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Landscaping Infrastructure Development in Africa: Past, Present, Future

Jing Zhang[1]

Abstract: Infrastructure has played a pivotal role in shaping Africa's development trajectory, from pre-colonial trade routes to today's modern projects in green transition. Overall, the continent has made considerable progress over the past two decades across key infrastructure sectors, including transportation, energy, ICT and water. Nevertheless, Africa's infrastructure development still lags other global regions, with progress varying widely across sub-regions and countries in terms of quantity, quality and network. The insufficient provision and poor quality indicate a huge financial gap in Africa's infrastructure development. At the same time, the continent's construction sectors face challenges: whilst domestic companies aspire to keep up, foreign players still largely dominate the delivery of critical mega-projects. This paper explores Africa's infrastructure landscape by examining the various types, from transportation, electricity and water to digital infrastructure and SEZs. By evaluating their stocks, service quality, and network connectivity, it highlights the potential of infrastructure development in shaping the opportunities and challenges for the continent in delivering sustainable structural transformation. The paper underscores the missing links between Africa's urbanisation and industrialisation, with discussion on the developmental impacts of different infrastructure types in supporting production and productivity, thereby enabling urban-industrial synergy at various spatial levels.

Keywords: Infrastructure development; urban-industrial nexus; Africa; infrastructure financing; construction

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1. Introduction

From pre-colonial trade routes to modern-day projects, infrastructure has played a pivotal role in Africa's development trajectory. In efforts to harness its potential for driving economic growth and structural transformation, the continent has made considerable progress over the past two decades in key infrastructure sectors, from transportation, energy and ICT to water.

Nevertheless, progress across the continent remains uneven. As commonly divided into five subregions, significant disparities persist between sub-regions and countries in terms of infrastructure development.[2] South Africa, along with countries from the Northern African region, shows substantial advancements with better-developed infrastructure. In contrast, many landlocked countries from Central and Western Africa struggle to keep pace. In general, Africa's infrastructure still needs to be significantly developed compared to global standards, presenting major challenges to bridging various actors and resources to achieve it.

This introductory section explores the historical evolution of infrastructure across key sectors. It follows with a theoretical lens for understanding the role of infrastructure development as a critical enabler in shaping the opportunities and challenges for the continent in delivering sustainable structural transformation.

1.1 Historical lens: evolution of Africa's infrastructure development

Infrastructure development in Africa has followed a complex trajectory influenced by colonialism, post-independence state-building, global economic liberalisation and privatisation, and, more recently, regional integration efforts and sustainable development. In general, the continent's infrastructure development has often lagged that of other global regions due to a combination of historical, geopolitical and political-economic factors. Below is an overview of the key phases in Africa's infrastructure development, highlighting the development of transportation, energy, water and digital infrastructure in different phases.

1.1.1 Pre-colonial and colonial eras and their legacy (1800–1950s)

Before European colonisation, African societies had already developed some early forms of infrastructure to support trade, agricultural development, and the movement of people. Predominantly mobilised and controlled by empire states and city-states across the continent, these early infrastructure developments were mostly focused on road networks and river transport (Charney, 2016; Adeyemo, 2019). Some extensive and sophisticated trade routes before the colonial period were the initial channels to connecting various regions within and beyond the continent, facilitating the exchanges of goods and ideas (Herbst, 2014; Jerven, 2016). The most notable examples include the Trans-Saharan routes connecting West Africa

[2] Generally, the five sub-regions are Northern Africa, Eastern Africa, Central Africa, Western Africa and Southern Africa. Among them, Eastern Africa, Central Africa, Western Africa and Southern Africa are grouped as Sub-Saharan Africa. In this paper, Northern Africa includes Algeria, Egypt, Morocco, Tunisia and Libya. Eastern Africa includes Ethiopia, Kenya, Tanzania, Uganda, Somalia, Rwanda, South Sudan, Sudan, Eritrea and Djibouti. Western Africa includes Benin, Burkina Faso, Côte d'Ivoire, Gambia, Ghana, Guinea, Guinea Bissau, Liberia, Mali, Niger, Nigeria, Senegal, Sierra Leone, Togo and Mauritania. Central Africa includes Burundi, Cameroon, Central African Republic, Chad, Republic of Congo, Democratic Republic of Congo (DRC), Equatorial Guinea and Gabon. Southern Africa includes Angola, Botswana, Lesotho, Madagascar, Malawi, Mozambique, Namibia, Zambia, Zimbabwe and South Africa. This categorisation has excluded small-island countries. It's important to note that in some grey literature sources, certain countries like Sudan, South Sudan and Mauritania are classified as part of Northern Africa; Burundi is grouped with the Eastern Africa region. The paper will provide clarification in cases where alternative sub-regional classifications are applied.

with North Africa and the Mediterranean, as well as the Indian Ocean trade network, which played a crucial role in the historical economic landscape of East Africa (Iliffe, 2017).

Infrastructure development during the early phases of European colonisation was mostly confined to coastal areas. Colonisers initially focused on setting up ports, forts and basic road networks to support the extraction of raw materials and the transatlantic slave trade. By the late 19th century, with the Scramble for Africa,[3] colonial powers began to penetrate the interior, necessitating a more robust infrastructure to facilitate resource extraction and administration. Railways became the most significant infrastructure during this era. Between the late 19th and early 20th century, beginning in Southern Africa and later in Western and Eastern Africa, the railway bears the imprint of the African colonial economy (see Figure 1.1). The system was primarily designed to serve the exploitation of resources from productive hinterlands, such as minerals and agricultural goods, to coastal ports; certain lines were also constructed to provide infrastructure for strategic and military purposes (Iliffe, 2017; Beck, Klaeger, & Stasik, 2017).

For example, the West line in the Gold Coast (now Ghana) was built at the turn of the 20th century (1898–1903) to serve the gold fields of Tarkwa and Obuasi. It also had military objectives, allowing the British administration to deploy soldiers to the Ashanti region. Meanwhile, the East Line's construction began in 1908, reaching Tafo by 1918 and Kumasi by 1923, with the aim of accessing not only gold-rich areas but also cocoa-producing regions (Debrie, 2010). Similarly, in Southern Africa, the construction of the Lourenço Marques rail line in today's Mozambique was driven by the strategic and economic interests of the colonisers to maintain their imperial control as well as make profits from raw materials exports. Jedwab and Moradi (2016) reported that roughly a third of colonial budgets were devoted to the construction of railroads.

In addition to a significant feature of the port and rail combination, infrastructure also evolved

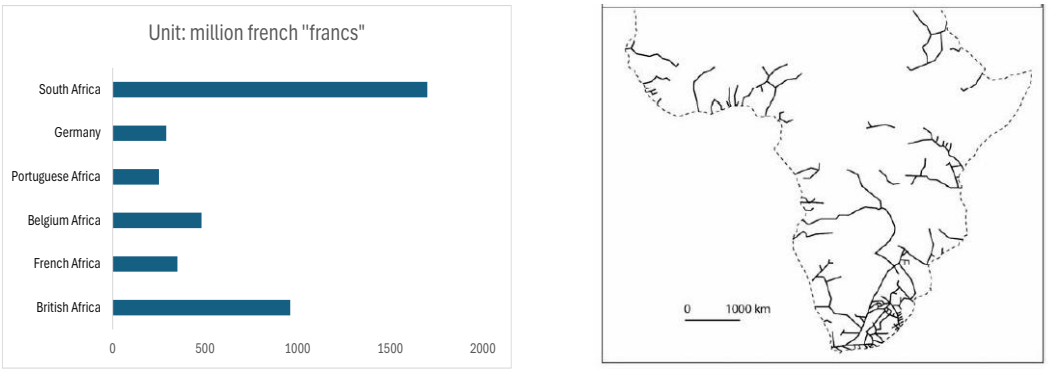


Figure 1.1. Rail investment in Africa to 1934 (left); rail routes: 1960 structure in Sub-Saharan Africa (right). Source: Debrie (2010) from *Historical Atlas of Africa*, recreated by the author

[3] The Scramble for Africa refers to the period between roughly 1884 and 1914, when the European colonisers partitioned the – up to that point – largely unexplored African continent into protectorates, colonies and "free-trade areas".

Note: The French franc was a commonly held international reserve currency of reference in the 19th and 20th centuries. The conversion of French francs to euros was carried out at a fixed rate of 6.55957 francs to 1 euro, with the exchange period for French franc banknotes ending on 17 February 2012.

in the continent for its road transport – as a branch structure added to the Pit-to-Port model. The initial roads were built to channel freight toward railway lines. For instance, in French Sudan (now Mali) and Upper Volta (now Burkina Faso), these paths provided access to agricultural regions, particularly cotton-producing areas. They connected to railway collection stations transporting goods to ports like Abidjan and Dakar. Likewise, roads for transporting peanuts in Senegal and bananas in Guinea are linked to Dakar and Conakry's railway and port systems (Ricart-Huguet, 2022). At a later stage, there were some expansions of the road network beyond the railway and port system. However, this led to proposals for restrictive operating permits to limit road transport by the railway companies. Overall, these early systems created minimal connectivity in the continent and sub-regions, except for in Southern Africa, where some levels of density and network existed (Gwilliam, 2011).[4]

1.1.2 State-led development in the post-independence period (1950s/1960s–80s)

After gaining independence from colonial powers throughout the 1950s and 1960s, African nations embarked on an era of state-led development. Governments took direct control of economic planning, with infrastructure development playing a central role in national strategies to modernise economies, promote industrialisation, and enhance social welfare. Notably, in Ghana's Second Five Year Plan from 1959, 80 per cent of spending was allocated to infrastructure development and social services (Wethal, 2019). Similarly, other resource-rich African nations like Algeria and Nigeria also directed substantial revenue from high-priced crude oil towards large-scale infrastructure projects (Meredith, 2011; Mold, 2012). In addition, a significant portion of these investments was supported through international loans. In 1973, infrastructure financing accounted for nearly 60 per cent of total aid to Sub-Saharan Africa (Nissanke & Jerve, 2008).

In terms of transportation, Africa's railways have been losing ground against road transport since the 1960s. Roads started to dominate passenger and trade traffic whilst the railway system grappled with a host of interconnected challenges, including inadequate investment, low usage levels, incompatible technology and poor maintenance (Beck, Klaeger, & Stasik, 2017). The state ownership of railway systems was a hallmark of the period. Nevertheless, most African governments failed to secure sufficient funding to extend the rail lines to more areas of economic activity. The most ambitious project during this period was the Tanzania-Zambia Railway, built in the 1970s with Chinese funding (Bailey, 1975). In comparison, road construction prospered. Jedwab and Storeygard's research (2019) shows a steady growth in road density over time throughout the post-independence period. Roads were seen as vital for fostering national unity by connecting rural areas to urban centres. Regarding ports and airport development, several major projects were undertaken across Africa to support state efforts in promoting industrial development, such as the expansion of Jomo Kenyatta International Airport in Kenya and the building of Tema Port in Ghana.

[4] On the other hand, some research also shows that the construction of the colonial railway had a strong and long-term legacy on European, Asian and urban settlement patterns (see Jedwab, Kerby, & Moradi, 2017).

Energy infrastructure, particularly in the form of hydropower and thermal power plants, was a central focus of post-independence development strategies. African leaders viewed energy generation as crucial to support industrialisation, modernise economies and improve quality of life. State-owned energy corporations were established to manage power generation and distribution, reflecting the broader state-driven economic models of the time. Large hydropower projects were launched in countries like Egypt (e.g., the Aswan High Dam) to control the Nile River and generate hydroelectric power; and the Akosombo Dam in Ghana, which was designed to provide electricity for the country's aluminium industry (Amankwah-Amoah & Osabutey, 2018). In parallel with the ambitious dam-building projects, the discovery of oil and natural gas in countries like Nigeria, Angola and Algeria during the post-independence period spurred the development of thermal power plants. These countries saw their energy sectors become dominated by oil and gas, which were also their primary export commodities (Edomah et al., 2016).

1.1.3 Privatisation, globalisation and regional integration (1990s-present)

By the late 1980s, many African nations faced economic crises exacerbated by falling commodity prices, high debt levels, and corruption. This led to a period of stagnation in infrastructure development. Structural Adjustment Programs (SAPs) imposed by the International Monetary Fund (IMF) and World Bank further reduced public spending on infrastructure, as governments were required to focus on austerity measures. Consequently, the 1990s and early 2000s saw an expansion of public divestiture programmes and increased private sector participation in infrastructure development, especially in areas of telecoms, power and urban transportation (Ndulu, 2006).

For example, by the 2000s, some telecommunication companies like MTN, Vodacom and Airtel emerged as major private players operating on the continent. The privatisation of energy utilities also began during this period, but many regions still struggled with electricity access. National grids in Sub-Saharan Africa remained underdeveloped, particularly in rural areas. In the urban transportation sector, SAPs generally led to the decline of public bus transport companies and a deterioration of local road networks. These changes paved the way for a massive expansion in minibus transport (paratransit) from the 1990s onwards, especially in cities undergoing rapid demographic growth and urban sprawl (Haas, 2022).

Globalisation and regional integration also profoundly impacted infrastructure development in Africa, starting in the 1990s. As African countries integrated more into the global economy, there was a renewed focus on building infrastructure to support trade and investments. Port modernisation and airport expansion were launched to boost international trade and tourism. Special Economic Zones (SEZs) were established as part of industrialisation strategies aimed at attracting foreign direct investment and boosting exports. Countries like Ethiopia, Egypt, Kenya, Nigeria and Morocco have all created different types of SEZs to attract global investors in sectors such as textiles, automotive and electronics. Though performances so far have shown mixed results, they indicate strong efforts of some African countries to move up the value chain and diversify their economies beyond raw material exports (Zeng, 2015).

Another important driver of infrastructure development in Africa from the 1990s was closely tied to regional integration efforts. African governments, regional economic communities (RECs), regional development banks and international partners increasingly recognised the need for efficient, cross-border infrastructure to foster economic cooperation and regional

stability. A major component of the efforts is the Trans-African Highway Network, initiated by the African Union (AU), aimed to create a network of nine highways across the continent, linking major cities and facilitating trade between different regions.

For example, the Cairo-Cape Town Highway and the Dakar-Lagos Corridor are part of this initiative to improve regional connectivity based on the improved road network (Cupers & Meier, 2020). Railway infrastructure, which had been neglected for much of the post-independence period, saw a resurgence of interest since the late 2000s, especially in the Eastern African region. China played a pivotal role in financing and constructing some new railways in the continent, notably the Mombasa-Nairobi Standard Gauge Railway (SGR) in Kenya, completed in 2017, and Ethiopia's Addis Ababa-Djibouti Railway (Bouraima et al., 2023).

1.1.4 Emerging trends: SDGs, climate change and green transition

In alignment with global initiatives to combat climate change and achieve the Sustainable Development Goals (SDGs), infrastructure investment is increasingly being directed toward adopting cleaner and more sustainable practices. Emphasis has been placed on renewable energy, green technologies, climate resilience, and fostering innovation across various infrastructure sectors (World Bank, 2023). Consistent with SDG 9 (build resilient infrastructure, promote sustainable industrialisation, and foster innovation), multilateral development banks, regional and international organisations, and donor communities have increasingly integrated sustainability and climate resilience principles into their infrastructure programmes (Yanamandra, 2020).

In the area of energy infrastructure, there has been a noticeable shift toward promoting renewable energy sources, including solar, wind and hydroelectric power. Energy efficiency standards for industrial processes and transportation systems are encouraged to reduce carbon emissions and promote sustainability (EBRD, 2023). In urban transportation, critical efforts include the promotion of electric vehicles, enhanced public transit systems, and non-motorised transport options (OECD, 2024). For example, the World Bank has been working to make electric mobility more accessible for developing countries and helping countries assess their readiness for e-mobility. Electrifying public bus transport fleets, as well as two/three-wheel vehicles, are two effective ways to jumpstart the green transition. In Senegal, the Dakar Bus Rapid Transit Pilot Project introduced the first all-electric bus fleet in Africa, marking a notable case in such promotion towards green transition. Additionally, shared mobility (vehicles-sharing service) is also increasingly proposed as a way towards transition.

Investment in digital infrastructure, such as high-speed internet and telecommunications networks, has also been prioritised to support energy transition and improve connectivity. The digitalisation of freight transport supports more resilient logistics and supply chains, and big data is being used to improve corridor performance. In the water sector, particularly in relation to urban and industrial development, efforts remain to address water supply and wastewater treatment challenges (UN Water, 2024). For instance, Eco-Industrial Parks (EIPs) development has been referred to as a recent response to improve water efficiency and reduce wastewater output. Major global organisations, including UNIDO, the World Bank and GIZ, have significantly supported governments and industrial park practitioners in establishing EIPs across various countries and contexts (World Bank, 2021).

1.2 Theoretical lens: potentials of infrastructure development in enabling industrialisation-urbanisation nexus

Structural transformation refers to changes in the structure of the economy towards activities with the scope for sustained high growth in productivity, through cumulative improvements (Andreoni et al., 2021). There is a strong sectoral dimension of such transformation, which historically centred on the shift of labour from rural activities, such as agriculture, to urban-based employment, particularly in industry and services (AfDB, OECD, & UNDP, 2016). While most Asian countries have followed a standard pattern of synergy between structural changes and urbanisation, Africa's urbanisation generally occurs in cities where employments are heavily skewed toward non-tradable and low-productive service sectors, such as local retail, education and health, as well as government and personal services (Gollin, Jedwab, & Vollrath, 2016; Ebeke & Etoundi, 2017). As African nations strive to shift their economies towards high-productivity industrial and service sectors, infrastructure is pivotal in facilitating this transition. By enhancing mobility, connectivity and accessibility, infrastructure investments can create the conditions for sustainable economic growth, bridging the gap between urbanisation and industrialisation in the continent.

