

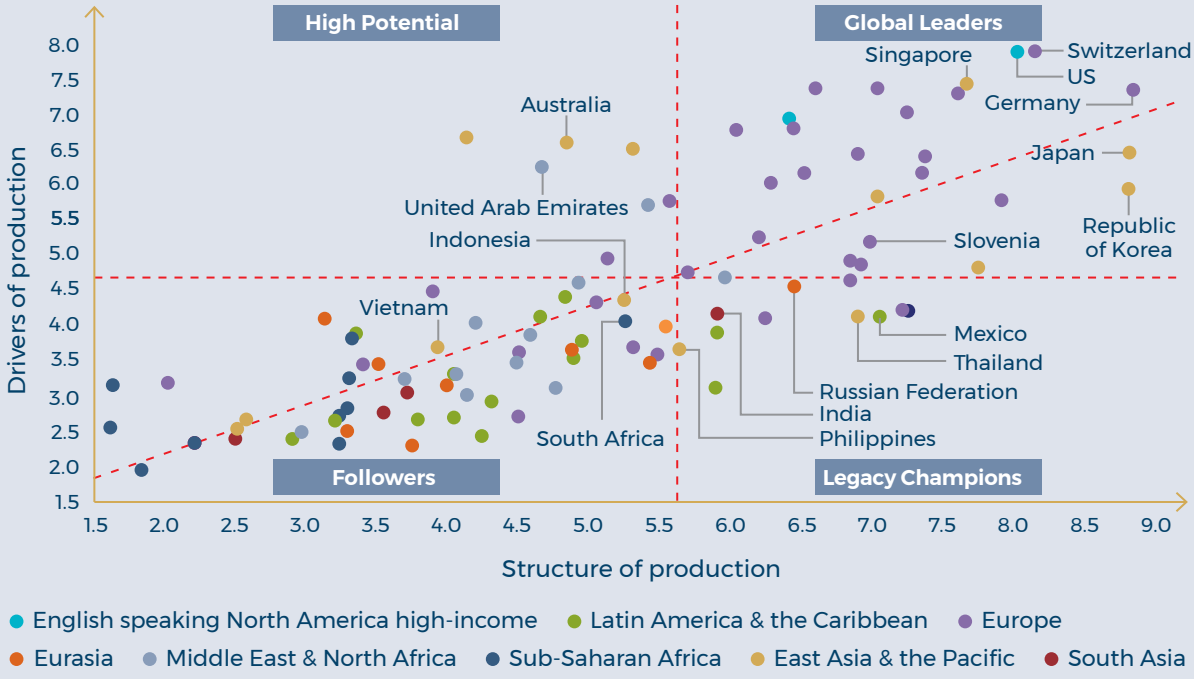
rate in SADC (using data from 2017) is slightly higher than the continental average at 26%.[17] These statistics, coupled with the fact that most African economies are still anchored to agriculture and natural resource extraction, do not position them as top investment destinations for emerging technologies.

In its analysis of country readiness for the 4IR, the WEF categorises countries based on whether they have a strong current base of production and whether they are well positioned to take advantage of technological changes stemming from the 4IR:[18]

- **Global leaders**: strong current base, positioned well for the future;
- **High potential**: limited current base, positioned well for the future;
- **Legacy champions**: strong current base, at risk for the future;
- **Followers**: limited current base, at risk for the future.

The sample of sub-Saharan African countries assessed are all typed as followers, with South Africa closest to entering one of the other three categories, as seen in Figure 2.

Figure 2 WEF 4IR country archetype analysis



Note: Axes are on a 10 point scale but have been zoomed to show variances between countries; country archetype lines drawn on average drive and structure scores for top 80 countries

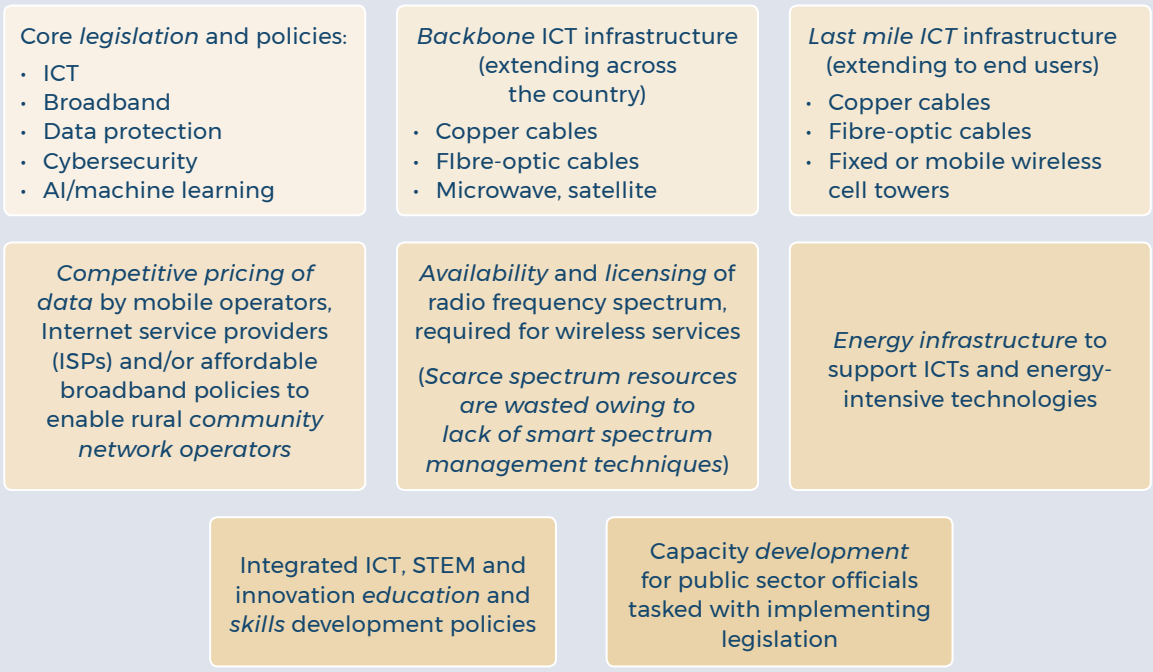
Source: Saunders M, 'Shaping the Future of Production in South Africa: Preliminary Country Readiness Results', CSIR, '2017

17 Mothobi O, Chair C & B Rademan, 'SADC not Bridging Digital Divide', RIA (Research ICT Africa) Policy Brief, 6, September 2017, https://researchictafrica.net/polbrf/Research_ICT_Africa_Policy_Briefs/2017_Policy_Brief_6_SADC.pdf, accessed 27 April 2019.

18 *Ibid.*

African and other 'follower' countries face several overarching challenges in improving connectivity to fully harness new technologies. The largest supply-side constraints include the lack of enabling ICT infrastructure and the policy frameworks/policy agility necessary for emerging GPT investments.[19] High-speed fixed and mobile connections are a prerequisite for more advanced 4IR infrastructural investments such as data centres.[20] Connections must be both widespread and affordable so that the tools for technological adoption and innovation are widely available. Many countries also have scarce or inefficiently allocated radio frequency spectrum, which is required for wireless connections.[21] From a demand side, ICT skills and innovation ecosystems are necessary to take advantage of such infrastructures. In particular, the digital divide in access to affordable ICTs and digital literacy between income levels and geographical locations is further exacerbating inequality, both between and within countries. Specific bottlenecks to ICT development and connectivity are categorised and expanded upon in Figure 3.

Figure 3 Common challenges faced by emerging markets in harnessing the 4IR



Source: Author's typology based on literature and interviews

19 World Bank, 2019, *op. cit.*

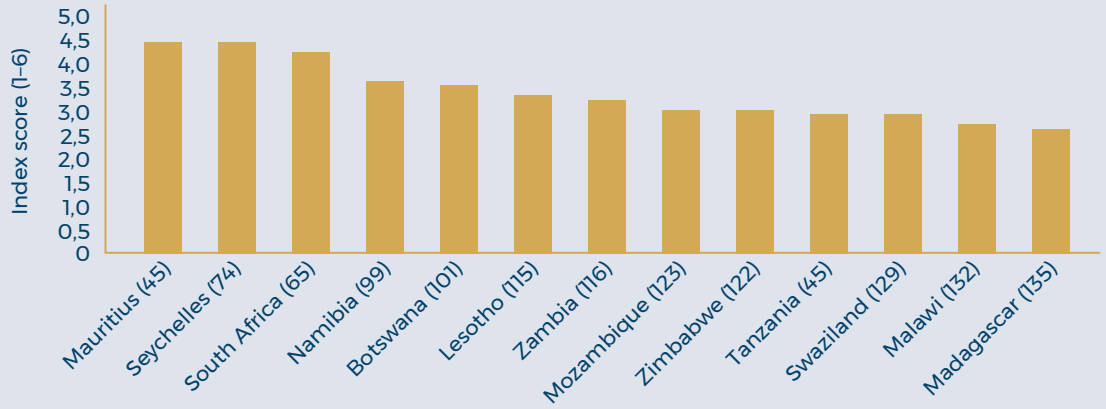
20 Data centres refer to a networked group of computers that store, process and distribute mass amounts of data.

21 According to the GSMA, '[s]pectrum relates to the radio frequencies allocated to the mobile industry and other sectors for communication over the airwaves'. [It is licensed by a country's government and availability is limited owing to the potential for interference. "What is Spectrum," *GSMA*, https://www.gsma.com/spectrum/what-is-spectrum/, accessed 18 May 2019.

The digital divide in access to affordable ICTs and digital literacy between income levels and geographical locations is further exacerbating inequality, both between and within countries

Global ICT and innovation indexes provide more detail in assessing countries' 4IR readiness. Given the scope of this paper, the analysis is limited to a comparison of SADC countries, with their global rankings in parenthesis.[22] Figure 4 gives an overall assessment of countries' readiness to take advantage of advances in ICT, while figures 5–7 cover specific elements such as infrastructure, data affordability, digital skills and innovation. Across all metrics, SADC countries rank low compared to global averages, with Seychelles, Mauritius and South Africa performing significantly better than other countries in the region. Interestingly, data costs show great variation in the region and are not necessarily correlated with infrastructure development, when compared in Figure 4 against the AfDB's AIDI for ICT. Tanzania has among the lowest data costs yet limited ICT infrastructure development, while South Africa has the most developed infrastructure in the region but comparatively high data costs. With regard to innovation, South Africa performs comparatively well within the Southern African region and ranks high globally at 58th; however, it performs comparatively poorer in other ICT and network indicators.

Figure 4 WEF Networked Readiness Index (2016)

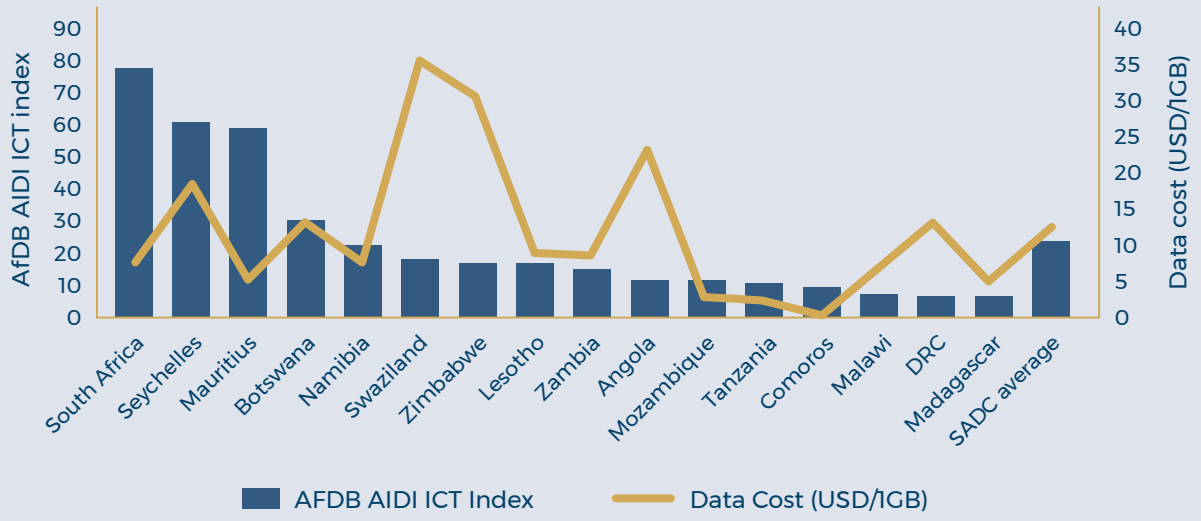


Note: numbers in parenthesis refer to country's global ranking

Source: WEF, 'Network Readiness Index', 2016, http://reports.weforum.org/global-information-technology-report-2016/networked-readi ness-index/, accessed 12 June 2019

22 RIA notes important caveats that must be considered when using these indicators. Firstly, limited baseline data on the continent makes it difficult to estimate exact numbers with regard to Internet access and other ICT indicators. Additionally, a country's GDP has a considerable impact on Internet affordability, regardless of policies or infrastructure. According to Esselaar, Gillwald and Stork, 80% of the variation in indices is explained by GDP. However, they can nonetheless be used loosely to form a broader picture of the region's standing. Esselaar S, Gillwald AN & C Stork, 'Analysis Instead of Summation: Why Indices Are Not Enough for ICT Policy and Regulation, SSRN, 2017, https://ssrn.com/abstract=3043719 or http://dx.doi.org/10.2139/ssrn.3043719, accessed 12 June 2019.

