The use of digital technology in the context of West African cities

EPFL

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Summary

Africa will experience significant population growth in coming decades, especially in urban areas. In order to limit potential problems such as increasing poverty, urban congestion and pollution, it is necessary to look for present-day solutions offering a sustainable response to the challenges posed by this population growth.

The development of information and communication technologies offers an opportunity to ensure urban development meets people's needs. However, the potential and sustainability of the mass development of digital solutions, particularly in West Africa, are not yet fully understood. The purpose of this report is to take stock of the use of digital technologies in West African cities, to estimate their potential for deployment to meet urban challenges, and to identify the challenges and potential technological, economic or societal barriers that could impede their development.

The report, therefore, summarises and condenses the results of a review carried out by EPFL, which looks at academic research on the application of digital technologies in urban areas. To ensure the results are usable, we went beyond West Africa to include cities across the continent. This report shows a recent explosion in the number of articles on the subject, with a tenfold increase over the past decade. It also highlights the potential of digital technology to achieve the Sustainable Development Goals (SDGs), as about 75% of scientific articles showed a clear link between digital technologies and the achievement of these goals.

An overview of the digital transformation of the African continent was also provided. Unsurprisingly, technical reports, especially those published by international organisations, show that Africa is lagging behind the rest of the world in terms of infrastructure. Internet access remains a luxury for many Africans, who pay proportionately more than people on other continents to access broadband. However, it should also be noted that connectivity in Africa has improved considerably

over the past decade and many initiatives are emerging to improve the situation and make Internet connections more affordable.

Governance and cybersecurity are also key aspects when considering the widespread use of digital solutions. Research for this report revealed that only 28 African countries out of 54 have adopted comprehensive legislation relating to the protection of personal data online. This remains insufficient, although the legal progress made in recent years is encouraging.

Finally, three main categories of digital use in urban Africa were identified as the most promising:
- The Internet of Things, which offers the application of possibilities in a wide range of fields (health, environment, energy distribution, etc.);
- Data analysis, e.g. improving transport safety or efficiency; and
- Mobile telephony, which is predominant in Africa and offers a multitude of services other than just a means of communication (mobile payment, e-health, etc.).

While the assessment of the digital transformation in Africa has highlighted gaps to overcome, it has also shown the potential of digital transformation, well served by the inventiveness of African researchers and entrepreneurs. African governments will nevertheless need to continue investing in their national digitalisation strategies in order to benefit from them.

Digital technologies represent a fertile ground for innovation in Africa, as illustrated by various examples of technological solutions detailed in Chapter 5 of the report. Innovation hubs attract many young digital entrepreneurs. This enables them to share their ideas and potentially bring solutions to economic, social and environmental issues faced by the continent. The picture must, of course, be put into perspective. For example, several academic studies and international reports have shown the very real risk of digital technology across a whole sector of Africa's economy, including the informal sector, where some players may miss the digitalisation boat. The comprehensive assessment of both the risks and the expected

benefits of digitalisation, is obviously a long-term exercise that will have to be meticulously carried out. At any event, it is clear that the digital solutions offered to date have, in many cases, contributed to poverty reduction in Africa.

Finally, the report focuses on West African countries, where population growth and urbanisation will be among the fastest in Africa in coming years. First of all, it is gratifying to see that the region is not lagging behind in terms of digital innovation. Whether in the field of urban transport, tele-medicine, waste collection and treatment or water management, examples of start-ups from Mali, Côte d'Ivoire and Benin, among others, have shown that digital solutions have already been proposed and adopted by the private sector.

Moreover, the analysis also revealed that West African governments have not been left behind, and almost all of them are now incorporating the digital dimension into their national development plans. In addition to regulatory aspects relating to the development of digital entrepreneurship, there is a strong interest in the use of digital technology in public administration and urban governance.

The study of different bibliographic sources carried out to write this report identified a large number of different actors who have, or will have, a role to play in the development of digital technology in West African cities. It is urgent to complete this mapping of key players by looking at their motivation, but also at their possible reluctance, to embark on the path of digitalisation. Without bias, it will then be a question of analysing them in order to learn from them and, if necessary, to adapt regulatory frameworks and technological solutions. Thus digital technology is used entirely to serve people, and not vice versa. It will also be a matter of putting in place the levers that will bring key players together in order to progress and make the best use of digital technology to overcome the challenges of future population growth and urbanisation.

With this in mind, institutes of technology and universities, which are key players in building local capacities and guaranteeing high-

quality, multidisciplinary research, both fundamental and applied, seem to be in the best position to act as a hub to bring together the different actors of digital development in West African cities. By creating synergies with cities and using them as open-air labs, universities could best use scientific research to serve citizens and train new generations of scientists, urban professionals and entrepreneurs to better understand future urban challenges in West Africa. In return, city authorities have the opportunity to steer this digital world in coordination with their public policies and territorial action plans.

International cooperation has a fundamental role to play in supporting the activities of the public and academic sectors to facilitate the development of sustainable and inclusive use of digital technology in African cities. Thanks to its wide scope of action, international cooperation could thus support vulnerable populations, while strengthening the ties between the different players of digital transition.

Introduction

Is Africa at the dawn of the digital revolution which, more than anywhere else, would allow the leapfrog effect that developmentalists dream of? Will digital technology reduce poverty and contribute to achieving the Sustainable Development Goals?
Is it a dream or a reality that is firmly in reach?

While digital technology is the burning topic of the moment, moment, it is important to understand its use, limits, potential and threats. For instance, social networks can support a new form of democracy but can also be used for misinformation and manipulation.

As with any new tool, its positive or negative value is the one we provide and those which we manage to regulate. In this domain, it can feel like the Wild West, as big global groups avoid State regulations.

From a power game between States, digital technology is now a battleground for large corporations under the helpless gaze of traditional power structures. This means that perhaps the greatest digital revolution will be one of governance and the redefinition of powers.

But if digital technology augurs a profound change in society, another – more traditional – revolution is underway: demography. If we take the demographic prospects seriously, even the most pessimistic, Africa's population will literally explode. This means a population pyramid that Europe has not seen for more than a century, that is to say, with an extremely large base resulting in a very young population. This raises the question of representation of power, traditionally held by older people making decisions for a majority of very young men and women whose demands will not be heard. Here again, a redefinition of power will take place.

The corollary to this demography is the explosion of cities in Sub-Saharan Africa, which will see their population double.

The development of the 21st century city must take into account the growing understanding of the diverse conditions that make cities sustainable – connected, green and inclusive. Since 1990, the development of the Internet and of information and communication technologies (ICTs) has fostered the emergence of new initiatives and technologies in a variety of ways, promoting a new wave of innovation within urban services (Lazaroiu and Roscia, 2018). Local authorities are

aware that the development of ICTs has increased in recent decades, making them more ubiquitous in everyday life and fundamental to the social and economic progress of their territories. In Africa, digital technology and its corollaries, such as artificial intelligence, digital education, or big data, are gaining traction in academic institutions (Traoré, 2014). More generally, they help bridge the gap between the transformative potential of African societies and a context where national and local authorities have not yet been able to meet the high expectations of a young population.

The aim of the next chapters is to analyse the potential impact that digital and new technologies can have on the sustainable development of West African cities and on reducing the vulnerability of their inhabitants, especially the most disadvantaged. After an initial overview illustrating the main continent-wide relationships between demographic growth, digitalisation and economic development, this study presents a review of the scientific literature on digital technology and the development of African cities. It follows a theoretical analysis of digital issues showing the opportunities and challenges of digital technology for sustainable development in Sub-Saharan Africa. The study concludes with a more empirical analysis of digital technology and new technologies as tools for innovation and cooperation, with a focus on the context of West African cities.

2.
Population growth and urbanisation in Sub-Saharan Africa

Urban challenges and the potential of digitalisation

Digital technology and economic growth

Urban challenges and the potential of digitalisation

In the coming decades, the increase in the urban population in Sub-Saharan Africa is likely to pose major socio-economic problems. The use of new technologies could play a key role in alleviating these problems, for example by improving access to basic services among the poorest urban populations.

x2

Population in Sub-Saharan Africa to double by 2050

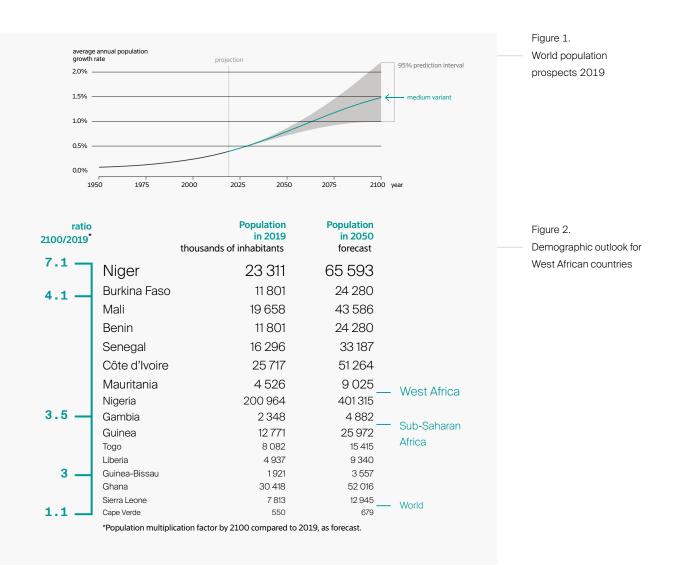Of this population increase will be absorbed by cities

80%

More than half of the world's population growth, from 7.7 billion in 2019 to 9.7 billion in 2050, is attributable to population growth in Sub-Saharan Africa, which is expected to double by 2050. In West Africa, the population is expected to increase slightly more, from 391 million in 2019 to 796 million in 2050.

By 2050, the populations of 18 least developed countries (LDCs), all in Sub-Saharan Africa, are likely to double in size, while in one country, Niger, the population is expected to almost triple. Mali, Burkina Faso and Benin are also expected to see significant population growth. The reasons

behind this expected demographic change are related to increasing life expectancy and maintaining a high fertility rate (United Nations, 2019).

Coupled with population growth, Sub-Saharan Africa is experiencing a rapid urbanisation. In 2020, it is home to 68 cities of at least 1 million inhabitants. By 2025, the number of such cities is forecast to reach 85 (UN DESA, 2018). This, coupled with an ever-increasing rural exodus, will lead to a significant increase in Africa's urban population by 2050. Around 45% of all Africans will live in a city, and certain countries – including Nigeria, Ghana and Angola – will see

Figure 1.
World population
prospects 2019

Figure 2.
Demographic outlook for
West African countries

ratio 2100/2019*		Population in 2019 thousands of inhabitants	Population in 2050 forecast
7.1	Niger	23 311	65 593
4.1	Burkina Faso	11 801	24 280
	Mali	19 658	43 586
	Benin	11 801	24 280
	Senegal	16 296	33 187
	Côte d'Ivoire	25 717	51 264
	Mauritania	4 526	9 025
	Nigeria	200 964	401 315
3.5	Gambia	2 348	4 882
	Guinea	12 771	25 972
	Togo	8 082	15 415
	Liberia	4 937	9 340
3	Guinea-Bissau	1 921	3 557
	Ghana	30 418	52 016
	Sierra Leone	7 813	12 945
1.1	Cape Verde	550	679

West Africa — Mauritania line
Sub-Saharan Africa — Gambia line
World — Sierra Leone line

*Population multiplication factor by 2100 compared to 2019, as forecast.

the proportion of urban residents reach 80% of their total population by 2050.

It is highly likely that cities will not be able to cope with this increase within their current limits. They are literally "overflowing" today and there is no indication that the situation will improve. One needs only to imagine the doubling of the area of today's major cities to get an idea of the challenges facing States and local communities.

While urban areas are characterised by generally higher incomes than the rest of the country, in most Sub-Saharan African countries, rapid urban change is not always linked to economic development. It is often caused by the expansion of precarious and informal housing, which is home to the majority of the poorest urban dwellers (World Bank, 2017) and provides limited access to basic urban services. In such cases, cities would not be able to reap the benefits usually associated with urban growth, as poor people would remain stuck in a poverty trap.

For cities in African countries to become real engines of economic growth, public and private actors must address the challenges of deprived urban populations. Urban

authorities need to find innovative ways to make basic services, such as access to water and electricity, waste management, sanitation and transport, more accessible to vulnerable urban dwellers (World Bank, 2018).

It is becoming increasingly clear that there is often an untapped potential in using digital technologies to solve urban problems. The spread of new technologies and mobile connectivity has recently led to the proliferation of digital solutions that appear to make vital basic services more efficient, accessible and affordable (OECD, 2020). One example is the spread of mobile money, which has been a key catalyst of financial inclusion throughout Sub-Saharan Africa and has, in particular, made it possible to develop solutions tailored to the realities of the poor.

In addition, cities are ideal test grounds and operational environments for testing innovative information and communication technology solutions. In this regard, the UN 2030 Agenda sees information and communication technologies (ICT) as a means of promoting socio-economic development and environmental protection, increasing resource efficiency, fostering human progress and knowledge in societies, and modernising existing infrastructures and industries based on sustainable design principles (Bibri, 2019). However, new technologies alone cannot make a city sustainable and resilient; it is how they are incorporated into the urban fabric that will determine the smartness of the city and how they contribute to its sustainability.

Today, thanks to the digital revolution, it is possible to connect and form urban settlements that offer economies of scale and agglomeration. In order to create integrated urban centres that make the citizen the centre of attention, it is important to promote intra- and inter-municipal cooperation. Cooperation between urban settlements is essential to create synergies and stimulate their economies and those of all African conurbations.

Improving financial inclusion through fintech

Less than one in four adults in Africa has access to an account with a formal financial institution. Increased access to financial services makes it easier for households to save and allows more people to invest.

MaTontine is a Senegalese company that provides a digital platform to give people excluded from the financial system in Africa access to a range of financial and non-financial services e.g. (savings, credit, insurance, financial education, Tontines, etc.). All transactions on the platform are carried out digitally using mobile phones and mobile money in an effort to achieve a greater degree of financial inclusion among those who are usually excluded.

**Rapid urbanisation is causing
the expansion of informal settlements that house
the majority of the urban poor**

**Local authorities and service providers
need to find innovative ways
to make basic services more accessible
to low-income city dwellers**

**The use of new technologies
is essential to help design an inclusive
urban future for African cities**

Africa is gradually turning towards digital technology. Although only 29% of the continent's 1.3 billion people use the Internet (ITU, 2021), this proportion is increasing rapidly as mobile networks expand and the cost of Internet-enabled devices continues to fall (Figure 3, p. 18). More than 830 million Africans have a mobile phone and some 300 million of them use the Internet (GSMA, 2020). This has led to a growing wave of innovations, with entrepreneurs and large companies launching projects on the Web. These include "pay-as-you-go" business models that make it easier for low-income urban dwellers to access paid energy 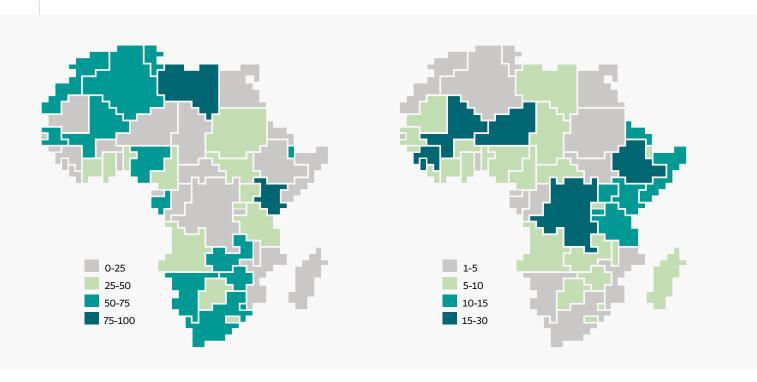services via mobile phones (see Chapter 6); mobile health technologies, such as GoMedical, developed by the Beninese start-up Open Si, which makes it possible to make an online medical appointment and avoid waiting times, or the use of mobile telephony to improve waste collection in deprived neighbourhoods.

Digital and economic growth

Figure 3.
Internet penetration
in 2020 (left) and its
increase over ten years
(right)

Governments are increasingly prioritising Internet-driven growth, as seen in Benin, Togo and Côte d'Ivoire (IOC Mag, 2021). They all have ambitious plans to extend broadband Internet access to the entire population. Most countries have developed national digital strategies (see Chapter 6), but many are still in the early stages of implementation. Today, the Internet's contribution to Africa's GDP remains low at 4%, half the rate of economies such as the United States and Switzerland. This figure varies considerably from country to country: 1.27% in Ethiopia, 5.27% in Côte d'Ivoire, 7.7% in Kenya (IFC, 2020).

Over the next decade, the number of users of Internet in Africa is expected to increase to 16% of the world's internet users. In cities in developing countries, the use of digital tools focuses on meeting urban dwellers' aspirations for infrastructure and services, such as adequate provision of clean water, improved sanitation and solid waste management, stable and constant electricity supply, and enhanced urban mobility (Jiménez, 2018; Schmitt and Muyoya, 2020).

Legend (left map):
- 0-25
- 25-50
- 50-75
- 75-100

Legend (right map):
- 1-5
- 5-10
- 10-15
- 15-30

In Sub-Saharan Africa, urban inequalities as measured by the Gini coefficient[1] are among the highest in the world, with an estimated 43% of the urban population living below the poverty line, 60% of informal urban jobs, and 54% of the urban population living in informal neighbourhoods[2] (World Bank, 2018; Turok, 2014). Many African cities have weak and poorly funded urban public management systems and complex and competing land tenure systems that operate through centralised, rigid and outdated planning laws and regulations. This does not allow to solve critical urban problems, on the one hand, and to plan for rapid urbanisation on the other.