1.2.1 Africa's urban trends and agglomerations

Africa is projected to have the fastest urban growth rate in the world: by 2050, the continent's cities will be home to an additional 950 million people (OECD, 2020). Its urban populations have been growing since the 1950s. The rate of urbanisation was rapid in the post-independence period, slowed in the 1990s, and picked up again in the 2000s (UN-Habitat, 2010). In 2020, the urban share in Africa rose to 54%, with the number of cities growing from 3,290 in 1990 to 8,999 in 2020. It is expected that urban populations in Africa will triple in the next 50 years, transforming the region's profile and challenging policymakers to harness the urbanisation phenomenon for sustainable industrialisation (UN-Habitat, 2024).

At sub-regional levels, African countries are urbanising at different speeds. As Figure 1.2 shows, Northern Africa and Southern Africa have the most urbanised countries in the continent and are moving more slowly. In comparison, Eastern Africa is one of the least urbanised sub-regions but is urbanising fast.[5] Specifically, countries such as Algeria and Botswana have urban populations exceeding 70% of their total population, whilst Tanzania, Uganda, Kenya and Ethiopia's urban populations only account for 37.4%, 26.8%, 29.5% and 23.2% of the total population. However, their annual urban population growth on average between 2013 and 2023 is as high as 5.82%, 6.2%, 4.27% and 5.35%. There are a few countries on the continent that have also experienced negative urbanisation in the last decade, notably Mauritius and Zimbabwe.

[5] The original data are collected by UNDP. Urban population refers to people living in urban areas as defined by national statistical offices. Care should be taken when comparing these figures across countries, as definitions of "urban" and "rural" vary between nations. Additionally, the population size of a city or metropolitan area is influenced by the specific boundaries used to define it. There are also different indicators for evaluating urbanisation, such as urban land cover or several agglomerations, which may render different results for different sub-regions and countries. Nevertheless, the percentage of the urban population is one of the most used indicators.

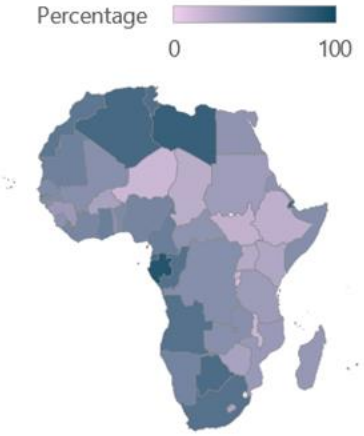
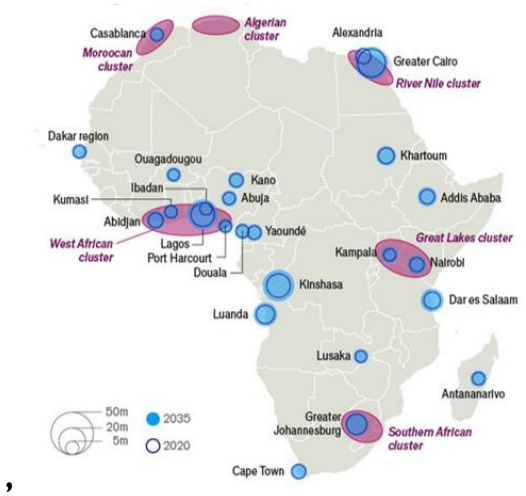


Figure 1.2. Urban population (% of total population), 2023. Source: World Bank; CIA, US Government, Worldfact Book; created by the author

Countries display diverse spatial patterns of urban growth. Globally, most of the fastest-growing cities are medium-sized, with populations below 1 million. However, in Africa, a larger share of the urban population is concentrated in its largest cities, a phenomenon known as “urban primacy”. For example, in countries like Burkina Faso, Cameroon, Republic of Congo and South Africa, the largest cities are growing faster than other urban areas. There are a few countries, such as Benin, Gambia, Liberia, Rwanda, and Sierra Leone, where urban growth has occurred outside the largest city, leading to a decline in urban primacy. In some countries like Morocco, urban growth is more evenly distributed across multiple mega-cities with a population of more than one million. According to different statistics, the continent now hosts approximately 65 urban agglomerations with populations of more than 1 million, 25 urban agglomerations with more than 3 million, and four with more than 10 million (UNDESA, 2018; CIA, US Government, OECD/Africapolis, 2020; Worldfact Book, 2024).



Cairo	Egypt
Kinshasa	DRC
Lagos	Nigeria
Johannesburg	South Africa
Luanda	Angola
Dar es Salaam	Tanzania
Khartoum	Sudan
Abidjan	Côte d’Ivoire
Alexandria	Egypt
Addis Ababa	Ethiopia

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Figure 1.3. Africa's largest cities and city cluster in 2035. Source: Economist Intelligence Unit, 2024

1.2.2 Missing links between urbanisation and industrialisation

While Africa's urban growth has been rapid, it has not always been accompanied by the necessary industrial development to create thriving and productive economies. In Africa, manufacturing and urbanisation were closely linked during the early postcolonial era, but manufacturing later decreased, hindering structural transformation and slowing economic growth. Although growth resumed in the mid-1990s, it did so without significant employment growth in manufacturing (de Vries, Timmer, & de Vries, 2014). Nevertheless, rapid urban transition in the continent continued, largely driven by the natural increase in urban areas (Fox, 2012) and migration induced by the resources rent windfalls spent in cities (Jedwab, 2013).[6] Consequently, the continued trend of urbanisation without industrialisation has resulted in cities with poorer populations and higher informality (UNECA, 2017).

This misaligned trajectory is featured by the premature deindustrialisation and emergence of consumption cities across Africa. Typically, the global trend shows that the share of manufacturing in total output increases as per capita income grows, peaking in upper-middle-income countries before declining as the services sector becomes more dominant (Gollin, Jedwab, & Vollrath, 2014). African nations are experiencing their peak in manufacturing at much earlier stages of development compared to today's advanced economies, missing out on the growth and productivity benefits that typically accompany a full manufacturing phase, a process known as "premature deindustrialisation". Research indicates that industrialisation peaked in European countries such as the United Kingdom and Sweden when income levels were around US$14,000 (in 1990 dollars).

In contrast, many low and lower-middle-income African countries saw their manufacturing employment peak at income levels as low as US$700 (Rodrik, 2016). Even the middle-income group in the continent, such as South Africa, showed signs of premature deindustrialisation as early as the 1980s. This ongoing process is trapping the country in a cycle of stagnant growth, limiting its ability to catch up with more advanced economies in recent years (Andreoni & Tregenna, 2021; Zalk, 2021).

[6] Some of these discussions also included push factors in driving the urbanisation process, for example, civil wars (Fay & Opal, 2000), poor rural infrastructure (Collier et al., 2008) and climate change more recently (Henderson, Storeygard & Deichmann, 2017).

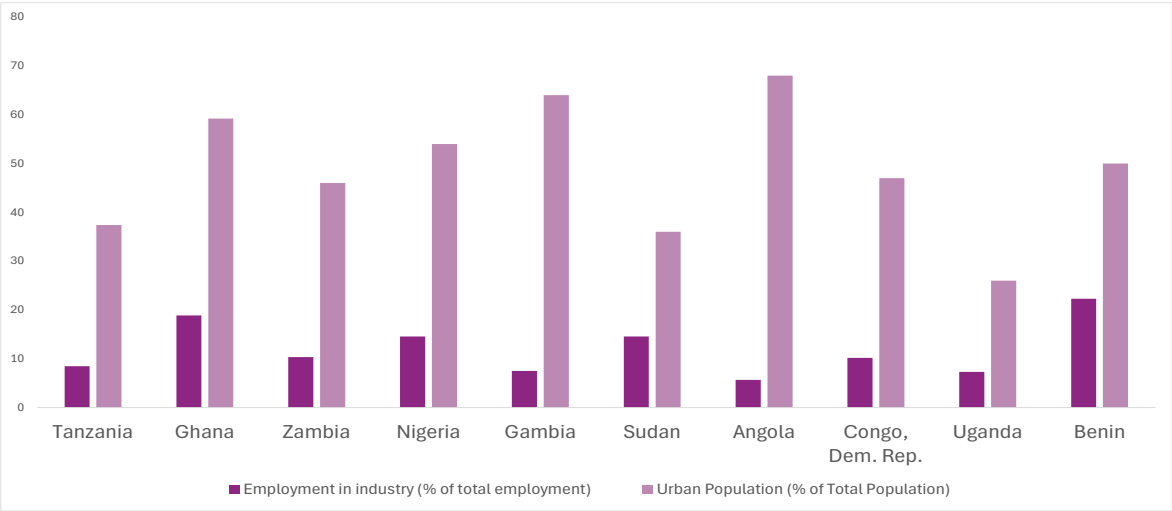


Figure 1.4. Urbanisation and industrial employment, 2022. Source: World Bank, created by the author

At the city level, natural resource earnings have generated income but not a broad base of formal and productive jobs, leading to "premature urbanisation" and "consumption cities" (UNECA, 2017). Rather than manufacturing sectors, employment growth in consumption cities tends to take place in non-tradeable service sectors, such as commerce and transportation or personal and government services. The shift of labour into the service sector, often with a strong informal component, can result in increased employment but limited value creation, indicating low or even negative productivity for new workers (Newman et al., 2016). Beyond these low-productive employment patterns, research also shows that consumption cities tend to have higher poverty rates and shares of the population in slums (Gollin, Jedwab, & Vollrath, 2016). They can also be disproportionately expensive. For example, according to cost-of-living surveys conducted by agency Mercer, Luanda is reputed to have become the most expensive city in the world (Turok, 2013).[7]

1.2.3 Developmental impacts of investments in infrastructure and their services

Sustainable structural changes require a process of production transformation accompanied by the creation of good-quality jobs and the expansion of collective capabilities (Andreoni & Chang, 2017). Likewise, Africa's rapid urbanisation needs to bring production and productive employment back into the transition in a timely manner. Infrastructure development can play a critical role in facilitating this process by enhancing connectivity, mobility and accessibility for individuals and firms at rural-urban, intra-urban, urban-regional and global levels, thereby supporting the building-up of collective productive capabilities and enabling the synergy between industrial growth and urban development. Different types of infrastructure drive the flow and access of labour, goods and information in different ways to support production and productivity. Evaluating their stocks, the quality of the service they provide, and their network are essential to understanding the readiness and potential of the continent in facilitating this synergy, thereby accelerating the process of sustainable structural transformation.

For example, enhanced transport and digital infrastructure support the efficiency of freight and passenger traffic. To individuals, this can be translated into less travel time and lower cost of living. To firms, improved logistics infrastructure expands market access by connecting them

[7] The survey measures the comparative cost of more than 200 items across 400 cities throughout the world, including housing, transportation, food, clothing, household goods, and entertainment.

to larger regional and global markets, facilitating the exchange of goods and services. It is worth mentioning that Africa's current exports are dominated by raw materials and natural resources such as minerals and precious metals, oil and gas and agriculture products, which have largely depended on the logistics network of road, rail and ports.[8] Equally important, access to reliable power and consistent water is essential for firms to maintain continuous operations and enable them to adopt advanced technologies and machinery. This is particularly important for some manufacturing sectors that are energy-intensive or agro-processing industries that are water-consuming (Perez-Sebastian & Steinbuks, 2017). On one side, it is important to accumulate a certain quantity of infrastructure assets before they begin to contribute at all to the productivity of the economy, which is called "threshold effects". On the other, the service of infrastructure provided is often through a networked delivery system. To benefit from one point in the network, capacities at other points are also important and complementary to each other. Production gains and positive externalities can only be generated if there are joint accessibilities of different services (Agénor, 2010).

Infrastructure can deliver services that have significant developmental impacts. At the same time, it is important to understand infrastructure as capital goods that necessitate project planning, financing, construction and operation. As capital goods, infrastructure is characterised by lumpiness and is usually very long-lasting (Prud'homme, 2004). Investment in infrastructure often generates immediate demand for construction services, which in turn stimulates other related sectors such as logistics, manufacturing and services (Calderon et al., 2018). In the history of development, the public sector has been the most pivotal actor in delivering and maintaining infrastructure systems. Nowadays, direct public provision is only one of the options, as the private sector is increasingly incentivised to get involved. The reasoning behind this shift is that the private sector can contribute its expertise, efficiency, and capital, particularly for projects that do not fully exhibit the characteristics of public goods (Gottschalk & Sampath, 2021).

The framework outlined below illustrates the structure of this overview. This section has outlined the importance of triangulation among urban-industrial synergy, production transformation and infrastructure development. Based on this abstraction, the next section will examine different types of infrastructure in the continent, including transportation (port, airport, railway, roads, urban transportation), ICT, electricity, water, and special economic zones (SEZs). Given the importance of "thresholds effects" and "network effects" of infrastructure development to provide their services, the analysis will focus on their quantity, quality, and network in shaping the readiness of different sub-regions and countries in enhancing productivity at different geographical scales. Following the analysis of existing infrastructure development in the continent, section three will focus on the most critical aspect of delivering infrastructure projects in the current discussion – infrastructure financing and construction, evaluating the continent's financing and projects landscape to better understand the potentials of sub-regions and countries. It concludes with a summary of opportunities and challenges,

[8] Logistics routes for various raw materials can also vary over time, subject to business decisions of companies, location of their projects, the nature of the products and the shifting pictures of infrastructure development in each different route. For example, lithium from Ewoyaa, Ghana primarily relies on road and port transport. Graphite exports from Mahenge, Tanzania utilise rail and port systems, while phosphate from Khouribga, Morocco largely depends on pipelines and rail. Landlocked countries face more complex and longer routes for exporting raw materials, such as copper from Lubumbashi, DRC or lithium from Manono-Kitotolo, DRC, which depend on a combination of road, barge, rail, and port systems. See Goodenough, Deady, & Shaw (2021), Blackrock mining (2023) https://blackrockmining.com.au/black-rock-signs-mou-for-rail-transport-from-mahenge, OCP (2024) https://www.ocpgroup.ma

and how they shed light on enabling industrial-urban synergy in Africa, with the key research agenda laid out for this stream in the next stage.

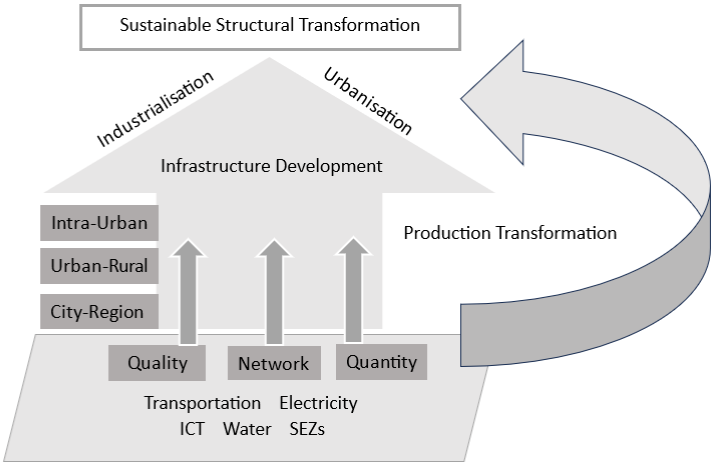


Figure 1.5. Framework of analysis

2. The status quo of infrastructure development in the continent

Overall, in the past two decades, Africa's infrastructure development has witnessed significant progress across all sub-regions. Established by the African Development Bank (AfDB), the Africa Infrastructure Development Index (AIDI) tracks nine indicators on four component indices across transportation, energy, ICT and water and sanitation, offering a relatively comprehensive picture over the past two decades of how different countries and sub-regions are performing in their efforts in establishing foundational systems that support both industrial and urban growth.[9]

From the index map of 2005 and 2022, we can see that infrastructure development across the continent has advanced in all sub-regions and most countries. Notably, South Africa and countries from Northern Africa have been leading this progress with the most developed infrastructure landscape. In contrast, Central Africa, particularly some landlocked countries in the region, is lagging in their progress. When further examining the index's four major components (transportation, energy, ICT, water and sanitation) over the years, a similar pattern emerges: South Africa and countries from Northern Africa are leading the way, while other regions are either stagnating or facing challenges in maintaining consistent progress.[10]

[9] The nine indicators include 1) total paved roads (km per 10,000 inhabitants); 2) total road network in km (per km^2 of exploitable land area); 3) net generation (kwh per inhabitant); 4) total phone subscriptions (per 100 inhabitants); 5) number of internet users (per 100 inhabitants); 6) fixed (wired) broadband internet subscribers (per 100 inhabitants); 7) international internet bandwidth (mbps); 8) improved water source (% of population with access); 9) improved sanitation facilities (% of population with access).