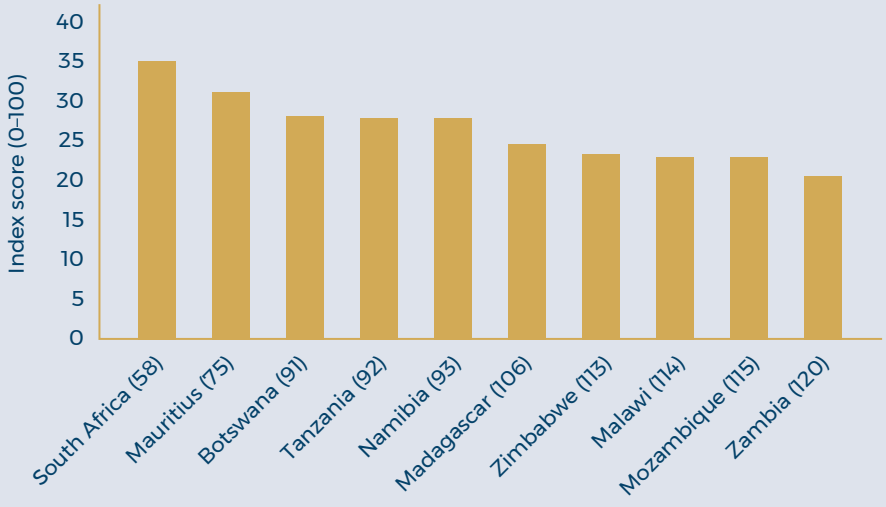
Figure 5 SADC ICT infrastructure development and data cost



Note: data cost for Comoros not available

Source: AfDB (African Development Bank), 'Africa Infrastructure Development Index'. Côte d'Ivoire: AfDB, 2018; Mothobi O, Chair C & B Rademan, 'SADC not Bridging the Digital Divide', RIA (Research ITC Africa) Policy Brief, 6, September 2017, https://researchictafrica.net/polbrf/Research_ICT_Africa_Policy_Briefs/2017_Policy_Brief_6_SADC.pdf, accessed 12 June 2019

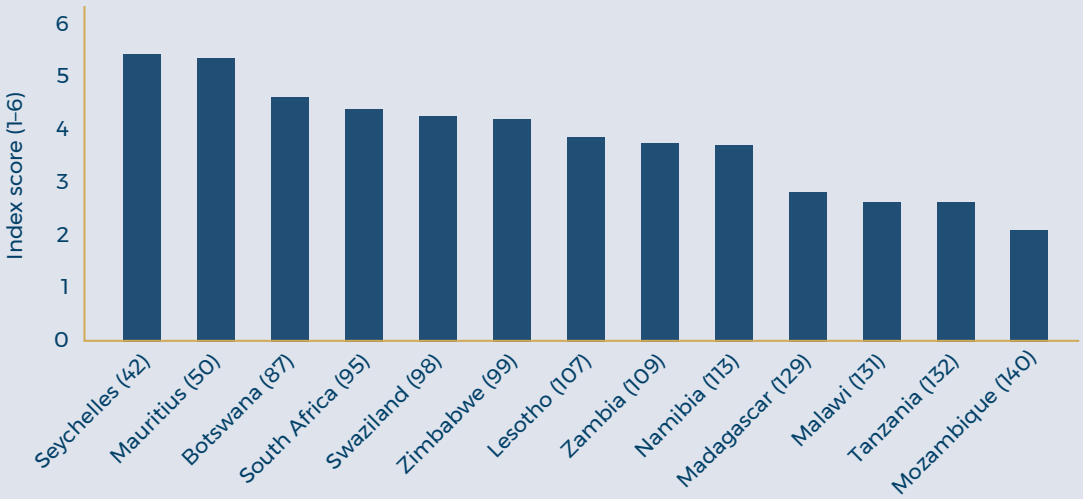
Figure 6 Global Innovation Index (2018)



Note: numbers in parenthesis refer to country's global ranking

Source: Cornell University, INSEAD & WIPO (World Intellectual Property Organization), 'Global Innovation Index', 2018, https://www.wipo.int/publications/en/details.jsp?id=4330

Figure 7 Digital Skills Development (subcategory of WEF Networked Readiness)



Note: numbers in parenthesis refer to country's global ranking

Source: WEF, 'Network Readiness Index', 2016, http://reports.weforum.org/global-information-technology-report-2016/networked-readiness-index/, accessed 12 June 2019

Thus, while the emerging 4IR brings common global challenges and opportunities, African countries face unique and specific bottlenecks that must first be addressed through focused technology investment and enabling policy responses.

Enabling policy responses

Urgent and evidence-based policy responses addressing the challenges outlined above (including equitable access, affordability and skills) can unlock the benefits of the 4IR, such as improved productivity and new employment opportunities, and ultimately create new long-term growth paths for African countries.[23]

A 2018 WEF paper offers generalised strategies for policymaking in the 4IR era that apply to developing and developed countries alike.[24] Its authors coined the term 'agile governance', which is defined as 'adaptive, human-centred, inclusive and sustainable policymaking, and which acknowledges that policy development is no longer limited to governments but is an increasingly multi-stakeholder effort'.

23 Baweja B *et al.*, *op. cit.*

24 Elmi N, Broekaert K & AE Larsen, 'Agile Governance: Reimagining Policy-making in the Fourth Industrial Revolution', WEF White Paper, January 2018, http://www3.weforum.org/docs/WEF_Agile_Governance_Reimagining_Policy-making_4IR_report.pdf, accessed 20 March 2019.

Agile governance uses both systems and design thinking:

- Systems thinking considers not only the direct problems that policies address but also examines policies within the framework of ecosystems that are constantly changing, looking for underlying patterns that can be applied more broadly to improve the efficiency and adaptability of policymaking.
- Design thinking promotes the test-bedding and piloting of technologies on a smaller scale so that policies can be adapted before broader release.[25]

Overall, agile governance promotes dynamic policymaking that reduces bureaucracy and relies on continual learning and adjustment, with governments working in real time alongside the private sector and academia/research institutions in policy development. Agile governance relies on these public–private collaborations to create flexible spaces for companies to trial technologies before regulations are developed and subsequently develop appropriate regulations together, often referred to as 'regulatory sandboxing'.

The international literature on specific policy and the 4IR often does not place basic ICT provision and policy at the core, as evidenced by a policy discourse primarily geared towards developed countries at the forefront of new technological developments

However, the growing pool of international literature on specific policy and the 4IR often does not place basic ICT provision and policy at the core, as evidenced by a policy discourse primarily geared towards developed countries at the forefront of new technological developments that already provide universal reliable and fast Internet access. African governments, in particular, must prioritise policies that develop the necessary infrastructure, ensure affordable Internet access and promote digital and STEM skills development and technological innovation, while also adopting regulations to protect users of technologies.[26]

Additionally, effective policymaking must be evidence based and inclusive to ensure benefits extend to the broader population. This requires extensive consultation. This is especially true in sub-Saharan Africa, where there are high levels of digital inequality. In light of the fast pace of technological developments, these requirements can contradict the concept of 'agile governance'. The WEF paper acknowledges this challenge and suggests that agile policymaking can actually increase inclusivity through involving more stakeholders

25 *Ibid.*

26 Access Partnership, 'Delivering the Fourth Industrial Revolution: The Role of Government', 11 July 2018, https://www.accesspartnership.com/cms/access-content/uploads/2017/07/FINAL_Cloud4IR1.pdf, accessed 25 March 2019.

and continually refining policy. However, the time-intensive element inherent in thorough policy development represents a remaining tension in the agile governance approach.

Following from this, the next two subsections will provide a broad overview of existing digital development and supply- and demand-side policies relevant to the 4IR across Africa and in the SADC region.

Continental policy responses

At a continental level, the AU has adopted frameworks to improve connectivity in the region. From 2008–2013, the AU, the ITU and the European Commission jointly adopted the Harmonisation of ICT Policies in Sub-Saharan Africa (HIPSSA) initiative. HIPSSA provided technical assistance at regional and national levels in developing policy frameworks covering a number of areas, including model laws for ICT, cybersecurity, e-transactions and data protection legislation, SADC guidelines for universal service and access funds, and analogue-to-digital migration guidelines.[27] These models have guided national legislation developed throughout the SADC region (and will be analysed below).

In 2013 AU heads of state signed the 'Smart Africa' manifesto at the Transform Africa Summit in Kigali, as an encompassing continental response to both the supply- and demand-side challenges of the 4IR and emerging GPTs.

The manifesto[28] contains five principles:

- **Principle 1**: To put ICT at the centre of the national socio-economic development agenda.
- **Principle 2**: To improve access to ICT, especially broadband.
- **Principle 3**: To improve accountability, efficiency and openness through ICT.
- **Principle 4**: To put the private sector first.
- **Principle 5**: To leverage ICT to promote sustainable development.

The subsequent Smart Africa strategic vision[29] focuses on integrating digital technologies in key sectors of agriculture, cities, education, finance and health, and on integrating digital technology into government services (ie, e-government). The vision proposes support in several other areas, such as capacity building and support for innovation and start-ups. The manifesto was originally launched by seven countries, but the Smart Africa Alliance

27 Analog-to-digital describes the migration from older analogue television broadcasting to digital television broadcasting infrastructure. It is completed at national level, and was initiated by some countries as early as 2006. ITU, HIPSSA Project, 'Support for harmonization of the ICT policies in sub-Saharan Africa', https://www.itu.int/en/ITU-D/Projects/ITU-EC-ACP/HIPSSA/Pages/default.aspx, accessed 3 May 2019.

28 Smart Africa Manifesto, Endorsed by Heads of State and Government in Kigali on 29th October 2013, Transform Africa Summit. http://smartafrica.org/new/wp-content/uploads/2019/01/smart_africa_manifesto_2013_-_english_version.pdf.

29 Smart Africa Strategic Vision, Smart Africa. http://hddrwanda.com/smartafrica/wp-content/uploads/2018/11/Design-English.pdf.

has now grown to 24 member countries, with the goal of bringing on board all African countries. Members are encouraged to develop national SMART country programmes, and the alliance pledges to assist with technical and financial assistance as well as mobilisation of funding from private and development finance institution partners.

A continental digitalisation plan is important, and Rwanda's national championing has played a major role in driving the private sector partnerships that are beginning to emerge under the Smart Africa platform. However, SMART Africa's objective to 'put the private sector first' does not explicitly acknowledge the underlying unequal ICT access in most countries, which necessitates a strong consultation and consensus-building component within public–private partnerships. Additionally, the capacity-building component within the strategic vision should be prioritised as a sub-component in any Smart Africa initiatives. An encouraging example is Smart Africa's 2019 partnership with the African Advanced Level Telecommunications Institute to offer ICT scholarships, training, regulatory capacity building and support to innovation hubs in Eastern and Southern Africa.[30]

Continental coordination on data protection and cybersecurity is essential given that private sector use of data often extends across borders, and cybercrimes can involve multiple countries. In 2014 the AU adopted the Convention on Cybersecurity and Data Protection (AU Convention). However, it has received only 11 signatures and four ratifications to date and needs 15 ratifications in order to take effect.[31] Although this does offer model frameworks that can be adapted nationally, again, the slow movement on regional adoption does not reflect the rapid pace of advances in cyberspace.

In terms of continental infrastructure, currently 112 active ICT projects form part of the AU's Programme for Infrastructure Development (PIDA). The vast majority include fibre-optic backhaul connections that link to the continent's major international undersea cables[32] and Internet exchange points, which allow data transfer between individual ISPs across countries. However, the most pressing infrastructural bottlenecks often involve 'last mile' connections to homes and businesses, which are managed at national level. This will be further explored in the national case studies.

SADC's policy response

SADC's current 4IR strategies must be considered in the context of past initiatives to improve connectivity, with a selection of important initiatives detailed below. Digital SADC 2027 can be viewed as the guiding framework for regional digitalisation, while HIPSSA model laws have played an important role in guiding national policy development.

30 Taarifa, 'Smart Africa signs deal with AFRALTI for prestigious scholarships to African youth', 31 January 2019, https://taarifa.rw/2019/01/31/smart-africa-signs-deal-with-afralti-for-prestigious-scholarships-to-african-youth/, accessed 5 May 2019.

31 AU, 'List of Countries which have Signed, Ratified/Acceded to the African Union Convention on Cyber Security and Personal Data Protection', 6 February 2019, https://au.int/sites/default/files/treaties/29560-slafrican_union_convention_on_cyber_security_and_personal_data_protection_2.pdf, accessed 3 May 2019.

32 AU, PIDA Virtual Information Centre, 'PIDA projects dashboard', http://www.au-pida.org/pida-projects/, accessed 12 May 2019.