Even before the spread of mobile telephony and use of the Internet, a causal link was established by the OECD between telecommunications infrastructure and economic output. A similar link was established with mobile telephony in 113 countries over a 20-year period, where a 1% increase in mobile penetration led to +0.03% of GDP (Torero and von Braun, 2006). More recent studies estimate that a 10% increase in mobile Internet penetration increases GDP per capita by 2.5% in Africa, compared to 2% globally (ITU, 2019). The greater economic impact on African countries is due to the increased use of mobile telephony to access the Internet, mobile

Internet penetration is extremely high in low-income countries. In addition, a 10% increase in digitisation, i.e. the conversion of information into a digital medium, increases GDP per capita by 1.9% in Africa, compared with 1% in non-OECD countries (ITU, 2020).

In a context of accelerating digital transition, the demographic structure of the African continent seems to be its greatest asset in terms of appropriating and disseminating new technologies. The increase in the urban population, coupled with the proportion (42%) of young people under the age of 14 (World Bank, 2020), who have an excellent understanding of digital tools, constitutes an important pool of digital skills.

[1]
The Gini index (or coefficient) is a synthetic indicator of the level of inequality for a variable and for a given population. It varies between 0 (perfect equality) and 1 (extreme inequality) – National Definition of Statistics and Economic Studies

[2]
There are, however, very large regional disparities. This proportion is lowest in South Africa at 26% and highest in the Central African Republic at 95%. Between these two extremes are Ghana (30%), Mali and Kenya (both 47%), Nigeria (54%), Côte d'Ivoire and Benin (60%).
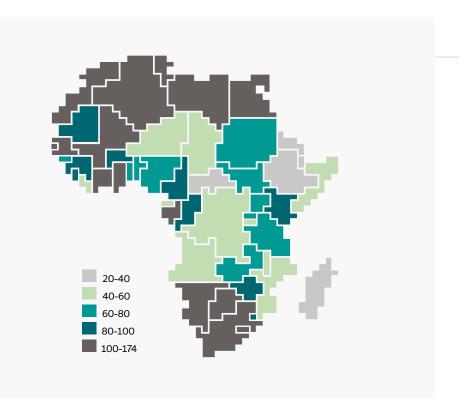
Figure 4.
Mobile phone subscriptions
(per 100 inhabitants)
in Africa in 2017

Legend:
- 20-40
- 40-60
- 60-80
- 80-100
- 100-174

The sharp increase in the number of telephones connected to the Internet explains the surge in social media accounts in Sub-Saharan Africa, which have risen from 50 million to 100 million since 2013, while at the same time the number of mobile phone subscriptions has risen from 581 million to 882 million in 2020, as illustrated by the International Telecommunication Union (ITU). Interestingly, mobile phone penetration is particularly high in West and Southern Africa, where mobile subscriptions exceed 100% of the population (Figure 4). Beyond its economic impact, digital transition should enable African governments to improve the standard of living of their citizens, especially the poorest. This would benefit many industries, including agriculture, a key sector for urban development, accounting for 36% of West Africa's GDP (Allen and Heinrigs, 2016).

The digital revolution seems to be underway on the African continent, offering unique opportunities for designing and managing urban spaces in a resilient and sustainable way. At the same time, digital technology brings opportunities for innovation in areas such as health, agriculture, education, energy, financial services, and transport, particularly in West Africa, which has one of the highest Internet penetration rates on the continent (Figure 3, p. 18).

The smartness of the city and the contribution of new technologies to its sustainability depend on how they are incorporated into the urban fabric.

3.
State of the art urban and digital research

Methodological approach

The state of digital research and African cities

Digital opportunities and threats for sustainable development

Academic knowledge generation on digital technology in African cities and the use of ICT are accelerating rapidly, along with technological innovations, while remaining fragmented and interdisciplinary. Assessing the state of knowledge on a particular subject is particularly useful when knowledge is produced in silos, as is often the case with urban research. A state of the art can generally be described as a method of collecting and synthesising scientific work, with the aim of providing an overview of a research topic or problem. It is an essential tool to provide a comprehensive view of areas where research is disparate and interdisciplinary, such as the use of digital technology in cities. We conduct this work to understand the relationship between the digital triptych, African cities and development by taking a robust methodological approach, relying on the largest databases covering the majority of scientific output, both academic and non-academic, and peer-reviewed.

Methodological approach

Based on the methodological approach used in the review articles of Milcu et al. (2013), Holleland et al. (2017) and Kemajou et al. (2020), a body of articles has been compiled through an extensive search of the Web of Science and Scopus databases to identify specific articles on digital technology and cities. ISI Web of Knowledge and Scopus are commonly used databases for bibliometric analyses and literature reviews. Although they are widely used, it should be noted that there are some biases in these databases, notably linguistically in favour of English and thematically in favour of the natural sciences, engineering and biomedical research as opposed to the social sciences and humanities. However, the databases cover the largest peer-reviewed scientific publishing houses: Elsevier, Taylor and Francis and Sage Publications, which house most of the journals on cities and ICTs (Kemajou et al, 2020).

We used several combinations of terms in English and French in the same search (1) "digital AND urban" (2) "digital AND city" (3) "smart AND urban" (4) "smart AND city" that had to be associated with the terms "Africa" and "development." Searches were carried out for "article title, summary, keywords" in all databases. The search excludes editorials, book reviews, book chapters, and includes articles written in both English and French. The research was conducted in March 2021 and a total of 477 articles were identified, published between 2010 and 2020. We excluded all articles that did

not focus on urban issues, as well as theoretical research papers that did not lead to a practical application. Finally, we retained 70 scientific papers (Appendix 1). We recognise that this selection does not include all the articles that mention digital technology in Africa, but it provides an overview of the most significant literature and draws reliable conclusions about the use of digital and new technologies in African cities and their role as accelerators in achieving the Sustainable Development Goals (SDGs).

The diversity of articles detected during a preliminary research on the use of digital technology in African cities, or more generally on the relationship between urban development and digital technology, illustrates that the city in the digital age is currently a fragmented area of research. To rally urban and digital research behind the shared goal of sustainable development, we consider it useful to identify key research topics specific to our objectives. We used a series of critical questions based on the review of background papers and expert advice to examine the relationship between digital technology, African cities and sustainable development. We obtained basic quantitative information on the urban discipline and methodology used, and then addressed the key factors and limitations of using digital technology for the purposes of sustainable urban development. Finally, we discussed the relationship between sustainable development and poverty. We answered the following questions: In what year was the article published? In which urban discipline was it published? These questions were

followed by selective questions to select the most relevant articles for further analysis: What is the scale of the study? What category of digital technology is covered? What is the methodology used? What are the key drivers of digital technology driving development? What are the limits of digital technology for development? Can digital technology contribute to sustainable development? Does the document specifically show the potential for cooperation between local authorities and the population based on digital technology? Does the document show the link between participation and the success of digital technology for development? Does the document show the role of the private sector in the use of digital technology in cities? Does the document link digital technology and social/environmental justice? For all these questions, a set of codes was developed to allow for a quantitative analysis of the answers. Thus, the codes used are usually keywords generated by the researcher.
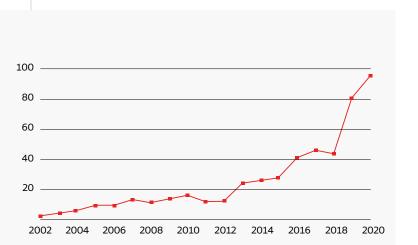
The state of research on digital technology and African cities

Research on digital technology is far from being in its infancy. On the other hand, the link between digital technology urban development and the assessment of its benefits has gained new interest over the past 20 years and has grown exponentially since 2010, justifying a focus on the last decade. The number of scientific studies published in peer-reviewed journals addressing both urban development and the role of digital technology in urban development has soared since 2012, increasing from about 10 contributions to almost 100 per year (Figure 5).

Among the 70 articles analysed, we were able to identify the key areas in which digital technology can be a driver of sustainable and resilient development of urban areas. Beyond the urban area addressed, the methodological approach is also important as it guides the use of tools

and their data for sustainable urban development. It should be noted that the field of urban planning, and therefore planning tools, is all too often dealt with solely from a qualitatively standpoint (Figure 6, p. 27). These are reflections, conceptualisations, lacking a tangible application of the tools in question (Bolay, 2019; Chelleri et al, 2016; Clarke et al, 2020). This demonstrates the need to apply so-called "smart" theories in African cities. This should be contrasted with the other four most studied fields: health, energy, environment and mobility. Quantitative methods are particularly prevalent in spatial health analyses, using remote sensing (Adeola et al, 2016; Weeks et al, 2012) or digital data collection (Abera al., 2017; Zhai, 2020), and energy supply optimisation (Diemuodeke et al, 2019; Mbungu et al, 2018; Numbi and Malinga, 2017). Another example is Mokoena and Musakwa, who have developed an Oracle-based

Figure 5.
Number of scientific publications citing digital use in African cities from 2000 to 2020
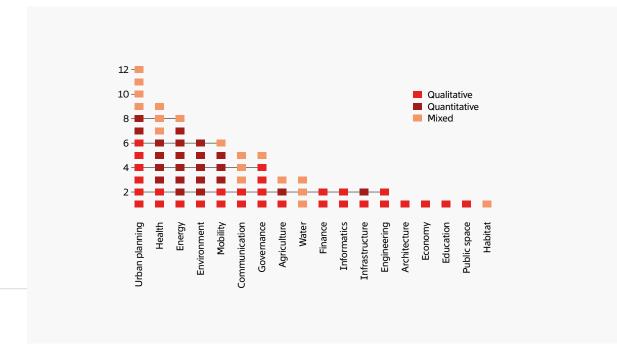
Figure 6.
Methods and topics
in research on
the use of digital
technology in cities

and web-based mobile GIS tool to perform the audit of the occupancy of informal settlements in Ulana, in the municipality of Ekurhuleni in South Africa. This tool identified, for example, that 27 households in Ulana have at least one disabled member, including 13 visually impaired, six physically impaired and three with multiple disabilities. While data collection tools for official censuses often miss persons with disabilities, the results indicate that the use of mobile GIS provides up-to-date, accurate, complete, and real-time data to facilitate the development of smart and integrated human settlements (Mokoena and Musakwa, 2018).
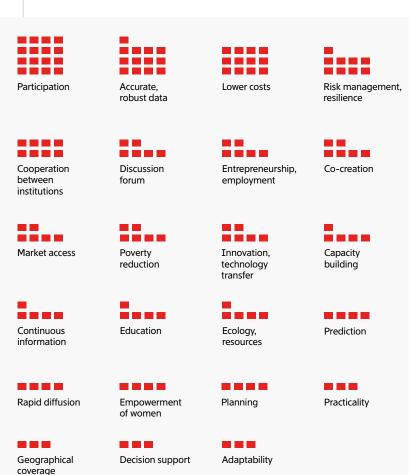
Digital opportunities and threats for sustainable development

The need for effective and efficient management of cities has emerged with their increasing complexity. As mass assemblies of people, combined with heavy physical infrastructure, cities are vulnerable to systemic and environmental risks (Oke et al, 2020; Slavova and Okwechime, 2016). By using ICT to process information as quantitative data, urban planners, investors and developers would be able to harness the computing power of computers, networked technologies and scientific knowledge to redefine the experience of urban living (Watson, 2020). The meaning of concepts such as "smart" and "technology" are used interchangeably, becoming an indication of the ability of information systems and technological tools to surpass human performance. The potential of the smart city as a driving force for empowering entrepreneurs (Steel, 2017), thus contributing to the formation of a thriving informal economy, would adequately mitigate the challenge of unemployment, for example. Modern technological advances are able to link the components of a city to its infrastructure (Chambers and Evans, 2020), thus improving the standard of living and the economic and social well-being of

its inhabitants. The scientific literature points to many benefits of digital technology (Figure 5, p. 26). For the city, on the one hand, providing a steady flow of accurate, robust data, lower operating costs, and better risk management to build the resilient and sustainable city of tomorrow (Figure 5, p. 26). On the other hand, digital technology also underpins socio-environmental and economic progress by promoting participation and inclusion, cooperation between public and private institutions, and innovation in a co-creative environment (Figure 5, p. 26). Also noteworthy is the strong correlation between digital technology and opportunities for poverty reduction as well as capacity-building and empowerment among women. This makes it easier for them to become self-employed. The series of questions posed by our methodological approach at the time of the literature showed that the scientific contributions reviewed clearly tended in this direction, with about three quarters of the articles showing a clear link between urban digitalisation and the achievement of the SDGs (Figure 7).

Africa's economy is undergoing rapid transformation driven by new digital technologies, with major implications for the 2030 Agenda for Sustainable Development. Increased levels of digitalisation in African economies and societies are creating new ways to address the continent's development challenges. However, there are risks that these changes will mainly benefit those who are already well prepared to create and capture value in the digital age, creating a new kind of social segregation rather than contributing to a more inclusive development (Figure 8, page 30). Technical and financial capabilities, the intra-urban but also rural-urban digital divide, data protection and transparency of procedures are challenges in Africa as in other parts of the world. The extent to which ICT will directly benefit people, especially the most disadvantaged, will essentially depend on their access to digital infrastructures (such as mobile money and the Internet) and the human skills needed to operate them. Beyond the broad and reliable penetration of mobile telephony and the Internet, the skill set needed to take advantage of new technologies is also required (Peprah et al, 2019). Countries need to improve the quantity and quality of education systems in order to exploit the opportunities offered by technology. In countries that are willing to adopt and disseminate digital technologies, skills development programmes – whether in formal or non-formal systems – should broaden their e-skills offerings to include elements ranging from basic e-skills (digital literacy) to

Figure 7.
Key drivers of digital technology for development.
(1 square = 1 article)

Participation

Accurate, robust data

Lower costs

Risk management, resilience

Cooperation between institutions

Discussion forum

Entrepreneurship, employment

Co-creation

Market access

Poverty reduction

Innovation, technology transfer

Capacity building

Continuous information

Education

Ecology, resources

Prediction

Rapid diffusion

Empowerment of women

Planning

Practicality

Geographical coverage

Decision support

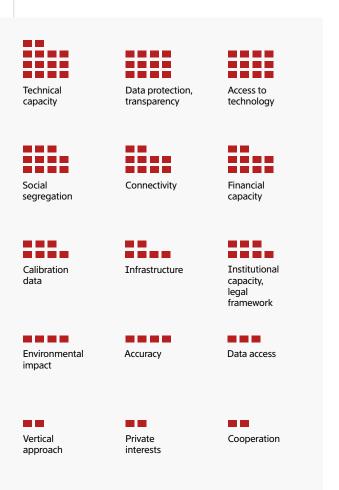Adaptability

more sophisticated training focusing on profession-specific tools and applications (Pfeffer et al, 2013).

These are real challenges with a view to creating cities that want to contribute to enhancing Africa's economies and its future. It should be noted that institutions and the legal framework rarely appear appropriate to take advantage of these innovations while limiting negative externalities such as environmental impact or control of competition by private interests (Figure 6, p. 27).

However, this analysis shows that meeting these challenges becomes easier when governments, universities, and industries work together (Lazaroiu and Roscia, 2018). For example, digital technology could facilitate learning between stakeholders to improve decision-making. In South Africa, various research initiatives linked to the University of Cape Town have been undertaken with the city, such as Mistra Urban Futures, FRACTAL and Climate Change Think Tank, which facilitate a city-wide understanding of climate change and sustainability issues between city officials and academics (Madonsela et al, 2019).

Through the literature review, including the explicit mention of the potential for cooperation with local authorities and the private sector (Figure 9), it is encouraging to note the increased focus and amount of research on innovative technologies, smart solutions and cloud computing by industry and academia in Africa. This shows that there is a genuine desire to harness the immense potential of digital technology in order to tackle the plethora of development challenges seriously on the ground and achieve a sustainable transformation of Africa's IT landscape.

Smart technology projects require relevant development models so that they can thrive in Africa without displaying premature and sudden decline. This would result in the

Figure 8.
Limitations on the use of digital technology for the sustainable development of African cities.
(1 square = 1 article)

Technical capacity

Data protection, transparency

Access to technology

Social segregation

Connectivity

Financial capacity

Calibration data

Infrastructure

Institutional capacity, legal framework

Environmental impact

Accuracy

Data access

Vertical approach

Private interests

Cooperation

73%

Can digital technology contribute to sustainable development?

60%

Does the document specifically show the potential for cooperation between local authorities and the population based on digital technology?

67%

Does the document show the link between participation and the success of digital technology for development?

Yes

DK
(do not know) means link is not clearly established in contribution

46%

Does the document show the role of the private sector in the use of digital technology in cities?

50%

Does the document link digital technology and social/environmental justice?