[10] Based on the African Development Bank, data for the four components of the AIDI are collected from various sources, including data collected by the Bank under the auspices of the Africa Infrastructure Knowledge Program (AIKP). The AIDI index of some countries that have ongoing political conflict, such as Libya, may be overestimated due to the methods of

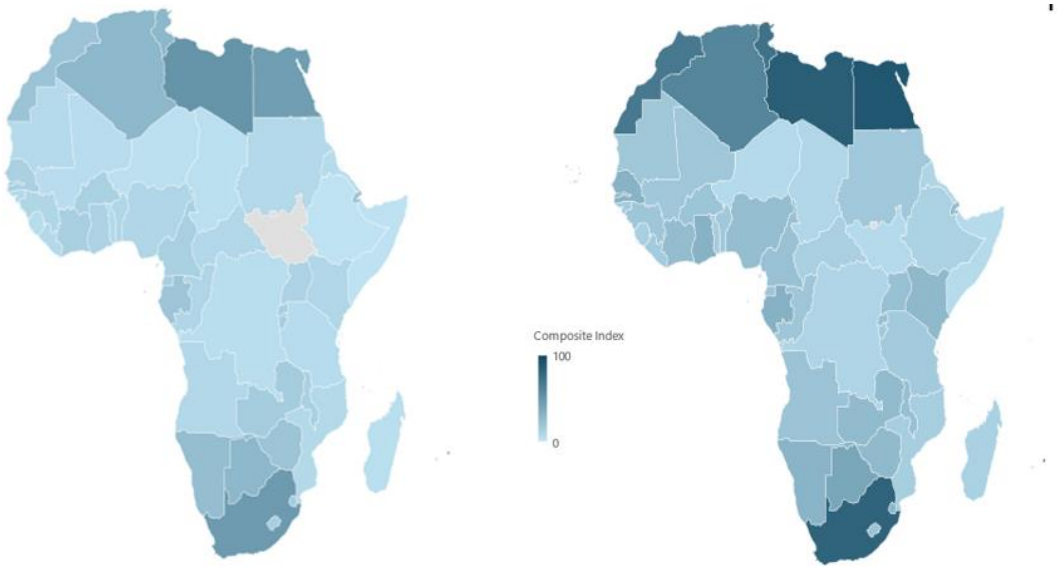


Figure 2.1. Africa Infrastructure Development Index, 2005 and 2022. Source: AfDB, created by the author, no data source for South Sudan in 2005

2.1 Transport: ports

Since colonial times, ports have held a special position among physical assets due to their strategic importance in controlling access to Africa's valuable natural resources, such as minerals and oil. This trend continues today, with numerous terminals and port facilities developed to accommodate rising volumes of mining exports and critical minerals sent abroad for processing. However, ports have evolved beyond their traditional role; they now offer profitable opportunities to tap into Africa's expanding domestic markets while reducing exposure to risks from individual countries. With Africa's population projected to increase from 1.4 billion to 2.4 billion by 2050, and with some of the fastest-growing economies globally, especially in West and East Africa, the combined economic and demographic expansion is boosting consumption and driving imports. Consequently, African ports are emerging as a highly appealing asset class for private investments, positioned for strong growth in the foreseeable future (AFC, 2024).

data collection. However, detailed information on data sources is limited, and no raw data has been made publicly available for verification.

Based on various sources,[11] Northern African countries, including Egypt, Algeria, Morocco, and Tunisia, each have a substantial number of ports serving both international and regional trade. Beyond the Northern Africa region, nations like South Africa, Nigeria and Angola are also among the leaders in the continent for their stocks of international ports. Among different indicators, the three most important ones, evaluating the services provided by port infrastructure, are published by the World Bank and UNCTAD. One is the Liner Shipping Connectivity Index (LSCI) score, which indicates how well countries are connected to global shipping networks based on the status of their maritime transport sector. Globally, Africa lags. Within the continent, Northern African countries, namely Morocco and Egypt, lead the connectivity index, showing a consistent picture of their advantages on the port stocks.

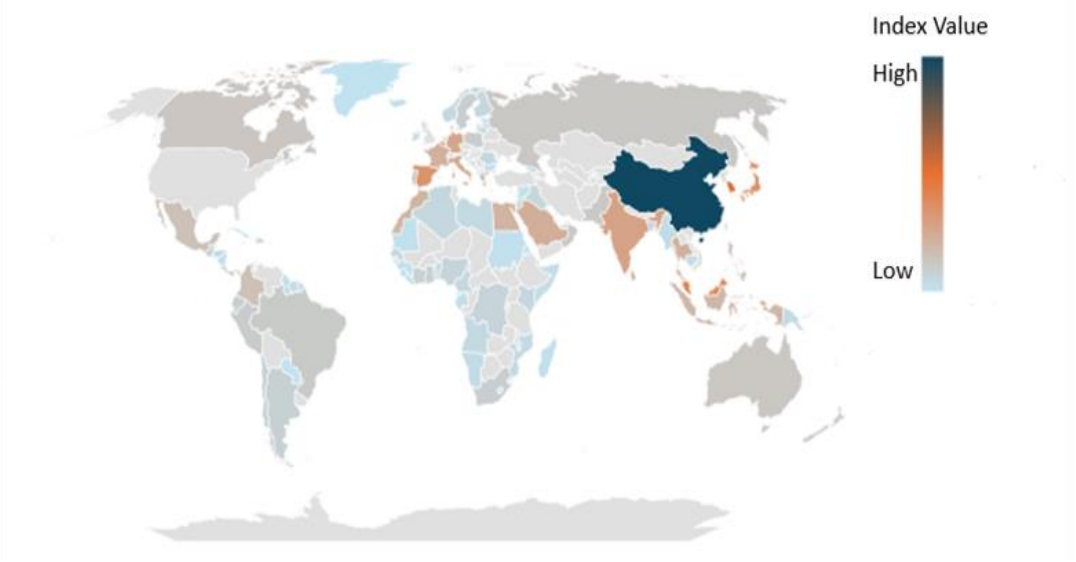
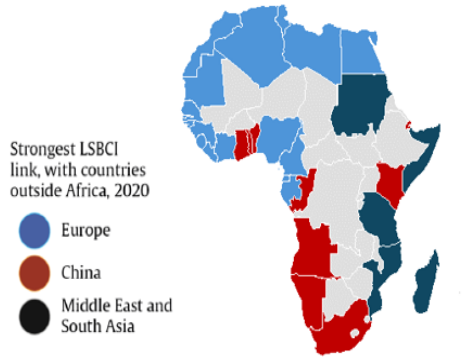


Figure 2.2. Liner Shipping Connectivity Index, global overview, 2023. Source: UNCTAD, created by the author

[11] Based on available data from the World Bank Infrastructure Map and Worldfact Book from CIA, US Government. However, the CIA database was updated in October 2024 and no longer includes port data.

In parallel, UNCTAD also developed the Liner Shipping Bilateral Connectivity Index (LSBCI) as a complement to the LSCI score, to measure how well two countries are integrated into



Stronger Connection with China	South Africa, Angola, Togo, etc
Stronger Connection with Europe	Morocco, Egypt, Nigeri etc.
Stronger Connection with Middle East and South Asia	Tanzania, Madagascar, Sudan, etc

Source: Guerrero, Nierat, Thill and Cohen (2022), based on the data from UNCTAD, recreated by the author

Figure 2.3. Global connectivity based on LSBCI.

global liner shipping networks. Figure 2.3 shows, based on data from 2020, how well each African country relates to the countries outside Africa. The results indicate that countries like South Africa, Angola, Togo, Djibouti and Ghana all have stronger connections with China; countries in Northern Africa like Morocco and Egypt, along with many Western African countries such as Nigeria, connecting strongly with Europe; and several Eastern and Southern African countries share a stronger connection with the Middle East and South Asia, including Tanzania, Somalia and Mozambique.

The second indicator to evaluate the connectivity and capacity of ports is the container port traffic. Figure 2.4 below shows a selection of African countries with meaningful port traffic based on data from 2010 to 2020. In terms of the absolute size of traffic, Egypt, Morocco and South Africa have led the first-tier rank. In terms of growth rate over a decade, Togo, Republic of Congo, Morocco, Djibouti, Ghana, Mozambique, Senegal and Tanzania are the strongest. Combined with the analysis showed by LSBCI, the growth of Morocco is likely to be driven by the trade connection with Europe. In comparison, the rapid growth of port traffic in Togo, Republic of Congo, and Djibouti are perhaps mostly driven by the increasing engagements with China, which is consistent with recent data on growing Chinese economic relations with these countries and their neighbouring regions (landlocked countries) between 2010 and 2020. Indeed, trans-shipment has seen the greatest increase in the continent, where regional and cross-border land networks are limited. Togo, for example, has now solidified its position as the leading trans-shipment hub for Africa's Atlantic coast, with trans-shipment operations constituting 70% of its total traffic. Likewise, port Djibouti has also seen strong growth in recent years – fuelled by its links to landlocked countries, of which Africa has the highest number globally (AFC, 2024).

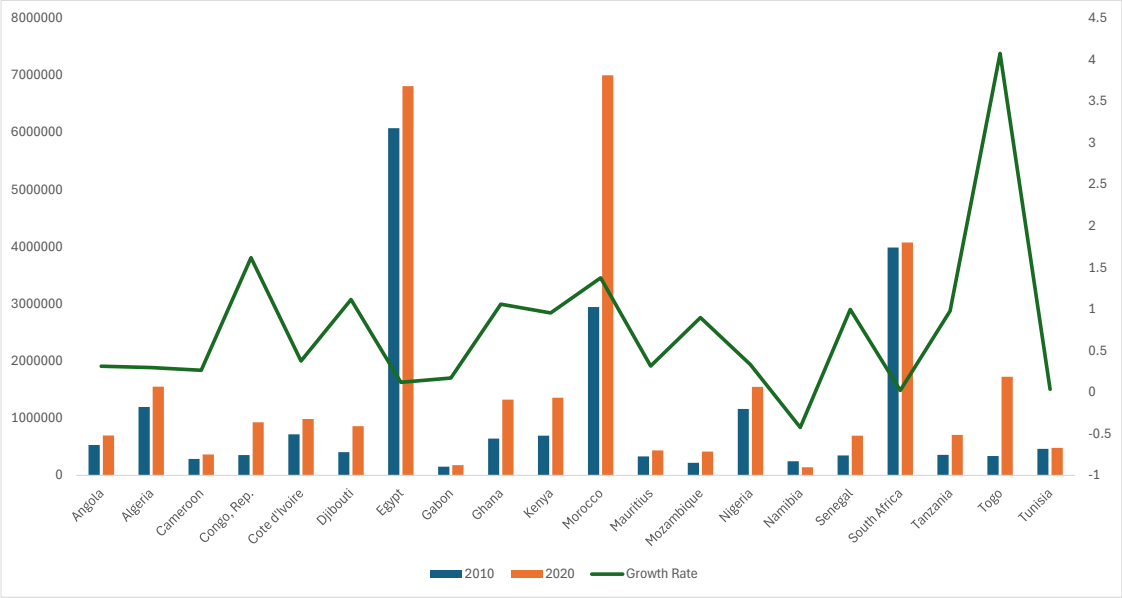


Figure 2.4. Container port traffic and their growth rate (2010–20) in major African ports (TEU: 20-foot equivalent units). Source: World Bank and UNCTAD, created by the author

The third indicator is the World Bank's Container Port Performance Index (CPPI), which measures a port's capacity to handle containers for export, import and trans-shipment (Table 2.1).[12] In the Top 25 ports under the CPPI 2023, Tanger-Med Port in Morocco is ranked third, leading the performance in Africa. Tanger Med port strengthened its position as a major Mediterranean hub, handling 7.5 million containers in 2022 – up 6 per cent from 2021 (see Box 2.1). An estimated 35 per cent of African trade with the rest of the world is now passing through Tanger Med, which is connected to about 40 African ports (UNCTAD, 2023). At the same time, Port Said in Egypt also made it to the global top 20. In comparison, no ports from South Africa entered the top 100 global list in 2023.[13] This aligns with the data on the growth rate of container port traffic between 2010 and 2020, which indicates an almost negligible increase of just 0.02 percent for South Africa. Similarly, ports in Tunisia experienced almost no growth, while Namibia saw a decline in growth over the same period (see Figure 2.4).

[12] Developed by the World Bank and S&P Global Market Intelligence, the CPPI 2023 has ranked 405 global container ports by efficiency, focusing on the duration of port stay for container vessels, based on the dataset covering more than 182,000 vessel calls, 238.2 million moves, and about 381 million twenty-foot equivalents (TEUs) for the full calendar year of 2023.
[13] Based on CPPI2023, four of South Africa's ports are ranked very low – for example, Durban was ranked at 398, and Port Elizabeth at 391. Some criticise the CPPI's methodology, arguing that it should be complemented with other assessments. Nevertheless, the current ranking highlights the serious difficulties that South African ports are confronting. To address the port inefficiencies, South Africa established the National Logistics Crisis Committee (NLCC) in June 2023, as well as developed the Freight Logistics Roadmap, which was approved by the cabinet towards the end of the year.

Table 2.1. 2023 World Bank's Container Port Performance Index (CPPI)

Port Name	Country	Overall Ranking (Global)
Tanger-Mediterranean	Morocco	3
Port Said	Egypt	16
Berbera	Somaliland	103
Mogadiscio	Somalia	176
Conakry	Guinea	208
Malabo	Equatorial Guinea	237
Freetown	Freetown	252
Bata	Equatorial Guinea	269
Takoradi	Ghana	273
Toamasina	Madagascar	294

Source: World Bank, created by the author

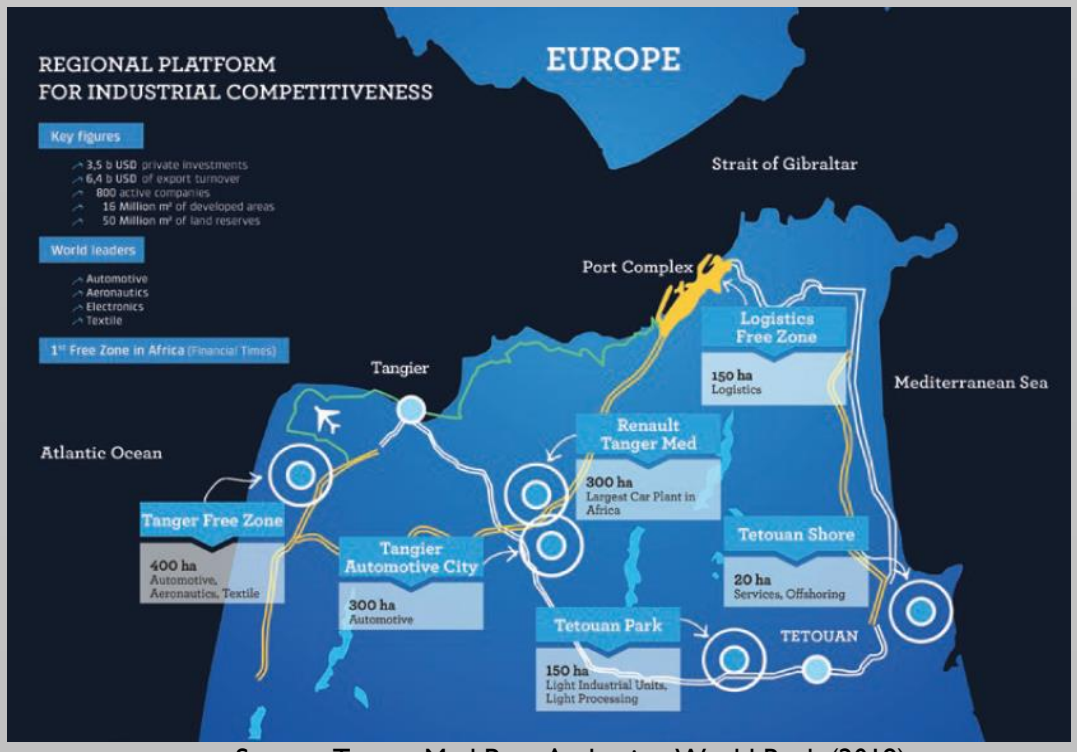
Box 2.1. Tanger Med: an integrated approach of infrastructure investments

Morocco's strategic location on the Strait of Gibraltar, at the intersection of major north-south and east-west shipping routes, allows ships to pass through without deviating from their path. Tangier is situated at a key point where approximately 20% of global trade crosses. In 2002, the Moroccan government launched a major integrated development project centered around Tanger Med, a global container port on the Strait of Gibraltar. The project includes over 1,000 hectares of industrial and commercial zones, along with new infrastructure that connects the port to the national road and rail network. Three key objectives have driven the government's vision:

a. Enhance Morocco's maritime connectivity with the global market.
b. Create a major industrial hub in the Strait of Gibraltar region.
c. Boost the economic and social development of Morocco's northern provinces.

Tanger Med began operations in July 2007 and has since developed into a key Mediterranean hub. The port is divided into three main sections: Tanger Med 1, Tanger Med 2, and the passenger port. Tanger Med 1 has a capacity of 3 million twenty-foot equivalent units (TEUs) and 1 million vehicles, alongside hydrocarbon and dry bulk handling. It is well-connected by rail. Tanger Med 2, as an expansion, includes two deep-water container terminals, increasing capacity by around 6 million TEUs. In 2023, the Tanger Med complex handled around 8.6 million TEUs, positioning itself as a major trans-shipment port for international trade between Africa, Europe and beyond.

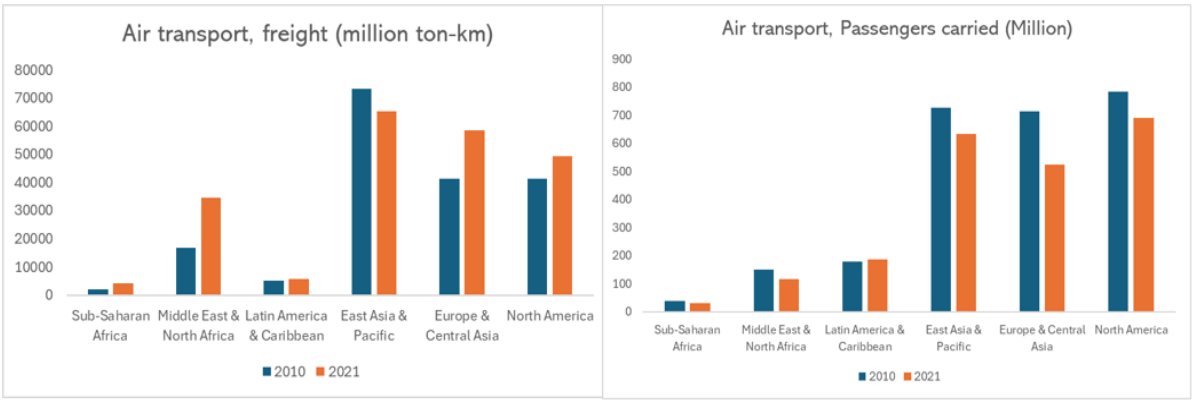
Based on the World Bank's report, the success of Tanger Med has seen a very crucial role played by the government from the beginning. By aligning a commercial approach to developing the port, logistics, and industry across all government entities, Tanger Med was designed not just as a trans-shipment facility but as a comprehensive economic hub that fosters freight transport and manufacturing. This strategy has made the port a vital export point for the Tangier-Tétouan region, particularly benefiting the region's thriving auto components and assembly industry, and for textiles, clothing, and other light manufacturing. The population of Tangier has surged from 250,000 in 1982 to 1.3 million in 2024, while the region's industrial GDP contribution has risen to 16.4 per cent of Morocco's total industrial output.