TABLE 1 SELECTION OF PAST SADC DIGITAL DEVELOPMENT INITIATIVES	
Initiative	**Description**
Digital SADC 2027 (2012)	ICT pillar of the 2012 SADC Regional Infrastructure Development Master Plan. Objectives include universal, harmonised broadband frequencies, fibre backbone infrastructure, spectrum allocation, harmonised ICT regulatory framework, centres of excellence
Analogue to Digital Migration (2009–)	Technical support to member states in meeting analogue-to-digital migration
HIPSSA Model Laws (2008–2013)	HIPSSA assisted in developing SADC model laws, including data protection, e-transactions, cybercrime, universal service/access
Roam Like at Home (2007–)	Driven by the Communications Regulatory Authority of Southern Africa (CRASA) to reduce roaming costs in the region
Declaration on Information and Communication Technologies (2001)	SADC ICT policy, highlighting infrastructure and regulation

Source: see column 1

However, such initiatives have also faced difficulties in implementation. For example, only seven member states have made the analogue–to–digital television migration, owing to funding and network constraints; initiatives to decrease roaming costs have faced resistance from mobile operators that have taken advantage of loopholes in regulations; and model laws that have been domesticated remain unenforced at national level.[33]

In recent years the SADC Secretariat has looked to integrate these past initiatives into strategies within the broader discourse of the 4IR. In 2017 SADC ICT ministers released the 'SADC Declaration on the 4th Industrial Revolution'.[34] The declaration focuses on creating an enabling environment for ICT development as being key to socio-economic development and an important enabler for the adoption of 4IR technologies. The document advocates that preparing SADC for the 4IR should encompass infrastructure and connectivity, affordability, skills and awareness, entrepreneurial development and local content.

The declaration further calls for the thorough implementation of SADC Digital 2027 and advocates for the establishment of a regional think tank on the 4IR. As a result of the declaration, a SADC 4IR task team has been set up and is tasked with selecting 10 priority ICT projects in the region.[35] Further to this, the SADC Ministers for Education

33 SADC, 'SADC Roaming Policy, 26 June 2015 Walvis Bay, Namibia', https://www.itu.int/en/ITU-D/Regulatory-Market/Documents/Roaming/SADC%20POLICY%20ON%20%20ROAMING%20APPROVED.pdf, accessed 3 May 2019; Mzekandaba S, 'SADC lags in digital TV implementation', *IT Web*, 26 September 2017, https://www.itweb.co.za/content/XGxwQDM1dxe7lPVo, accessed 20 March 2019.

34 SADC ICT Ministers, 'SADC Declaration on the 4th Industrial Revolution', Zimbali, 7 September 2017.

35 SADC, News, 'SADC senior officials responsible for communication and ICTs met for an extra-ordinary meeting,' 18 March 2018, https://www.sadc.int/news-events/news/sadc-senior-officials-responsible-communication-and-icts-met-extra-ordinary-meeting/, accessed 20 March 2019.

and Training, and Science and Technology convened in June 2018 for a policy dialogue on SADC's position on the 4IR.[36] The dialogue resulted in several recommendations, among them a regional assessment of digitisation in terms of strengths, weaknesses, challenges, opportunities and potential partnerships. It also focused on strategies relating to digitalisation, including a regional roadmap, the development of legal frameworks, skills development and education, sharing of best practices, and strategies to further involve the private sector.

In July 2018 the SADC ICT Subcommittee also presented a wide-ranging number of recommendations relating to the 4IR.[37] The meeting recommended implementing the SADC Interconnection Policy Framework and Reference Interconnection Offer, focused on seven priority ICT projects, and submitting a revised list of SADC Broadband Targets for 2025. It recommended the development of draft SADC rural broadband guidelines and recommendations, a draft SADC cyber security action plan, a SADC strategic position paper on big data and a draft SADC resolution on the 4IR.

SADC is clearly not lacking in scope in terms of policy frameworks for ICT and the 4IR. However, as is often the case with regional organisations with limited enforcement powers, implementation progress has been slow, with new policies developed on top of past unimplemented ones.

Deep dive into the landscape of select SADC countries

The following section will build on the above frameworks through national-level analyses, examining the 4IR policy readiness of three SADC countries: South Africa, Lesotho and Malawi. The case studies are organised under three headings:

- **Supply-side** ICT development and regulation – examines progress on infrastructure supply, and the development of policy frameworks regulating ICT, broadband, data and cybersecurity. In particular, it examines successes in providing equitable Internet access.
- **Demand-side** education, capacity and skills – examines the capability to use the supply-side policy frameworks and infrastructure indicated above to drive innovation and technological development. This encompasses STEM and digital education policy and skills, capacity to implement legislation and innovation ecosystems.
- Emerging developments – examines a 4IR-related development unique to each country, including challenges and/or successes with regard to its implementation.

36 SADC, News, 'SADC ministers responsible for education and training and science technology and innovation ministerial policy dialogue', 22 June 2018, https://www.sadc.int/news-events/news/sadc-ministers-responsible-education-and-training-and-science-technology-and-innovation-ministerial-policy-dialogue/, accessed 20 March 2019.

37 SADC, Media Release, *op. cit.*

Following the case studies, this section summarises the key findings, allowing for comparative analysis and demonstrating the variation among SADC countries with regard to their digitalisation needs. It ends with a brief snapshot of two global best practice cases of 4IR national strategies – South Korea and Rwanda – that can be compared with the case study countries.

South Africa

Supply side: ICT development and regulation

South Africa's National Development Plan (NDP) 2030 aims to achieve widespread ICT coverage to underpin an information society and knowledge economy. Specifically, this entails extensive high-speed broadband available at competitive prices.[38] South Africa has built a solid base of ICT infrastructure and is one of the leaders within SADC and on the continent. According to Siemens's 2017 African Digitalisation Maturity Report, 100% of the population has mobile coverage and 93% 3G coverage, with mobile operators reporting 80% 4G coverage.[39]

The ICT sector is regulated by the Independent Communications Authority of South Africa (ICASA), established in 1993, and is governed by the Electronic Communications Act (ECA) of 2005. South Africa's current broadband policy, SA Connect, was promulgated in 2013, and in its first phase is prioritising connection of schools, health facilities and government offices.[40] Fixed-line copper cable service provision was initially provided by one government-owned operator, Telkom, until the Telecommunications Act of 1996 and the 2001 amendments allowed for competition in the sector. Liberalisation has been slow, and the sector has struggled to create an enabling environment for new entrants in fixed-line provision. However, the advent of fibre has now ensured stiff competition through a range of companies providing backhaul infrastructure. Mobile broadband has surpassed fixed broadband in growth, and mobile operations in South Africa consist of four major players – Vodacom, MTN, Cell C and Telkom – with a wide range of mobile ISPs as well. However, there is minimal price competition in the mobile market. The size of Vodacom and MTN (owning over 80% market share) makes it difficult for new players and even existing midsize players to invest to improve their service area/quality or purchase new spectrum. Research ICT Africa (RIA) emphasises the need for greater price regulation to create opportunities for smaller players.[41]

38 South Africa, 'National Development Plan 2030', https://www.gov.za/issues/national-development-plan-2030, accessed 20 April 2019.

39 Siemens, 'African Digitalisation Maturity Report', Munich: Siemens, 2017; Gillwald A, Mothobi O & B Rademan, 'The state of ICT in South Africa', RIA Policy Paper, 5, July 2018, https://researchictafrica.net/wp/wp-content/uploads/2018/10/after-access-south-africa-state-of-ict-2017-south-africa-report_04.pdf, accessed 29 September 2019.

40 South Africa, Department of Communications, 'South Africa Connect: Creating Opportunities, Ensuring Inclusion – South Africa's Broadband Policy', 20 November 2013, https://www.dtps.gov.za/index.php?option=com_phocadownload&view=category&download=90:broadband-policy-gg37119&id=21:broadband&Itemid=333, accessed 20 April 2019.

41 Gillwald A, Mothobi O & B Rademan, *op. cit.*

An absence of underlying policy continuity has also impeded the implementation of ICT policies and contributed to the country's high data costs and unequal Internet access. The Department of Telecommunications and Postal Services (DTPS) and ICASA continually reshuffle leadership positions, with some appointments politically motivated, and have engaged in multiple departmental restructurings in the past decade. The sectoral policy review, which began in 2012, only resulted in the National Integrated ICT Policy White Paper in 2016 and has yet to be implemented. An amendment to update the ECA in 2017 also stalled owing to regulator and private operator disagreements about the proposed national Wireless Open Access Network.[42] The Universal Service and Access Agency of South Africa, which should be at the centre of targeting unequal access challenges, has been plagued by political controversy and corruption, such as levy funds collected that subsequently went missing.[43]

South Africa also needs additional licensed spectrum. The switch from analogue to digital TV, which will free more spectrum, was pushed back from the first national deadline of 2011 to the ITU deadline of 2015, and now to 2020.[44] The abovementioned political turmoil and resistance from operators have delayed the process. The re-splitting of the DTPS between communications and telecommunications in the white paper could cause additional complications, as both departments are involved in this process. The release of new high frequency 4G spectrum allocated to government (which was initially set for 2016) is also yet to be completed, also owing to political disputes and court challenges.[45] In both the 2019 state of the nation and budget speeches, high-demand frequencies were prioritised as a matter of urgency for release in 2019. Adherence to this deadline would be promising. The findings of a 2019 market inquiry into the cost of data in South Africa by the Competition Commission are also encouraging, having found that the four main operators set prices too high for low-income customers. It has made recommendations to operators with regard to fair price setting, expansion of infrastructure to poorer areas, competitive spectrum assignment and free public Wi-Fi, and legal action may be considered if changes are not made.[46] On a positive note, ICASA, in collaboration with the Council for Science and Industrial Research (CSIR), has already published the technical regulations for TV white space (TVWS) network enablement in South Africa. TV white space reallocates unused

42 *Ibid*.

43 Mcleod D, 'Usaasa crisis far from over', *Tech Central*, 13 September 2018, https://techcentral.co.za/usaasa-crisis-far-from-over/83739/, accessed 20 April 2019.

44 Omarjee L, 'Switching off analogue TV signal outright risks "destroying" SABC – communications minister', *Fin24*, 15 March 2019, https://www.fin24.com/Companies/ICT/switching-of-analogue-signal-all-at-once-will-destroy-sentech-sabc-communications-minister-20190315, accessed 20 April 2019; Gillwald A, Mothobi O & B Rademan, *op. cit.*; Omarjee L, 'Digital migration: What does it all mean?', *Fin24*, 22 October 2018, https://www.fin24.com/Companies/ICT/digital-migration-what-does-it-all-mean-20181022-2, accessed 20 April 2019; Omarjee L, 'Deadline for digital migration still to be set – minister', *Fin24*, 4 December 2018, https://www.fin24.com/Companies/ICT/deadline-for-digital-migration-still-to-be-set-minister-20181204, accessed 20 April 2019.

45 *Ornico*, 'South Africa's maturing telecommunications industry and its consumer interaction', 19 July 2018, http://website.ornico.co.za/2018/07/south-africa-telecommunications-industry/, accessed 15 June 2019.

46 *BusinessTech*, 'Competition Commission says data is too expensive in South Africa – here's what you need to know', 24 April 2019, https://businesstech.co.za/news/telecommunications/313106/competition-commission-says-data-is-too-expensive-in-south-africa-heres-what-you-need-to-know/, accessed 5 May 2019; *iAfrica*, 'Can MTN, Vodacom face legal action over Competition Commission findings?', 27 April 2019, https://www.iafrica.com/can-mtn-vodacom-face-legal-action-over-competition-commission-findings/, accessed 5 May 2019.

broadcasting frequencies in the wireless spectrum to 4G use. This targets the high prices resulting from limited available spectrum.

In summary, although South Africa's telecommunications infrastructure is comparatively advanced, policy inconsistency has delayed progress. Private operators have also shown resistance to supporting or proposing new methods that close the digital divide.[47] In contrast, dynamic research partnerships in South Africa on advanced wireless technologies such as 5G are moving forward rapidly.[48] Political delays and disputes do not reflect the dynamic and cooperative 'systems thinking' governance needed to move ahead in digital development.

Although South Africa's telecommunications infrastructure is comparatively advanced, policy inconsistency has delayed progress. Private operators have also shown resistance to supporting or proposing new methods that close the digital divide

A recent study initiated by the WEF found that the South African business sector loses approximately ZAR[49] 5.8 billion[50] ($396.1 million) a year due to cybercrimes. In 2018 alone, South Africa experienced five major national data breeches that affected its citizens.[51] Cybersecurity capacity development interventions thus far have largely been preparatory, such as developing a cybersecurity national skills framework and cyber-crimes awareness portal.[52] While the Cybercrimes and Cybersecurity Bill was released in 2015, there has not been a clean delineation of power between different government departments in overseeing cybercrime issues, resulting in conflicting interests: the 'Cybercrimes' section is managed by the Department of Justice and the 'Cybersecurity' section by the State Security Agency.[53]

47 Skype interview, independent telecommunications policy analyst a, Glasgow, 12 April 2019; Skype interview, Independent telecommunications policy analyst b, Windhoek, 25 April 2019; South African public research entity representative, *op. cit.*

48 See more on 5G developments in South Africa at Ericsson & CSIR, 'Making 5G a Reality for Africa', https://www.ericsson.com/assets/local/press-releases/africa/2018/5g-africa-report-11-2018.pdf, accessed 15 June 2019; Moyo A, 'CSIR develops test bed to prepare Africa for 5G', *IT Web*, 7 June 2018, https://www.itweb.co.za/content/KzQenMj8A91vZd2r, accessed 7 July 2019.