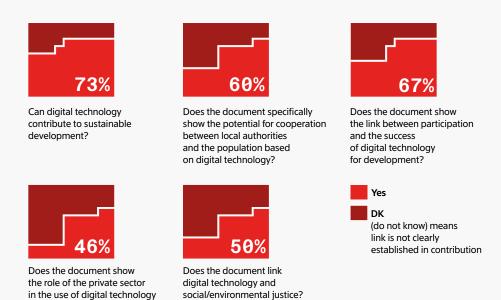Figure 9.
Role of digital technology in the development of African cities

termination of projects prior to implementation due to ineffective governance between partners or a lack of funding. The development and implementation of innovative and pragmatic models in Africa is long overdue as there is a lack of synergies between institutes of technology, universities, indigenous industries, multinational corporations, civil societies, and local, state and federal governments (Dogo et al, 2018). The current model of governance of technology projects in most African countries is not yet fully inclusive due to information isolation, which acts as a barrier to integrating resources into the process of implementing technology projects at the managerial and technical levels (Watson, 2014). There is a need to reform the existing modus operandi and to develop governance and project management model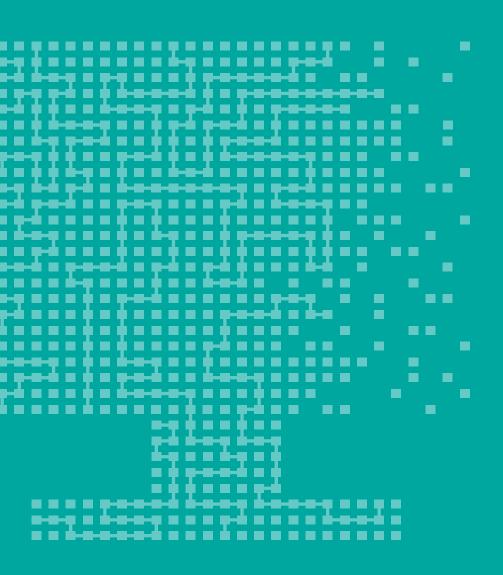s that will enable ICT data and services to be useful to citizens, accessible for decision-making, readily available and effective in meeting Africa's diverse development needs (Ranchod, 2020). This effort will open up a wider range of opportunities in African countries to ensure that their citizens, local businesses and government agencies are adequately prepared to reap the benefits of designing and developing smart applications and systems.

4.
Digital transformations in Africa

Infrastructure: a gap that needs closing rapidly?

Governance and cybersecurity

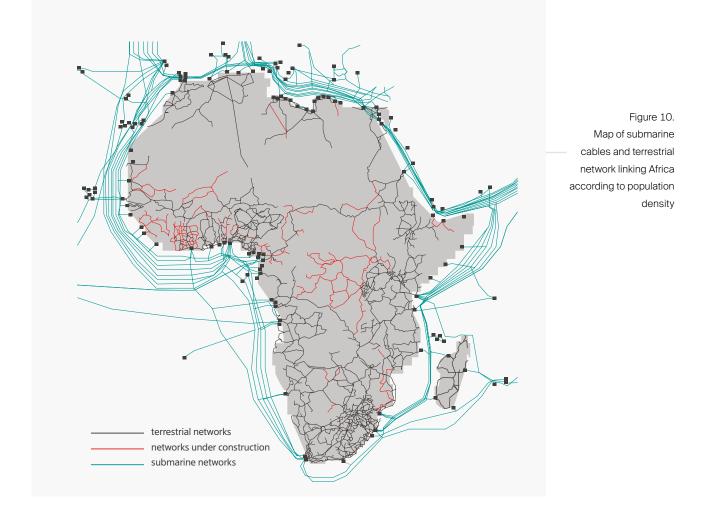**The different uses of digital technology in the city**

Infrastructure: a gap that needs closing rapidly?

The stakes are high, the African continent is lagging behind other parts of the world when it comes to digital infrastructure. However, we see that the infrastructure infrastructure and use of digital technology can be decoupled, reducing the implications of a deficient infrastructure.

At the heart of the digital infrastructure is first and foremost the supply of energy, i.e. the supply of electricity, which is undoubtedly the first and most important element, but also the Achilles' heel of any digital device. According to the World Bank, more than 600 million people are still forecast to be without electricity in 2030, many of whom will live in Sub-Saharan Africa. Only 42% of Africa is electrified, with huge disparities between the electrification rates of rural households and urban households in Africa of 22% and 71%, respectively. In addition to low access rates, households and businesses also often experience several hours of unpredictable power cuts every day, limiting the use of electricity for productive purposes (Beegle and Christiaensen, 2019).

In terms of telecommunications, global connectivity is provided by submarine fibre-optic cables (SMCs), which are used by almost all Internet communications, according to the United Nations Conference on Trade and Development (UNCTAD). In 2019, some 99% of all international data transmissions were made via these cables (Figure 10). The remainder of international telecommunications is provided by satellites (about 1%). The Internet is a network of connected channels that allow the flow of data from any point in the network to any other point in the network. Originally, Internet signals circulated over the copper wire network that telephone companies had established in most Western countries throughout the 20th century. Landline penetration in Sub-Saharan Africa has always been low, and in 2003, for example, there were only 1.6 subscriptions per 100 Sub-Saharan Africans. As a result, the region lacked a copper-wire network to carry the Internet, which made it difficult to transmit data across the continent.

terrestrial networks
networks under construction
submarine networks

At the same time, the transmission of data to and from Africa was also a major challenge. In 2008, only three submarine fibre-optic cables connected the entire African continent to the Internet, two of which landed in North Africa. Thus, until 2009, Sub-Saharan Africans had to rely on a single old-generation submarine cable for their connection. Over the past decade, African connectivity has improved dramatically. Today, a number of submarine cables along Africa's coasts transfer data to central servers, where data is transmitted across the continent via a complex network of copper wires, fibre optic cables, cell towers and satellites to telephones, smartphones, tablets, laptops and industrial computers. The rapid increase in Internet-enabled mobile phones has enabled more Africans to connect than ever before.

However, in West Africa, more than 61% of the population is still disconnected from the Internet, with connectivity unevenly distributed across the continent. Often, those who connect can only do so through expensive and unreliable connections. While coastal countries with a direct connection to undersea cables enjoy the benefits of high-speed Internet, landlocked West African countries have to rely on less efficient wireless substitutes due to the shortage of terrestrial cables (Figure 10).

Even in countries with a direct undersea landing port, some have only one undersea cable linking the country. For example, a misplaced anchor of a vessel causing a small tear or scheduled maintenance on the cable may result in prolonged Internet outages. As a result, even countries with a direct

submarine cable port continue to experience regular Internet slow-downs and downtime. In May 2020, a consortium of major companies such as China Mobile International, Facebook and Orange announced plans to build a new 37,000 km long submarine cable that will carry out 21 landings in 16 African countries. Other initiatives by private actors, such as Starlink and Google, will also contribute to infrastructure development in the near future (see Chapter 6 on private actors).

Since neither landlines nor cable television have ever been particularly popular in Sub-Saharan Africa, the region still lacks an adequate telecommunications cable network. In addition, mobile phones are much cheaper to buy and easier to use than more sophisticated devices (such as personal computers) with wired connectivity capability. As a result, Internet adoption in Africa has been largely boosted by mobile phone penetration. More recently, the advent of cheaper smartphones has brought more Internet to even more people in Africa. In its 2019 report, the GSMA predicted that 3 G (which allows faster browsing and downloading) will overtake 2G to

become the region's leading mobile technology. Most West African countries lag behind the rest of Sub-Saharan Africa in broadband Internet penetration, apparently due to low 3G coverage. This first finding thus highlights the insufficient coverage of terrestrial telecommunications infrastructure as the first barrier to mobile Internet (Goujon and Cariolle, 2019)[3]. In terms of mobile phone subscribers, West Africa does not lag behind other African countries on average. In this case, the deployment of the mobile Internet infrastructure would be a major lever for improving Internet access in West Africa.

Reliable mobile phone connections have not yet reached all regions, although more than 70% of the African population has a mobile phone subscription. And Internet penetration is just beginning. Technological advances are, however, making new leaps forward.

Another facet of the digital infrastructure is data centres. Most data centres are located in developed countries and only 2% of these centres are located in Africa due to the very high energy costs of their cooling systems (UNCTAD, 2019). However,

3
Michaël Goujon, Joel Cariolle. Infrastructure and the digital economy in Africa Sub-Saharan Africa and WAEMU: state of play, actors, and new vulnerabilities. 2019

data centres are increasingly being established in low-income countries with the aim of keeping data closer to users, reducing latency times and lowering the cost of using broadband.
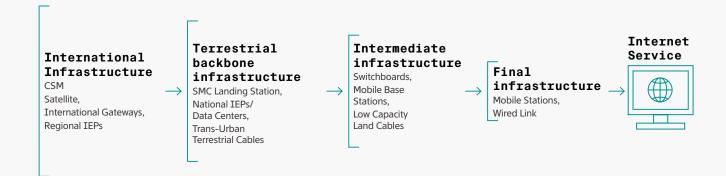
For example, in 2021, Senegal chose to transfer all its government data and digital platforms currently hosted on servers abroad to a new national data centre, with the aim of strengthening its digital sovereignty. Worth 46 billion CFA francs (approximately 70 million euros), the data centre was financed by a Chinese loan and built with the Chinese multinational Huawei, which provided the equipment and technical assistance (RFI, 2021).

The first phase of the new facility opened in early 2022 and offers hosting services to businesses and other public bodies. The data centre is connected to global networks via a submarine cable and to the country's 6,000 km-long fibre optic network.

Connectivity in Africa has improved dramatically over the past decade. Global, national and private initiatives have made Internet connections more accessible across the continent and created new opportunities for employment, socialisation and education. However, as more and more Africans connect to the Internet each year, several challenges remain.

Figure 11.
Digital infrastructure and value chain of Internet access

International Infrastructure
CSM
Satellite,
International Gateways,
Regional IEPs

→

Terrestrial backbone infrastructure
SMC Landing Station,
National IEPs/
Data Centers,
Trans-Urban
Terrestrial Cables

→

Intermediate infrastructure
Switchboards,
Mobile Base
Stations,
Low Capacity
Land Cables

→

Final infrastructure
Mobile Stations,
Wired Link

→

Internet Service

Today, the Internet is still out of reach for much of the continent's population. Mobile data is particularly expensive, with African users paying, on average, the highest prices for mobile data in the world relative to their monthly income. And in areas where physical Internet connectivity is possible, the cost of the data plan or digital device needed to connect makes broadband unaffordable for most Africans. Finally, high levels of digital illiteracy across the continent make it difficult for many Africans to make the most of the Internet once they are connected. If the impact of new technologies is to be economically visible and benefit everyone, greater public and private sector commitment is needed to strengthen digital infrastructure in Sub-Saharan Africa (World Bank, 2016).

Governance and cybersecurity

Infrastructure is only one aspect of the use of ICT for sustainable urban development. For people to benefit from digital services, governments must ensure that appropriate regulations and consumer protection safeguards are in place. Regardless of the technology used, digital services must be tailored to the needs of groups that are not usually the primary beneficiaries of progress, such as women, the poor and new users, who may have low literacy and numeracy levels.

While Internet connectivity has generated new innovative services, new capabilities and new forms of sharing and cooperation, it has also generated new forms of crime, abuse, surveillance and social conflict. Internet governance refers to the rules, policies, standards and practices that coordinate and shape global cyberspace. The many problems associated with the use of digital services cannot be addressed by traditional territorial national institutions alone. Governance involves a polycentric, less hierarchical order; it requires transnational co-operation between standards developers, network operators, online service providers, users, governments and international organisations.

It is difficult to imagine that Sub-Saharan Africa can "go to the next level" in digital technology unless governments develop and update their national digitalisation strategies, ensure regional interoperability of those strategies, and work with their foreign partners to add digital provisions to their agreements. The scarcity of digital arrangements in Sub-Saharan Africa threatens to slow down the region's digital transformation, without which governments cannot facilitate secure and sustainable digital growth. According to the Organization for Economic Co-operation and Development (OECD),

28
African countries
have comprehensive legislation on the protection of personal data

11
African countries
have adopted substantive laws on cybercrime

by 2021, only 28 African countries have comprehensive personal data protection legislation, while only 11 countries have enacted substantive cybercrime laws. The lack of digital strategies and legislation leads to serious security gaps that leave countries vulnerable to the misuse of digital platforms and data. According to the Center for Strategic Studies in Africa (CESA), African governments face a rapidly evolving set of digital threats – critical infrastructure sabotage, organised crime and the use of technology for military use – from a variety of actors. For this reason, African governments should focus on three key issues – intellectual property (IP) protection, data protection and cyber security. Policymakers in many African countries have made tremendous strides in developing regulatory frameworks for technology and the Internet in Sub-Saharan Africa. These policies have helped fuel vibrant technology ecosystems and growing digital economies in many parts of the continent (see Chapter 6, p. 75).

At the same time, there are other challenges Internet governance in Africa. Across the continent, government-imposed Internet cuts, emerging tax regimes for social media, and a lack of access to finance, among other existing and ad hoc technology-related policies, complicate and hinder market access, growth and innovation for online users and technology entrepreneurs. Internet cuts by some African governments are particularly problematic for digital rights. Data and privacy protection has become a sensitive issue for Internet governance in Africa due to events regarding influence and interference in elections in various countries, as appears to be the case in Kenya and Nigeria.

E-Government

Sometimes when we talk about Internet governance, we also think about e-government, or electronic administration, which covers the use of information and communication technologies made by governments to carry out their functions.

Interestingly, the topic of urban governance as seen through the technological prism, or "smart governance," is an important topic for sustainable urban development. One of the pillars of digital governance is to foster transparency by improving service delivery and promoting citizen engagement through ICT (Pretorius and Sangham, 2016; Willems, 2019), simplifying citizen and business interaction with government, and improving empirical decision-making in cities (Loideain, 2017; Ranchod, 2020). Although the definition of smart governance remains unclear in the literature, it is generally accepted that it consists of two essential elements: (i) it focuses on using different forms of empirical evidence to strengthen evidence-based decision-making for better governance, and (ii) it encourages wider collaboration through the inclusion and involvement of civil society actors in urban decision-making processes. However, it would be worthwhile to implement these recommendations in practice, in particular by applying quantitative methods with measurable indicators enabling long-term monitoring of smart governance models.

The Rwandan example?

Rwanda has become the spearhead of smart governance and is also home to the Smart Africa initiative, which has two objectives: to make ICT a driving force for the continent's socio-economic development and to provide fast and reliable broadband Internet access for all. Jean Philbert Nsengimana, former Rwandan Minister of ICT and Youth, said in 2016 **"We are really on the verge of making this dream a reality. In Rwanda, for example, most of the government's administrative services are now online, which has increased efficiency, dramatically reduced bureaucracy and eliminated corruption."** Rwanda wants to be a pioneer in the digitalisation of public services such as the management of birth and death certificates, land transactions and registration for driving licences. These services, among others, are now available online in Rwanda. Despite persistent connectivity challenges, the country has also deployed innovative services such as the use of drones to transport blood donations, medicines and vaccines (UCLG, 2016).

Rwanda wants to become an important centre in digital Africa, and to that end it is investing more in the development of the Rwandan university. It plans to train 5,000 engineers a year, compared to 2,000 today through several training centres in the country.

The potential uses of digital technology in urban development range from the use of technology by governments to fight crime and ensure public safety to the development of municipal infrastructure that makes services more accessible to all, to ensuring that all urban dwellers have effective and widespread access to digital technology for their businesses and researchers.

Conceptually, the notion of "smart" in urban centres goes beyond the instrumentation of urban infrastructure and environments and is linked to knowledge-based economies, where learning and education create the conditions for innovation, creativity and entrepreneurship (Allwinkle and Cruickshank, 2011). Governance – the process of designing and implementing policies – underpins every aspect of countries' development and the functioning of their institutions (Beegle and Christiaensen, 2019). This smart governance model typically focuses on two key elements: (i) the nature, type and use of data to strengthen evidence-based decision-making for better governance, and (ii) collaborative governance through the inclusion and involvement of civic actors in urban decision-making processes (Ranchod, 2020). It requires relevant public authorities to engage in ongoing consultation with all relevant stakeholders, e.g. individuals, civil society, academia and the private sector, throughout the design, implementation and review of ICT systems. Moreover, the implementation of a governance system that combines transparency with rigorous monitoring and respect for human rights also ensures a deeper consideration of the potential threats to the rule of law posed by the development of smart cities, such as disproportionate monitoring and corruption.

The development of city governance founded on data produced by digital technology and technological advances could mark the beginning of a systemic encroachment on the independence, freedom and privacy of individuals. A survey on Internet security and trust conducted by the Center for International Governance Innovation (CIGI) and Ipsos found that 78% of Internet users in 25 countries, particularly in Africa, were at least somewhat concerned about their online privacy (CIGI-Ipsos et al, 2019). The most concerned were in Egypt and Nigeria, where the proportion was 90% or more. Conversely, the lowest level of concern was in Kenya, at 44%.

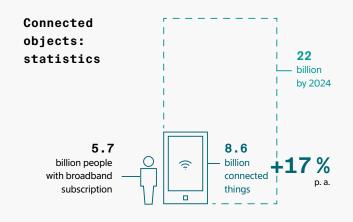# The different uses of digital technology in the city

The digitalisation of African cities encompasses advances in communication, data management, the evolution of the Internet of Things (IoT) an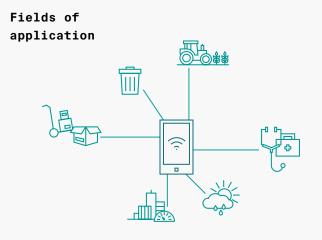d a set of physical networks for smart business management. Creating a new archetype of urban management and development requires a favourable framework to achieve better functioning and sustainability for all urban dwellers. This is necessary to advance the control and efficiency of urban activities, as well as to facilitate

participation and promote inclusion by taking advantage of and using modern technologies. As discussed in previous sections, it has become clear that a successful approach to the use and integration of ICT in cities goes beyond technology to enable government, individuals and businesses to make better-informed decisions and improve the sustainable functioning of society. Three essential and interdependent uses of digital technology in African cities have been identified: the Internet of Things (IoT), analytics (data analysis) and mobile phones.

Internet of Things

The Internet of Things (IoT) refers to Internet-connected devices such as sensors, metres, radio frequency identification chips and other instruments that are embedded in everyday objects, enabling them to send and receive various types of data in real time. These objects are connected to the Internet by wireless or wired means. Sensors are used through various types of local connections such as RFID, near-field communication, WI-FI, Bluetooth, etc. More broadly, the IoT can be defined as a technological base and backbone consisting of interconnected devices and sensors. The set of services, platforms, protocols and other technologies required to provide functionality, collect data from

Connected objects: statistics

22 billion by 2024

5.7 billion people with broadband subscription

8.6 billion connected things

+17 % p. a.