Source: Tanger Med Port Authority; World Bank (2019)

2.2 Transport: airports

As another important aspect of shaping connectivity and mobility for goods and people, Africa's airport infrastructure has witnessed continued expansion in recent years. Air transport capacity in Sub-Saharan Africa experienced significant growth, increasing from approximately 47 million seats to 105 million, with an average annual growth rate of nearly 6 per cent between 2001 and 2015 (Bofinger, 2017). However, the general performance falls short of global standards for passenger flows and handles only a modest freight volume. As Figure 2.5 indicates, its passenger traffic only accounted for approximately 1 per cent of total global traffic in 2021, and freight merely represented roughly 2 per cent of the total global share in the same year.



Source: World Bank, created by the author

Figure 2.5. Air transport: freight and passenger traffic. Global overview (2010 and 2021). Source: World Bank, created by the author

Twelve African countries have more than ten operational airports across the sub-regions, with Algeria, Egypt and South Africa leading the list (see Figure 2.6). Nevertheless, the Airports Council International report shows that no African international airport got into the world's top 60 by passenger or freight traffic in 2023.

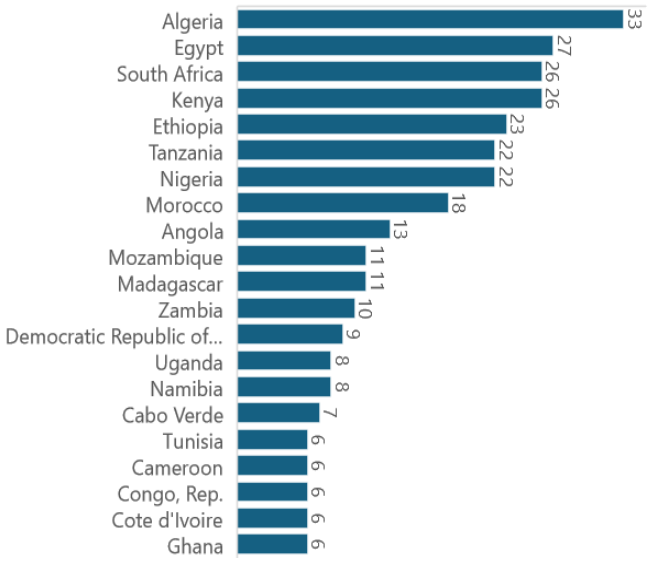


Figure 2.6. The number of airports in a selection of African countries. Source: CIA, US Government, Worldfact Book, 2024; FlightConnections.com, 2024, compiled by the author

Zooming in on the continent, countries like Egypt, Morocco, Ethiopia, South Africa, Kenya and Nigeria show stronger global mobility regarding passenger transport by air (Figure 2.7). According to Airports Council International (2022), Africa's ten busiest airports with the highest international passenger traffic are also based in Egypt, South Africa and Morocco. Looking into the routes that are actively flying at some of the busiest international airports on the continent, Morocco and Egypt tend to carry more passenger traffic to Europe. At the regional level, Morocco and Egypt focus more on routes to different parts of Northern Africa and Western Africa. At the same time, South Africa carries more regional traffic within Southern Africa, and Ethiopia's regional passenger routes are more evenly distributed across Southern, Western and Eastern Africa (Figure 2.8).

In fact, a major issue of Africa's air transportation network is the lack of regional interconnectivity. Despite initiatives like the Yaoundè Treaty and the Yamoussoukro Decision, which aimed to establish a jointly owned airline or integrate national carriers, progress toward creating a robust, interconnected air network across the continent remains unsatisfactory. Factors such as restricted competition, skill shortages, and inefficient subsidies have all contributed to this poor level of connectivity (Button et al., 2015).

Africa's 10 Airports with Highest International Passenger Traffic in 2022 (million), Source: ACI			
1	Cairo International Airport	Cairo/Egypt	16.5
2	Mohammed V Airport	Casablanca/Morocco	6.8
3	Hurghada International Airport	Hurghada/Egypt	6.5
4	OR Tambo International Airport	Johannesburg/South Africa	6
5	Tunis Carthage International Airport	Tunis/Tunisia	5.3
6	Marrakech Ménara Airport	Marrakech/Morocco	4.74
7	Jomo Kenyatta International Airport	Nairobi /Kenya	4.69
8	Alger Houari Boumédiene Airport	Algiers/Algeria	4.1
9	Bole International Airport	Addis Ababa/Ethiopia	3.8
10	Sharm El Sheikh International Airport	Sharm El Sheikh/Egypt	3.7

Figure 2.7. Air transport, passengers carried across African countries (thousands of people) in 2021/Africa's ten busiest airports with international passenger traffic in 2022. Source: World Bank, 2021, most recent data; Airports Council International (ACI), 2022, compiled by the author

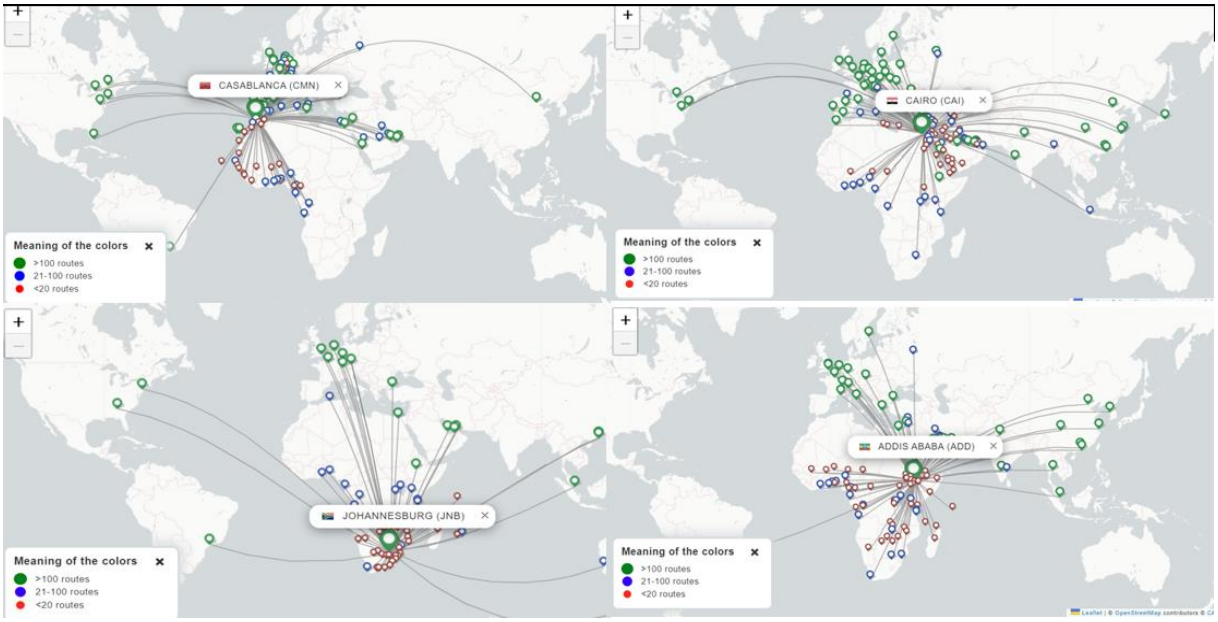


Figure 2.8. Global connection of the busiest African international airports. Source: FlightsFrom.com, 2024
Note: This data measures the number of scheduled daily departures, rather than the number of passengers. It includes only scheduled passenger flights and excludes freighters or chartered flights.

Like the pattern of passenger traffic, the capacity of commercial air freight in the continent is also limited to specific countries where economies are faring better, such as Egypt and South Africa; or countries like Ethiopia, which has one of the most prominent African airlines to lead the capacity. According to World Bank data, Ethiopia, Egypt, Kenya, Mauritius, and Zambia have the highest air freight volumes in 2021. In comparison, research from ACI Africa and AFC indicates that in 2021, the top five regional cargo hubs were Kenya (JKIA, Nairobi), Egypt (CIA, Cairo), South Africa (O. R. Tambo, Johannesburg), Ethiopia (BIA, Addis), and Nigeria (MMIA, Lagos). This highlights the urgent need for increased investment to expand air cargo handling capabilities across the continent – particularly for landlocked countries which face significant challenges in transporting perishable goods.

2.3 Transportation: railway and roads

Historically, the development of Africa's railway infrastructure was heavily shaped by colonial industrial and logistical strategies, primarily following the Pit-to-Port model. During its early development, railways had little competition from other transport modes. However, with the rise of roads as a more modern and attractive alternative, road networks have since become dominant for both passenger travel and trade at the city-regional level. Meanwhile, the railway sector faces numerous challenges, such as inadequate investment, low usage, and outdated or incompatible technology. Currently, 36 out of Africa's 54 countries have railway systems. In terms of total railway route length, the top five countries are South Africa, Egypt, Algeria, DRC and Nigeria, based on data from the World Bank.

Considering the vast land size of over 29 million square kilometres, Africa's railway network is relatively small. By comparison, India, which occupies just 11 per cent of Africa's land area, has a rail network that is roughly 75 per cent the size of Africa's. China, on the other hand, covers approximately 31 per cent of Africa's surface area, boasting a rail network 1.26 times that of Africa (AFC, 2024). Within the region, most of the continent's rail capacity is in the northern and southern areas, aligning with the distribution of other major infrastructure developments. At the country level, South Africa and Tunisia have the highest density in terms of their networks (see Figure 2.9).

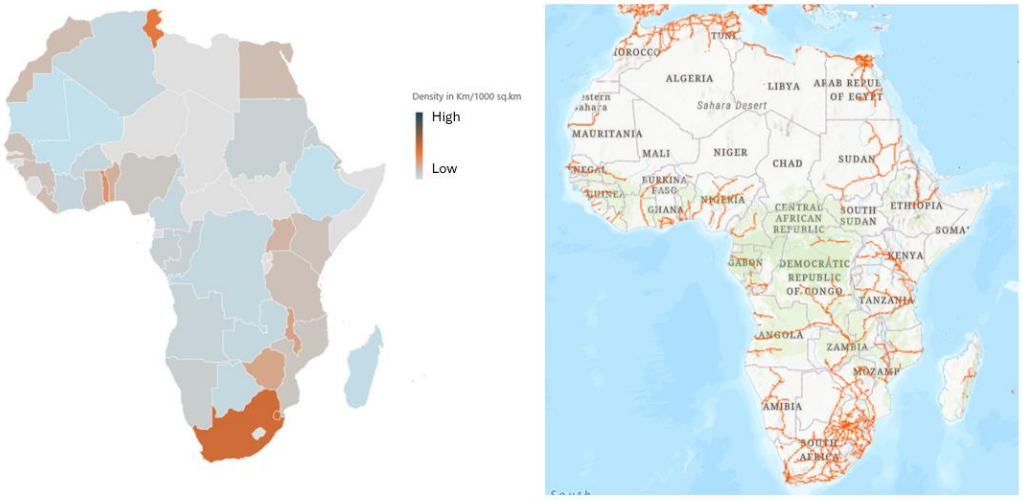


Figure 2.9. Left: Railway network density (Km/1,000 km^2). Right: The distribution of railway network in Africa. Source: World Bank, 2022, most recent data, created by the author (left). Global Infrastructure Map, World Bank (right)

Rail systems across Africa also utilise various track gauges. Northern, Eastern and parts of Western Africa primarily operate a combination of older metre gauge lines and newer SGRs, while Southern Africa predominantly relies on Cape gauge networks (see Figure 2.10). The variety of track gauges adds complexity to transporting goods and moving people across regions with the rail systems. Differences in gauges, technical standards, and specifications across African railways make it difficult to establish interconnected and interoperable logistics and supply chain systems, especially presenting significant challenges for some resource-rich but landlocked countries.[14]

[14] A gauge break occurs when rails of different gauges meet. At a gauge break, loads must be unloaded from one set of rail cars and reloaded onto another, which can be expensive and time-consuming. There are various ways to address break-of-gauge situations currently, including trans-shipment stations, dual gauge tracks, gauge conversion projects, rolling stock adaptations, and transfer facilities (ex., dry ports). For example, Tanzania has a break of gauge at the Kidatu trans-shipment station, which connects the Tanzania Railways Corporation network to the TAZARA Railway network. In Kenya, the Nairobi terminus acts as a key transfer point where cargo and passengers can transfer between the SGR and the metre-gauge railway. For freight, goods are often transferred between the two systems via cranes and container-handling equipment.

In comparison to the railway, roads are now the backbone of shaping connectivity and mobility in Africa. Roads support 80 per cent of goods transportation and 90 per cent of passenger movement on the continent (AFC, 2023, 2024). Enhancing access to well-maintained roads is also essential for promoting economic and social development in both urban and rural areas. However, despite their critical importance to Africa's economic growth, the road network faces major obstacles regarding its insufficient quantity and substandard quality.

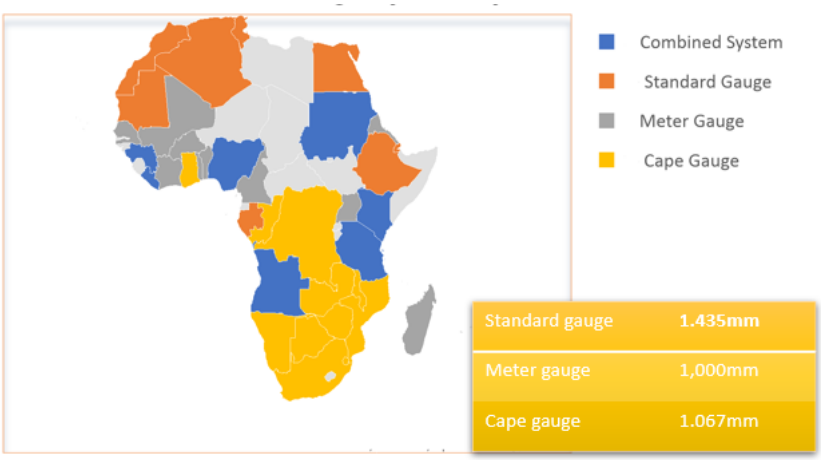


Figure 2.10. Different gauge system by countries. Source: CIA, US Government, Worldfact Book, 2024; and Logistics Capacity Assessments, 2024, compiled by the author

Overall, Africa's road density is considerably lower than that of other parts of the world. With an average of about 2.3 kilometres of roads per 100 km^2, it falls well behind Asia, where India averages 138 kilometres and ASEAN nations average 29.5 kilometres per 100 km^2. Regarding road quality, Africa's total paved road network is around 680,000 kilometres, which is six times less than India's and represents only 1.5 per cent of the global total of paved roads. Within the continent, the distribution is uneven across countries and rural/urban areas. South Africa has the most extensive total roadways, including paved roads. Whilst countries like DRC, Ethiopia, Kenya and Tanzania have relatively higher total road lengths, their paved road stocks are lower on the continent. In terms of road density, small island nations are at the forefront. Among larger economies, South Africa ranks highest in both overall road density and paved road density (Figure 2.11).[15]

[15] Establishing a benchmark to gauge the actual gap in Africa's road density and regional road networks poses a considerable challenge due to the continent's vast land area and a variety of topographies – which may underestimate the road density level of Northern Africa. To address this, the IMF recently introduced a novel method for evaluating road quality, focusing on average travel speeds between major cities using Google Maps data. This approach offers a fresh perspective on road infrastructure, revealing regional disparities. As expected, Northern and Southern Africa boast better-quality road networks, while Western, Central, and Eastern regions face poorer road conditions.