49 Currency code for the South African rand.

50 Ikdal A, '6 challenges to financial inclusion in South Africa', WEF, 27 April 2017, https://www.weforum.org/agenda/2017/04/financial-inclusion-sou, accessed 2 May 2019.

51 Niselow T, 'Five massive data breaches affecting South Africans', *Fin24*, 18 June 2018, https://www.fin24.com/Companies/ICT/five-massive-data-breaches-affecting-south-africans-20180619-2, accessed 3 May 2019.

52 Polity.org, 'Stella Ndabeni-Abrahams: Address by Deputy Minister of Telecommunications and Postal Services, during the Telecommunications and Postal Services Dept Budget Vote 2018/19, Parliament, Cape Town', 17 May 2019, http://www.polity.org.za/print-version/sa-stella-ndabeni-abrahams-address-by-deputy-minister-of-telecommunications-and-postal-services-during-the-telecommunications-and-postal-services-dept-budget-vote-201819-parliament-cape-town-17052018-2018-05-18, accessed 2 May 2019.

53 Hunter M & A Tilley, 'Cybercrimes Bill defanged, but our privacy rights are still not secured', *Daily Maverick*, 21 December 2018, https://www.dailymaverick.co.za/article/2018-12-21-cybercrimes-bill-defanged-but-our-privacy-rights-are-still-not-secured/, accessed 2 May 2019.

The bill focuses on defining cyber-related crimes to enable government to act against such crimes and to enhance the state's surveillance capabilities to tackle new-generation challenges such as 'fake news' by creating mechanisms to control individuals' activities on social media platforms. When the bill was made available publicly for comment, critics argued that the cybersecurity element intruded on the online freedom of expression of South African citizens. As a result, the cybersecurity section was removed, and it is now called the Cybercrimes Bill.

South Africa's data protection legislation is the Protection of Personal Information (POPI) Act of 2013, with which the Cybercrimes Bill must be compliant.[54] The core purpose of the POPI Act is to provide a legal framework for data subjects to take action against data breaches. The act has been adjusted in part to closely resemble the EU General Data Protection Regulation (GDPR), which became fully enforceable on 25 May 2018. This is important, given that the GDPR applies not only in the EU but to any EU-based companies doing business globally, and signals that South Africa will be generally aligned to global best practice. Although the POPI Act was signed into law in 2014, certain aspects are still not in force.[55] The primary bottleneck is the establishment of a fully functional information regulator.

South Africa has recently seen data centre investments by large multinationals, including Huawei, Microsoft and Amazon, in addition to a much smaller local data centre ecosystem.[56] Establishing local cloud bases allows lower costs and higher speeds of data transfer; an important development for the Southern African countries where local development may not be economically feasible.[57] This developing industry reinforces the need for duly enforced data protection legislation to ensure that cloud services can be used by companies across borders.

Demand side: Education, capacity and skills

Following from the SADC indices cited earlier, there is a gap between South Africa's relatively strong innovation ecosystem and its low ICT skills use and development as a middle-income country. South Africa's national goal is to increase R&D expenditure from 0.8% (as of the most recent 2015–2016 survey) to 2%, with public sector R&D investment currently much stronger than that by the private sector.[58] South Africa has a growing innovation hub ecosystem, boasting private, public and academia-sponsored hubs, with a concentration of tech hubs in Cape Town.

54 Michalsons, 'Alert: Cybercrimes Bill 2018 Update', https://www.michalsons.com/blog/cybercrimes-bill-2018-alert/36243, accessed 3 May 2019.

55 Fynn M, 'Data breaches: What is required?,' *Go Legal*, 1 August 2018, https://www.golegal.co.za/data-breaches-privacy-laws/, accessed 3 May 2019.

56 *Eyewitness News*, 'Huawei to build data centres in South Africa', 14 February 2019, https://ewn.co.za/2019/02/14/huawei-to-build-data-centres-in-south-africa, accessed 7 May 2019.

57 Skype interview, ICT research institution, Cape Town, 6 May 2019.

58 Mzekandaba S, 'SA's R&D spend on a steady rise', *IT Web*, 1 November 2018, https://www.itweb.co.za/content/O2rQGMApzGQ7d1ea, accessed 25 March 2019.

Despite the high 3G and 4G coverage rates, only 53% of the population accesses the Internet.[59] Inequality plagues South Africa, and this is reflected in current access to ICT – as overall access increases, the disparities in access based on income, education and geographical location also continue to grow. South Africa's data costs are high compared to the SADC region and other middle-income countries, owing to the aforementioned uncompetitive pricing and regulatory disarray and inaction. According to research by BDRC Continental, South Africa's mobile data ranks 94th in competitiveness of 197 countries surveyed, and RIA's data cost survey ranks the price of 1GB prepaid data 36th of 49 African countries. According to RIA, 47% of South Africans list the cost of data as the primary constraint to Internet usage (with the cost of devices in second place at 36%).[60] It follows that the large percentage of the population excluded from access is also not developing the digital skills necessary to participate effectively in the changing global economy. These dynamics (costs and skills) act as a major barrier to data-intensive technology investments and innovations.

Numerous supportive initiatives and investments have been proposed to support innovation and digital skills in recent years, with important examples summarised in Figure 9.[61] However, piecemeal approaches across departments have yet to coalesce into a coordinated national plan. In March 2019 the Department of Science and Technology (DST) promulgated an updated White Paper on Science, Technology and Innovation (STI) to replace the previous outdated version from 1996. The white paper seeks to establish an 'innovation culture' through better interdepartmental coordination, especially with regard to human capital development. The DTPS also established the iKamva National e-Skills Institute,[62] which targets the basic ICT deficit and coordinates existing initiatives. Doubling down on implementation of the initiatives in Figure 9, including greater coordination with not only the DTPS and Department of Higher Education and Training (DHET) but also the DST (which will now be merged with the DHET) and local educational and research institutions, and ensuring that initiatives expand beyond urban centres, are important factors in realising results.

59 Dicey N, 'SA's maturing telecommunications industry and its consumer interaction', *Financial Mail*, 18 July 2018, https://www.businesslive.co.za/redzone/news-insights/2018-07-18-sas-maturing-telecommunications-industry-and-its-consumer-interaction/, accessed 20 April 2019; Gillwald A, Mothobi O & B Rademan, *op. cit.*

60 Gillwald A, Mothobi O & B Rademan, *op. cit.*; Dicey N, *op. cit.*

61 Campbell R, 'A "sovereign innovation fund" proposed in draft technology policy', *Engineering News*, 21 September 2018, http://www.engineeringnews.co.za/article/a-sovereign-innovation-fund-is-to-be-set-up-by-south-africa-2018-09-21, accessed 25 March 2019; *City Press*, 'New white paper on science and technology aims to change lives', 11 November 2018, https://city-press.news24.com/News/new-white-paper-on-science-and-technology-aims-to-change-lives-20181109, accessed 25 March 2019; PMG (Parliamentary Monitoring Group), 'Department of Science and Technology 2018/19 Annual Performance Plan; with Minister', 17 April 2018, https://pmg.org.za/committee-meeting/26118/, accessed 25 March 2019.

62 iNeSI (iKamva National E-skills institute), http://inesi.org.za/, accessed 25 April 2019.

TABLE 2 INNOVATION AND TECHNOLOGY POLICIES IN SOUTH AFRICA			
Initiative	**Description**	**Departments**	**Status**
R&D tax incentive (since 2006)	150% tax incentive for investment in R&D	DST	Active
iKamva National e-Skills Institute Bill (2018)	Offers digital and multimedia skills, merges the National Electronic Media Institute of South Africa, the e-Skills Institute and the Institute for Space and Software Applications	DTPS	Institute established
Sovereign Innovation Fund (2018)	Seeds public investment to mobilise additional private equity, targeted at high-tech entrepreneurial investments Supports 2% R&D goal	DST Potential funding from Technology Innovation Agency, Industrial Development Corporation, Development Bank of Southern Africa	First endorsed in 2015 Intention to establish fund set out in 2018 DST white paper
Budget Coordination Initiative (2015)	Pools R&D allocations across multiple departments to decrease fragmentation in spending	Department of Trade and Industry (dti)	As of 2018, reports on engagement with National Treasury on achieving this objective
Commercialisation Framework (2015/2016)	Supports locally developed technologies with commercial potential	DST	Active
Technology Localisation Programme	Provides technology assistance and grants to firms or sectors to improve competitiveness to secure public procurement contracts, through Technology Assistance Programme (TAPs)	DST (implemented by CSIR)	Active

Source: see column 1

Emerging developments: A Fourth Industrial Revolution strategy

In 2019 the South African presidency established the 4IR Commission.[63] According to its terms of reference (TORs), the commission seeks to formulate policies and strategies to ensure that South Africa can effectively take advantage of the 4IR by bringing together a range of relevant stakeholders, including 'public sector, business, academia and research institutions, experts, labour, Small Medium & Micro-sized Enterprises (SMMEs), youth, women and non-governmental organisations'[64]. The commission will advise on a research

63 South Africa, Department of Telecommunications and Postal Services, 'Invitation to Nominate Candidates for the Presidential Commission on Fourth Industrial Revolution', Notice 764 of 2018. Pretoria: Government Gazette, 4 December 2018.

64 *Ibid.*,

agenda and specific interventions to maintain competitiveness in industries that are exposed to technological advancements, such as manufacturing, finance, agriculture, mining and ICT. It will also explore enabling 4IR infrastructure and an institutional framework to coordinate 4IR interventions. Lastly, it will address issues of inclusivity around new technologies, including skills development and opportunities for SMMEs.[65] The focus on multi-stakeholder collaboration, supportive institutional frameworks and skills development is well aligned with priority needs for the region.

The recently released list of commission members shows a wide spread of expertise between the public, private and academic sectors, although of the 30 members only four are under the age of 35.[66] The commission should urgently release more detailed plans of coordination mechanisms with the dti, DST, DTPS and National Treasury. This will ensure confidence that the strategy will move beyond a gathering of intellectuals to a forum that integrates and enhances existing departmental programmes. Strategies to link education and training to specific skills required by industry should also be central to the commission's initial action plan.[67] Forums and workshops engaging cross-disciplinary stakeholders on the policy implications of the 4IR in South Africa have already begun, most notably the University of Johannesburg with its 4IR dialogue series and new academic curricula.[68] The 4IR Commission can leverage these resources.

Lesotho

Supply side: ICT development and regulation

Lesotho's national Vision 2020 statement directly highlights the role of ICT in development:[69]

> By the year 2020 Lesotho shall be a stable democracy, a united and prosperous nation at peace with itself and its neighbours. It shall have a healthy and well-developed human resource base. Its economy will be strong; its environment well managed and its technology well established.

The vision highlights the importance of overcoming the digital gap between Lesotho and developed countries, as well as of producing and diffusing appropriate technology. The resulting National Strategic Development Plan 2012/13–2016/17 (NSDP) recognises ICT in terms of its role in production processes and in giving the people of Lesotho access to information, as well as a cross-cutting enabler across many sub-sector strategies. The

65 *Ibid.*,

66 *IT Web*, 'Industry heavyweights appointed to 4IR commission', 9 April 2019, https://www.itweb.co.za/content/RgeVDqPoe8dMKJN3, accessed 5 May 2019.

67 Personal interview, South African government official, Pretoria, 24 April 2019.

68 UJ (University of Johannesburg), 'UJ Fourth Industrial Revolution', https://www.uj.ac.za/fourth-industrial-revolution, accessed 2 May 2019.

69 Lesotho, 'Lesotho's Vision 2020', 2005, https://www.gov.ls/wp-content/uploads/2018/04/National_Vision_Document_Final.pdf, accessed 11 April 2019.

objectives in these plans are wide-ranging, and include technologies to improve fixed line connections, ICT roll-out plans for schools and cybersecurity. At a national strategic level, the importance of ICT infrastructure and skills is clearly articulated.

The Lesotho Telecommunications Policy (1999) and Lesotho Telecommunications Act (2000) underlined the process of liberalisation of the telecommunications sector and establishment of the Lesotho Communication Authority (LCA), which serves as the sector's independent regulator. These were followed by the ICT Policy of 2005 and Communications Policy of 2008, which aim to address remaining challenges such as competition, low Internet penetration and lack of infrastructure in rural areas.[70] The Telecommunications Act of 2012 currently governs the sector. The country also adopted the Lesotho National Broadband Policy in 2014, with a goal of 100% broadband penetration in urban areas and 75% in rural areas within the next five years, and released a Spectrum Management Policy (2014) to effectively allocate spectrum. The process of migration from analogue to digital has yet to be completed, and is in part affected by South Africa's slow migration (owing to its physical location within South Africa). However, congested spectrum is not as much of a constraint to ICT provision in Lesotho as in other countries in the region.

Lesotho has been particularly successful in the administration of its Universal Service Fund (USF). This is notable given the significance of the digital divide within countries, and given that many universal service funds in the region have not been successful. The USF (formerly Universal Access Fund) was established in 2009, with LSL 10 million[71] ($ 1.33 million) seed funding, revenues derived from the LCA and 1% net operating income of network operators. According to RIA,[72] the USF has fully spent its annual allocations while sustaining relatively low operating costs through projects such as ensuring base station deployment, providing school Internet connections, and coordinating with the Ministry of Education and Training to provide ICT education and skills development. It will now be shifting its focus to broadband provision.