Fields of application

43

Internet of Things (IoT) to ensure vaccine cooling in Burkina Faso

In 2015, a 30-year-old Burkina Faso engineer from the Polytechnic University of Bobo-Dioulasso, Burkina Faso, found the solution to secure the transport of vaccines. With the support of the incubator of the International Institute of Water and Environmental Engineering (2iE), he created the "Laafi Bag," a smart bag that uses the Internet of Things. In a backpack, an insulated box, coupled with a thermoregulation system, allows vaccines to be kept at the temperatures recommended by the World Health Organization (WHO) for more than four days. That's four times as long as other vaccine carriers. The temperature of the Laafi Bag can also be controlled remotely, a way to ensure that at no time during transport have the vaccines been altered by thermal variation.

peripheral devices and have the ability to communicate and exchange information over a network is called an "ecosystem." It has a basic framework consisting of electronics, firmware, software, sensors, etc. with three key features that enable it to function: interconnection, intelligence, and instrumentation (Mohanty et al, 2016). Portable devices, smartphones, smart electronics and smart home instruments are just a few examples of the IoT. Many IoT applications can be essential for cities, including energy metres, radio frequency identification of goods for manufacturing, livestock and logistics, agricultural soil and weather monitoring, and portable technologies. According to Ericsson, there were more things (8.6 billion) connected to the Internet in 2018 than people (5.7 billion mobile broadband subscriptions), and the number of "Internet of Things" connections is expected to grow by 17%

per year, to exceed 22 billion by 2024. In this increasingly connected world, many African countries have already taken advantage of the Internet of Things, ranging from caregivers who monitor patients' health through tele-medicine, to utilities that use connected metres to track consumption trends, target outages, and anticipate peak demand (Ndubuaku and Okereafor, 2015).

From the same environmental and health protection perspective, the University of Rwanda has developed an IoT system for monitoring air quality. The aim is to develop cost-effective and sustainable systems that provide real-time information and alerts on the amount of pollutants in indoor environments. The system tracks carbon dioxide (CO_2) and elemental particles (PM2.5) using environmental sensors and a low-cost micro-controller to collect data and send it to an open source IoT cloud platform for analysis, storage and visualisation.

The readings of the parameters detected are sent to the cloud and algorithms allow real-time processing and access to the measured data. They are then compared with measured historical values and World Health Organization baselines. For policy makers, data is sent to a web user interface (Tawhirwa et al, 2020).

Analytics (data analysis)

Analytics refers to the smart applications and data analytics capabilities that can be used to turn primary or secondary data into alerts, signals and information that end users and decision makers can use. It involves extraction, manipulation, analysis, organisation and decision-making functions. This digital use is the interface between the IoT and the governance components. One of the most emblematic examples of analytical tools is Geographic Information Systems (GIS).

These are sets of technologies designed to link information to a geographic location, which is useful for combining a massive amount of information from a wide range of sources, including real-time data on weather, natural systems, and participatory data collection sources (e.g. OpenStreet Maps), making it an essential part of efficient operation if cities go digital. However, in order to be effective, the maps and data on which GIS is based must contain up-to-date, relevant information that is easily and quickly accessible. This is one of the main challenges to the use of GIS in African cities. Fortunately, the massive growth in the use of GIS tools has led to the development of innovative processes for collecting, sorting and analysing spatial data, including through the use of participatory approaches and remote sensing. There are many fields of application: software development, agriculture, transport and mobility, climate change and risk detection, public health, etc.

Despite many projects conducted in Africa over the past two decades, services based on remote sensing data are still limited, mainly due to the lack of local expertise in the production and use of remote sensing data, and the lack of interaction between data providers and users. Numerous types of high-quality spatial data are already available such as products for terrestrial biophysical variables (leaf area index, soil moisture, surface temperature, spectral vegetation, etc.), land use and land use maps such as the Burkina Faso Land Use Database (BDOT) at a scale of 1:100,000 produced by the Burkina Faso Geographical Institute (IGB), and satellite imagery from the Sentinel-2 Earth observation satellites operated by ESA and NASA's Landsat-8. Beyond the physical features of equipment, infrastructure, data, and training that would explain the low quality of existing products or their limited use, it appears that remote sensing and space technologies are not recognised at any decision-making and evaluation levels in the fields of urban management and development (Tonneau et al, 2019).

Using remote sensing and geographic information systems (GIS) to prevent the effects of urban flooding

In recent years, urban floods in West Africa have become increasingly recurrent, with a devastating impact on poor communities. Africa's vulnerability to climate change is compounded by a number of factors, including population growth, rapid urbanisation and weak disaster preparation and response mechanisms.

Effective flood risk management can be supported by the use of technologies throughout the disaster management cycle: prevention, preparation, response and recovery. Technologies such as remote sensing and geographic information systems (GIS) can help reduce and mitigate flood risks by providing reliable, near-real-time data over large areas. The data provided contribute to the reduction and mitigation of flood risks and to humanitarian action in the form of rapid flood mapping.

The introduction, use and integration of geographic information systems (GIS) have already improved the way urban floods are managed. Maps and tables containing alphanumeric data related to the characteristics of the flood areas have been used to present information. Various aspects of the elements causing floods, such as storm runoff, precipitation, river flow, drainage systems, groundwater depth and slope, have been modelled using a number of GIS techniques.

Researchers believe that the use of remote sensing and geographic information systems (GIS) may provide decision-makers with access to appropriate spatio-temporal data to monitor climate change emergencies related to seasonal floods, but the cost of acquiring aerial or spatial data and data processing expertise may limit the use of this technology in some countries.

An example of this recognition is the implementation by the City of Cape Town of one of the first research and data strategies to improve decision-making for the city with an evidence-based approach. The objective of this strategy is both to ensure that sector institutions and universities make the most of the data they already have, and to identify significant data gaps and how to address them (Haas and Kriticos, 2018).

Mobile phone

In just a few years, the proliferation of mobile phone networks has transformed communications in Sub-Saharan Africa. It has also enabled Africans to skip the stage of landline development and move directly into the digital age.

In addition to being a means of communication, mobile phones are widely used in Sub-Saharan Africa to make or receive payments (mobile money). It is also an important means of learning about politics, accessing social networks, obtaining information about health and medicine, and searching or applying for a job offer.

Mobile telephony in the urban context permeates various dimensions of social life, including financial transactions, transport practices, small businesses and, increasingly, e-health.
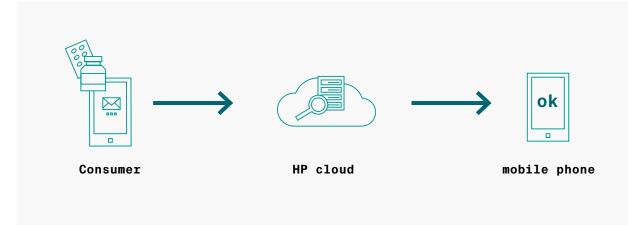
The mobile money financial services sector is expanding rapidly in the West African sub-region. The experience of countries in Eastern and Southern Africa confirms that mobile money offers a unique opportunity to encourage and strengthen financial inclusion with the potential to increase economic growth. Effective financial systems are essential to poverty reduction, and inefficiencies reduce the ability of financial inclusion to generate growth and reduce inequalities. Traditional banking institutions have high transaction costs, making it very difficult for the poorest households to maintain savings and deposit accounts. Among those working in the informal sector or in low-income occupations, a mobile money account is the most commonly used means of paying or being paid for a service.

West Africa has become a pioneer in Africa's mobile money revolution. The West African sub-region experienced the largest increase in the number of registered accounts (14.5%) and the value of transactions (34.9%). There are now more mobile money services available online in West Africa (59) than in any other region of the world (GSMA, 2019). During the COVID-19 pandemic, digital payments were increasingly used to reduce the risks associated with exchanging cash. This is the case in Senegal, where it has become common practice to pay for a taxi with Orange Money, the most popular mobile money service in West Africa, provided by the French telecommunications group Orange.

In the coming years, thanks to falling prices and a new generation of "digital natives," the GSMA (Global System for Mobile Communications Association) predicts a significant increase in smartphone use in Sub-Saharan Africa, which in 2020 has already reached 50% of all connections. Connecting to 3G and 4G networks via a smartphone provides the opportunity to improve access to information and other services.

We find several examples of tele-medicine and the use of social networks for health promotion throughout the region. Mobile phones have been used to obtain maternal health support in South Africa, detect fake drugs in Ghana and access a digital health financing platform in Kenya.

As mobile telephony and device prices fall, mobile phones are changing and becoming increasingly accessible to people of all income levels. Mobile operators continue to innovate to reach more subscribers and new solar-powered phones have recently been rolled out on the market. The challenge now is to develop appropriate policies to assess and spread the benefits of mobile phones across the continent.

Consumer → **HP cloud** → **mobile phone**

Fighting counterfeit medicines with an SMS

Only 3% of the drugs consumed in Africa are produced on the continent. This often involves a long pharmaceutical supply chain that drives up drug prices. These high prices often discourage patients, who end up buying products in the street. As a result, more than 1,000 people die each year in West Africa alone from poor quality drugs (World Health Organization – WHO).

A Ghanaian company (MPedigree) has developed a simple technology that allows consumers to check whether their drugs are genuine or fake. It is simply a case of scratch an area of the package on the medicine box to reveal an ad-hoc code and then sending it free of charge by SMS; the system then sends an instant reply via the same channel: "OK" or "NO," meaning that the product is clean or unfit for consumption. Since its launch in 2007, MPedigree estimates that millions of lives have been saved, even though it is difficult to quantify accurately the impact of this digital system.

Figure 12.
The mPedigree/HP
system to combat
counterfeit medicines

5.
New technologies to meet the challenge of rapid urbanisation

Digital innovation and development

Potential of innovation to combat poverty

Limitations of innovation projects in Africa

Digital innovation and development

The majority of African countries are making progress in terms of digital accessibility and use (Figure 3, p. 18 and Figure 4, p. 20). Complete digitalisation now presents itself as a societal horizon to be built. Against this backdrop, there is a widespread use of the term ICT (Information and Communication Technologies). While ICT is presented as one of the keys to economic growth and development in Africa, it is worth noting that States invest little in producing information for digital players. The term ICT is often used without diagnosing existing technologies and data and without considering the specific needs of each business sector or the limitations of the existing institutional and legal framework. As a result, many players face difficulties in establishing and developing their technologies on a sustainable basis.

Despite the technical and institutional constraints on the growth of the digital economy in Africa, technology and innovation hubs have emerged. Digital hubs present themselves as incubators of a dematerialised ecosystem conducive to the development of digital entrepreneurship and partnership. It is therefore a question of securing investors and entrepreneurs by offering them digital training services, support for the creation of start-ups, integration into platforms and stakeholder forums in order to forge partnerships on digital innovations.

As niche players, hubs present themselves as having the ability to solve economic, social and environmental problems through the tools of digital entrepreneurship and business innovations (Jiménez, 2018). The number of such structures in Africa increased from 442 in 2018 to 618 in 2019 (including 22 in Côte d'Ivoire and 14 in Mali), an increase of 39.8% (Giuliani and Ajadi, 2020). The growing attention to, and rapid expansion of, innovation spaces not only show

the strong support of entrepreneurs for the economic potential of digital technologies, but also the rapid integration of digital technologies to meet the challenges of development, including sustainable development. Schmitt and Muyoya (2020) found that all major initiatives linked to one of these hubs supported digital solutions for sustainable development. This opens up new opportunities for Africa, as digital technologies are no longer just imported: innovation spaces are creating development environments conducive to the creation of local and specific solutions.

AfriLabs is one such key hub for regional digital start-up and innovation projects in Africa. AfriLabs was founded in 2011 and is headed by Rebecca Enonchong, a Cameroonian businesswoman known for her pioneering role in digital technology in Africa, notably by the World Bank and the World Economic Forum. AfriLabs supports a network of 268

incubators in 48 African countries and positions itself as one of the matrices of digital innovation in Africa. It aims to accelerate innovations that promote economic growth and job creation through innovative digital governance, in particular including local universities.

Research on these hubs shows that integrating universities with digital innovation hubs to move towards R&D is another important step in economic growth (Lazaroiu and Roscia, 2018). Indeed, research institutes and universities have the ability to influence the course of policy on urban development. They bring new talent to the innovation market in exchange for societal ownership of job opportunities and basic infrastructure. Thus, AfriLabs has entered the fields of development and action research with African universities. For the French Development Agency (AFD), AfriLabs is a key intermediary in reaching 600 hub managers, 3,600 entrepreneurs

and developers from West Africa, but above all 200,000 stakeholders in Africa's technology and innovation ecosystem, according to its sources.

Like AfriLabs, digital hubs demonstrate a strong ability to invest and internationalise their activities, reflecting the strength of their business networks in which international telecommunications players, notably GAFAM[4], play an important role. However, if their anchoring and development are linked to strong international and local demand, these hubs are victims of their dematerialisation: the links between entrepreneurs are weak, especially between those who make up the local nucleus of the cluster. Observable connections between the hub's communities

are orchestrated by organisations through annual international events.

Despite these structural weaknesses, which cast a doubt over the real possibilities for synergy and diffusion of technologies on the continent, these hubs have become dominant in the digital landscape. While the AFD is investing in capacity building in the digital sector, other players are giving these hubs an innovative place. This is the case, for example, of the German cooperation (GIZ) which financed the Smart Cities Innovation Programme (see box).

4
GAFAM stands for the web giants – Google, Apple, Facebook, Amazon and Microsoft – who are the top five US companies that dominate the digital market.

Smart Cities Innovation Programme – accelerating digital urban innovation

The Smart Cities Innovation Programme, funded by the German Cooperation (GIZ), is an accelerator that aims to support young, high-potential start-ups operating in the fields of smart mobility, smart housing and affordable finance, within communities. Based in Rwanda, this programme – open to other African countries – will provide 30 start-ups with individual mentoring, training and intensive networking as well as putting them in touch with international business partners and investors such as Volkswagen, Siemens and the African Business Angels Network (ABAN), among others. The criteria are simple: be based in one or more African countries, have a socio-environmental impact, and have growth prospects coupled with job creation (SCIP Africa, 2021).

In addition to free participation, start-ups will also be able to use Green City Kigali, Rwanda's flagship smart city project, as a "living lab": a real-world application to test their solutions. The results of the initiative are expected by the end of 2021.

The proximity between Lagos University, political and economic authorities, a notable start-up incubator, GAFAM and international telecommunications figures in Africa has made Nigeria the most advanced country in innovation and support for digital development in West Africa.

In West Africa, the number of digital start-ups is now over 900 (StartupRanking, 2021), making it the most vibrant region in Sub-Saharan Africa from an entrepreneurial perspective. However, West African countries show significant disparities in the development of these digital ecosystems (see Figure 8). For example, Nigeria stands out with the existence of the Yabacon Valley, ranked as one of the five major digital hubs in Africa. Created in 2010 to enable economic operators to bypass the congestion of cars in the centre of Lagos and offer development opportunities for this new digital industry, Yabacon Valley initially welcomed the major players in the telecommunications industry in Africa, followed by CChub, one of Africa's largest hubs, also involved in the KTN Global Alliance Africa project. In the second half of the 2010s, Marc Zuckerberg's move to Yabacon Valley followed the installation of a start-up incubator NG_Hub by Facebook and the Google Launchpad Space in Lagos. GAFAM's investment in the emergence of local digital skills

has led to an explosion in the number of start-ups in Nigeria, positioning Yabacon Valley as a prime location for investment: 20% of Africa's fund-raising activities are now carried out in the digital sector. The proximity of Lagos University, political and economic authorities, a notable start-up incubator and GAFAM, not to mention the international telecommunications figures in Africa, has made Nigeria the most advanced country in innovation and support for digital development in West Africa.

In the rest of the region, while digital ecosystems are less developed and more fragile, political efforts and investments in telecommunications support a clear momentum for the development of the digital sector. Côte d'Ivoire, for example, demonstrated significant political investment in this area by supporting, in the second half of the 2010s, the digitalisation of some of its public services (national education, land registry and land services, customs services, hospital services, the fight against cybercrime). The advent of a digital university in the late 2010s for 3,500 students is a symbol of the place that digital technology plays in the construction of the future horizon (see Chapter 6, p. 91).