Top Ten African countries on Road Density	
1-Sao Tome and Principe	6-Comoros
2-Mauritius	7-Cabo Verde
3-Seychelles	8-Rwanda
4-South Africa	9-Gambia
5-Burundi	10-Ghana

Top Ten African countries on Paved Road Density	
1-Mauritius	6-South Africa
2-Seychelles	7-Rwanda
3-Comoros	8-Morocco
4-Sao Tome and Principe	9-Tunisia
5-Cabo Verde	10-Nigeria

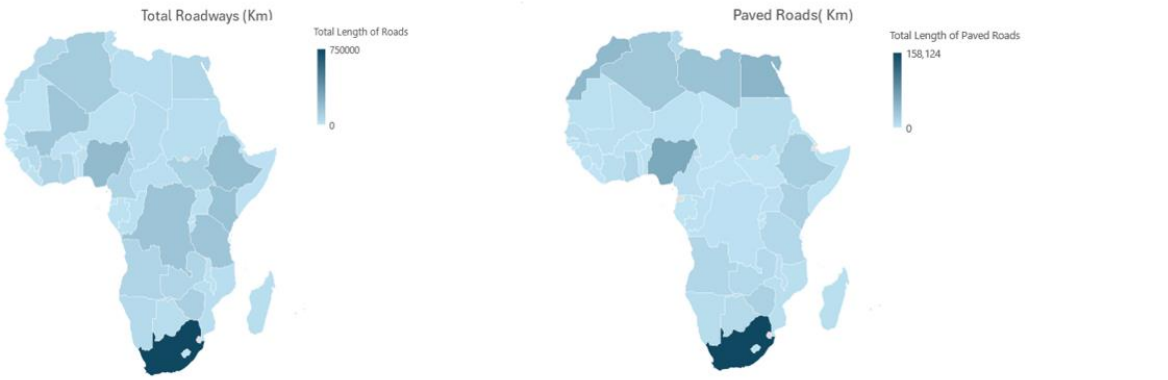


Figure 2.11. Total stock and density of roads and paved roads by countries. Source: CIA, US Government, Worldfact Book, latest road data 2020; and Logistics Capacity Assessments 2024, World Bank land area data, 2023, compiled by the author

Apart from regional disparities, African roads are concentrated in urban areas and predominantly connect large towns and ports. Rural areas are particularly underserved, with many existing roads being unpaved, hindering vehicle travel and impeding goods flows, which has implications for logistics barriers to transporting agricultural goods and minerals in remote areas. Based on a World Bank report, approximately half of Africa's main road network, which is under the responsibility of the central state, is in good condition. In comparison, only 25 per cent of the rural classified roads, usually under local government remit, are in good or fair condition (Beck, Klaeger, & Stasik, 2017).

One of the indicators that has been developed to measure road accessibility in rural areas is the World Bank's Rural Access Index (RAI). The RAI measures the proportion of the rural population who live within 2 kilometres of an all-season road. Available data across different years indicates that Kenya, Gambia, Rwanda, South Africa and Uganda have made significant progress in rural accessibility over the past decade, while Madagascar, Chad, Zambia, Ethiopia, and Lesotho have seen much slower advancement (Figure 2.12). Another source that measures access to cities in the continent has also shed light on the situation, suggesting that, in general, Southern Africa and Western Africa have better road access to cities, with average travel time to the nearest densely-populated area between 60–120 minutes. In comparison, many Central African countries, such as Central African Republic, Republic of Congo, and DRC spend between 400 and 600 minutes accessing the closest cities.[16]

[16] Data comes from global infrastructure map/World Bank based on Malaria Atlas Project. It enumerates land-based travel time to the nearest densely-populated area for all areas between 85 degrees north and 60 degrees south for the nominal year 2015; see https://maps.worldbank.org/toolkit/infrastructure?infraToolkit=global&layers=infra621&transparencies=0

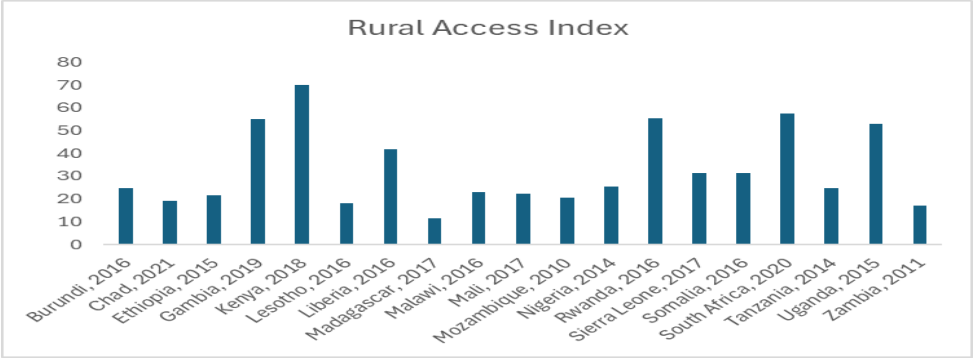


Figure 2.12. Rural Access Index across several African countries, multiple years. Source: World Bank, most updated 2024

2.4 Urban transportation

As African countries rapidly urbanise, urban transportation has become an important aspect of the infrastructure system that plays a substantial role in shaping mobility at the intra-urban level. One of the major features of African cities is urban sprawl, with development focused on a few main roads rather than a well-connected street grid. An UN-HABITAT report notes that cities in Sub-Saharan Africa allocate significantly less land to streets, particularly local roads that connect homes, businesses, and services. For example, cities like Paris, New York and Tokyo dedicate 25–30 per cent of their land to street networks that support various modes of transportation, while cities like Nairobi and Accra allocate just over 10 per cent (Figure 2.13).

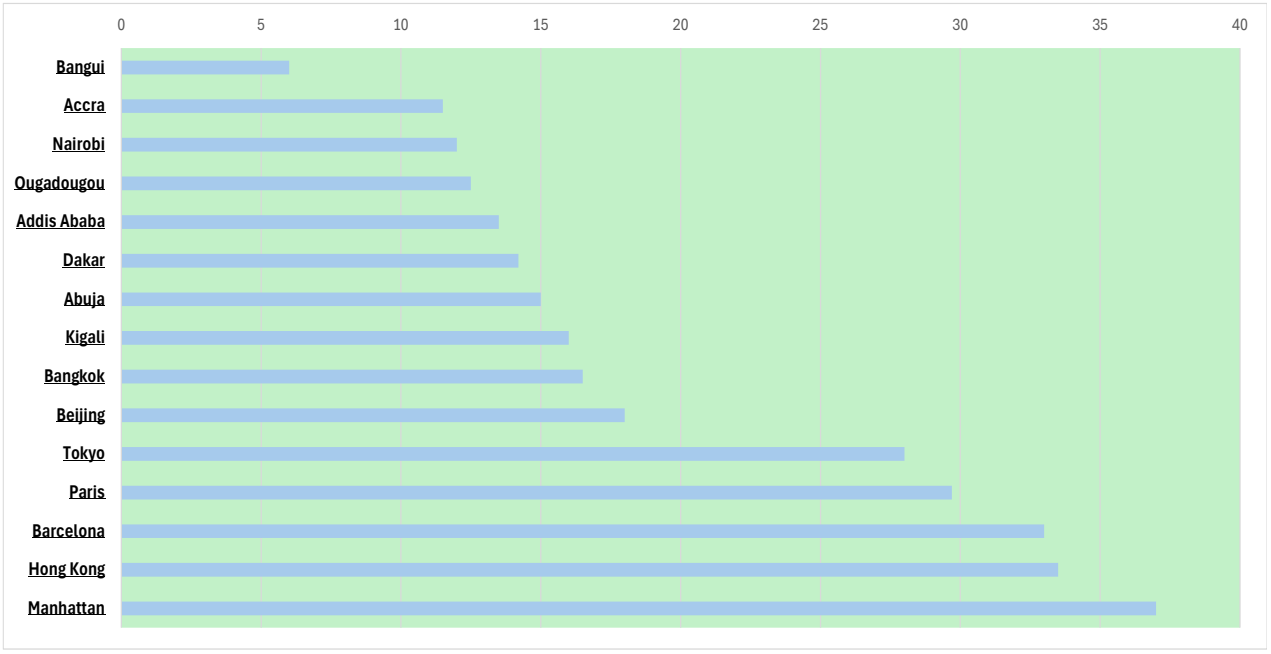


Figure 2.13. The percentage of land allocated to streets. Source: AfDB, 2022; UN-Habitat, 2013, recreated by the author

As a result, a small number of roads handle most of the traffic, leading to congestion and limiting direct routes for pedestrians and cyclists. In cities like Kampala, this issue is worsened by narrow roads, making it difficult to implement Bus Rapid Transit systems without expanding the roads or restricting private vehicle use.

Without sufficient investment in constructing and maintaining a network of local streets that accommodates all road users, the spreading-out of urban forms has paved the way for increasing motorisation in the continent. While most residents do not own cars, this number steadily rises as income increases. In countries such as Algeria and South Africa, a significant portion of the population already owns cars (Figure 2.14), while private car ownership in places like Ghana and Tanzania has been rising rapidly (SLOCAT Transport and Climate Change Global Status Report, 2022). In fact, most vehicles that are sent to Africa are used. Nearly 40 per cent of the global exports of used light-duty vehicles (cars, vans, SUVs and pickup trucks) go to Africa, compared with only 2 per cent of new vehicles (Gaventa, 2021). Global projections also suggest that around 40 per cent of Africa's vehicle fleet must be electric by 2040 to meet climate objectives (see Box 2.2). At the same time, motorcycle use is growing rapidly. Several cities, such as Lomé (Togo), Cotonou (Benin), and Bamako (Mali), have experienced significant increases in motorcycle usage. They are also widely used as taxis in rural area throughout the region.

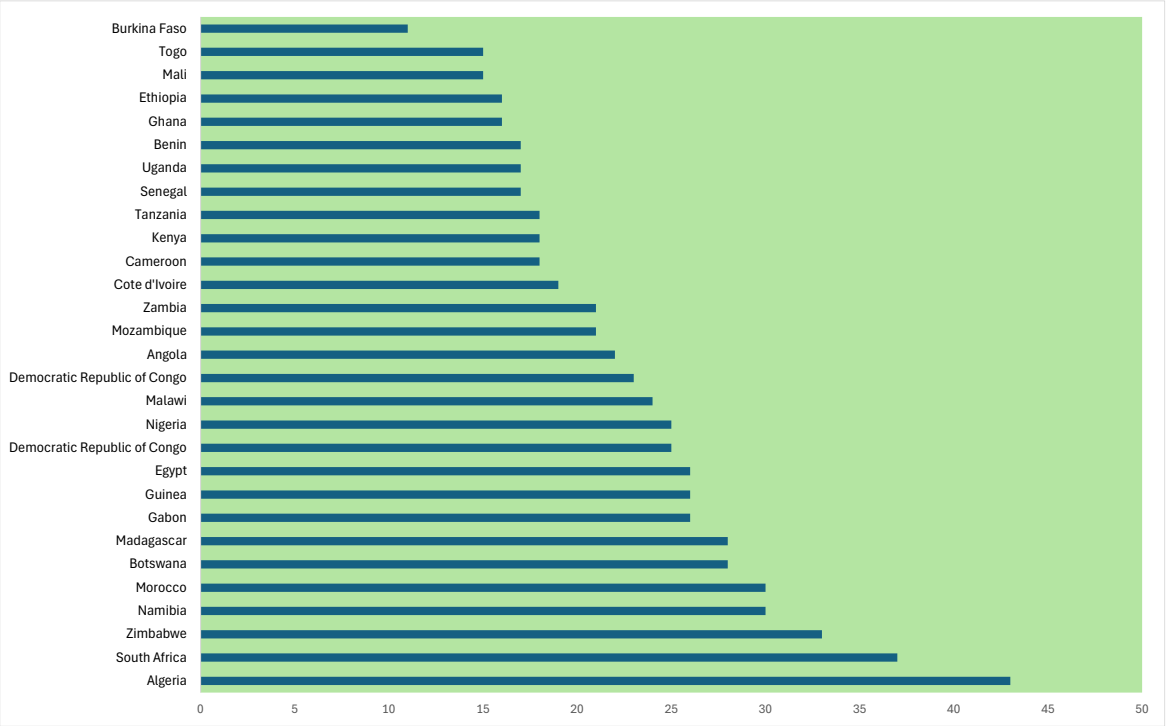


Figure 2.14. Car ownership across Africa (percentage of the population currently owning a car). Source: Sagaci Research, 2021

Globally, Japan, the EU, the USA, and South Korea are the four largest exporters of used vehicles. Between 2015 and 2022, approximately 22.6 million used light-duty vehicles were

exported from these regions to destinations in Asia-Pacific, EECCA,[17] LAC,[18] the Middle East, and Africa. Figure 2.15 illustrates the quantity and global flow of used vehicles from the main exporters in 2022. Historically, Africa imports used vehicles mainly from the EU and Japan. In 2022, 46 per cent of Africa's imports of its used light-duty vehicles came from the EU and 31 per cent from Japan. Northern, Western, and the Horn of Africa are key destinations for used vehicles from the EU. Japan primarily exports to Eastern and parts of Southern Africa. Additionally, the United States and South Korea also capture smaller market shares in Western and Central Africa.

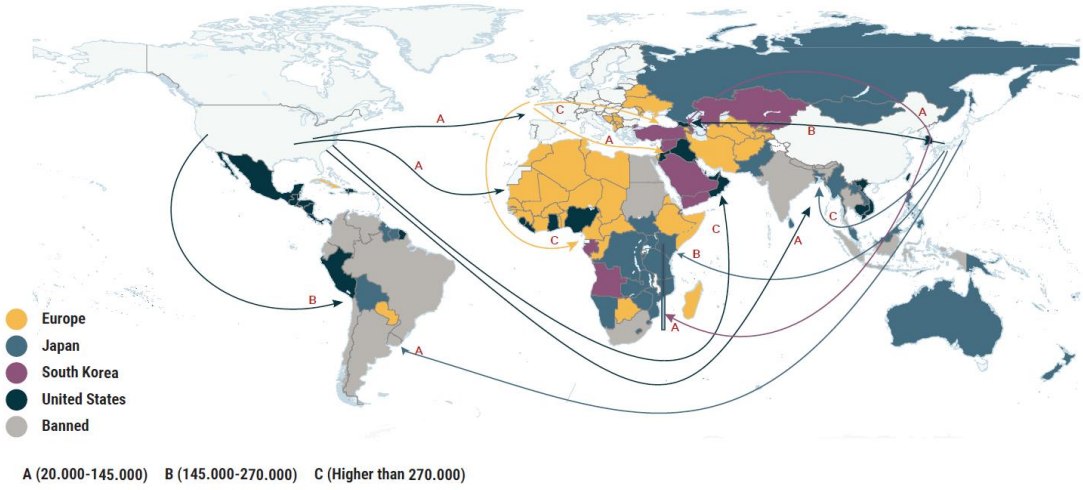


Figure 2.15. Used light duty vehicles quantity and flow to main destination markets from the EU, USA, Japan, and ROK in 2022. Source: UNEP (2023)

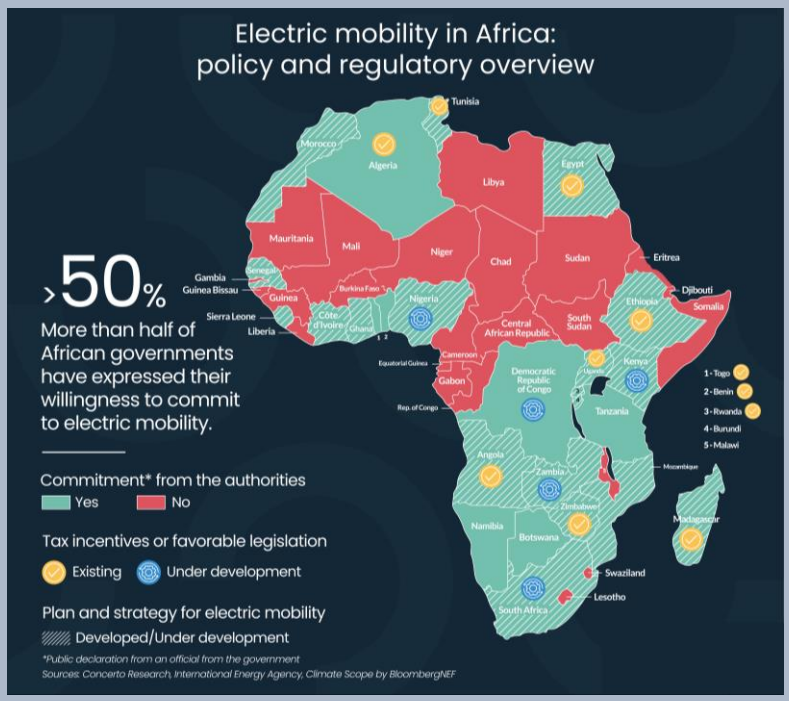
[17] Eastern Europe, Caucasus and Central Asia (EECCA) region.
[18] Latin America and the Caribbean (LAC) region.

Box 2.2. Electric mobility: decarbonising urban transportation in the context of climate change

There is a growing challenge to address Africa's urban transport needs, while at the same time bearing in mind climate change concerns and reducing emissions and reliance on fossil fuels. In this space, e-mobility is receiving increasingly favourable attention as different technologies have evolved to allow for the realisation of vehicles that deliver measurable benefits. Key drivers behind this progress include better utilisation of clean energy sources like solar and wind, enhanced battery storage with more compact designs, and reduced manufacturing costs for electric vehicles (EVs). On the policy front, electrification of road transport vehicles was recognised as a powerful low-carbon transport strategy by the Intergovernmental Panel on Climate Change and the 2015 Paris Declaration on Electro-Mobility and Climate Change launched at the climate summit COP-21.

Several electric vehicle deployment initiatives covering all categories of road vehicles have recently emerged on the African continent, underpinned by the collaboration between governments and local authorities, international organisations and private players. Cities in Morocco, such as Rabat and Marrakesh, have started to electrify their public transport system and put electric buses on the road to decarbonise mobility. More ambitiously, cities like Dakar in Senegal have recently launched their fully electrified BRT system, aiming to formalise the informal bus system in the renewal of citywide bus fleets. Meanwhile, two- and three-wheel electric-powered vehicles are also flourishing. For example, the Ugandan government has recently forged a strategic partnership with Spiro, which is a leading electric two-wheeler manufacturing company in West and East Africa, launching a large-scale electric motorbike initiative that will deploy an impressive fleet of 140,000 electric motorbikes across the country.