Currently there is no legal framework for cybersecurity in Lesotho despite international assistance on drafting cybersecurity legislation dating back to 2013.[73] In 2019 the National University of Lesotho established a centre for cybersecurity research, which is the first national institution offering cybersecurity capacity building.[74] In 2011 the country adopted the Data Protection Act, which provides a framework for strong data regulation. However, like South Africa, the act has yet to establish an independent regulator.[75]

70 Gillwald A, Deen-Swarray M & O Mothobi, 'The State of ICT in Lesotho', Lesotho Communications Authority & RIA, 2016, https://researchictafrica.net/2018/01/12/state-of-ict-in-lesotho/, accessed 29 September 2019.

71 LSL is the currency code for Lesotho Loti

72 *Ibid*.

73 World Bank, *Unlocking the Potential of Lesotho's Private Sector*. Washington DC: World Bank, 2018.

74 IST-Africa, 'National ICT research capacity and priorities for cooperation: Kingdom of Lesotho', http://www.ist-africa.org/home/default.asp?page=doc-by-id&docid=5189, accessed 29 April 2019.

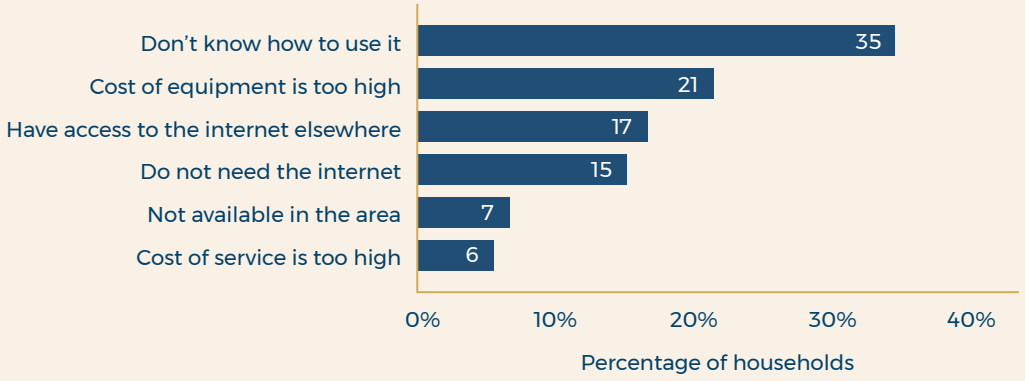
75 'Data Protection Act, 2011, Government Gazette, Act no. 5 of 2012, http://www.nic.ls/lsnic/community/policies/Data_Protection_Act_2011_Lesotho.pdf

Mobile coverage in Lesotho is extensive; 90% of the country is covered by 3G. Coverage is missing particularly in mountainous rural areas, where the topography and resulting lack of electricity and transportation infrastructure increase set-up costs.[76] Despite high coverage, the absence of competition in mobile services contributes to higher prices and limits access. Currently there are two primary operators: Vodacom Lesotho (with 76% of the market share) dominates the mobile market and Econet Liquid (ETL) dominates the fixed market.[77] These companies' investment in backhaul infrastructure has allowed the high rates of 3G coverage. However, their structure as subsidiaries of larger continental service providers makes it difficult for smaller players to compete. Despite the duopoly, data costs are still lower than the SADC regional average. Compared to mobile, fixed-line Internet provision in Lesotho is extremely limited, with only 2.5% of the connected population using fibre or ADSL connections. Competition among ISPs is especially low compared to the rest of the region, with ISPs noting high prices from mobile operators for the leasing of services.

Demand side: Education, capacity and skills

A 2017 LCA and ITU study found that mobile phone penetration had reached 78.65%, with Lesotho ranking comparatively well at fifth in the SADC region. However, the demand for voice calls significantly outweighs demand for broadband services, and national Internet penetration sits at only 30%. In 2017 only 17% of rural dwellers, 38% of peri-urban dwellers and 50% of urban dwellers accessed the Internet. According to the 2016 Population and Housing Census, 57% did not know what the Internet is, and 49% did not own a device with potential Internet access.[78] Based on data collection from RIA, Figure 10 paints a similar picture: 35% of Lesotho households without Internet access are not trained to access the Internet and 15% do not think they need the Internet.

Figure 8 Constraints to Internet use for households without Internet



Source: Gillwald A, Deen-Swarray M & O Mothobi, 'The State of ICT in Lesotho', Lesotho Communications Authority & RIA, 2016, https://researchictafrica.net/2018/01/12/state-of-ict-in-lesotho/, accessed 29 September 2019

76 Email interview, Lesotho private sector ICT representative, Maseru, 7 May 2019.

77 Gillwald A & O Mothobi, 'Low Internet Penetration Despite 90% 3G Coverage in Lesotho', Africa Portal, August 2017, https://www.africaportal.org/publications/low-internet-penetration-despite-90-3g-coverage-lesotho/, accessed 29 April 2019.

78 Gillwald A & O Mothobi, *op. cit.*

The above statistics, which indicate high Internet coverage, reasonable data prices and high mobile phone usage, suggest that additional demand-side constraints contribute to low Internet usage. Research points to an absence of digital awareness creation and skills development, and inadequate opportunities for digital entrepreneurship (especially in rural areas), which should be driving Internet demand.[79] The country's National Policy on Science and Technology (2006–2011) stipulated that R&D spending should increase to 1% of GDP and established an Innovation Fund in 2018 to support such activities. However, in 2015 R&D expenditure still sat at 0.05% of GDP. The UN Educational, Scientific and Cultural Organization's (UNESCO) 2030 Science Report characterised Lesotho's national innovation system as fragile.[80] This skills gap also extends to general STEM education despite Lesotho's enjoying a comparative human capital advantage and one of the highest literacy rates in sub-Saharan Africa. This skills gap is partially explained by the 'brain drain' of skills out of the country owing to a lack of domestic economic activity and its geographic position, surrounded by a more developed South Africa.[81]

Statistics, which indicate high Internet coverage, reasonable data prices and high mobile phone usage, suggest that additional demand-side constraints contribute to low Internet usage

Nevertheless, recent positive developments include the establishment of Lesotho's first innovation hub in 2018, located at the National University of Lesotho.[82] The hub incorporates the Lesotho Innovation Fund, which is tasked with making funding available to local talent. This aligns with recommendations from the RIA report that Lesotho must focus on local content creation to stimulate digital literacy.[83] This paper also recommends that Lesotho release an updated STI framework that integrates digital literacy development along with traditional STEM and R&D skills development. Future supply-side ICT policy interventions should include skills and sensitisation components, as these have been shown to be the most binding constraint to ICT development.

79 World Bank, 2018, *op. cit.*; Lesotho private sector ICT representative, *op. cit.*

80 UNESCO (UN Educational, Scientific and Cultural Organization), 'UNESCO Science Report', 2015, https://en.unesco.org/unesco_science_report, accessed 17 July 2019.

81 UNCTAD (UN Conference on Trade and Development), *Science, Technology and Innovation Policy Review: Lesotho – An Implementation Strategy*, 2009, https://unctad.org/en/Docs/dtlstict20097_en.pdf, accessed 29 April 2019.

82 National University of Lesotho, 'National University of Lesotho launches innovation hub', 7 November 2018, http://www.nul.ls/national-university-of-lesotho-launches-innovation-hub/, accessed 29 April 2019.

83 Gillwald A, Deen-Swarray M & O Mothobi, *op. cit.*

Emerging developments: 5G

Vodacom Lesotho released a 3.5GHz spectrum in 2018, which is not yet available commercially in other African countries.[84] This was enabled through the regulator's provision of spectrum to Vodacom.[85] The network delivers a speed of up to 700 megabits per second. 5G networks can potentially enable applications such as smart factories, augmented reality and autonomous vehicles in the future. The two institutions currently using 5G are the Central Bank of Lesotho and the Letseng Diamonds mining company.[86]

However, the trials and commercial use in Lesotho are not compliant with the three sets of standard 5G use cases, namely

- enhanced mobile broadband (high data speeds across a wide coverage area);
- ultra reliable low latency communications (latency and reliability required for applications such as autonomous vehicles and remote surgery); and
- massive machine-type communications (ability to support a large number of connected devices in a small area, for applications such as the IoT). [87]

Lesotho's 5G trials have not employed the latter two uses, and with regard to the first, the speeds are well below the 1 gigabit per second benchmark, and are fixed rather than mobile.[88] Lesotho is reportedly exploring expanding 5G coverage to accommodate increased private sector interest in the frequency and using 5G's low latency for medical applications.[89] Creating an enabling environment and supporting more advanced uses, rather than merely expanding the current commercial usage, will determine whether this will move beyond an isolated trial to harness future competitive advantage and investment opportunities.

Malawi

Supply side: ICT development and regulation

In Malawi, much less national focus has been placed on the broader applications and impacts of digitalisation. This is in part because Malawi still faces significant challenges in basic connectivity. In comparison, 3G covers 42% of the population, and 4G only 15.8%.[90] Basic infrastructure such as national backbone infrastructure remains a much larger

84 *News24*, 'Lesotho emerges as unlikely testbed for 5G revolution', 9 August 2018, https://www.news24.com/Africa/News/lesotho-emerges-as-unlikely-testbed-for-5g-revolution-20180907-2, accessed 9 April 2018.
85 Lesotho private sector ICT representative, *op. cit.*
86 *News24*, 9 August 2018, *op. cit.*
87 Kavanagh S, 'What is enhanced Mobile Broadband (eMBB)', 5G.co.uk, https://5g.co.uk/guides/what-is-enhanced-mobile-broadband-embb/, accessed 5 June 2019.
88 South African public research entity representative, *op. cit.*
89 Lesotho private sector ICT representative, *op. cit.*
90 ITU (International Telecommunication Union), 'Measuring the Information Society Report: Malawi', https://www.itu.int/en/ITU-D/LDCs/Documents/2017/Country%20Profiles/Country%20Profile_Malawi.pdf, accessed 3 May 2019.

constraint in Malawi than in many other SADC countries. These conditions create a difficult environment for innovations reliant on Internet connections. However, recent years have seen investments in national fibre backbone by the government of Malawi as well as an investment by Harith, a South African infrastructure-financing company, in Malawi's largest national fibre provider.[91]

While Malawi's Vision 2020 underscores science and technology-led development, the subsection on use of IT does not link IT to an overarching vision for growth or highlight it as a development necessity. The most recent strategy under Vision 2020, the Malawi Growth and Development Strategy (MGDS), improves upon this slightly through a section dedicated to transport and ICT, which highlights the need to improve coverage, affordability and use of ICT. However, the proposed outcomes and strategies do not set any specific targets or objectives, in contrast to South Africa and Lesotho's national plans.

On paper, Malawi's ICT-specific legislative frameworks are in line with international standards. The telecommunications regulator, Malawi Communications Regulatory Authority (MACRA), was established in 1998 and is governed by the updated Communications Act (2016). At the core of the Communications Act is universal service and universal access. These are pressing challenges for Malawi, as ICT infrastructure in rural areas is seriously underdeveloped. The Communications Act calls for implementation of a USF, which has been on the table since the sector was liberalised in the late 1990s.[92] The telecommunications sector is guided by multiple iterations of Malawi's national ICT policy (2003, 2006, 2009 and 2013). These policies note that Malawi has made progress in establishing an independent regulator in the migration from analogue to digital (with the official switchover completed in 2016) and in the introduction of fibre-optic cables to improve speed.[93]

The country has two mobile operators, Airtel and Telekom mobile. They essentially serve as a duopoly through little price differentiation, contributing to high data costs. Additional mobile operators have failed to break into the market, which indicates a need for further probing from MACRA. The country also has two fixed-line providers, MTL and Access Communications, with a range of ISP providers.[94] Like most countries in the region, fixed-line installation is limited.

Like South Africa, Malawi faces spectrum constraints for mobile operation, which also contribute to high data costs. Malawi was at the forefront globally of trials for TV white space

91 Tobor N, 'Malawi to enjoy faster Internet speeds as the Malawi National Optic Fibre Backbone Project nears completion', *iAfrikan*, 2 February 2018, https://www.iafrikan.com/2018/02/02/malawi-national-optic-fibre-backbone-project/, https://mwnation.com/firm-invests-k18bn-in-fibre-network-provider/, accessed 2 April 2019.

92 Malawi, 'Malawi Communications Act, No. 34 of 2016', http://www.macra.org.mw/wp-content/uploads/2014/07/Communications-Act-2016.pdf, accessed 15 April 2019.

93 Malawi, 'Malawi National ICT For Development (ICT4D) Policy', July 2006, http://unpan1.un.org/intradoc/groups/public/documents/unpan/unpan033688.pdf, accessed 15 April 2019.