The results can already be seen in terms of technology runoff in Ivorian society. The Fondation Jeunesse Numérique, headed by telecommunications engineer Linda Nanan Vallée, plays an important role as an incubator of digital innovations in Côte d'Ivoire. It has so far supported the incubation of more

than 260 digital projects and around 50 start-ups. One of these start-ups, Moja Ride, offers a mobile money travel booking and payment system in Abidjan (see box). The trajectory of this digital start-up in Côte d'Ivoire illustrates the "technological leap" which visionary digital technology entrepreneurs in Africa are capable of. The technological leap, successful in the fields of telephony and mobile Internet, has been highlighted many times in the scientific literature on Africa (Pretorius and Sangham, 2016; Willems, 2019). Thus, despite the infrastructural and institutional weaknesses in Côte d'Ivoire, Abidjan continues along its path to becoming the leading innovative ecosystem in French-speaking West Africa, with more than 20 innovation hubs. They include Seedspace, a connected co-working hub active in emerging countries, as well as four Jokkolabs – spaces for co-working and supporting digital projects, imported from Dakar. The entrepreneurial capacity of African companies in the digital economy is recognised by governments and private actors. In Senegal, Orange set up Orange Digital Ventures Africa (ODVA) in 2017, a €50 million investment fund dedicated to economic and social innovation projects based on mobile applications. The government has launched a 25-hectare Digital Technology Park (PTN) project in Diamniadio, on the outskirts of Dakar. A cornerstone of the "Digital Senegal 2025" national digital economy strategy, this technopole aims to support a genuine digital research economy in order to support West Africa's digital ecosystem. The park will offer hosted companies an entire connected environment, including a data centre, an audiovisual production studio, as well as training and research institutions: 100,000 direct and indirect jobs are expected from the creation of this digital ecosystem. In addition to Côte d'Ivoire and Senegal, all countries in the region, such as Mali and Togo, show signs

In Abidjan, Moja Ride offers a cash-free travel booking and payment system – online or by specific card – for all 35,000 group taxis ("Woro-Woro") and 8,000 minibuses ("Gbaka") in the Abidjan metropolitan area. The success of the initiative, which allows drivers to identify transport needs, save time at each stop, enjoy greater transparency in the management of the sums collected, not to mention reducing disputes and stress over the issue of extra charges for users, has pursued its development and integration into everyday life. One year after its launch in 2020, Moja Ride will partner with O-CITY, owned by the US investment bank BPC, which operates in 130 cities around the world, to develop its payment platform.
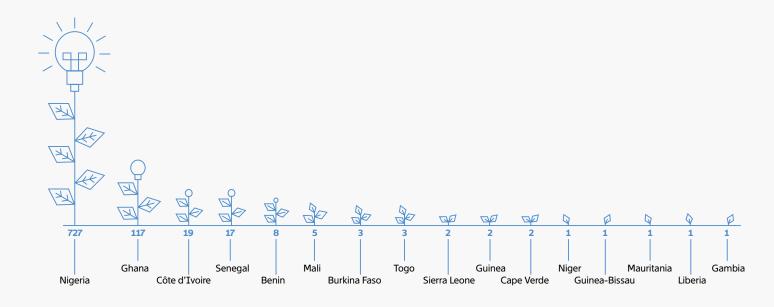
Figure 13.
Number of start-ups in West
African countries in 2020

of rapid growth in digital innovation. Emerging and growing ecosystems are present in Benin, such as Sèmè City, and Burkina Faso (Giuliani and Ajadi, 2020). These innovation and digital solution ecosystems are positioning themselves as essential elements in building inclusive and sustainable urban frameworks in Africa across a wide range of sectors. In Mali, the Map Action application (see box Chapter 6, p. 73) enables participatory mapping in order to record, analyse and transmit data on local environmental problems, enabling participatory management of environmental and health problems in cities. In the same vein, the start-up Capture Solutions

West Africa in Nigeria and Digital Smart Trash in Côte d'Ivoire aim to optimise urban waste management and recycling through the Internet of Things (IoT) by creating a virtuous circular economy ecosystem along the entire urban waste value chain.

Potential of innovation to combat poverty

The increase in the urban population between now and 2025 calls for a reflection on the structure of cities, which need to rethink their management and development models in order to offer their inhabitants more appropriate, stable and sustainable infrastructure and public services. Digital technology offers solutions to alleviate poverty in Africa by improving people's daily work performance. The World Bank acknowledges that this can only happen if public policies promote three elements: (a) removing barriers to the adaptation of technologies to local conditions and their percolation at all levels, (b) building a broad network of cross- and intra-sectoral skills among consumers and producers of these technologies, and (c) building an appropriate ecosystem to take advantage of the new opportunities offered by technologies (Beegle and Christiaensen, 2019). In this context, the use of technology is emerging as a serious avenue to address the physical challenges of transportation, energy and housing, but also as an opportunity to merge the digital economy into the local entrepreneurial ecosystem (Beegle and Christiaensen, 2019). Today, population growth and migratory pressure, particularly due to rural-urban migration, make urban areas overcrowded, congested, polluted and unaffordable for a large proportion of the population. It is estimated that 72% of urban dwellers in Sub-Saharan Africa live in so-called "informal" settlements or precarious neighbourhoods, often in temporary structures with no land security. In 2021, it is estimated that 490 million people were living in extreme poverty in Africa, accounting for 36% of the total population. This figure was up from 481 million in 2019 (Hendrik Human, 2021). According to current trends, only two of Africa's 46 Sub-Saharan countries are on track to meet their SDG targets 1 to eradicate poverty in all its forms: Mauritania and Gabon (Hendrik Human, 2021).

Extreme poverty is particularly prevalent in cities where more than 50% of the population still lives in precarious neighbourhoods in Sub-Saharan Africa, compared to 13% in North Africa (UN-Habitat, 2020).

Agriculture and digital technology: a triple objective

Following the social and economic crises caused by the COVID-19 health crisis in 2020, Africa saw nearly 40 million people plunge into extreme poverty (AfDB, 2021). In addition to natural hazards such as the drought in the Sahel and the invasion of locusts in East Africa, this has put additional pressure on the continent's agricultural systems. Africa's food systems should be more resilient to floods, droughts and disease. This must be coupled with an urgent and sustainable increase in food production to ensure the independence of cities from imports and reduce poverty.

Digital technology can be used for agriculture in order to meet three objectives: bridging the rural-urban divide, reducing rural poverty (and thus preventing urban migration), and ensuring national food security.

As a pioneer, Microsoft 4Afrika made its first investment in agri-technology, working with a local East African start-up, AGIN, to connect more non-banked farmers to financial services. As a result, more than 390 agri-tech solutions registered in Africa, including Twiga Foods in Kenya, Tulaa and Virtual City, ensure that value chain stakeholders (farmers, financial service providers, retailers, distributors, manufacturers and other service providers) join forces to enable farmers to save and borrow, buy inputs, and market their crops at the right time. However, the potential remains enormous: 90% of the market for digital services that support African smallholders is still untapped (Microsoft 4Afrika, 2021)

In that way, OFI (Olam Food Ingredients) contributes to the sustainability of the cashew nut supply chain with the Cashew Trail Program. The goal is simple: to shorten the value chain to reduce poverty among farmers. To do so, they set up Olam Direct, a mobile platform that allows farmers to access the latest market prices and negotiate directly with OFI rather than with traditional buying agents. This means that they can retain more value for their crops while reducing their expenses, as OFI manages the "last mile" of the chain. To date, 50,000 farmers have already benefited from the initiative with a target of 250,000 by 2030, doubling their previous income by an average of $3 per day (OFI, 2021).

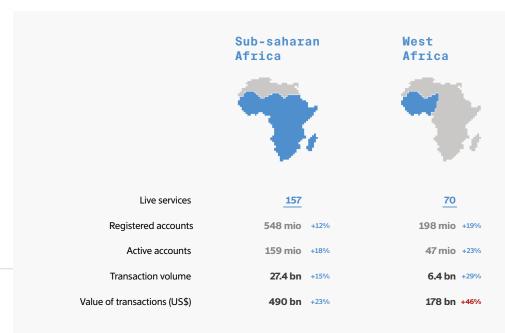|	Sub-saharan Africa	West Africa
Live services	157	70
Registered accounts	548 mio +12%	198 mio +19%
Active accounts	159 mio +18%	47 mio +23%
Transaction volume	27.4 bn +15%	6.4 bn +29%
Value of transactions (US$)	490 bn +23%	178 bn +46%

Figure 14.
Regional penetration of mobile money in Sub-Saharan Africa and West Africa, 2021.

It is estimated that, as a proportion of their income, urban households in Africa, especially vulnerable households, have daily expenditures linked to housing and transport that are 55% and 42% higher, respectively, than households in other parts of the world. In addition, the damage caused by environmental pollution (air, water, soil, etc.) has a major impact on low-income neighbourhoods (World Bank, 2017). For example, air pollution is estimated to have killed nearly 600,000 people in Sub-Saharan Africa in 2019 (Bauer et al., 2019). Local authorities do not have the capacity to deal with the material, economic and technical issues related to the expansion of African cities, be it in terms of financial resources, local budgets and external endowments or skilled personnel. The digitalisation of urban spaces is presented as a rational response to future population projections and the inability of

governments to respond structurally to a strong increase in demand for housing, infrastructure and urban services. Unlike the new post-independence capitals, connected cities are now part of a broader economic development strategy (Côté-Roy and Moser, 2018). They are often supported by business-government partnerships and presented as the solution to today's urban challenges (Chenal, 2014; Moser et al., 2015). Technological advances are seen as a potential means of coping with unstable urbanisation patterns.

Among the various innovative experiences put in place to combat poverty, those acquired in two key sectors, such as agriculture and mobile money, need to be considered (see boxes).
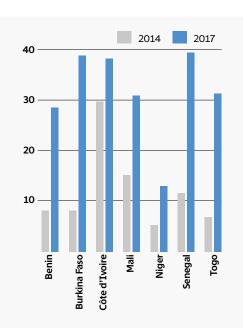
Mobile money penetration in Africa

Sub-Saharan Africa has been at the forefront of mobile money for over a decade and continued to account for the majority of growth in 2020 (43% of all new accounts). At year-end, there were 548 million registered accounts in the region, of which more than 150 million were active on a monthly basis (GSMA 2021).

The number of mobile money accounts now exceeds the number of traditional deposit accounts, with 21% of adults in the region holding a mobile money account (IMF, 2019).
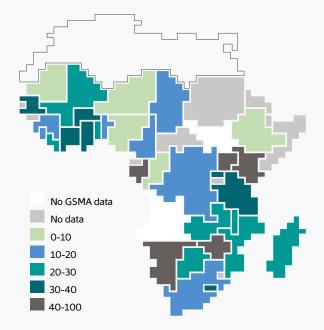
In contrast, penetration is uneven (Figure 16). The strongest presence is concentrated in East Africa, and especially Kenya with 73%. Gabon, Namibia and Zimbabwe, where the share of mobile money accounts among adults is around 50%, also show strong growth.

The fastest growth rates in this technology are found in West Africa, including Burkina Faso, Côte d'Ivoire, Ghana and Senegal, where more than 30% of adults now have a mobile money account. Significantly, 200,000 Kenyan households have emerged from extreme poverty as a result of creating a mobile money account, thereby demonstrating the effectiveness of this technology in the fight against extreme poverty. Women are still 33% less likely than men to have a mobile money account, even though mobile money has the potential to increase inclusion and bridge the gender gap in terms of access to financial services.

Figure 15.
BCEAO region: digital payment
Number of adults holding an
account as %

Figure 16.
Mobile money
penetration in
Sub-Saharan Africa

To meet the challenges of urban growth, several innovative local solutions are flourishing on the continent. For example, the South African start-up CarTrip offers a car-sharing service that can complement and offer an affordable alternative to public services. The company estimates that by offering its service between 6 and 9 a.m. in Cape Town, it saves around 5 tonnes of CO_2 emissions and 2,200 litres of fuel per year for three car-poolers. In Senegal, the start-up Ping! has set out to be a pioneer among Dakar's taxi companies by using solutions (e.g. hybrid cars) that are less pollutant and use 50 to 75% less fuel than conventional taxis. In 2017 in Kenya, the city of Nairobi announced the implementation of a smart traffic management system (The Nairobi Intelligent Traffic System). Funded by the World Bank to the tune of $13.7 million, this project will use smart traffic lights, ground markings and more effective signalling at 100 key road intersections in the city (Energy Stream, 2018).

Poor people can benefit from these leveraged technologies, either directly or indirectly through the widespread dissemination and availability of low-cost goods and services following their adoption by others. Urban dwellers, both as producers and consumers, can access their markets of interest to buy and sell their services through improved access to equipment, while improving their productivity. To illustrate the potential of digital technology in the fight against poverty, between 2008 and 2014, access to the services of the M-Pesa mobile money system enabled about 200,000 Kenyan households to lift themselves out of extreme poverty, accounting for 2% of the total poor households (Suri and Jack 2016).
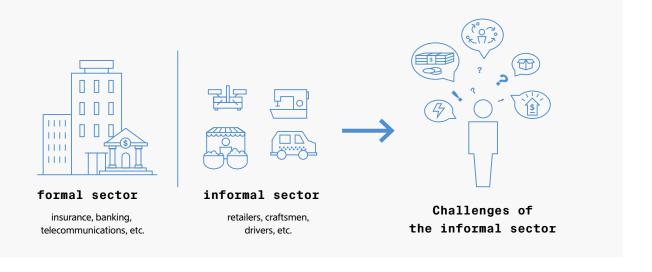
Limitations of innovation projects in Africa

Despite encouraging growth, digitalisation in African cities remains nascent compared to developed economies. Among governments and industry in most African countries, there is a general reluctance to venture and invest in new knowledge and technology. However, the appropriate adoption and judicious use of the digital industry for the benefit of cities offers undeniable opportunities for solving certain socio-economic and industrial challenges.

In Africa, businesses are largely organised in the formal and informal sectors. Formal sector firms tend to be large corporations such as banks and insurance companies, telecommunications operators, agro-industries and oil and mining companies. Small and medium-sized enterprises in the formal sector are quite limited in size and number, especially in Sub-Saharan Africa. In general, African firms are, on average, 20% smaller than other firms in developing regions (L. Iacovone et al., 2013). Businesses in the informal sector tend to be small, with fewer than five employees. Examples include retailers, craftsmen and drivers in urban areas. In most African countries, the informal sector accounts for a significant share of economic activity. In Sub-Saharan Africa, the share of economic output from the informal sector ranges from 26% in South Africa, 33% in Kenya, 46% in the Democratic Republic of the Congo, to 57% in Nigeria, for a regional average estimated at 40% of GDP in 2015 (Medina and Friedrich, 2018).

The digital economy offers opportunities to address the challenges faced by businesses and informal workers, who often have less access to finance and make little use of modern business practices, including accounting (Mahadea and Zogli, 2018). They also face higher costs when dealing with suppliers or customers due to poor logistics, multiple intermediaries and the prevalence of cash transactions. In the informal sector, access to electricity is less secure and the overall business environment is unstable. However, the vast majority of workers in the informal sector own a mobile phone, often used for private and business purposes. To date, most successful companies in Africa's digital economy are tackling the problems faced by companies or workers in the informal sector. One example is the large-scale spread of mobile money in several African countries, such as Kenya, Côte d'Ivoire and Mali.

formal sector

insurance, banking,
telecommunications, etc.

informal sector

retailers, craftsmen,
drivers, etc.

**Challenges of
the informal sector**

However, the scope of the informal sector goes beyond digital financial services to encompass a growing number of economic sectors such as e-commerce, services, etc. This represents more opportunities for innovative solutions to meet the specific needs of working populations. A survey of African start-ups conducted by Google in 2019 found that recruiting start-ups or small businesses, as well as building a strong pipeline of high-quality, high-value-added companies, are among the biggest challenges facing accelerators and other incubators. The lack of reliable data and data-based evidence of the positive impact of these companies' activities is a challenge for both investors and entrepreneurs (IFC, 2020). Providing an innovative

means of collaboration between the stakeholders involved in innovation and the use of digital technology in cities would therefore create a virtuous circle of research and development, while allowing entrepreneurs to target the growth opportunities of their business models. While technology is essential, its strength and relevance depend on citizens, their ability to innovate and their desire to adopt technology in order to participate in local life, generate new knowledge and thus contribute to improving living conditions.

6.

West Africa: progress and challenges for the digital transition of cities

The use of digital technology in West African cities

Digital players in West Africa

City-university partnerships

The use of digital technology in West African cities

The increasing urbanisation of West Africa requires new solutions in terms of governance and land-use planning to provide basic services: water, electricity, sanitation, health care infrastructures and education. Urbanisation in West African cities is characterised by an urban fabric that has become increasingly dense in a complex manner, with a tangle of formal and informal land registers and urbanisation processes.

Digital technology thus presents itself as an innovative way to rethink urban development

The success of sustainable urban development, particularly in informal areas, is hampered by a number of factors: the lack of sanitation infrastructure and basic urban services; the considerable distance between peripheral areas and the city centre, making access to public transport services more expensive and difficult; and the problem of land (lack of official government deed). This urban complexity hampers many development projects because of the difficulties in some areas of installing networks (water, electricity, sanitation).

At a time when UN rhetoric is stressing the right to the city, it is a matter of dealing with the existing urban fabrics, which nevertheless produce a city that is relatively dysfunctional in its everyday practices. Digital technology thus presents itself as an innovative way to rethink urban development: it makes it possible to circumvent the challenges of urban planning and management, but also to reduce the costs of infrastructure investment. Digital innovation can turn things around. In Senegal, for example, a tele-medicine case (see box opposite) allows different physiological data to be measured, which is then transmitted to a hospital for diagnosis, thus avoiding long journeys. These innovations make it possible to provide better care and prevent the saturation of public transport, providing access to specialist care and advice. The results of these technologies are measurable: My Healthline, Orange's text message service relating to health and sexuality distributed primarily to pregnant women and young mothers in Mali, has reduced infant mortality by 30%.

Intelligent transport system in Abidjan

There is a wide range of public transport services in Abidjan, but the lack of structure in the sector does not allow city dwellers to move quickly and safely. Urban mobility issues have been one of the government's priorities for several years. In this context, the Abidjan bus company SOTRA and the French company Zenbus have developed a partnership for the implementation of an intelligent transport system. Zenbus provides an **intelligent transport system** that is installed in city buses and offers the implementation of an operational assistance and traveller information system (SAEIV). This system allows users to see their buses moving in real time and provides the operator with numerous statistical tools to improve its transport offer. Data collection significantly increases the number of users and improves their travel conditions.