The promotion of e-mobility will inevitably intensify an existing issue: e-waste. The continent is already grappling with millions of tons of e-waste driven by digitisation. According to the International Telecommunications Union (ITU), less than 10 per cent of e-waste in Africa is currently properly disposed of or recycled. The adoption of EVs will further increase both the volume and the complexity of e-waste, including more hazardous materials. To prepare for this additional waste stream, efforts to manage e-waste must be significantly scaled up. Some countries, including South Africa, Nigeria and Ghana, have already included extended provider responsibility (EPR) principles under which manufacturers are held responsible for the collection and disposal of their products once they reach the end of their life or when they need replacement.



Source: Concerto, https://concertopr.com/en/2023/06/mobility-in-africa-the-electric-two-wheeler-bid/

On the one hand, urban sprawl has assisted in the growing use of private cars, especially in higher-income countries and wealthier cities like Cape Town and Johannesburg. On the other, in most African cities, walking and collective transport (including formal mass transit and informal paratransit) are still the most dominant modes of individual mobility, especially for lower-income groups. Based on different estimations, the share of walking in all commutes is roughly 50 per cent in Dar es Salaam and Quelimane, 40 per cent in Naribi, and the combined share of walking and cycling trips in Casablanca is as high as 60 and 70 per cent in Dakar (Agora Verkehrswende & GIZ, 2023[19]). At the same time, demand-responsive, privately-owned minibus taxis, sometimes referred to as "paratransit", are the predominant public transport mode. Various forms existed on the continent, such as *dala dalas* in Tanzania, *matatu* in Kenya, and *boda b*oda in Uganda. In many cases, paratransit is also the only motorised transit option besides motorcycle taxis. Overall, paratransit represents approximately 10 to 70 per cent of all trips across the different sized cities in the continent (see Figure 2.16).

The prevalence of poorly regulated informal systems, high transportation costs and lengthy commuting times have been defining challenges for urban transportation in Africa. For instance, surveys indicate that low-income households in cities like Nairobi and Lagos spend between 15–54 per cent of their income on travel (UN-Habitat, 2013). In South African cities, the average bus commute takes 74 minutes each way (Statistics South Africa, 2014). To improve urban mobility at the individual level and address rising urban demand, African cities urgently need more affordable and efficient public transit systems up and running. Such efforts have been made in several African cities in recent years, especially large-sized cities or more affluent ones, to take steps to transition from paratransit to mass transit

[19] https://www.agora-verkehrswende.de/en/publications/leapfrogging-to-sustainable-transport-in-africa-twelve-insights/

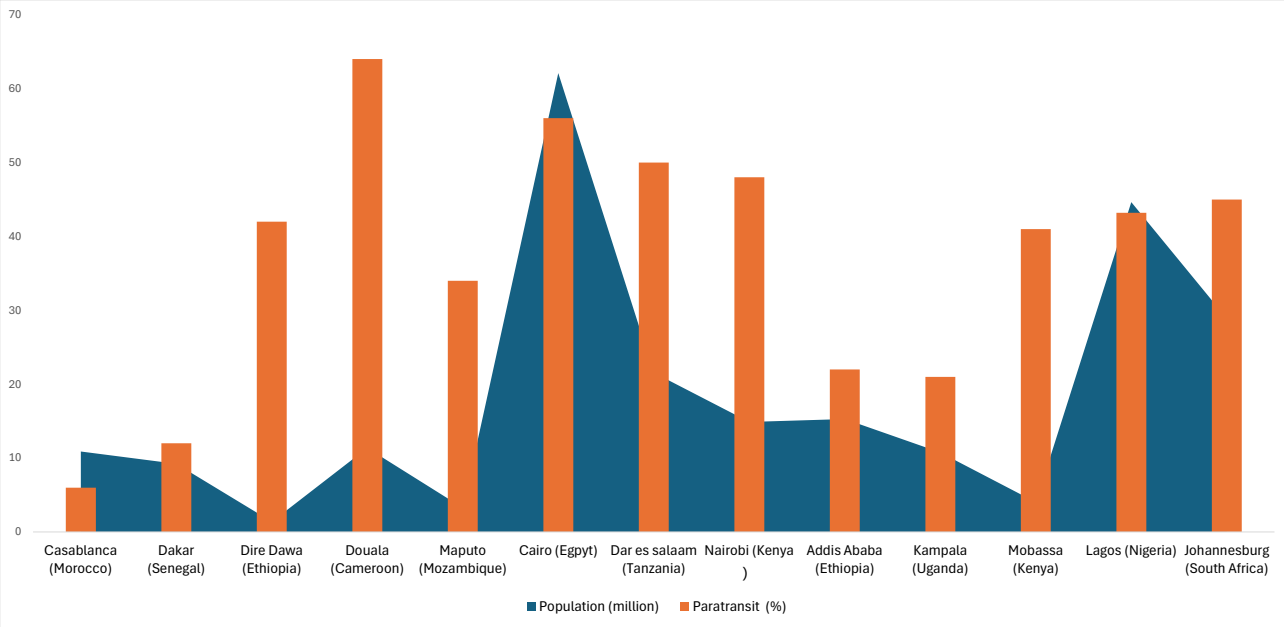


Figure 2.16. The share of paratransit in different sized African cities. Source: Deloitte (2019); Un-Habitat & ITDP (2022); Agora Verkehrswende & GIZ (2023), compiled by the author

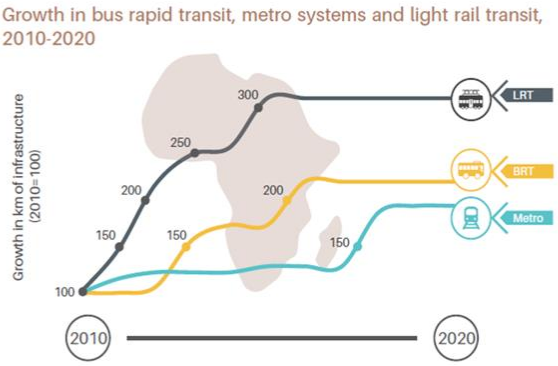
systems such as Bus Rapid Transit (BRT) and light rail. In some cases, paratransit services have now been integrated as "feeders" to support these main transit networks (Jennings & Behrens, 2017).

In 2020, Africa was estimated to have approximately 650 kilometres of Bus Rapid Transit (BRT), Light Rail Transit (LRT), and metro systems across the continent, with 70 per cent of this infrastructure constructed since 2007 (Slocat, 2018; Alstom, 2023). To put this in context, the London Underground alone spans around 402 kilometres over its eleven lines. In Northern Africa, cities like Cairo and Algiers have had metro systems since the 1980s and continue expanding them to accommodate growing urban populations (Inclusive Infrastructure, 2019). Tunis and Casablanca rely on LRT systems for public transport, which were launched in 1985 and 2012 (Troin, 2015). Additionally, there are numerous BRT routes and projects across Africa, in cities such as Dakar, Marrakesh, Lagos, Dar es Salaam, and multiple locations in South Africa (Klopp et al., 2019).

Nevertheless, in cities where BRT and LRT systems are being proposed, built and operated to reform the existing system, the pace has been slow, with paratransit still providing the bulk of trips. For instance, Kampala first proposed BRT corridors in 2010, with initial pilots still being scoped. Addis Ababa has been seeking to implement BRT since around 2014. There are also worries about the costs and subsidies required for BRT systems, as well as the possibility of higher fares compared to existing transport options. This could place a significant financial burden on low-income public transport users, who already spend a large portion of their income on transportation. As such, serious concerns have been raised about whether these interventions will offer a safe, clean and widely accessible public transportation alternative beyond just a few specific corridors (Klopp et al., 2019).

City with (Sub)Urban Light Rail
Cape Town
Johannesburg
Pretoria
Durban
Casablanca
Lagos
Addis Ababa
Tunis

City with Metro
Abuja
Cairo
Algiers



City with BRT Scheme Complete	City With BRT Scheme Planned (under construction or delayed in operation)
Dakar	Conakry
Lagos	Kumasi
Cairo	Kampala
Pretoria	Douala
Johannesburg	Kinshasa
Accra	Luanda
Cape Town	Mombasa
Dar es Salaam	Durban
Nairobi	Addis Ababa
Marrakech	Kigali
Casablanca	Abidjan

Source: Slocat Partnership; Global BRT Data, Alstom, 2023

Figure 2.17. Overview of formal public transit in the continent. Source: Slocat Partnership; Global BRT Data, Alstom, 2023

2.5 Electricity infrastructure

Electricity infrastructure encompasses various elements, with this section focusing specifically on electricity access. Sub-Saharan Africa holds most of the global population without electricity access, a gap that has remained largely unchanged over the past two decades. While the global electricity access rate reached 90.48% per cent in 2020, Sub-Saharan Africa achieved only 48.48 per cent. The region now accounts for 83 per cent of the global electricity access deficit, up from 50 per cent in 2010. In 2021, 567 million people in Sub-Saharan Africa still lacked electricity access, nearly the same as the 566 million recorded in 2010 (Tracking SDG7 report, 2024).

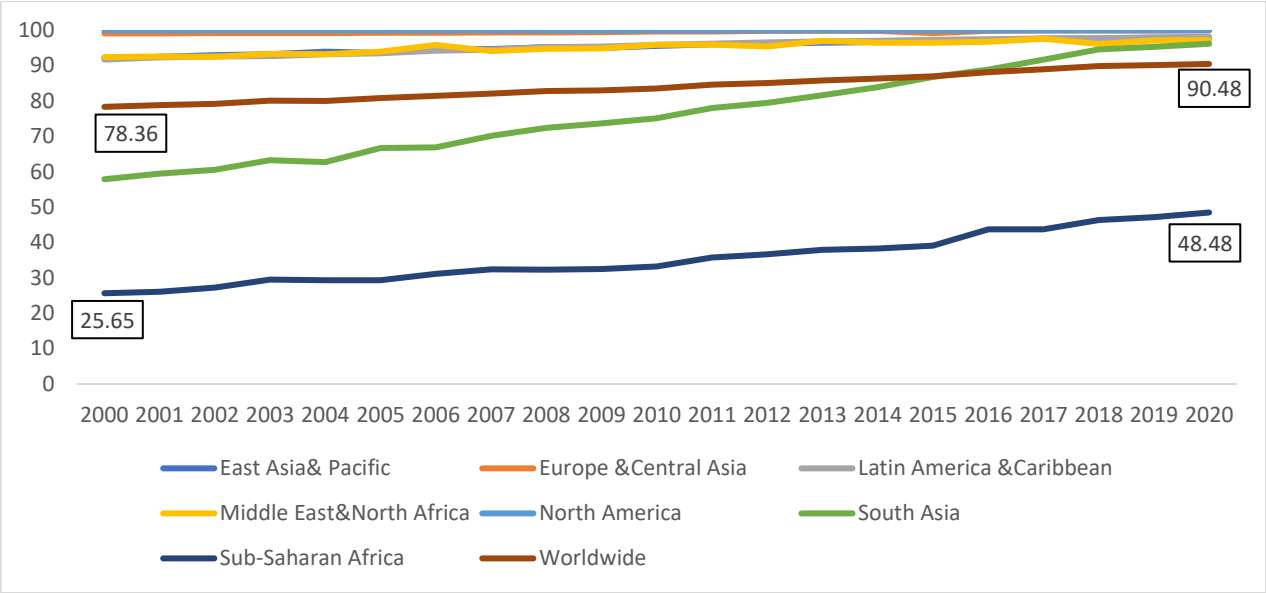


Figure 2.18. Uneven global access to electricity (percentage of the population). Source: World Bank, created by the author

Eighteen of the 20 countries with the largest access deficits in 2022 are in Sub-Saharan Africa. In terms of absolute numbers, the top three – Nigeria (86 million), DRC (78 million), and Ethiopia (55 million) – accounted for nearly a third of the entire global deficit. South Sudan, Burundi and Chad have the highest share of their populations without access to electricity, with nearly or more than 90 per cent of their people lacking access.

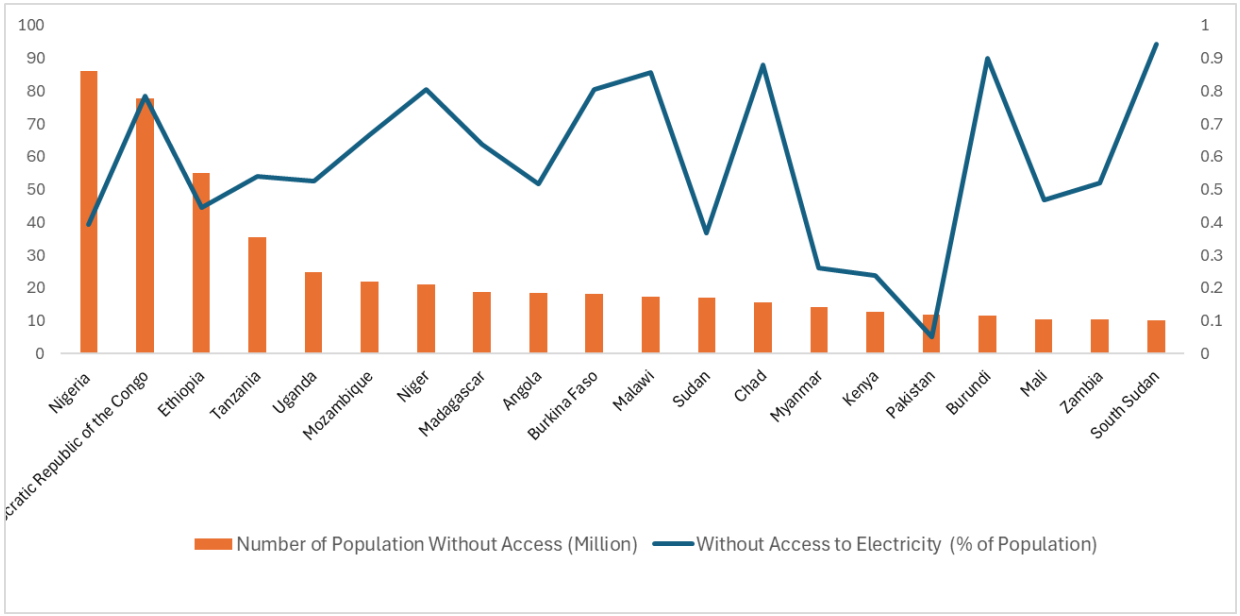


Figure 2.19. Share and absolute size of population without access to electricity in the top 20 access-deficit countries, 2022. Source: World Bank, created by the author

Zooming into the changes in accessibility rate between 2010 and 2022 across Africa, the fastest electrifying countries in terms of annual growth rate are Kenya, followed by Rwanda, Eswatini, Uganda, Lesotho, Guinea-Bissau, Tanzania, Ethiopia, Sudan and Liberia. Two countries have seen a falling access rate in the same time, namely, Somalia and Libya. Four countries from Northern Africa and two small-island countries achieved universal access in 2022, including Morocco, Algeria, Tunisia, Egypt, Mauritius and Seychelles. Overall, the Northern African region has the highest electricity access rates on the continent.

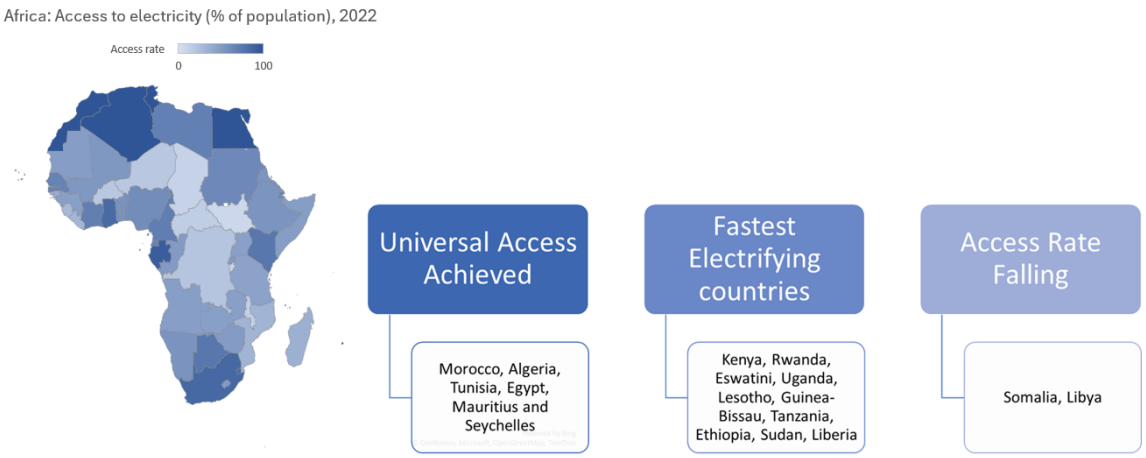


Figure 2.20. Changes in accessibility rate (2010–22). Source: World Bank, created by the author

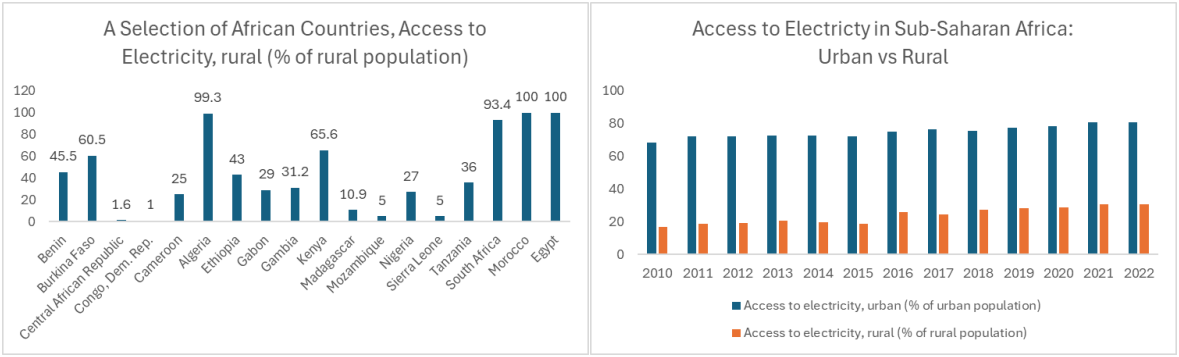


Figure 2.21. Rural access to electricity. Source: World Bank, created by the author

Like roads, access to electricity also shows a significant disparity between rural and urban areas. In general, African cities have been much better at accessing electricity throughout the years, and the gap remains at a similar level – roughly 50 per cent of the difference. Northern African countries and higher-income African countries like South Africa have better electricity access in rural areas than lower-income African countries across the continent.