94 Malakata M, 'Malawi initiates changes to national ICT policy framework', *IT Web Africa*, 23 June 2017, http://www.itwebafrica.com/more-countries/malawi/238058-malawi-initiates-changes-to-national-ict-policy-framework, accessed 15 April 2019; Skype interview, Malawi ICT academic, Lilongwe, 16 April 2019.

in 2013 (which have now expanded to many more countries on the continent), which were largely considered a success. In 2015 MACRA released draft regulations to allow for TV white space. In 2017 MACRA allowed the first commercial operator, C3, access to set up TV white space.[95] C3 noted the support of the government in making this development a success, indicating that the successful trails helped it to get funding support from Microsoft. It also received a duty waiver. This is a practical example of policy flexibility in the face of new innovations through close communications between government and the private sector to allow for trials before legislation. However, ongoing delays in finalising the regulations have meant that this innovative development cannot be implemented nationally, while other countries have now moved ahead with their own white space implementation. The company that trialled white space has now dissolved owing to internal issues, which has contributed to the fall-out from an initially successful partnership.[96]

In 2016 Malawi also introduced the Electronic Transactions and Cybersecurity Act (E-transactions Act). The act is lauded in terms of its focus on targeting cybercrime, but has also been met with criticism regarding certain provisions that could enable government suppression of free speech (as was the case in South Africa). Malawi is currently also developing a national cybersecurity strategy with assistance from the Commonwealth Telecommunications Organisation.[97] However, it does not have a data protection law. The 2016 E-transactions Act makes some provision for data privacy; however, given that the act covers a much more encompassing topic, data privacy issues are not fully fleshed out.[98] According to the ICT minister in 2018, a separate Data Protection Act will be introduced in Parliament. No follow-up action has been taken since.[99]

With the lowest GDP per capita in SADC, it is important to note that Malawi faces resource constraints in financing these policies and infrastructure, as it has to deal with many additional pressing development challenges. Development partner assistance therefore plays a major role in much of the country's policy formulation and implementation, including in digital spaces. All of Malawi's digital policies and legislation have been advocated for and supported by development partners.

One fair-sized programme funded by the World Bank is the Digital Malawi Program Phase I: Malawi Digital Foundations Project, with a $74.2 million seed credit allocation.[100]

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95 Balancing Act, 'C3 to launch a nationwide wireless data network using Mimosa, TV white spaces and Wi-Fi – targeting corporates, SMEs and NGOs', 28 April 2017, https://www.balancingact-africa.com/news/telecoms-en/40520/malawi-c3-to-launch-a-nationwide-wireless-data-network-using-mimosa-tv-white-spaces-and-wi-fi-targeting-corporates-smes-and-ngos, accessed 15 April 2019.

96 Mzekandaba S, 'ICASA makes headway with TV white space regulations', *IT Web*, 12 April 2018, https://www.itweb.co.za/content/rxP3jMBp6lXvA2ye, accessed 15 April 2019; Independent telecommunications policy analyst, *op. cit.*

97 Malawi, Ministry of Information and Communications Technology, 'Malawi develops national cyber security strategy', 17 April 2017, http://www.ict.gov.mw/index.php/news-media/news/item/23-malawi-develops-national-cyber-security-strategy/23-malawi-develops-national-cyber-security-strategy, accessed 15 April 2019.

98 Malawi, 'Malawi E-transactions Act No. 33 of 2016', http://www.macra.org.mw/wp-content/uploads/2014/07/E-Transactions-Act-2016.pdf, accessed 15 April 2019.

99 Kakande A, 'Data protection law on the cards', MBC, 26 March 2018, https://www.mbc.mw/index.php/news/sports/item/6016-data-protection-law-on-the-cards, accessed 15 April 2019; Malawi ICT academic, *op. cit.*

100 Meyers C, 'World Bank funds Malawi Digital Foundations Project', *The Borgen Project*, 25 August 2017, https://borgenproject.org/malawi-digital-foundations-project/, accessed 2 April 2019.

The programme seeks to improve access through four pillars, which encompass policy and legislation, digitalisation of public sector institutions, improved digital capacity and project management.[101] As of December 2018, the project has developed 18 regulations to support the Communications and E-transactions Acts, put in place a national broadband strategy, and recruited a project team for the Malawi Research and Education Network, among others.[102]

Demand side: Education, capacity and skills

Malawi's national Internet penetration sits at 13.8% of the population with mobile phone penetration at 40%.[103] Cell phone services comprise 56% of the average Malawian income with data costs at 40%.[104] However, limited baseline household data collection also limits the accuracy of these numbers. In addition to the infrastructure deficit, literature and interviews highlight a limited national recognition of the role that ICT inevitably must play in future growth and development. ICT is often viewed monolithically as computer processes such as word processing and Internet browsing, and data and the Internet remain a luxury for a privileged few rather than a right that must be provided to all and protected.[105] For example, there is limited general awareness of the implications of migration from analogue television to digital beyond the expansion of TV channels.[106] As a result, this process has not yet resulted in the licensing and utilisation of newly freed spectrum. Both public and private sector ICT capacity is underdeveloped as it stems from an under-focus on ICT skills in the education system, compounded by the brain drain. This results in a significant disconnect between the promulgation of legislative frameworks and effective implementation and enforcement of policies on the ground.

ICT is often viewed monolithically as computer processes such as word processing and Internet browsing, and data and the Internet remain a luxury for a privileged few rather than a right that must be provided to all and protected

101 World Bank, 'Digital Malawi Program Phase I: Malawi Digital Foundations Project', http://projects.worldbank.org/P160533?lang=en, accessed 5 April 2019.

102 World Bank, 'The World Bank Implementation Status & Results Report Digital Malawi Program Phase I: Malawi Digital Foundations Project (P160533)', 12 December 2018, http://documents.banquemondiale.org/curated/fr/273391543716028014/text/Disclosable-Version-of-the-ISR-Digital-Malawi-Program-Phase-I-Malawi-Digital-Foundations-Project-P160533-Sequence-No-03.txt, accessed 5 April 2019.

103 Kumwenda V, 'Is Malawi prepared for the Fourth Industrial Revolution?,' *Medium*, 28 November 2018, https://medium.com/@kristungati/is-malawi-prepared-for-the-fourth-industrial-revolution-e56d9b27eedd, accessed 2 April 2018.

104 Meyers C, *op. cit.*; A4AI (Alliance for Affordable Internet), 'TV white space technology set to transform access and affordability in Malawi', 14 June 2017, https://a4ai.org/tv-white-space-technology-set-to-transform-access-and-affordability-in-malawi/, accessed 2 April 2019.

105 Kainja J, 'Digital rights, Internet accessibility, and affordability in Malawi: Part 1', *MW Nation*, 14 January 2019, https://mwnation.com/digital-rights-internet-accessibility-and-affordability-in-malawi-part-1/, accessed 15 April 2019; Malawi, July 2006, *op. cit.*

106 MISA (Media Institute of Southern Africa), 'Malawi: Way forward In 2018', 3 May 2018, http://malawi.misa.org/2018/05/03/malawi-way-forward-2018/, accessed 15 April 2019.

According to interviews and literature, liberalisation of the ICT sector was arguably premature, resulting in politically determined appointees and a regulator that was only independent on paper. As a result, MACRA faces lingering challenges in terms of capacity and political will, with internal politics often blamed for delaying enforcement of legislation.[107] As of 2018, two years after implementation, MACRA was still conducting exploratory workshops on implementing the Communications and E-transactions Acts, and MACRA itself has acknowledged that loopholes in the Communications Act have stunted implementation.[108] Capacity to detect cybercrimes in Malawi and therefore implement cybercrime legislation is also underdeveloped. The Malawi University of Science and Technology has been offering a cryptography programme since 2017.[109] The E-transactions Act also provides for the establishment of a Computer Emergency Response Team in order to address reported cybercrime incidents in the country; however, the team has yet to be established.[110]

From a policy perspective, Malawi lacks supportive frameworks for ICT skills development, innovation, and science and technology. Its STI Policy was released in 2002 but never fully implemented.[111] The innovation landscape has changed drastically since this time in terms of the integrated role that ICT (and particularly data) plays in technological innovation. As in Lesotho, an updated STI policy (that appreciates and integrates digital skills development programmes, which have been called for in Malawi's ICT policies but not developed) is needed. Yet Malawi spends 1% of GDP on R&D, which is comparatively high for the region. The 2015 UNESCO science report characterises the country's innovation systems as viable.[112] A successful public–private–donor partnership, the Malawi Innovation Challenge Fund (with support from the UN Development Programme) has awarded grants for innovative, technology-driven business models from the private sector to improve Malawi's export competitiveness in agriculture and manufacturing. This has linked innovation to areas of importance in Malawi's economy by demonstrating how research and technology can improve agricultural productivity.

Overall, it is questionable whether donor-funded policies and regulations fully target the abovementioned awareness and sensitisation constraints in the public and private sectors. There is still a need to explore what such policies can and should mean specifically for Malawi, based on the country's unique context and challenges, in order to drive the

107 Malawi ICT academic, *op. cit.*; Chigona W & G Kunyenje, 'External actors in forming national ICT policy in Malawi: A cause for concern in low-income countries?', *The African Journal of Information Systems*, 11, 1, 2019, p. 2; Makoza F, 'Power Relations Among Stakeholders in the Implementation of National ICT Policy: Case of Malawi.' PhD diss., University of Cape Town, 2017.

108 Kainja J, 'The pitfalls of telecommunication regulation in Malawi', *MW Nation*, 2 February 2018, https://mwnation.com/pitfalls-telecommunication-regulation-malawi/, accessed 15 April 2019; Kumwenda S, 'Malopa says ICT platforms need strong legal frameworks', *Nyasa Times*, 19 March 2018, https://allafrica.com/stories/201803190289.html, accessed 15 April 2019.

109 Makanda K, Vallent TF & H Kim, 'Remarks on National cyber security for under developed and developing countries: Focused on Malawi,' *American Journal of Engineering Research (AJER)*, 6, 7, 2017.

110 Malawi ICT academic, *op. cit.*

111 CAAST-Net, Science, Technology and Innovation System Profile, 'Country: Malawi', https://caast-net-plus.org/page/55/attach/Attachment_2_STIprofileMalawiversion2.pdf, accessed 25 April 2019.

112 UNESCO, *op. cit.*

public buy-in necessary for effective implementation. Ultimately, these contextualisation objectives should play a more visible role in development partner strategies.[113]

Emerging developments: Drone testing

In 2017 Malawi entered the 4IR spotlight through a programme to establish a humanitarian drone-testing corridor. Emerging markets offer the advantage of an enabling environment and have gained traction as testing sites because they have fewer legislative restrictions. Fragile transport systems in rural areas and frequent flooding also create a development need and an opportunity to leapfrog underdeveloped transport infrastructure.[114] As part of the programme, companies or universities using the test site must engage in skills development and training. As a result, the first drone launched was built by Malawian students.

Amos Gumulira/AFP/Getty Images

The government of Malawi is piloting the use of drones for humanitarian purposes in Kasungu District to see how they can be used for transporting blood and mucus samples for TB and HIV tests to big hospitals where they will be quickly tested and returned to the rural health facilities. Drones will also be used for imaging in disaster areas, which are impassable to humans, to determine the extent of damage by floods and how victims can be assisted, as well as boosting telephone and internet network connectivity (June 2017)

113 Kunyenje W & G Chigoma, *op. cit.*; Malawi ICT academic, *op. cit.*

114 Scheibenreif M, 'Malawi: Low-cost drone built by students delivers medicine over 19km distance', UNICEF Stories, 20 November 2017, http://unicefstories.org/2017/11/20/malawi-low-cost-drone-built-by-students-delivers-medicine-over-19-km-distance/, accessed 25 April 2019.

Although government formed a cooperative partnership with the UN Children's Fund (UNICEF), a more active partnership based upon 'design thinking' could help to establish Malawi as a national frontrunner with regard to innovation and technology. Unlike similar testing in Rwanda, Malawi has not developed drone and/or traffic management regulations, which would support the permanent implementation of this innovation beyond an isolated test.[115] The lack of national innovation and skills development frameworks also does not support the harnessing of this capacity building beyond the finite programme lifetime. These tests could also be a major centrepiece of a public awareness campaign around the tangible developmental applications of ICT and innovation.

Comparative analysis and summary

At the broadest level, South Africa has effectively contextualised the 4IR in its national objectives via the NDP and the 4IR Commission's mandate. The NDP clearly connects ICT to a national goal of an information society and knowledge economy, acknowledging that in order to do this, government strategy must consider ICT as cutting across all sectors. The choice to establish the commission in coordination with the DTPS acknowledges the importance of ICT-related goals as the immediate target, and ICT is prioritised in the context of digital infrastructure, bridging the digital divide and skills development. Perhaps most importantly, the TORs state that the commission will 'make recommendations on an institutional framework and mechanism to coordinate 4IR programs', which is paramount to effective 4IR policy responses.[116] The TORs do not reference national-level policies such as the ICT vision, broadband, data protection and cybersecurity, which should be integrated into further action plans. With regard to meeting these objectives, South Africa is already comparatively advanced in the region in terms of infrastructure and mobile coverage (both 3G and 4G). However, lack of support to new broadband network technologies, high mobile data costs and skills deficits still prevent access in rural areas. Government release of spectrum, spectrum sharing between competing wireless networks, and the rollout of affordable broadband networking technologies such as the TVWSs, are of utmost importance in both decreasing costs and extending access. Government must prioritise the widespread rollout of programmes such as the iKamva Skills initiative, with integration beyond DTPS to include the DST, DHET and research and education institutions.