The strong growth of new urban neighbourhoods on the outskirts of cities such as Abidjan, Ouagadougou or Cotonou is a challenge for urban planning against a backdrop of weak, decentralised resources. There is growing interest from the private sector in providing digital solutions to the shortage of basic services. The main sectors targeted are health, transport, sanitation, water, electricity, and e-governance to improve administration, land management and risk prevention in the city.

In Abidjan, for example, the deployment of connected metres simplifies the management of electricity consumption, allowing greater billing flexibility (post-payment or prepayment) and simplified access to use. The Ivorian economic capital is rapidly modernising with the help of digital solutions and aims to become the first true "smart city" in Africa. Digital cities, or smart cities, are a growing phenomenon in West Africa. New smart cities are being designed in the vicinity of economic capitals to offer innovative solutions for managing urban services, both ecologically (energy) and economically using digital technology. In 2017, in the municipality of Sèmè-Kpodji, near Cotonou, the Beninese government launched Sèmè-City, a smart city programme dedicated to innovation and knowledge. In Senegal, a similar project is currently under development with a future administrative city called Diamniadio, with another such project in Burkina Faso, just 15 km from Ouagadougou, in the future city of Yennenga.

Smart cities alone cannot solve major urban problems in West Africa, such as the growth of peripheral and informal areas isolated from economic and administrative hubs. This requires tangible solutions to provide effective and affordable access to services and to provide a viable and affordable mobility offer enabling residents to access business centres. Although the situation remains critical in terms of basic infrastructure for the subregion's urban periphery, several start-ups, sometimes in collaboration with local authorities, sometimes independently, provide services using digital tools. Several solutions have been implemented in the areas of health, energy, waste, and water and sanitation.

Health care

The increasing penetration of the Internet in West Africa has led to the emergence of dozens of health start-ups that aim to ease the strain on existing health services and help patients better manage their condition.

Private-sector investment in health care has been accelerated by the COVID-19 pandemic, between increased barriers to accessing health care and the emergence of a new market for health protections for professionals and citizens. Virtual health care offers, powered by digital technologies, include a range of services that can address the lack of health care infrastructure, minimise the spread of infections, and foster patient-clinician relationships. In addition, collaborative technology platforms are extending the utility of digitisation to help strengthen communication between all health care professionals and management teams.

Beninese start-up provides patients with a medical identity
In Benin, a young doctor founded the start-up KEA Medicals, which aims to provide all patients with a medical identity (which includes the history of medical records) using a wristband with a QR code. The platform aims to interconnect hospitals across the country through a single database to manage patient health information and increase access to health care and micro-health insurance. The lack of information and coordination between hospitals is often fatal for patients, as there are no centralised databases in Benin that can easily and quickly trace a patient's file. Kea Medicals is a social enterprise that has made this interconnection possible through the universal medical identification system for patients.

A tele-medicine kit

A tele-medicine kit has been created to carry out health examinations with the aim of making such examinations available in peripheral areas of Senegal. The kit is equipped with, among other things, an ultrasound, an electrocardiogram and a glucometer. In addition, it is linked to a tele-medicine platform that provides front-line health workers with the opportunity to be supported by regional specialists through tele-consultation and tele-expertise.
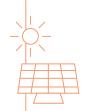
Energy

More than 150 million people in West Africa do not have access to electricity and spend up to 30% of their income on polluting fuels such as kerosene. In addition to rural areas, informal settlements in cities are often cut off from the national electricity grid and disadvantaged urban populations are particularly affected by unreliable access to energy. Electricity companies sometimes struggle to meet the needs of a growing population while ensuring their commercial and financial viability. The sometimes ageing and expensive electricity infrastructure of countries in the West African sub-region, coupled with poor grid management, leads to energy instability crises, which can be frequent, with many daily power cuts or power rationing. Digitalisation can contribute, among other things, to improving the reliability of electricity networks and lowering the cost of access. The integration of smart grids and new digital solutions into energy generation and distribution systems enables operators to improve performance and diversify their offers while increasing access to reliable and clean energy services. Start-ups are increasingly offering alternative services that rely on digital technology to offer solutions to the inaccessibility of the electricity grid.

A project for smart solar energy

PEG Africa provides home solar installations on a subscription basis for electricity-free homes. Operating in Ghana, Côte d'Ivoire, Senegal and Mali, PEG Africa allows low-income people to pay by telephone ("pay as you go") for solar energy according to their consumption. If the user does not top up the credit, the system – consisting of a solar panel – is blocked and cannot be used, but after one year of payment, the customer becomes the owner of the system. This avoids spending on poor-quality pollutant combustibles and helps generate electricity from solar power. This system allows off-grid homes to have energy for lighting, phone charging, radios, televisions and fans.

Recycling plastic waste using web and mobile support

The Ivorian start-up Coliba has created a mobile app to make it easier to collect plastic waste. To request plastic waste collection, the user simply presses a button on the app. It is then geo-located and the company sends one of its 50 collectors to collect the waste. In return, the user receives points which are converted into telephone credit, data for the Internet connection or vouchers or school kits for the neighbourhood. The sorted waste is then transformed into usable plastic that is sold to industries (automotive, construction and textile industries, etc.).

Waste

The amount of waste generated worldwide is growing rapidly, particularly in Africa, where formal waste management systems are often inadequate. The total amount of waste generated in Africa is expected to triple by 2050. In 2015, the city of Abidjan alone produced more than one million tonnes of waste, without the waste being collected at collection points. The unauthorised dumping of this waste can have a dramatic impact on the health of the city's inhabitants. Smart waste collection solutions that improve management and make citizens and businesses more accountable have become a priority. Digital platforms, for example, allow residents to report a problem to the municipality in real time, thus ensuring greater responsiveness and accountability of the administration when collecting waste. The use of digital solutions in waste management, as well as start-up partnerships with municipalities, can help reduce waste pollution and generate circular economies.

Water and sanitation

In Sub-Saharan Africa, fewer than 25% of urban dwellers have access to running water. In disadvantaged peripheral areas, lack of sanitation services is accompanied by poor access to safe drinking water. When they have the financial means to do so, households not connected to the public network turn to private providers, whose services are often expensive. For the most disadvantaged, conflicts over the supply of water for domestic purposes

are common in urban areas served by fountains. These challenges can be met by smart network management based on the installation of sensors, the deployment of communicating metres and efficient networks for data transfer, the use of aerial and satellite imagery and, increasingly, artificial intelligence to model the ageing of networks and prevent failures.

Social start-ups are now proposing to use sensors to improve the decentralised distribution of water by means of automatic distributors, for example as part of mini-networks.

These services use a water metre connected to a platform and billing software. This allows users to prepay any amount of water via a consumer payment system using mobile phones. New technologies are also used in this field for prevention purposes.

Most of the digital solutions used to make West African cities more functional and sustainable are developed by the private sector and rarely partnered with governments. However, it is crucial that local authorities be engaged in this digital transition and become involved in guiding it at the subregional level.

A Malian start-up to improve "WASH"

Founded in February 2018, the Malian start-up Map Africa has developed a real-time interactive mapping tool calling on civic involvement, which helps development partners and municipal authorities manage WASH issues. The start-up provides a mobile app that allows citizens to send a photo of an environmental problem such as polluted water or a landfill; thanks to a geo-locator, these areas are identified and listed. Map Action also carries out a more in-depth analysis of the environmental impact, for example by identifying the source of the pollution and determining the severity of the impact. The results are presented visually on a map and made available to development partners and government authorities for decision-making. The start-up has built a map of the city of Bamako, showing problem areas such as a punctured or broken pipe, a bad rainwater or sewage drainage system. Google Earth imagery and drone monitoring are then used to supplement the information provided by citizens in identifying environmental problems in Bamako.

Governments should be able to access innovations and business-generated data to support and redirect government action. To achieve this, it is also necessary to strengthen its internal digital capabilities. Municipalities have an important role to play in the coordination and synergy of the local digital ecosystem consisting of start-ups, NGOs and companies. This role would make it possible to develop a strategy for managing and using data for the citizens of their city.

Figure 17.
How digital solutions can help fill gaps in basic urban services

Gaps to be filled   **Digital solutions**

Unaffordable
Consumer payment models can make services affordable for low-income consumers by enabling micro-payments

For service providers, mobile money can reduce operating costs and improve revenue collection

Not connected
Geographic Information System can generate data to assess needs and coordinate service delivery

Digital tools help identify problems and better match supply and demand for essential services

Unreliable
Intelligent monitoring and metering can improve operational efficiency

IoT can improve service delivery and consumption management

Digital tools have the ability to establish a verifiable trace of financial transactions and to measure the environmental and social impact

Lack of urban planning
Data can inform urban service delivery plans

Big data can support policy making with evidence

Lack of security
IoT sensors can be used to monitor service quality and prevent failures

Digital solutions and platforms can foster accountability in the informal sector, making service delivery more secure

Digital players in West Africa

States committed to digital technology: digital technology in national policies in West Africa

In West Africa, states are now integrating the digital issue to define and address a wider range of public issues (Table 1, p. 72). In the 2000s, digital technology presented itself as an emerging public problem, confined to diagnosing infrastructure weakness and its role in marginalising the globalisation of African economies. In the 2010s, the adoption of digital-based urban marketing strategies in the major African cities that are best-suited to face international economic competition (Nairobi, Cape Town, Lagos) supported the circulation of digital development issues in public arenas. While cities have become the preferred area of intervention for experimenting with both pro-growth and developmental strategies focusing on digital technology, this technology has now become a tool for constructing public policies on a national scale. Digital technology is as much a condition for their renewal as it is the reference point for a new society – digital and connected.

Digital public policies reveal an uneven level of political commitment to the process of digitalising societies in West Africa. The role of digital technology in various areas of public action provides information on the level of penetration of digital technology in society. It also highlights the priority of digital technology in the national political project and the resources used. Table 1 is based on programmatic documents (National Development Plan, policy or sectoral strategy) which are publicly available online. The following typology, therefore, does not take into account all the existing programmatic documents or data on the processes of public policy-making in each country.

The first group of countries is engaged in a process of digitalisation of society with the presence of institutions and sectoral policies focused on translating digital technology into a wide range of societal fields of action. As in Benin, continuing to improve Internet coverage and connectivity remains a priority, with a focus on broadband and ultra-fast broadband for business purposes.

National digital strategies and policies of West African States

Benin

Sectoral Policy Statement (2016-2021)

Ministry of Digital Affairs and Digitization

Nigeria

National digital economy policy and strategy (2020-2030)

Federal ministry of communications and digital economy

Burkina-Faso

National Policy for the Development of the Digital Economy (2016)

Ministry of Development of the Digital Economy and Posts

Senegal

Digital Senegal Strategy (2016-2025)

Inter-ministerial Council

Côte d'Ivoire

ICT Sector Development Strategies (2016-2020)

Ministry of the Digital Economy and the Post

Togo

Sectoral Policy for the Digital Economy (2018-2022)

Ministry of Posts and the Digital Economy

Ghana

Information and Communication Technology for Accelerated Development (ICT4AD) Policy 2017

The Minister for Communications and Digitalization

Group 1 Strong digital strategy

Cape Verde

Cape Verde Digital Strategy (2016-2021)

No specific department

Mauritania

Broadband and Universal Access Strategy / National Cybersecurity Strategy (2019-2022)

Ministry of Higher Education, Scientific Research and Information and Communication Technologies

Guinea

National Economic and Social Development Plan (2016-2020)

Ministry of Planning and International Cooperation

Niger

Telecommunications and ICT Sector Policy (2013-2020)

Ministry of Posts, Telecommunications and the Digital Economy

Liberia

Liberia information and communications technology policy (2019-2024)

Ministry of Posts and Telecommunications

Sierra Leone

National innovation & digital strategy (2019-2029)

Consortium of commissions, ministerial directorates and public institutions

Mali

"Digital Mali 2020" Strategy

Ministry of Digital Economy, Information and Communication

Group 2 High priority on digital technology with institutional/operational weaknesses

Gambia

The Gambia national Plan (2018-2021)

NDP Inter – Ministerial Steering Committee

Guinea-Bissau

Plano nacional de desenvolvimento (2020-2023)

Ministry of Transport and Infrastructure

Legend:
- Governance
- Infrastructure
- Economy
- Development
- Utilities
- Connectivity
- Land use planning
- Security
- Capacity building
- Legislative framework
- Economy/e-service
- Cybersecurity

Group 3 Low interest in digital technology

However, in this group of countries, digital public policies are part of the continuation of public policies already initiated in the 2010s. Group 1 is thus witnessing second-generation digital policies that strengthen the ability of actors to use digital technology to transform society. Thus, the focus is more on digital institutions and the consolidation of a legal framework for the development of e-governance (public services, banking, cybersecurity, etc.). The interest in introducing digital technology into public administration and service provision is clearly linked to a project designed to support the digital economy, by providing a stimulating institutional environment. This group of countries is also distinguished by policies that promote digital technology as a tool for development. Digital technology supports both access to and functioning of essential public services, such as education, and poverty reduction strategies.

The second group presents policy strategies that demonstrate a strategic interest in incorporating digital technology into the functioning of societies. The scope of digital penetration into society may nevertheless be smaller, with a lower propensity to enter the fields of governance or development. However, as is the case in Mali, some public policies are very ambitious, without being accompanied by a thorough diagnosis of the state of the resources to be mobilised and the constraints on the process of digitalisation of society. In addition, Group 2 distinguishes itself by the assignment of the digital task to ministries belonging to traditional fields of public policy, particularly that of telecommunications. As a result, digital governance institutions are less well represented in this group. In Sierra Leone and Cape Verde, no ministries are responsible for implementing the digital strategy. While in Sierra Leone a consortium of government institutions has been designated, without specifying how they should be coordinated, Cape Verde has assigned implementation to all state ministries.
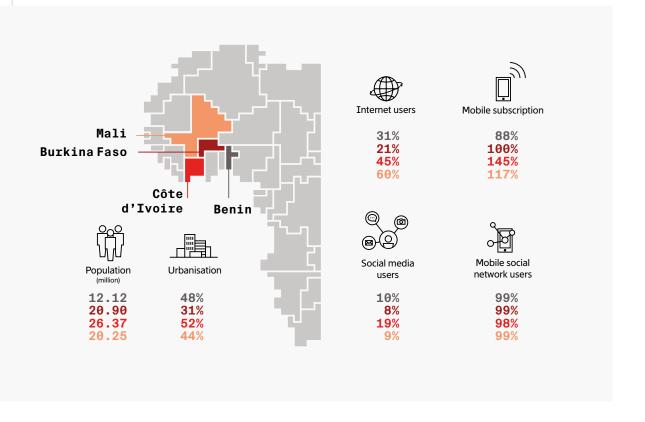
Finally, Group 3 stands out for its low level of investment in the digital sector, in addition to the problems of broadband network coverage across the national territory. Infrastructure weaknesses are still a major obstacle to the digtalisation of these societies. The digital issue has not, therefore, led to the reconfiguration of public institutions or the construction of specific sectoral policies on digital technology.

This analysis shows that the majority of countries in Groups 1 or 2 show a political will to put digital technology at the centre of the framework for sustainable development. However, it must be translated into a tangible action plan aimed at creating a sustainable implementation ecosystem, particularly in cities with the greatest potential for digital technology, but which will also face major socio-environmental and economic challenges in the coming decades.

Figure 18.
Overview of Internet penetration and connectivity in four West African countries

Mali
Burkina Faso
Côte d'Ivoire
Benin

Internet users

31%
21%
45%
60%

Mobile subscription

88%
100%
145%
117%

Social media users

10%
8%
19%
9%

Mobile social network users

99%
99%
98%
99%

Population (million)

12.12
20.90
26.37
20.25

Urbanisation

48%
31%
52%
44%

Multilateral development partners

Over the past two decades, digital technology has played a prominent role in discussions on economic growth and development in Africa. These discussions have been accompanied by extensive data production on the Internet in Africa and have supported a change in the interpretation of the role of the Internet in the political, economic and social development of African societies. An index of Africa's marginalisation of the globalisation of the economy in the 2000s, the Internet is today one of the flagship tools for building a developed, sustainable and inclusive society. As a new embodiment of development, it is at the heart of the agendas of donors and major Western and more recent development agencies (China, Japan, Turkey). In this paradigm shift, the United Nations played a leading role in organising the first international World Summit on the Information Society (WSIS) conferences, held in 2003 and 2005, on information technology issues in the Global South. In 2006, the establishment of the Internet Governance Forum institutionalised the issue of Internet access as a global public issue. However, in the 2000s, the issue of the Internet was limited to the matter of the digital divide between countries. It was not until the second half of the 2010s, when the UNDP led the new agenda for the Sustainable Development Goals (SDGs) in 2015, that the issue of Internet access was programmatically broadened to include other areas of development. By placing the issue of the Internet

on the agenda of the SDGs (SDGs 5b and 9c) and by widening the scope of humanitarian intervention, the Internet is now promoted by the United Nations as a public good, finely articulated to the defence of human rights and, therefore, to the consolidation of democracies.

The work of UN agencies to make the Internet a common priority among governments, donors, NGOs and private actors has been strengthened by the rapidly evolving World Bank position on digital technology. In the wake of the SDGs, the World Bank primarily supports the development of the digital economy, whose markets are estimated to be worth tens of billions of dollars. In its "World Development Report 2016: Digital Dividends", the World Bank defends the link between the development of the digital economy and GDP, while at the same time raising the issue of the digital divide in the Global South. Priorities for action are: access to digital infrastructure, financialisation of the economy, changes in legal frameworks and support for entrepreneurial skills. In West Africa, it is particularly involved in digital currencies and financial services project in partnership with the Central Bank of the West African Economic and Monetary Union (WAEMU) and the Central Bank of West African States (BCEAO). At that time, it also financed numerous projects to strengthen entrepreneurial skills in the digital sector by financing hubs. However, the difficulties faced by the World Bank in the economic sphere (low public interest in financial services other than remittances or

bills, large digital divide between urban and rural areas, high cost of a dysfunctional Internet, and the challenge of cybersecurity for governments and businesses) would lead it to refocus its work on the issue of infrastructure, to the detriment of financial services. In its 2021 "Data for better lives" report, the Bank fully explored the field of digital development by linking the anchoring and management of data in regional data centres to the fight against poverty. It is a question of linking development and the "digital revolution."