Although progress has varied, significant efforts have generally been made to improve electricity access, including investments in a combination of mini-grid and off-grid solutions, along with the expansion of main transmission and distribution (T&D) networks on the

continent. In general, off-grid solutions refer to standalone systems that generate electricity for a single household or a small unit independently from any central grid. A mini-grid is a localised, small-scale power generation and distribution network that may serve multiple households or a small community, which can be either off-grid or grid-tied (see Box 2.3).

Despite playing important roles in addressing individual households and small communities' needs, especially in remote areas in the continent, these solutions have limitations in providing the reliable, high-capacity electricity needed to support broad-based industrialisation goals. To truly provide the kind of electricity required to support Africa's production and structural transformation, sustained efforts must be put towards channelling investments in transmission and distribution. Unfortunately, current investment in Africa has mostly focused on generation and distribution, leaving medium and high-voltage transmission largely underfunded.[20]

Based on the latest available data, a 2017 World Bank Group study found that the 38 countries in Sub-Saharan Africa had only 112,196 km of transmission lines of 100 kV and above, or 247 km per million people, one of the lowest per capita rates of any region included in the study. Low margins, more difficult land use and public and state ownership, are considered the major barriers to private participation in transmission projects (AFC, 2024). Within the continent, the available data shows that Southern Africa boasts the most extensive transmission and distribution grid, while Central Africa has the smallest network. In terms of future development, Western Africa is the sub-region that endeavours to make the most significant efforts to expand its grid infrastructure (Figure 2.23).[21]

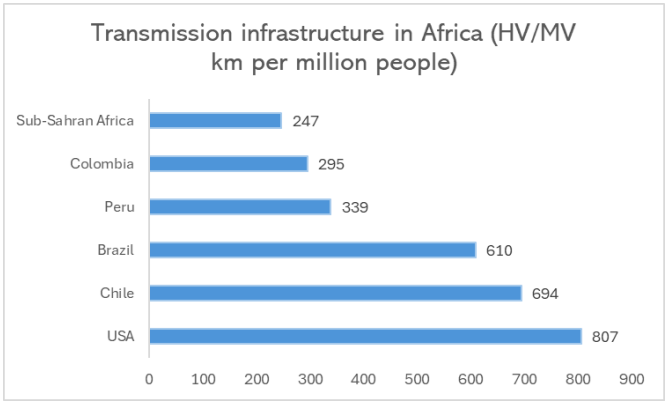


Figure 2.22. Transmission infrastructure: global comparison. Source: World Bank, linking up; AFC, 2024, recreated by the author

[20] According to the World Bank Group's Private Participation in Infrastructure database, between 2010 and 2020, 98.2 per cent of electricity infrastructure investments in Africa were directed toward electricity generation projects, while less than 0.3 per cent was allocated to transmission projects.

[21] This dataset serves as an updated and improved replacement for the Africa Infrastructure Country Diagnostic (AICD) data that was published in 2007. However, it may still inadequately capture the transmission lines for the MENA region, highlighting a gap in regional representation.

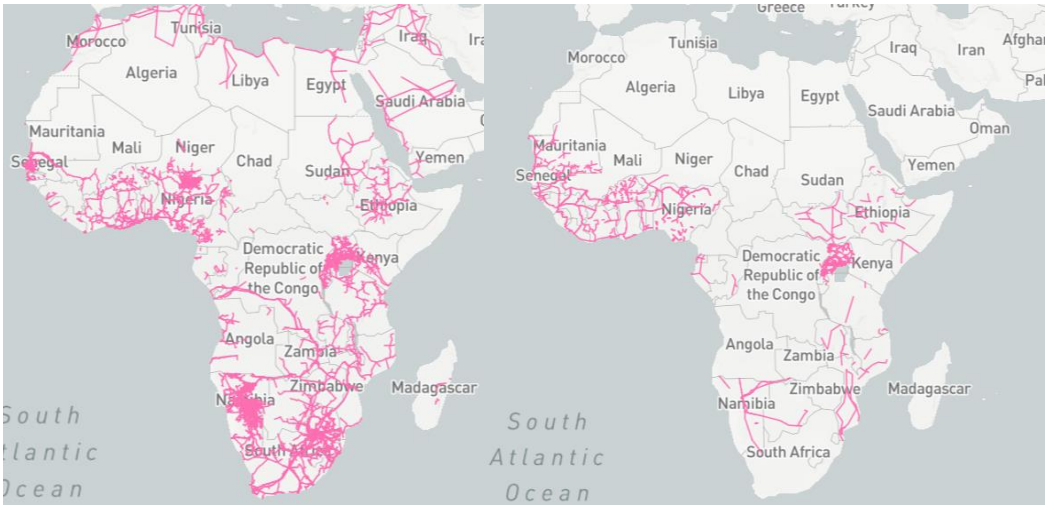


Figure 2.23. Electricity transmission and distribution grid. Left: existing network. Right: planned network. Source: Africa Infrastructure Country Diagnostic (AICD) and OpenStreetMap; contributors for MENA: Arab Union of Electricity and country utilities. For West Africa: West African Power Pool (WAPP) GIS database World Bank projects archive and IBRD maps. There were many additional sources for specific countries and areas. All compiled by World Bank/ENERGYDATA.INFO

Box 2.3. Mini-grid and rural accessibility

Mini-grids are localised, small-scale power networks that can operate independently or be connected to the main grid. These systems generate, distribute, and manage electricity within a defined area, making them particularly well-suited for remote locations. They can be powered by a variety of energy sources, including solar, wind, hydro, biomass, and diesel, though renewable energy is increasingly preferred for its sustainability and cost-efficiency. For example, the deployment of solar mini-grids has markedly accelerated in Sub-Saharan Africa, from around 500 installed in 2010 to more than 3,000 installed in 2023, and a further 9,000 planned for development over the next few years. This mini-grid opportunity is centred around falling hardware costs (solar modules, batteries, energy-efficient appliances), disruptive digital trends (mobile money, digital platforms and data), and innovative private sector business models. In Africa, mini-grids are on track to provide power at a lower cost than many utilities. The cost of electricity produced by mini-grids could be as low as US$0.20/kWh by 2030, making it the lowest-cost solution for underserved villages and communities across Sub-Saharan Africa to close the energy access gap.

Case study: hydropower in Tanzania's rural highlands

Before 2012, households and businesses near Njombe in southern Tanzania struggled with unreliable electricity access. The Mufindi Tea and Coffee Company factory received only sporadic power from the national grid and had to rely on a backup generator during frequent outages. Most households in the region were not connected to the grid at all and lacked access to electricity. Workers at the Mufindi factory and plantation, who were dependent on local jobs, began leaving to seek opportunities in urban areas where they could enjoy electrified homes. In response to this issue, the Rift Valley Corporation, through its subsidiary Rift Valley Energy, Ltd., launched the Mwenga Hydro and Rural Electrification Project, a hydropower mini-grid. The project aimed to provide reliable electricity to the Mufindi factory and plantation, offer affordable power to nearby villages where many plantation workers lived, and sell surplus electricity to Tanzania Electric Supply Company Limited (TANESCO) under the country's new Small Power Producer (SPP) programme. With support from the ACP-EU Energy Facility and Tanzania's Rural Energy Agency, Rift Valley Energy, Ltd. installed a 4-MW hydropower plant, a mini-grid connected to the national grid, and 140 kilometres of distribution lines. By 2017, the project was supplying 21.5 GWh of reliable alternating current (AC) electricity to over 2,200 rural customers in 17 villages, small businesses, the Mufindi factory, the plantation's irrigation systems, and the national grid.

Challenges and lessons learnt

The project faced several challenges, particularly in the design phase and water resources assessment. Land acquisition and obtaining necessary permits were also difficult and time-consuming. Another significant challenge during operations was TANESCO's inconsistent payment performance, which strained Rift Valley Energy, Ltd.'s cash flow, making it difficult to meet commercial loan repayment obligations. For future medium- to large-scale hydropower mini-grid projects, it is crucial to have an experienced developer with a strong understanding of implementing rural infrastructure projects in the region. Projects should also account for the time required to secure approvals and permissions. Moreover, adopting flexible business models can help mini-grid operators navigate unexpected challenges, such as when an anchor customer, like a national utility, fails to make timely payments.

Source: USAID and World Bank

2.6 Water infrastructure

Population growth, rapid urbanisation, rising consumption, and economic development drive increased water demand across Africa. Agriculture, which accounts for around 79% of total water withdrawal, contributes approximately 25 per cent of Africa's GDP and supports the livelihoods of about 60 per cent of the population, most of whom are smallholder farmers. Domestic water demand, currently around 13 per cent of total withdrawal, is surging in urban and peri-urban areas, posing significant challenges for service providers, especially in underserved informal settlements (Dos Santos et al., 2017). Industrial development, crucial for structural transformation, represents about 7–8 per cent of total water withdrawal, and this share is expected to rise in the coming years (Boretti & Rosa, 2019). Based on the FAO data, Egypt has the highest water withdrawal in Africa for both agricultural and industrial uses.

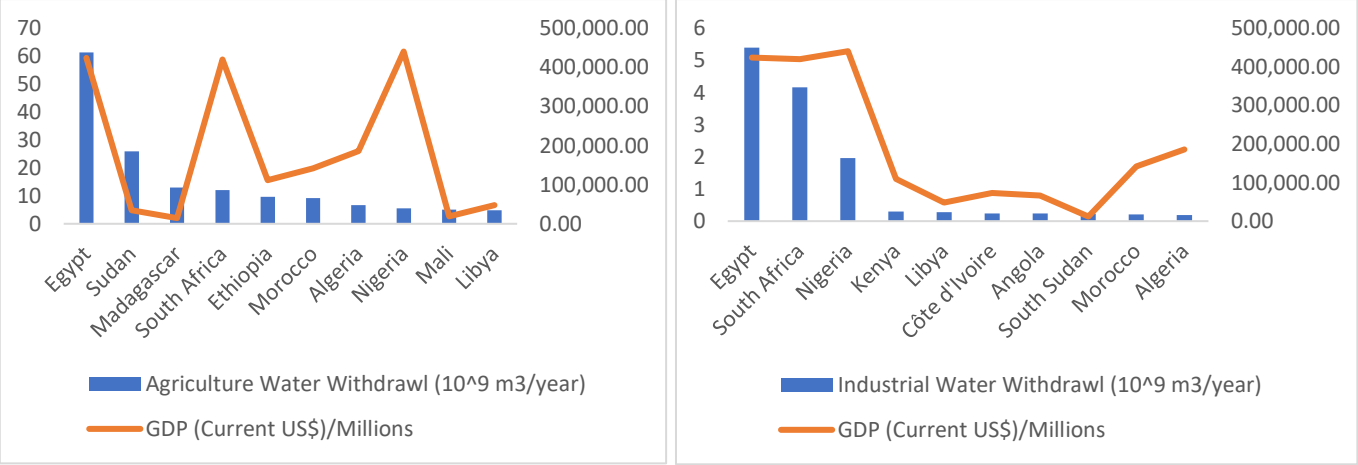


Figure 2.24. Left: African countries with the largest water withdrawals for agriculture use. Right: African countries with the largest water withdrawals for industrial use. Source: FAO, 2021 data, created by the author

Water supply in Africa comes from several key sources, including surface water, groundwater, and alternative methods like desalination and rainwater harvesting. The availability and reliability of these sources vary by region, driven by climate, geography, and infrastructure development. Over a third of the countries in Africa are considered "water-insecure", and the continent receives around one-third of global official development assistance directed towards the water sector (Oluwasanya et al., 2022).

Climate change intensifies water insecurity by causing rising temperatures and increasing both temporal and spatial variability in precipitation, affecting water availability through impacts on soil moisture and runoff. For example, below-average rainfall for prolonged periods has dried up an estimated 90 per cent of water boreholes in some countries. In Kenya, approximately 95 per cent of water sources in Turkana and Marsabit dried up, leading to the emergence of unregulated water markets, with vendors selling poor-quality water and hiking prices at will. In Gauteng, South Africa's industrial hub, water demand surpasses supply due

to the province's rapidly growing population and industrial needs. Drought-induced water shortages have exacerbated the situation (UN Water, 2024).

Total dam capacity, measured in cubic kilometres (km^3), is a crucial indicator in assessing water supply infrastructure, particularly in regions with highly variable climates and seasonal water availability, such as Africa. Dams serve multiple purposes, including water storage for domestic use, irrigation, hydropower generation, flood control, and industrial purposes. According to the available data in 2021, Egypt, Ghana, Tanzania, Zambia and Zimbabwe are the African countries with the largest dam capacities on the continent.

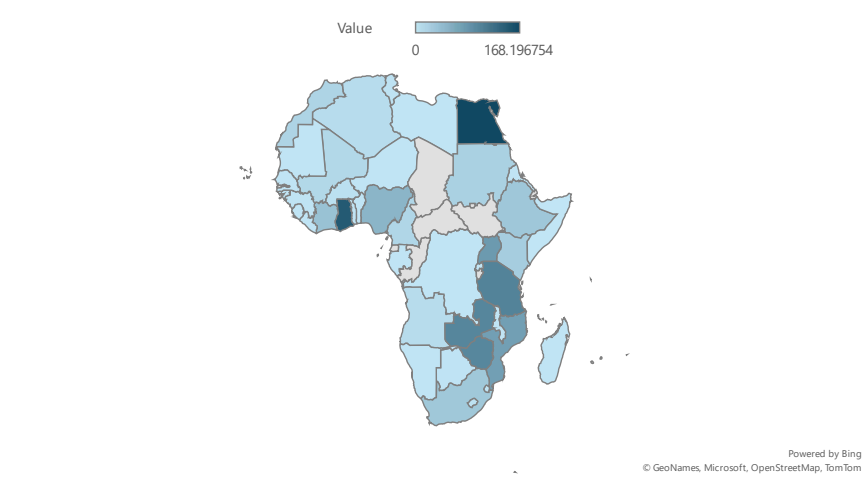


Figure 2.25. Total dam capacity/km^3, 2021. Source: FAO, 2021, created by the author. The grey area has no data

Given that the agriculture sector accounts for the continent's major water use, it is also essential to investigate the development of irrigation and drainage systems. The total area equipped for irrigation is one key indicator to consider when assessing relevant water infrastructure, particularly in regions heavily reliant on the agriculture sector. This metric refers

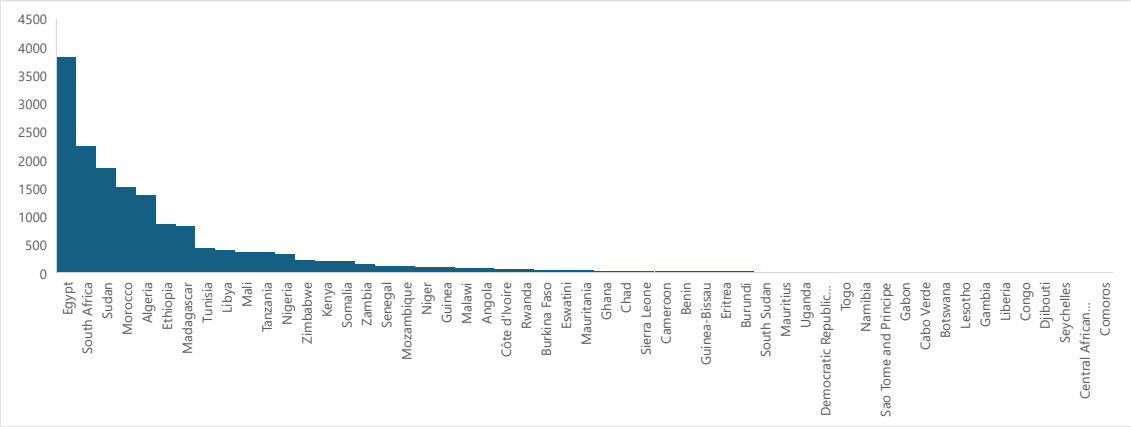


Figure 2.26. Area equipped for irrigation: Total/1000 ha. Source: FAO, 2021, created by the author

to the amount of land that has access to irrigation systems, which can include canals, pumps, reservoirs, and other water management facilities. Again, Egypt has led the ranks, followed by South Africa, Sudan, Morocco, Algeria and Ethiopia.

2.7 Digital infrastructure

Africa's internet traffic has experienced significant growth, with internet penetration rising rapidly since the 2010s. Northern Africa and small island nations are at the forefront of this growth. Countries like Morocco, Egypt and Algeria have increased their individual Internet usage from 52%, 21.6% and 12.5% to 88.1%, 72% and 70.7%, respectively. Several countries in Western Africa (e.g., Ghana) and Southern Africa (e.g., Botswana) have also seen substantial increases (Figure 2.28). Despite this progress, the overall penetration rate in Africa remains well below the global average. As illustrated in Figure 2.27, while about 70 per cent of the population in East Asia & Pacific and Latin America & the Caribbean had access to the internet in 2021, internet penetration in Sub-Saharan Africa reached only around 40 per cent.