At the broadest level, South Africa has effectively contextualised the 4IR in its national objectives via the NDP and the 4IR Commission's mandate

115 Cheney C, 'Rwanda could become a model for drone regulation', Devex, 23 January 2019, https://www.devex.com/news/rwanda-could-become-a-model-for-drone-regulation-91868, accessed 20 April 2019.

116 South Africa, Department of Telecommunications and Postal Services, 2018, *op. cit.*

Although Lesotho does not have an overarching 4IR or digitalisation strategy, its national strategies (Vision 2020 and the NSDP) recognise the critical importance of ICT and STI skills. This is evidenced through the inclusion of 'well established technology' in the country's overarching vision statement, with a range of specific connectivity objectives highlighted in the NSDP.[117] Subsequent development of broadband, spectrum and science and technology strategies demonstrates Lesotho's commitment at policy-development level to establish itself as a connected economy. However, high-level policy understanding of the importance of Internet connectivity has not diffused through the population beyond urban centres. While infrastructure remains a constraint in some of the most rural mountainous regions, survey data indicates ICT and STEM skills are still remarkably low and act as the most binding constraints to Internet usage. However, the primacy of skills development in comparison to (for example) coverage or spectrum, which are relatively well established, is not clearly fleshed out in current policy frameworks. An updated overarching ICT policy, which is called for in Vision 2020 and the NSDP, has not been developed and the country's STI policy is also outdated. Therefore, developing an integrated STI and ICT policy could present a vehicle to highlight and unpack in detail skilling initiatives and drive cross-departmental collaboration between ICT and innovation.

Contextualisation of the 4IR represents a gap in Malawi, indicating the need for both further exploration on what 4IR means for the country, and thereafter, domestically driven integration of these findings into the national strategy

Compared to the above countries, in Malawi overarching national policy and strategy have not been fully contextualised with reference to global shifts in production and connectivity. Malawi's Vision 2020 and resulting MGDS, while briefly touching on ICT, do not articulate the link between connectivity, technology and development, or outline specific targets and objectives. Fieldwork confirms that at a national level, ICTs are viewed as a luxury rather than a human right or developmental objective, and ICT policies are primarily donor driven. The contextualisation of the 4IR therefore represents a gap in Malawi, indicating the need for both further exploration on what 4IR means for the country, and thereafter, domestically driven integration of these findings into the national strategy. This starts with education and awareness creation in both schools and the public sector around the imminent impacts of automation and connectivity for production and the link with broader economic and social development goals. Secondly, funding is needed for more in-depth data collection in terms of access and usage, which would then feed into appropriate policy responses.[118] Both of

117 Lesotho, 2005, *op. cit.*

118 Malawi ICT academic, *op. cit.*

these objectives can eventually drive the implementation of many policy frameworks that remain stalled.

Global examples

Two global best practice examples of 4IR policy responses can be found in South Korea and Rwanda. As Rwanda is a low-income country and South Korea is a high-income country, they face starkly different productive bases and development challenges. Thus, this subsection should be considered loosely in terms of examples of 4IR strategies and/or opportunities for partnership rather than in terms of economic development models.

South Korea

South Korea is paraded as a global success story for its rapid transition from an agrarian economy, devastated by war in the 1950s, to a technology-driven developed economy today. In addition to shipbuilding and automobiles, the economy has taken the lead in the development of semiconductors, smartphones and LCD screens, making South Korea ideally placed to take advantage of the 4IR.[119] The government has invested heavily in R&D on the '6Ts' – ie, information technology, biotechnology, nanotechnology, engineering technology, computer technology and space technology – over the past two decades.

> A siloed approach separating STI and ICT development at national level impedes technological progress

The department driving the 4IR strategy is the Ministry of Science and ICT (MSIT), and 'Industry Korea 4.0' is the ministry's underlying vision.[120] Policies such as the Master Plan for the Intelligent Information Society, Government R&D Innovation Plan and the Innovation Growth Engine combine the ICT basis required for new technologies with the innovation and R&D necessary to spur new ideas and local content production.[121] As emphasised throughout this paper, a siloed approach separating STI and ICT development at national

119 Chung BH, Park HK & Y Jung, 'Nanobiotechnology R&D strategy in the Republic of Korea', APBN, 10, 17, 2006, https://www.asiabiotech.com/10/1017/0978_0987.pdf, accessed 7 May 2019; South Korea, Ministry of Science, ICT & Future Planning, Creative Economy: New Growth Engine, 2015, http://english.msip.go.kr/cms/english/pl/policies2/__icsFiles/afieldfile/2015/11/11/creative%20economy.pdf, accessed 10 August 2019.

120 South Korea, Ministry of Science and ICT, https://www.msit.go.kr/, accessed 7 May 2019.

121 South Korea, 'Mid- to Long-Term Master Plan in Preparation for the Intelligent Information Society Managing the Fourth Industrial Revolution', http://english.msip.go.kr/cms/english/pl/policies2/__icsFiles/afieldfile/2017/07/20/Master%20Plan%20for%20the%20intelligent%20information%20society.pdf, accessed 7 May 2019; South Korea, 'Government R&D Innovation Plan,' https://english.msit.go.kr/cms/english/pl/policies2/__icsFiles/afieldfile/2015/11/11/Government%20RnD%20Innovation%20Plan.pdf, accessed 7 May 2019.

level impedes technological progress, and thus the integrated structure in South Korea is important.

With regard to data collection and benchmarking, the MSIP has two sub-bodies, the National Science and Technology Information Service and ITStat.[122] The former provides full information on national R&D stats, R&D facilities, researchers and equipment across the country, as well as active projects and past project outcome reports. The latter provides information on ICT access and use, and ICT contribution to economic indicators. Such statistics provide the basis necessary to formulate appropriate and contextualised policy.

The department consistently hosts and participates in regional and global forums on emerging GPTs and facilitates a number of bilateral as well as regional Memoranda of Understanding (MoUs) and workshops. These serve the dual purpose of promoting Korean technologies and companies abroad and providing lesson-sharing for partners on policy development and support for private sector innovation. For example, Korea recently signed MoUs with Croatia, the Central American Bank for Economic Integration (CABEI) and El Salvador.[123] The Croatia partnership focuses on knowledge sharing between universities and research institutes, while the partnerships with CABEI and El Salvador are more closely focused on ICT and broadband policy development, as well as ICT skills development through the establishment of an Information Access Centre in El Salvador. Given that digital skills are arguably the greatest deficiency across the board in the SADC region, similar skills-based partnerships could prove especially valuable. South Africa, which has a more well-established innovation ecosystem, has participated in cross-regional collaborations,[124] but could nonetheless benefit from a more established partnership similar to that with Croatia.

More broadly, the Asia-Pacific region has built a strong culture of regional collaboration and has organised several forums to bring together national policymakers, international experts, research institutions and other stakeholders to share lessons and facilitate cooperation. For example, in January 2019 the Asia-Pacific Science and Technology Cooperation Forum was co-hosted by the Korean Ministry of Science and ICT and the Science and Technology Policy Institute (STEPI). A core focus of this forum was to discuss cooperation opportunities with the Association of Southeast Asian Nations (ASEAN) and prepare papers on activities of the attending Asia-Pacific organisations to be distributed to ASEAN members. A similar forum

122 South Korea, Ministry of Science and ICT, 'Statistics', https://english.msit.go.kr/english/msipContents/contents.do?mId=NDcz, accessed 7 May 2019. South Korea, Ministry of Science and ICT, 'Korea-Croatia MoU on Science and Technology Cooperation Signed (February 14)', Press Release, 21 March 2019, https://english.msit.go.kr/english/msipContents/contentsView.do?cateId=msse42&artId=1703799, accessed 7 May 2019.

123 *Ibid.*; South Korea, Ministry of Science and ICT, 'Korea to strengthen ICT cooperation with Central America (December 28)', 28 January 2019, https://english.msit.go.kr/english/msipContents/contentsView.do?cateId=msse42&artId=1502251, accessed 7 May 2019; South Korea, Ministry of Science and ICT, 'Ministry of Science and ICT to establish Information Access Center in El Salvador, Central America (December 20)', 28 January 2019, https://english.msit.go.kr/english/msipContents/contentsView.do?cateId=msse42&artId=1502248, accessed 7 May 2019.

124 In 2018 South Africa's CSIR participated in a 5G Forum in Korea on applications of 5G to ICT, automation, media and 4IR enabling policies, and established a relationship with the Korean Advanced Institute of Science and Technology (KAIST).

was held on ICT cooperation in Indonesia in 2018.[125] SADC can take advice from these types of collaborative regional forums and explore potential coordination opportunities with other RECs such as ASEAN that are well positioned in terms of the 4IR.

Rwanda

Rwanda is a more contextually relevant example of a least developed country with limited resources and productive capacities, emerging from a devastating genocide only two decades ago. Rwanda has nonetheless positioned itself as a '4IR ready' country in Africa. Its success stems from a clear national vision for a digital economy, which is facilitated by high levels of national political centralisation as well as international partnerships.

Rwanda's development process began with a three-stage National Information Communications Infrastructure Policy in 2000, which was followed through at every stage (rather than replaced by new policies after partial implementation, as is the case in many countries in the region). The first stage focused on legal frameworks and liberalisation and the second stage on infrastructure and the construction of a national fibre backbone. The third stage focused on improved service delivery, notably the 'one laptop per child' programme delivering laptops to primary schools.[126] The country now aims to focus on ICT skills development. The results are telling, with growth from 25 000 Internet users in 2002 to 1.2 million in 2014.[127] Throughout this process Rwanda has sought bilateral partnerships, particularly with technologically advanced but recently developing Asian countries such as China, Singapore and Thailand.

In 2013 Rwanda's presidency, in partnership with the World Bank, drove the creation of the overarching digitalisation/4IR strategy Smart Rwanda Master Plan 2015–2020, building on the previous NICIs. The plan specifically targets the integration of ICT into seven SMART sectors: agriculture, finance, business and industry, health, education, government and cities.[128] Rwanda was also the driving force behind the continental SMART Africa Initiative highlighted earlier, with Rwandan President Paul Kagame chairing the initiative, and the country hosts the Transform Africa Summit every two years in Kigali. Rwanda is also the first African country to partner with the WEF's Centre for the 4IR in developing performance-based regulations for drones (that have been tested for humanitarian purposes) and traffic management regulations. This is an example of political will to rapidly develop and implement policies in order to harness 4IR developments. Rwanda has also recently

125 South Korea, Ministry of Science and ICT, 'Attend the 13th ASEAN-Korea TELMIN and approve ASEAN-Korea ICT Cooperation Plan 2019 (December 7)', 28 January 2019, https://english.msit.go.kr/english/msipContents/contentsView.do?cateId=msse42&artId=1502250, accessed 7 May 2019.

126 Rwanda, 'SMART Rwanda Master Plan 2015–2020', 2015, http://www.minecofin.gov.rw/fileadmin/templates/documents/sector_strategic_plan/ICT_SSP__SMART_Rwanda_Master_Plan_.pdf, accessed 7 May 2019.

127 Ben-Ari N, 'Big dreams for Rwanda's ICT sector', *Africa Renewal*, April 2014, https://www.un.org/africarenewal/magazine/april-2014/big-dreams-rwanda%E2%80%99s-ict-sector, accessed 7 May 2019.

128 Rwanda, 2015, *op. cit.*

attracted $400 million for its Kigali Innovation City, and opened a statistics training centre and data science campus in line with its Data Revolution Policy.[129]

Moto taxi drivers are connected with cell data in downtown Kigali, the capital of Rwanda. The country has almost universal cell coverage

William Campbell-Corbis via Getty Images

Challenges remain in this strategy, notably the integration of innovation and R&D into ICT initiatives, as was highlighted in the 2017 UNCTAD review of Rwanda's STI policies.[130] Additionally data costs are still relatively high. However, Rwanda shows that low-income, resource-constrained countries can harness digitalisation for development through strong policy development and political will, and by leveraging international partnerships.

Analysis and takeaways

Policy insights for SADC countries

The preceding sections of this paper have highlighted that the 4IR is a convoluted term encompassing many technological changes grounded in Internet connectivity, automation, AI and media. Therefore, countries' policy responses must vary depending on productive capacities, socio-economic development needs, and proposed areas of specialisation. Most importantly, policies must be clearly linked to broader national objectives such as improved competitiveness and productivity derived from connectivity, reduced unemployment through new digital jobs, and reduced inequality through equitable access to the

129 Kwibuka U, '2018: The five milestones that shaped Rwanda's ICT sector,' *The New Times*, 25 December 2018, https://www.newtimes.co.rw/news/2018-five-milestones-shaped-rwandas-ict-sector, accessed 7 May 2019; *CNBC Africa*, 'Rwanda unveils statistics training centre', 3 May 2019, https://www.cnbcafrica.com/videos/2019/05/03/rwanda-unveils-statistics-training-centre/, accessed 7 May 2019; Rwanda, 'National Data Revolution Policy', April 2017, http://statistics.gov.rw/file/5410/download?token=r0nXaTAv, accessed 7 May 2019.