Internet access packages are also expensive due to the costs of getting connected to the electricity grid. The World Bank therefore supports the financing of the West African Electric Power Trading System (EEEAO) to

reduce the costs of telecommunications operators who distribute the Internet. The World Bank takes a holistic approach by supporting better access to public services through digital skills: the ID4D initiative (Identification for Development) implemented in West Africa leverages digital and biometric technologies as well as mobile devices in order to deliver an identification document unique to each individual, recognised by governments, thus benefiting from economies of scale.

The World Bank shares its digital diagnosis with the African Development Bank (AfDB) through the DE4A initiative – a diagnosis on the state of a country's digital economy (World Bank, 2021a): it supports the African Union's goal of ensuring every individual, business and government has access to digital equipment by 2030 (World Bank, 2021).

Figure 19.
Cost of a high-speed
Internet subscription (US$)

West Africa

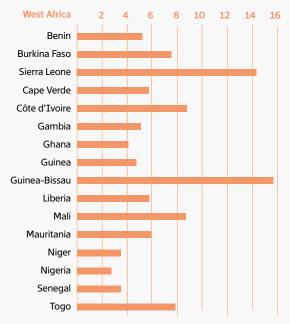| Country	Cost (US$)
Benin	
Burkina Faso	
Sierra Leone	
Cape Verde	
Côte d'Ivoire	
Gambia	
Ghana	
Guinea	
Guinea-Bissau	
Liberia	
Mali	
Mauritania	
Niger	
Nigeria	
Senegal	
Togo	

Figure 20.
Cost of one gigabyte of
mobile broadband (US$)

The African Development Bank also supports information and communication technologies. In its Regional Integration Strategy 2020-2025 for West Africa, it shares the World Bank's position on the benefits of a digital economy, which will facilitate payment systems, increase productivity and support the diversification of African economies (AfDB, 2020). Its Digital Economy Action Strategy focuses on two priority areas: improving the connectivity of resilient cross-border infrastructures and modernising and harmonising ICT policies and the associated legal framework. The African Development Bank aimed to increase Internet penetration in the region by 12% in 2019, with a target of 25% by 2025. Although youth training, identified as a challenge for ICT development in the region, is not explicitly mentioned in the AfDB's programme documents, the inclusiveness of the AfDB's actions and the desire to diversify the region's economies require training in this area. Since 2015, it has been working in Dakar as part of the Digital Technology Park project in Diamniadio. In line with the desire of the President of the Republic of Senegal to position the country as a true service hub in the region, the project will help develop an infrastructure that promotes innovation and the creation of value-added jobs and should host an incubation centre that will help start-ups develop strong entrepreneurial skills. The Senegalese government's investment in the development of the digital economy also reflects the desire to develop applications and services for the benefit of the administration and the population as a whole.

The World Bank's ID4D Initiative uses global knowledge and expertise across all sectors to help countries realise the transformational potential of digital identification systems to achieve Sustainable Development Goals.

While the state of digital infrastructure is the focus of attention among multilateral development agencies, the African Development Bank is reaching a turning point in the relationship between institutions and digital technology in Africa by positioning cybersecurity as a public priority. The growth of the digital economy and, more generally, the advent of digital societies are indeed subject to the ability of states and institutions to ensure the security of public and private data. The rise in cyberattacks has reached an extent that has tarnished the image of West Africa, particularly Côte d'Ivoire and Nigeria, with investors at the global level. This inability to ensure the security of digital banking transactions and the functioning of institutions would result in an investment loss of more than $3 billion per year for African companies, according to various IT security firms. Cybersecurity software publisher Kaspersky recorded 28 million cyber attacks in Africa in the period from January to August 2020 alone. To address this challenge, the African Development Bank funded the establishment of the Africa Cybersecurity Resource Center (ACRC) for Financial Inclusion in 2021. Located in Dakar, the aim will be to identify cyber-attacks against financial service providers and individuals and to provide expertise to strengthen cybersecurity for institutions and businesses. The desire to create a viable digital ecosystem for investors, businesses and institutions also supports the emergence of governance tools at the level of states, institutions and interregional commissions. The aim is to establish coherent digital policies at regional and national levels to facilitate financial transactions.

The "Inclusive Digital Economy Scorecard (IDES)"
was developed by the UNCDF (UN Capital Development Fund). IDES is a policy tool that governments can use to help them define their country's digital transformation priorities. It identifies the main market constraints impeding the development of an inclusive digital economy and helps to set the right priorities with public and private actors in each country to foster an inclusive digital economy.
A key tool for UNCDF's "Leaving no one behind in the digital era" digital strategy, it measures market development and prioritises the digital transformations needed for these countries.
It is therefore initially a tool for governments to use. Good results could then be used to attract potential partners. With a score of 38/100, for example, Benin's digital economy still needs to be developed, as does Senegal's (40/100) (UNCDF, 2019)

Through the PRIDA project, the African Union (AU), the European Union (EU) and the International Telecommunication Union (ITU) are developing a harmonised regulatory framework within African regional organisations that will serve as a reference framework agreement for governments.

Finally, to help countries assess their efforts to digitalise their economies, UNCDF launched IDES (Inclusive Digital Economy Scorecard), a new tool that measures inclusion in emerging digital economies. The pilot was deployed in 8 of the 47 poorest countries, including Benin and Senegal in West Africa.

Bilateral development cooperation

Since the second half of the 2010s, bilateral cooperation agencies in West Africa have been integrating digital technology with a view to renewing their development intervention programmes. For example, the French Development Agency (AFD) and the African Development Bank (AfDB) are developing a programme to finance the digital financial inclusion of women: $6.95 million will be allocated to support their access to digital financial services. GIZ is also working on the same issue. To promote women's employment and develop or strengthen their digital capabilities, the #eSkills4Girls initiative was launched by GIZ in 2017. From programming courses to helping young women start their own businesses, the initiative promotes the education, employment and entrepreneurship for women and by women in the digital economy in Ghana and Cameroon (GIZ, 2020b). These digital initiatives, which aim to strengthen existing interventions to reduce gender inequalities (SDG5), do not change the traditional perimeters and operating modes of development agencies: the digitalisation of African societies is part of the SDG matrix.

However, the commitment of bilateral agencies to the digital issue leads them to design development programmes that aim to digitalise West African societies. From this perspective, the focus is on the ability of students, entrepreneurs, civil servants and public officials to develop, implement and manage innovative solutions to the major challenges facing African societies. Programmes to strengthen skills and finance innovations via hubs, structure the areas of intervention of all the actors present in West Africa: AFD (Afric'innov, Digital Challenge, AFIDBA), GIZ (Make-IT in Africa), JICA), USAID (Development Innovation Ventures) and the International Trade Center (#FastTrackTech project funded by Canada, Finland, Germany, Ireland, Norway and Sweden). For example, the GIZ "Make-IT in Africa – The Tech Entrepreneurship Initiative" project, set up between 2017 and 2019, mainly in Nigeria, aimed to help 50 innovative start-ups grow and strengthen ties between them and investors by drawing on the experience of digital giants such as IBM. Awareness-raising measures have been introduced by facilitating access to information on available financing via online platforms and by organising events, such as B2B, and training courses to strengthen entrepreneurs" skills. For example, in 2019, the Ghana Tech Lab,

a stakeholder in the project, developed an entrepreneurial innovation section, "Makers Assemble," to combat COVID-19, through the Internet of Things. One of the innovations is a 3D printer to produce protective and health equipment for professionals, including respirators. The equipment has been approved by the Ministry of Health and licensed in Ghana. The bilateral agencies' support for the emergence of technologies is aimed at meeting the immediate needs of African companies, which support the provision of dematerialised services, in particular financial and commercial, rather than at the development of targeted technologies, shifting the relationship of dependency between North and South with regard to the issue of innovation patents.

With a view to initiating the digitalisation of African societies, cities have recently invested in integrating technology into the delivery of public services and transforming ways of solving public problems. In English-speaking Africa, the AFD has set up the ASToN programme in collaboration with the ANRU (National Agency for Urban Renewal) to form a network of cities with a view to exploring the digital transition of sustainable and inclusive cities (URBACT, 2021). The network enables the exchange of information, knowledge and co-learning

The digital land registry that works using the blockchain[5]

The problem of land, i.e. the lack of official property deeds from the administration, is a major factor in urban insecurity and is at the heart of the precariousness of informal neighbourhoods, coupled with the lack of infrastructure. Faced with the unreliability of land registries (property titles missing from registers, addresses not found in land registries, complexity linked to customary law, etc.), Ghana turned to the blockchain and in 2015 developed a digital land registry project. The aim of the initiative is to enable secure recordings thanks to blockchain and thus more reliable (transparent and impossible to falsify). The NGO Bitland offers citizens who do not have the necessary official documents that chance to carry out the necessary investigations (at the Ghana Land Commission and in the field) to confirm the validity of ownership deeds, register the GPS coordinates of the property in the system and issue a paper certificate to the owner of the property. In particular, such a database could facilitate the resolution of land disputes through the use of "Bitland Certificates," which would then serve as a reference in the absence of official land deed.

5
The blockchain is a growing list of records, called blocks, which are linked together using cryptography. This technology for storing and transmitting information en-sures the transparency and security of recorded data.

on the effects and benefits of the digital transition to make cities more sustainable. This programme, which has received funding from the AFD totalling 2.995 million euros for two and a half years, should result, by the end of 2021, in a clear action plan. It should ensure that cities successfully accomplish their digital transition process, even if the amount allocated to this type of experiment remains symbolic in terms of needs. The cooperation programmes implemented do not specifically concern urban issues, but rather the development of public policies and the functioning of institutions (e.g. AFD's PAGOF, JICA's PoC). The support of

public institutions for digital transition, however, primarily benefits cities, which remain privileged laboratories for pilot projects of bilateral cooperation agencies through the priorities of support for decentralised public action. For example, the GIZ – supported by SECO (State Secretariat for Economic Affairs), USAID and Global Affairs Canada – introduced "dLRev" software into the administration of some seventy (70) districts in Ghana. By digitising their administration, the new land registry allows districts to collect data more quickly and to abandon handwritten invoices, resulting in increased income and thus greater autonomy. This tool is useful for urban planning, but above all it is an innovative solution for greater transparency and traceability of land disputes that hinder the smooth running of urban projects. Readily accessible land registry data can now be used for the purposes of sustainable urban development (GIZ, 2020a).

Promoting individual initiatives through cooperation

The "Mobile for Development Utilities" programme brings together the professional association GSMA and the Scaling Off-Grid Energy (SOGE) partnership supported by the UK Department for International Development (DFID) and USAID. This programme, which is deployed in four continents, aims to improve access to basic services through mobile technologies and infrastructures" (GSMA, 2020). The digital nature of the programme is understood very broadly, including the exchange of e-mail messages, connectivity between tools, or networks of mobile operators, etc. with the aim of improving energy or water infrastructure to make it more affordable for all.

The integration of skills enabling digitalisation of part of the provision of public services is a necessary basis for examining public-private partnerships, such as those promoted under Mobile for Development Utilities (see box above).

Programmes supporting the digitalisation of public services are paving the way for innovative solutions in West African cities to tackle urban problems that are hampered by the complexity of the urban fabric. Digital Transport4Africa, an AFD initiative, contributes to sustainable mobility in Abidjan through digital inclusiveness. Digital Transport4Africa is one of the digital embodiments of sustainable development in African cities. This platform, which functions as an inclusive resource centre, supports a reconfiguration of public transport. In Abidjan, urban planners have taken up the field of urban mapping of all modes of transport, formal and informal, that structure daily mobility. Mobile apps linked to digital mapping technologies make it possible to understand the mobility strategies of inhabitants by tracing all the vehicles dedicated to public transport. Reducing congestion in the Ivorian capital and the planning potential for urbanisation on the outskirts are based on inexpensive technologies such as dynamic mapping linked to the OpenStreetMap functionality and the creation of a General Transit Feed Specification (GTFS), which is one of the most widely used means of transport data sharing in the world. It describes what is available to travellers and allows route calculators to work in real time. This innovation in Abidjan must also be seen in terms of governance, as it involves governing the city from "digital commons," based on open and collaborative data creation and sharing platforms" (AFD, 2019). The aim is to provide residents and economic actors with urban functionality in a city of more than 4 million inhabitants, where the main players in the field of mobility have been omitted from urban planning considerations.

The link between digital technology and development is also taking on new forms in light of the emergence and strengthening of the influence of non-European bilateral agencies such as Turkey, which promotes its digital diplomacy, or China, which promotes its digital technologies through trade agreements. Development through digital technology is not exclusive to international development actors.

The private sector
On the eve of the launch of Starlink by Space X and Google, a new satellite technology to cover the world's disconnected areas – financially inaccessible to most Africans – West Africa's digital market is provoking fierce competition between international telecommunications players and the GAFAM. In West Africa, this confrontation particularly concerns the French group Orange and Facebook, which respond with different corporate strategies. The saturation of the consumer markets for digital goods in North America and Europe is leading to the deployment of innovative and aggressive strategies by international private actors to conquer and control the emerging markets of West Africa. These include financing hubs and support for start-ups, closer ties with universities, aggressive commercial offerings to guide the use of the

Internet, experimentation with promising technologies and philanthropic action. After testing their implementation in Kenya and South Africa, GAFAM are showing a growing interest in West Africa, starting with Ghana and Nigeria. The rise in the production and consumption of virtual content in West Africa nevertheless requires two challenges to be addressed. First of all, the growth of digital technology is based on the consolidation of young digital entrepreneurs, able to identify the innovations and digital content sought in societies that are socially and culturally unrecognised by American firms. Second, the growth of the digital sector in West Africa is determined by the ability of private actors to replace, in part, states, both for terrestrial fibre-optic cabling and for equipping the sub-region with regional data centres. Since 2002, West African states have made significant investments in connecting Africa to the rest of the world via submarine cables, while abandoning the land-based network and, in particular, the infrastructure that anchors the Internet to regional and local data flows. The Internet in West Africa thus remains below the required standards, both in terms of the speeds provided and the prices charged, to envisage the transition from a connected society to a digital society, built around digital goods.

To change the situation, private actors are making huge investments in terms of the investment capacity of states. Facebook and a consortium of telecommunications operators, including Orange, will invest $1 billion in a 37,000 km submarine cable that will travel around Africa from London to Barcelona, Marseilles and Genoa via the Suez Canal. The technology used is expected to triple Africa's bandwidth capacity. The "2Africa" project, scheduled for completion in 2023-2024, is already criticised for the lack of plans for the terrestrial network's capacity to absorb and distribute bandwidth via submarine cable. Google, with its "Equiano" submarine cable, will link Portugal to South Africa on the basis of an investment of $47 billion. The investment capacities of international private actors are such that they fuel the construction of separate regional networks, making the digital divide more complex to understand. The operator Orange, which invests one billion euros per year in infrastructure in Africa, has invested several hundred million euros to build the first interstate network in West Africa (Figure 21). With a length of 10,000 km, the Djoliba – African fibre optic backbone – will be operated in partnership with Sonatel from Dakar, but also from centres in the United States and India. These private investments dwarf those made by states, even

when combined. Sixteen West African states, supported by the World Bank, under the Regional Communications Infrastructure Program for West Africa (WARCIP), are mobilising $300 million to develop the Internet over several years.

Historically involved in the financing of the ACE and Main One Africa submarine cables, and now in "2Africa" by partnering with Facebook, Orange is entering the field of land-based investments. The strategy is to adapt to the structural decline in the volume of voice over-the-air communications in favour of text and digital communications (Snapchat, Whapp). Voice would now account for only 30% of operators' revenues in Africa. It is also the embodiment of an open confrontation with the GAFAM in order to prevail against the states in the regulation of telecommunications and the Internet. Orange and Djoliba, Facebook and "2Africa," Google and "Equiano," among other digital projects, are indeed competing openly to change the rules of the broadband Internet market in Africa. It is much more than capturing the digital market of producing and consuming virtual content. Competition between the digital giants is of course accelerating the connectivity of the sub-region: the number of access points to the marine and terrestrial network makes it possible to expand

the network, the infrastructure supports the quality of the speed provided, and the development of regional data centres promotes lower Internet costs. These gains, which are essential for the democratisation of the Internet, must, however, be balanced against the power that these players have over states and national telecommunications operators. While Orange is pursuing a traditional business strategy of consolidating its hold and capturing new digital markets, Facebook, Microsoft and Google are not.
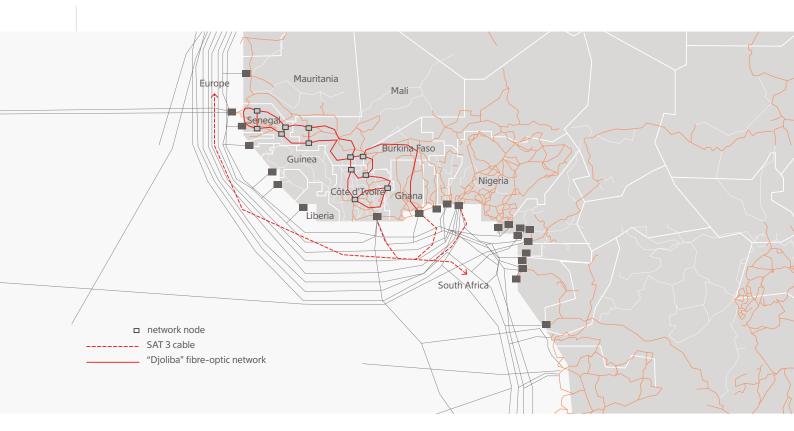
GAFAM have recently demonstrated a continental desire to ignore partnerships with the International Telecommunication Union (ITU), African states and telecommunication operators to advance the Internet in West Africa. As such, Google is displaying the most radical stance by turning away from any cooperation or partnership to develop the Internet in Africa. Google alone financed the "Equiano" submarine cable project, which runs along all of West Africa but is only intended to connect Lagos in the sub-region. This cable offers data transfer capacity twenty times greater than existing bandwidth and will then be the only gateway to this new technology, putting Google in a position to offer it to states on its terms.