130 UNCTAD, 'Science, Technology, Innovation and Policy Review: Rwanda', 2017, https://unctad.org/en/PublicationsLibrary/dtlstict2017d8_en.pdf, accessed 7 May 2019.

Internet.[131] However, generalised policy insights can also be distilled from the above case studies. The following section details areas of focus at national and regional level, ending with specific recommendations for SADC.

Equitable access

Given that widespread Internet access and affordability remain major constraints within SADC, ICT spectrum and infrastructure sharing among different operators is vital in reducing costs and improving coverage . As an example, South Africa's CSIR is developing technologies and models to allow unused spectrum such as TVWS (which is now regulated) to be reallocated to rural operators. Community-based models can be used temporarily until the participation of the major licensed operators becomes financially viable. Overall, a number of innovative technologies and regulatory tools are on the verge of becoming standard and enabling new start-up small and medium-sized enterprise (SME) operators to provide networks and services in rural areas. The industrial potential of the spectrum innovation ecosystem and technology and affordable broadband ICT services has been discussed at SADC level with a CSIR tutorial for CRASA. This coincides with several other SADC countries now developing spectrum sharing/TV white space technical regulations. A CSIR-CRASA report35 is available for further discussion.[132]

ICT spectrum and infrastructure sharing among different operators is vital in reducing costs and improving coverage given that Internet access and affordability remain major constraints within SADC

However, both spectrum- and infrastructure-sharing policies across the region have experienced limited enforcement owing to pushback from operators. Fieldwork has indicated a need for increased opportunities for national public–private dialogues/evidence-based working groups, which allow operators and regulators to discuss common strategies for spectrum and infrastructure sharing, including affordable broadband Internet service expansion in rural areas and fair pricing based on enabling policies. However, given that Internet access is now recognised as a human right, it is ultimately incumbent upon regulators to either legislatively mandate existing operators to provide greater access or allow new local operators to do so through infrastructure and spectrum sharing.[133]

131 *Ibid.*; ICASA, 'Regulations on the use of television white spaces', *Government Gazette*, 4512, 23 March 2018, https://www.icasa.org.za/uploads/files/Regulations-on-the-use-of-Television-White-Spaces-2018.pdf, accessed 2 May 2019.

132 CRASA & CSIR, 'Spectrum Innovation Eco-System and Dynamic Spectrum Sharing', Report on a Tutorial by CSIR and partners, Centurion, 4–5 February 2019.

133 Malawi ICT academic, *op. cit.*; Independent telecommunications policy analyst b, *op. cit.*; South African government official, *op. cit.*; South African public research entity representative, *op. cit.*

The advent of new technologies such as Over-The-Top (OTT) services[134] will make lower prices a reality that operators cannot avoid. In the long run this will benefit everyone, including operators, through investment savings and a bigger customer base.[135] These challenging issues represent another opportunity for regional lesson-sharing by countries that have managed to establish more effective collaboration between regulators and operators in accelerating affordable broadband Internet to rural areas, as well as incentivising countries to lower mobile broadband data costs.[136]

Public sector capacity

Countries in the region face important policy development and implementation gaps. At a minimum, it is essential for countries to have updated policies governing ICT, broadband, STI and Internet security (ie, data protection and cybersecurity), as well as technical regulations to support new innovations. The role of regional institutions such as SADC in continuing to facilitate workshops on the domestication of templates is crucial. However, the case studies show that there is a need for strategic adjustments to the way regional and international initiatives and templates (eg, HIPSSA) are adapted at SADC forums. Examples/evidence of the need for process improvements include stalled implementation of the (2016) E-transactions Act and Communications Acts in Malawi, cybersecurity legislation workshops in Lesotho in 2013 that have yet to result in legislation, and unestablished data protection authorities to support data protection legislation in South Africa (2014) and Lesotho (2011).

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In many cases, model templates are fully developed externally, and then brought to regional forums without enough opportunities for regional input in the initial development phase. There is also limited opportunity for a wide range of actors beyond ICT ministers (such as industry members, parliamentarians and civil society organisations) to contribute early on.[137] This contributes to low rates of domestication and is compounded by the gaps in baseline country data that should support informed participation from ministers. Greater local input and contextualisation are essential to improving sensitisation, buy-in and ownership at a national level. This also requires increased and intensive capacity building, going beyond

134 OTT services provide content directly to users, bypassing traditional telecommunications distributors. Examples include Skype, WhatsApp and Netflix.

135 South African government official, *op. cit.*; South African public research entity representative, *op. cit.*; Independent telecommunications policy analyst b, *op. cit.*

136 Independent telecommunications policy analyst b, *op. cit.*

137 ICT research institution, *op. cit.*

a handful of ministerial workshops. Although capacity building is often included as a component of policy development strategies, the extent needed to ensure effective policy implementation is often underestimated. For example, for the CSIR to effectively develop TVWS regulations in South Africa it required four years of capacity building and trials/testing.[138] The range of stakeholders involved in capacity building must also include R&D and educational organisations in order to build institutionally sustainable capacity.

Capacity building should involve strategic guidance to countries on which departments are most suited to handle new digital policies, and when it is necessary to create new institutional structures vs. using existing structures. For example, it is often assumed that ICT departments already have expertise in every new digital challenge. Considering the financing constraints in the region, help with resource allocation and budgeting for policy adoption and implementation is important. These efforts should include strategies for close coordination with the private sector and civil society in order to pool resources. This guidance should continue after the passage of legislation to assist and monitor the establishment and initial operation of new structures such as cybercrime response teams and data authorities.

Skills and education

The inadequate regional skills base is a significant bottleneck. This skills gap can be attributed to a lack of quality STEM education, ICT skills development and usage, and innovation ecosystems. Regional ICT studies show that digital knowledge is a significant limiting factor for those currently offline, and even among Internet users the capacity to use digital tools beyond basic functions such as word processing and internet browsing is limited.[139] ICT policies in countries such as Lesotho still favour supply-side interventions such as infrastructure and regulation when the lack of demand-side skills to use ICTs is equally if not more serious.[140]

At national level, inter-sectoral government working groups comprising education, science and technology, industry and ICT departments should be established to update curricula and vocational programmes that respond to shifting global skills needs. In most countries, siloed approaches to curricula development still prevail, yet intensive coordination is critical. For example, foundational maths, science and coding educational programmes must be integrated with creativity, critical thinking and adaptability skills.[141] This also entails engaging a far wider range of ages and life situations in the education/skills process, and diverse institutions such as innovation hubs and SMEs, and ethics and environmental institutions to target the human impact aspects of new technology. As an example of an innovative partnership, the communications authority of Kenya has developed an e-skills

138 South African public research entity representative, *op. cit.*

139 Gillwald A, Deen-Swarray M & O Mothobi, *op. cit.*; Gillwald A, Mothobi O & B Rademan, *op. cit.*

140 Gillwald A, Deen-Swarray M & O Mothobi, *op. cit.*

141 WEF, *The Future of Jobs and Skills in Africa: Preparing the Region for the Fourth Industrial Revolution*. Geneva: WEF, May 2017; World Bank, 2019, *op. cit.*;

platform in collaboration with 56 Kenyan library providers throughout the country to educate and provide content on 4IR digital skills for public use.[142]

Such curricula must also be directly coordinated with industry needs to ensure that graduates fit their requirements. Formalised institutions tasked with facilitating these linkages (for example, the Johannesburg Centre for Software Engineering in South Africa) are needed in every country, with branches outside major urban centres to target the digital divide.[143] As shown, skills development provides an opportunity to facilitate knowledge exchange with countries throughout the world that have developed interdisciplinary innovation systems.[144] SADC can serve as a platform for such exchanges. Overall, the most important consideration in developing a capable and ready skills base to take advantage of the 4IR is wide collaboration among different disciplines to drive the necessary innovations.

Establishing a common vision

The preceding sections have highlighted the importance of ICT policies and skills development as starting points for the SADC region to establish the connectivity and human capital needed to harness the 4IR. However, the case studies have also shown that while many relevant policies already exist, implementation is weak. This speaks to an intangible yet vital element that is often difficult to cultivate – a convincing national vision of a connected society that inspires both public and private sector urgency and buy-in. While vision documents and strategies exist in many countries, the disconnect with political will and buy-in on the ground manifests in multiple ways, including lack of cross-sectoral and cross-industry collaboration and continual shifting of blame, sluggish implementation, politically motivated appointments and departmental disputes .

While vision documents and strategies exist in many countries, the disconnect with political will and buy-in on the ground manifests in multiple ways, including lack of cross-sectoral and cross-industry collaboration and continual shifting of blame, sluggish implementation, politically motivated appointments and departmental disputes

For example, the testing of 5G in Lesotho and drones in Malawi was a missed opportunity to capitalise on international technology transfer and develop supportive, adaptable

142 EIFL (Electronic Information for Libraries), 'Transforming Public Libraries In Kenya', https://www.eifl.net/system/files/resources/201704/eifl_brochure_hr.pdf, accessed 5 May 2019; South African public research entity representative, *op. cit.*

143 Johannesburg Centre for Soft Engineering, https://www.jcse.org.za/, accessed 2 May 2019.

144 South African government official, *op. cit.*; ICT research institution, *op. cit.*

regulations and domestic skills development programmes to ensure that such innovations are not a once-off endeavour. This is at the core of the 'design thinking' principles that are key to governance in the 4IR era. In South Africa, protracted institutional disputes with regard to ministers and departmental structures and the blocking of policy implementation are at least partly caused by a lack of buy-in into a greater common goal (and can also be attributed to the creation of too many new government departments and ministerial positions under the previous presidency). Tackling this challenge should be underpinned by strong leadership, which inspires government and the private sector to move beyond short-sighted margins towards a shared long-term vision where all will benefit from digital inclusion, socioeconomic development and industrialisation.

With new political leadership and the establishment of the 4IR Commission, South Africa has shown initiative to overcome this barrier. However, this will only succeed if the Presidency and commission members show a commitment to tangible, adaptable and urgent action plans that coordinate all the necessary moving parts (including STI policies, ICT policies for skills development and equitable access, private sector players, innovation hubs and research institutions). Digitalisation by nature is cross-cutting, and this level of coordination forms the essence of 'systems thinking'. For other countries in the region, developing an overarching 4IR, digitalisation or technology strategy can provide a platform to facilitate this process. Countries can also leverage international partnerships such as the SMART Africa platform (offering assistance to countries in developing national SMART strategies), the WEF Centre for 4IR, and the CSIR 5G Research Alliance.[145] Bilaterally, countries can leverage partnerships with countries looking to actively share and promote their developments in research, skilling programmes, policy and regulatory frameworks, such as South Korea. However, new policies, partnerships and incentives are only as effective as the vigour with which they are implemented, determined by the ability to inspire belief in a common vision .

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Takeaways for SADC

While many of the above policy recommendations must be nationally driven, there is also a distinct need for regional collaboration. This paper proposes a focus on the third pillar

145 A global research collaboration alliance involving the CSIR, the Korean Advanced Institute of Science and Technology (KAIST), South African universities and the Institute of Electrical and Electronics Engineers, promoting research on relevant 5G use cases (an example is Frugal 5G, which explores effective transitions to the latest wireless technologies in developing regions still reliant on 3G).

This paper proposes a focus on the third pillar of the SADC 4IR Declaration: skills and awareness, considering both SADC's strength as a regional convening power and its limitations in terms of resources and enforcement mechanisms

of the SADC 4IR Declaration: skills and awareness, considering both SADC's strength as a regional convening power and its limitations in terms of resources and enforcement mechanisms. It proposes the following recommendations:

- Ensure better national baseline ICT and innovation data collection in SADC countries. SADC ministers of education, science and technology can conduct the proposed country SWOT analysis, and partnerships with institutions such as RIA and the ITU, and SADC ministers of ICT, must be leveraged for funding and capacity.
- Develop a SADC 4IR Strategic review task force. The task force should consist of regional technocratic experts and seek input and feedback from member states on past unsuccessful or partially successful regional initiatives relating to digital development. The task force should use experience-based feedback as well as evidenced-based research to assess which frameworks are most practical at a regional level (vs. national), whether past stalled frameworks should ultimately be continued, or how they can be amended and adjusted, before proposing new frameworks/initiatives.
- Support the proposed Centres of Excellence (proposed in SADC Digital 2027), which should bring together an array of stakeholders beyond ICT ministers and provide demand-driven opportunities for in-country intensive training. These centres should focus on:
  - » lesson-sharing on successful implementation of equitable ICT access programmes in the region, such as spectrum innovation eco-systems, infrastructure sharing and USFs;
  - » continuing current workshops on regulator capacitation and domestication of legislation facilitated by CRASA (special focus should be placed on the creation of new national structures such as data protection authorities, and on budgeting and monitoring throughout implementation, while greater national input in adapting model templates should be allowed for); and
  - » lesson-sharing on the development of public research capacity and local skills development programmes in the region, SME/innovation hub support as well as private sector–academia linkage programmes (for example, support countries such Lesotho and Malawi to develop updated STI/ICT skills policy and programmes) – this can support the longer-term establishment of a SADC think tank as outlined in the SADC 4IR strategy.

Within the above takeaways, there is a need for closer coordination between the SADC ministers of education, training, and science and technology, and the ICT ministers (as well as relevant subcommittees).

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