Figure 21.
Djoliba Network: 1st
Pan-African fibre-optic
network

As such, Google, like Facebook, has a particular interest in having its own data centres in their networks to control the flow of data. For the GAFAM, it is not so much a question of entering into operating partnerships with national telecommunications operators – in order to sell the Internet – as of securing a monopoly on the hosting of data and its traffic. The prospect of Internet privatisation raises questions about the security of the data of states, companies and citizens, but also the sustainability of Internet access.

Like Google's investment in Kenya, the Internet may disappear from certain regions overnight, depending on the company's commercial, political or strategic interests. The closure in January 2021 of the Loon project, which had been providing 4G in Kenya since 2020 in several rural areas over an area of 50,000 km² using connected and solar-powered weather balloons, illustrates the firm's lack of commercial interest in the poorest and most remote audiences. Facebook's "Free Basics" system, which operates in 23 African countries,

provides free access to the Internet via the Facebook mobile app. However, it questions the control of the circulation of web content to the poorest and its public regulation in West Africa.

Finally, the visibility of GAFAM in West Africa, as in the rest of the continent, is related to the rise of Chinese "BATX" (Baidu, Alibaba, Tencent and Xiaomi) in the consumption of virtual content. Digital technology has become a geopolitical battlefield for redesigning what the Internet is (its uses, contents) and how it is regulated. The barriers and tensions faced by the GAFAM in China support a strategy to control the "free flow" of content on the Internet in states that have a mistrust of the democratic values of the Internet in Africa.

What motivates me as Director of the ESMT is to achieve the following goal: the accessibility of ESMT training to all. It is not just a matter of being present in Senegal, but of being everywhere in French-speaking Africa and the development of the distance learning platform is our priority. We want to develop a new Master's in Artificial Intelligence, as well as a Master's in Health Sciences Technologies: all of Africa must be able to benefit from this (...).

Interview given by Adamou Moussa Saley, Director General of the ESMT, at EPFL's EXAF Center on 23 June 2021 via videoconference.

Universities
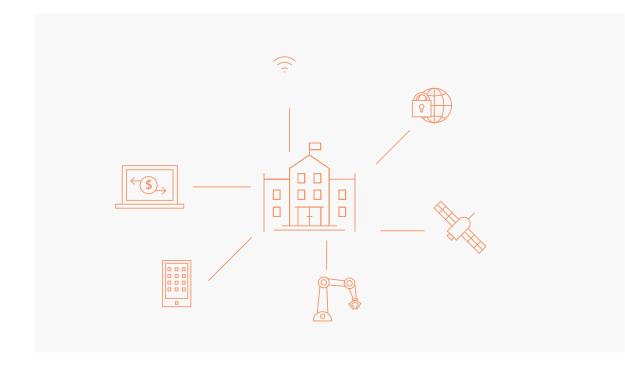
Universities in West Africa appear, at first sight and paradoxically, to be retreating from the digital economy. However, these institutions play a major role in training engineers, entrepreneurs and digital technicians. Digital training capacity in West Africa is crucial for the future of digital technology in the region: it is a question of countering the brain drain that affects the leading sectors in Africa (engineering, pharmaceuticals, medicine, etc.). This brain drain relates both to the lack or poor quality of training in high-tech sectors and to differences in pay and career prospects in Africa. Public and private actors anticipate this reality in the ICT sector and, more broadly, in the digital sector

by supporting both the development of higher education and access to training equivalent to that provided in Europe. Like the Ecole Supérieure Multinationale des Télécommunications (Senegal, Guinea, Mali, Burkina Faso, Benin, Mauritania, Niger), which has been operating in Dakar since 1981, higher education institutions assess the need for digital training and the challenges to be addressed:

West African states now consider digital technology and digital training as a public priority. In Abidjan, the Virtual University of Côte d'Ivoire has been training 6,000 students in computer science and digital sciences since 2016. The fields of study are

resolutely ambitious. They include application development and e-services, cybersecurity, e-administration, the Internet of Things, dematerialised financial transactions, geospatial intelligence, etc. These innovative courses are linked to the creation of a doctoral school that paves the way for digital research and development in West Africa – a field previously reserved for start-ups and living labs. As such, the Ivorian government has institutionally worked on the links between universities and the digital economy. For example, the creation of the Digital Youth Foundation supports the growth of young entrepreneurs

and the strengthening of start-ups in their innovation project, which makes it possible to channel the potential of young graduates. More recently, since 2019, the African Rethink Awards (ARA) start-up competition, created in partnership with the Permanent Conference of African and Francophone Chambers (CPCCAF) and the Land of African Business (LAB), has helped attract investors for Ivorian entrepreneurs. Through the Virtual University of Côte d'Ivoire, the government is thus structuring the foundation of its digital ecosystem by investing in higher education and setting up relay institutions that channel high-

level graduates wishing to embark on digital innovation. Other West African countries have also adopted this model by developing digital universities, with research into cutting-edge fields, such as robotics in Senegal and Burkina Faso. West Africa, for example, has distinguished itself by its capacity to provide high-quality and cutting-edge technology: it has been selected four times by the World Bank (three times in Dakar and once in Accra) to host the Pan African Robotics Competition (PARC), created in 2015. In 2019, following the edition in Accra, Google decided to create an Artificial Intelligence (AI) research centre, its first in Africa. These events (contests, competitions) co-organised by universities not only serve as a springboard for young entrepreneurs, but also prove to the big players in the digital world that young people in West Africa can find solutions for sustainable development.

The proximity of universities to digital players is now a public issue. In Lagos, Google Developers Spaces' proximity to Lagos University and one of Africa's largest hubs, CC Hub, supported Google's creation of the Black Founders Fund Africa. Of the 13 African countries eligible for the $3 million fund, four West African countries can have their start-ups supported by Google and hope to win a prize ranging from $50,000

to $100,000. Google's recognition of the potential of young graduates from the sub-region is also the recognition of training provision in West Africa, which has evolved considerably since the second half of the 2010s. The majority of universities are now working on digitalising their training offerings, making higher education more accessible and offering digital training. Expectations for ICT and digital training in West Africa are such that digital technology supports the development of a private market for digital training. For example, the telephone operator Orange launched "Orange Campus Africa" in partnership with the Virtual Universities of Senegal and Tunisia, as well as French schools (UNIT, AUNEGE, EPITA). Hosted on a server in Dakar, "Orange Campus Africa" is a common teaching platform for these institutions, which is intended to be accessible to students from West African countries that host the Orange telephone network.

City-university partnerships: a model for facilitating the sustainable development of West African cities

Universities have played a marginal role in the development of digital technology in West Africa. The sub-region's ICT and artificial intelligence training offerings remain recent, and low government funding for research has not supported an innovative capacity that drives the digital economy. The hubs and living labs, supported by the state, donors, the major telecommunications operators and, more specifically, by the GAFAM, have been addressing the weaknesses of higher education in the field of digital technologies for the last ten years.

The inclusion of digital technologies in the functioning of cities today depends on the ability of universities to make a name for themselves in the production of digital commons.

However, hubs are not a substitute for higher education in ICT and AI in the long term. Capacity building offered by the hubs to local entrepreneurs is appropriate in the context of the

emergence of digital technology in Africa. In the emerging state, the digital market is proving to be easily penetrated by players with low capital and basic knowledge of technology, who are willing to take significant risks in the face of a regulatory framework that is unsuitable for the dematerialisation of the economy and social ties. However, the introduction of technological innovations coupled with attractive economic prospects leads to the emergence of competition between entrepreneurs whose outcomes are favourable to those with significant innovative capabilities.

The analysis of academic institutions, presented earlier, shows a significant shift in the positioning of West African universities with respect to digital technology. The demand for training West African youth in this sector, the interests of states in halting the brain drain and decongesting a saturated formal labour market for graduates, as well as the real prospects for economic growth are driving a shift in public priorities. As with the ESTM in Dakar,

training capacities are being leveraged by the digitalisation of the training offer, and the use of foreign teaching staff supports new training on ICT, AI and digital innovation in sectors reserved for public investment, such as health.

The inclusion of digital technologies in the functioning of cities today depends on the ability of universities to make a name for themselves in the production of digital common goods. The latter means it is not only a matter of considering the inclusion of universities in the issue of governance of rights (the issue of common free and creative licences) to ensure the diffusion and reproducibility of technologies in African societies. Higher education and research institutions in the digital field are indispensable for orienting digital skills and technologies to the needs of cities in terms of urban development. Currently, direct transfer of skills between universities and urban governance structures in West Africa remains an institutional area for investment. The challenge of involving

universities in urban development, and more generally in public action, is one way of stimulating both the digital economy and supporting the production of common goods. In Europe, and particularly in France, the need to build partnerships between cities and universities, such as the "French Tech" initiative and its "Metropole French Tech" label, supports a public policy on digital technology that focuses on the ability of public actors to govern territories against the backdrop of the growing role of technologies and data in urban management and planning. In addition to supporting digital innovation and local start-ups, the aim is to produce digital commons while limiting the risk of the instruments of territorial governance being taken up by private actors. In the United States, partnerships between cities and universities respond differently to public/private issues: partnerships aim to support both industrialists and municipalities in joint investment sectors, such as transportation. The Metro Lab Network, which brings together 28 cities and 36 universities,

is involved in generating data and identifying urban needs to design urban sustainability and the place of technology in it. Other initiatives such as that of the University of Michigan, with the promotion of MCity, allow industry to explore opportunities for interconnecting public and private connected modes of transportation in the city.

Whatever the context, meeting the challenge of producing digital commons for sustainable development relies on innovative institutional mechanisms bringing together start-ups, local authorities, universities and donors in joint promoting urban development. The "living labs," "tech labs" and "fab labs" have thus established themselves as a form of governance that is not

restrictive for digital players, while at the same time strengthening their ability to attract funding and their opportunities for synergy around common issues, defined in advance by the public players. As such, new institutional frameworks such as "living labs," "urban transition laboratories" or "real-world labs" are booming in Europe, as is the European Network of Living Labs (ENoLL). Living labs are made up of a variety of partnerships, forums and methodologies that foster trans-disciplinary sustainability science, providing a means that is sustainable over time and space of supporting innovation and the integration of knowledge in cities. In the countries of the Global South, the link between municipalities and cities is less well developed and remains an imported reference point. India and South Africa clearly distinguish themselves by their ability to integrate the challenge of the digital economy into specific urban projects such as those in Bangalore and Cape Town. However, digital technology is above all a tool for positioning cities in a globalised and dematerialised economy by producing and showcasing urban projects. As a result, investment is concentrated in city centres, while ignoring the townships of South Africa as well as the Indian slums.

The "living labs," "tech labs" and "fab labs" have thus established themselves as a form of governance that is not restrictive for digital players, while strengthening their ability to attract finance and their opportunities for synergy around common issues.

This diversion of the social and digital divide in these cities is all the more pronounced as governance choices are based on the delegation of public services through public-private partnerships. It suggests that development can be achieved throughout the country by relying on innovation, along with trickle-down economics. The latter is a theory widely contested by scientific studies.

The university positions itself as a key player in strengthening local skills

The success stories built around these two emerging cities contribute to the circulation of the smart city model in West Africa, while questioning its potential for re-appropriation in urban contexts marked by the challenge of sustainable poverty reduction. In West Africa, different models of digital governance are in circulation, with a predominance of technopoles or digital cities, such as in Cotonou, Lagos and Dakar. The involvement of donors, telecommunications operators and the GAFAM in the emergence of an endogenous entrepreneurial fabric capable of investing and innovating in African societies has been structured around the strengthening of skills in the digital sector. With this in mind, the university positions itself as a key player in strengthening the local skills needed for digital innovation in African cities. What's more, their research and development capabilities, as well as their expertise on urban issues, are invaluable to local authorities in digital governance, which must ensure the development of technologies to meet West Africa's urban challenges.

Conclusions

West African cities face the challenges of population growth, with population forecast to double by 2050. To ensure that population growth is accompanied by economic development and to prevent people from falling into a poverty trap, it will be necessary to ensure that rapid urbanisation is inclusive and sustainable.

Digital solutions have proven their value in improving urban services in Sub-Saharan Africa by providing the data for relevant public policies and contributing to the development of many innovations and start-ups.

The extent to which people, especially the most disadvantaged, will benefit from digital development will essentially depend on their access to digital infrastructure and the human skills they can acquire to operate it. In particular, the price of Internet connection is an important aspect to consider in order to understand the potential for digital development in West Africa.

An analysis of the scientific literature shows that the contribution of digital technology to sustainable development can only be made if an ecosystem of effective implementation is in place. This is particularly true in cities, which face enormous socio-environmental and economic challenges. Nevertheless, cities are also the preferred spaces for the implementation of effective digital technologies.

The analysis also reveals a lack of synergy among universities, local industries, multinational corporations, civil societies and governments. For a digital revolution to take place, the above-mentioned actors, especially those in the public sector, need to work together.

Most West African governments rely on digital development as an engine for growth. This is the case in Benin, Mali and Côte d'Ivoire, for example. These countries all have a public digital policy aimed at strengthening the ability of actors to use digital technology to transform society.

An equitable and diffuse proliferation of digital technology can greatly support the economy and serve as a basis for reducing poverty and inequality.

However, it is unlikely that West African States will be able to meet this challenge on their own. International cooperation and private investors have an important role to play.

A lack of technical and financial resources, the digital divide within cities, data protection and transparency of procedures are major challenges for all cities around the world. In West Africa, there is tremendous potential for unprecedented, collaborative and innovative cooperation.

The university-city partnership model is ideal for implementing these measures. The promotion of local know-how and entrepreneurship in a high-tech sector such as digitisation can benefit from academic skills and university research, which too often lack adequate means to test "in real situations."

In return, the city authorities would have the opportunity to closely monitor these developments and orient their public policies and action plans within their territory.

Given the interests at stake and the differences in investment capacities between the public and private sectors, international cooperation should play a major role in ensuring that the digital revolution benefits everyone.

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Tableau 1.
National digital strategies and policies of West African States

List of acronyms

ABAN	African Business Angels Network
AFD	French Development Agency
AFIDBA	AFD for Inclusive & Digital Business in Africa
ARA	African Rethink Awards
AUNEGE	Association of Universities for the Development of Digital Education in Economics and Management
AfDB	African Development Bank
BATX	Baidu, Alibaba, Tencent et Xiaomi
BCEAO	Central Bank of West African States
BDOT	Land Use Database
BOAD	West African Development Bank
CESA	Africa Center for Strategic Studies
CFA	African Financial Community
CIGI	Center for Innovation in International Governance
UNCTAD	United Nations Conference on Trade and Development
CPCCAF	Permanent Conference of African and Francophone Consular Chambers
CSM	Submarine Fibre-Optic Cables
FDFA	Federal Department of Foreign Affairs
DIV	Development Innovation Ventures
DT4A	Digital Transport4Africa
EEEAO	Échanges d'énergie électrique ouest-africain
EPFL	École polytechnique fédérale de Lausanne
EPITA	School of Informatics and Advanced Techniques
ESATIC	École Supérieure Africaine des Technologies de l'Information et de la Communication
ESMT	Ecole Supérieure Multinationale Des Télécommunications
EXAF	Excellence in Africa
FCDO	Foreign Commonwealth and Development Office
GAFAM	Google, Apple, Facebook, Amazon, Microsoft
GCRF	Global Challenges Research Fund
GIZ	Agence de coopération internationale allemande pour le développement
GSMA	Global System for Mobile communications Association
AI	Artificial intelligence

ID4D	Identification for Development
IDES	Inclusive Digital Economy Scorecard
IGB	Geographical institute of Burkina Faso
IoT	Internet of Things
IXP	Internet Exchange Points
LAB	Land of African Business
OECD	Organization for Economic Co-operation and Development
SDGs	Sustainable Development Goals
ODVA	Orange Digital Ventures Africa
OFI	Olam Food Ingredients
WHO	World Health Organization
NGO	Non-Governmental Organization
UN	United Nations
PAGOF	Support Project for Open Governments in Francophone Countries
PARC	Pan African Robotics Competition
PGO	Open Government Partnership
IP	Intellectual Property
GDP	Gross Domestic Product
LDCs	Least Developed Countries
PTN	Digital Technology Park
R&D	Research and Development
SAIS	Scaling digital Agriculture Innovations through Startups
SCIP	Smart Cities Innovation Programme
SECO	State Secretariat for Economic Affairs
GIS	Geographical Information System
SOGE	Scaling Off-Grid Energy
ICT	Information and Communication Technologies
AU	African Union
EU	European Union
WAEMU	West African Economic and Monetary Union
ITU	International Telecommunication Union
UNCDF	United Nations Capital Development Fund
UNIT	Digital University Engineering and Technology
WARCIP	West Africa Regional Communications Infrastructure Project
WASH	Water, sanitation, and hygiene
WSIS	World Summit on the Information Society

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Appendix 1
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