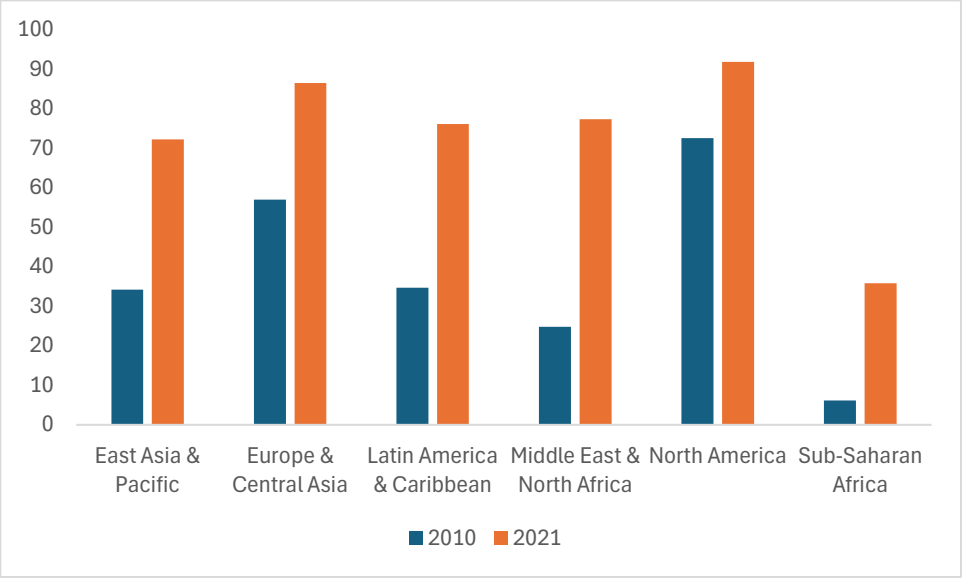


Figure 2.27. Individuals using the internet (percentage of the population) globally, 2010 and 2021. Source: World Bank, created by the author

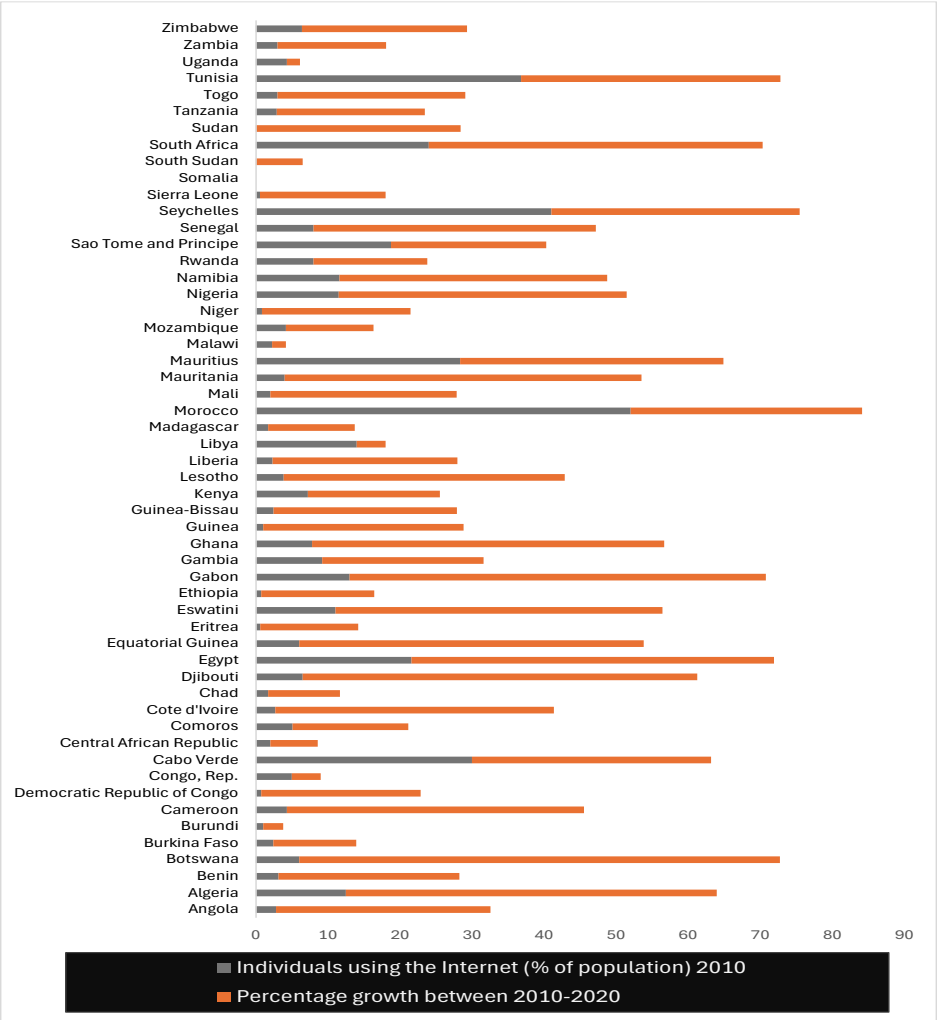


Figure 2.28. Individuals using the internet (percentage of the population) 2010 and 2020. Source: World Bank, International Telecommunication Union (ITU) World Telecommunication/ICT Indicators Database, created by the author

Notably, Africa's growing digital connectivity is largely mobile-based, while fixed broadband penetration remains the lowest globally. Active mobile broadband subscriptions per 100 inhabitants in Africa reached 84 in 2021 but trailed the world average of 111 by a considerable margin.[22] As for fixed broadband, the subscription rate for Sub-Saharan Africa was 0.7 per 100 inhabitants in 2021, well below the worldwide average of 18.4. African countries with the highest fixed broadband subscriptions are Seychelles, Tunisia, Algeria, Cabo Verde and Namibia. In parallel, the top five African countries on mobile subscriptions are South Africa, Mauritius, Eswatini, Seychelles and Côte d'Ivoire. Several internet providers also offer satellite broadband, which is vital for industries operating in remote areas, with the highest presence in countries like Kenya, Nigeria, South Africa, Tanzania and Zimbabwe.

[22] Mobile cellular telephone subscriptions are subscriptions to a public mobile telephone service that provide access to the PSTN using cellular technology. The indicator includes (and is split into) the number of postpaid subscriptions, and the number of active prepaid accounts (i.e. that have been used during the last three months). Data source comes from International Telecommunication Union (ITU) World Telecommunication/ ICT Indicators Database.

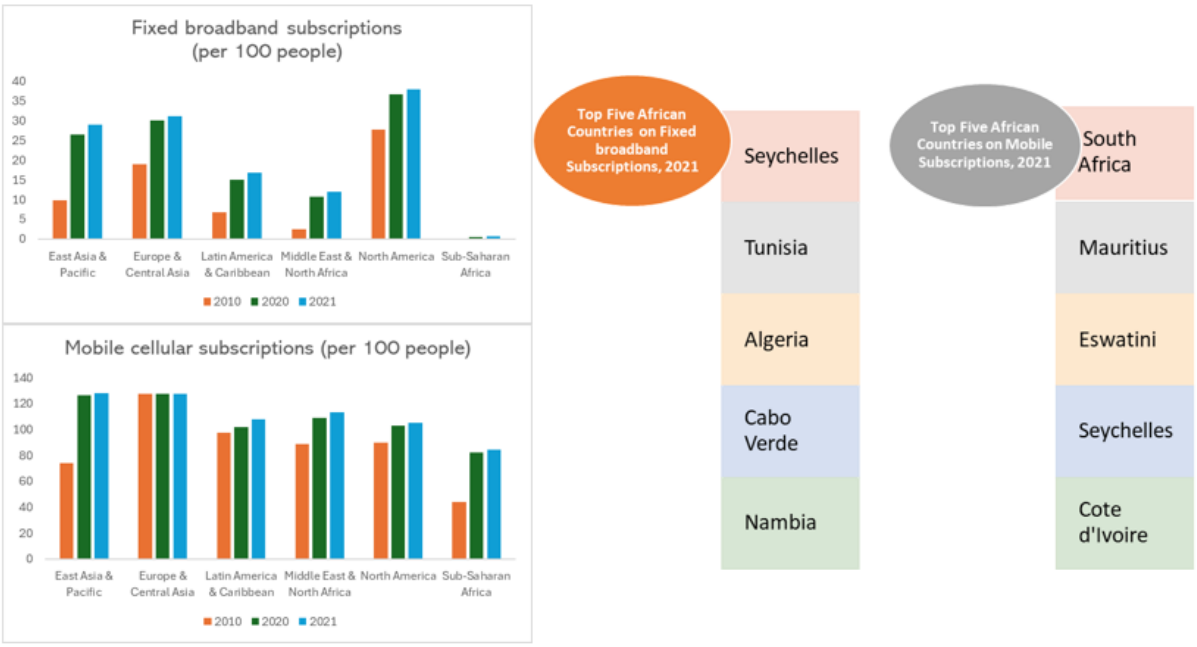


Figure 2.29. Mobile internet penetration vs fixed broadband internet penetration. Source: World Bank, International Telecommunication Union (ITU) World Telecommunication/ICT. Indicators Database, created by the author

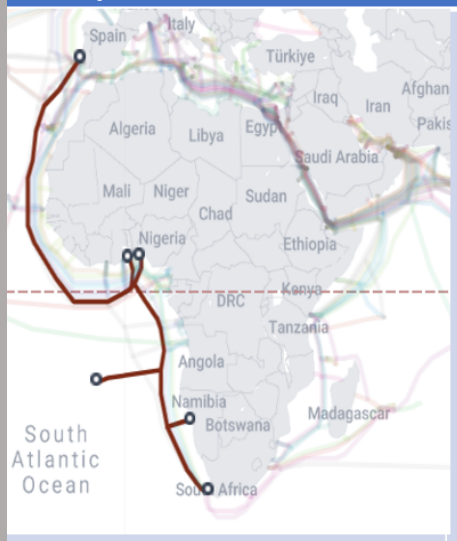
Affordability has been a key factor driving demand for mobile connectivity over the more reliable and efficient fixed broadband. According to ITU price data (2021), Africans typically pay around US$25 per month for a basic fixed broadband subscription, compared to US$6.40 for a data-only mobile plan (AFC, 2024). While mobile broadband technologies offer greater flexibility and are less costly to deploy, they are less stable. A cell tower relying on microwave or satellite connections delivers lower signal speed and capacity, hence limited connectivity compared to one connected by fibre. Despite efforts to increase mobile penetration and reach more users, Africa still needs significant investment in fixed infrastructure. Prioritising fixed broadband investment is essential to making high-speed internet more accessible and affordable for firms to digitise and accommodate larger-scale industrialisation across the continent.

In fact, the absence of legacy infrastructure has played a role in this context. Africa's principal form of fibre-optic connection is through subsea cables. All but one of the continent's 38 countries connected to the sea have at least one subsea cable landing – the exception being Eritrea. Thanks to these submarine cables, growth in Africa's internet bandwidth between 2019 and 2023 far outpaced Asia and Latin America – 44 to 32 and 31 per cent, respectively. However, for Africa's first-mile infrastructure to be effective and resilient, it needs more diversity in routes and ownership, especially as older sub-sea cables start to reach the end of

their lifespan. For example, currently, most traffic on Africa's eastern coast goes through Egypt, stressing the need for more alternative routes to places like Mombasa in Kenya.

Box 2.4. Digital infrastructure structure and first mile in Africa

Given the growth potential of Africa's internet sector, a more diverse mix of investors has emerged in recent years — including big private players like Meta and Google, alongside traditional telco players — to fund major first-mile infrastructure projects like Equiano and 2Africa.



- Equiano Project is financed by Google and activated in 2023 — the third private international cable owned by Google and the 14th subsea cable they have invested in overall.
- 15,000 kilometers (9,320 miles) starting in Portugal and ending in South Africa. It has branches to Nigeria, Togo, St Helena, and Namibia.

Source: TeleGeograpgy, and AFC, 2024

However, the more pressing challenges lie in the middle-mile segment and last-mile connectivity. Around 60 per cent of Africans lack internet access, and the absence of fibre infrastructure hinders the local distribution of high-quality bandwidth. Limited regional infrastructure and network gaps drive up connectivity costs, pricing many Africans out of the digital world. The World Bank estimates that roughly 45 per cent of Africa's population lives more than 10 km away from fibre network infrastructure, a higher percentage than any other continent. As shown by International Telecommunication Union (ITU) data, Africa's current network of operational terrestrial fibre cables is among the smallest globally in both length and density. Only Southern Africa, Northern Africa (mainly Algeria and Tunisia), and the Gulf of Guinea region have a reasonably developed network, reflected in their higher fixed broadband subscription rates. In particular, the lack of terrestrial infrastructure in landlocked countries

results in higher costs and lower internet penetration in these regions, contributing to their poor rankings in most global digital indexes.

Figure 2.3. Global digital transmission network: operational fibre optic cable. Source: Infrastructure Connectivity Map, International Telecommunications Union (ITU), 2024

To maintain that momentum and develop the type of regional infrastructure that can build resilience to increase the quality and affordability of broadband, Africa needs more than just terrestrial fibre networks. Investments in data centres, Internet Exchange Points (IXPs) and 4G/5G cellar also form an integral part of developing efficient digital corridors. The continent currently has over 50 active IXPs across 36 countries and slightly more than 100 data centres spread across 140,000 square metres of space. Globally, this represents only 1 per cent of the world's data capacity, approximately 250 MW. Additionally, this capacity is unevenly distributed, with more than half located in South Africa. Even so, South Africa's capacity remains far below that of major global economies. For instance, Johannesburg has 55 MW of capacity, compared to 796 MW in Dublin and 728 MW in London.

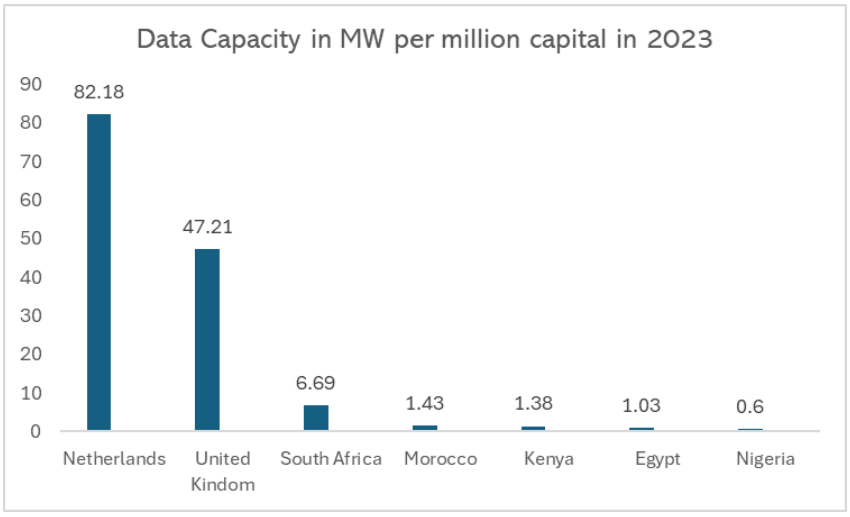


Figure 2.3.1. Data capacity disparity. Source: Africa Data Centres Association, created by the author

In recent years, the rapid development of digital infrastructure and ICT has also led to the integration of technologies into different infrastructure systems. Multiple digital tools and platforms like GPS, IoT devices, and AI algorithms have enabled real-time monitoring and predictive analytics to ensure optimal resource usage, thereby significantly improving the systems' efficiency, sustainability and reliability.

Box 2.5. Digitalisation and intelligent integration of infrastructure development

- **Smart traffic management**

Smart traffic management is transforming how African cities address urban congestion by leveraging technology to optimise traffic flow, improve safety, and enhance the overall efficiency of transportation systems. For example, intelligent traffic signal systems use real-time data from traffic cameras, sensors, and GPS devices to adjust traffic signal timings dynamically. Johannesburg has implemented adaptive traffic signals in certain areas to manage peak-hour traffic more effectively. These systems adjust signal timings based on current traffic conditions, thereby minimising wait times at intersections and improving the flow of traffic. Nairobi has also explored smart traffic lights that prioritise buses and emergency vehicles, aiming to improve the efficiency of public transport and reduce response times for emergency services.

- **Smart grids**

Smart grids represent an innovative approach to energy distribution and management, leveraging advanced digital technologies to optimise the generation, transmission and consumption of electricity. Unlike traditional grids, smart grids can collect real-time data, analyse consumption patterns, and adapt dynamically to shifts in demand and supply. They also can integrate renewable energy sources, such as solar and wind power, into the grid seamlessly, addressing the challenges of intermittent renewable energy. For example, the South African government has allocated more than US$108 million in 2024, which state utility Eskom would use to replace about 6.9 million meters with smart meters. Morocco is also gearing up for its own smart metering initiative, with a current feasibility study underway focused on the city of Marrakech. Egypt, since 2020, has actively engaged with several private players such as Siemens, Schneider and Huawei to transform its electricity grid into a smart grid.

- **Smart water management**

IoT sensors and digital platforms enable real-time monitoring of water distribution systems, helping detect leaks, optimise water usage, and reduce waste. Smart meters, for instance, allow consumers to track their water consumption and promote more sustainable usage habits. The African Union High-Level Panel on Emerging Technologies (APET) has encouraged African nations to adopt smart water meters as part of their broader efforts to integrate emerging technologies. In Kenya, the town of Shinyalu introduced smart water meters, which have helped identify and repair leaks, ensuring better water quality and availability for the local community. Similarly, in Nairobi, the City Water & Sewerage Company implemented smart water meters, leading to more accurate billing, improved revenue collection, and reduced water loss from leaks.

2.8 Special Economic Zones (SEZs)

Special economic zones are one of the most important place-based industrial policy instruments that can potentially bring the urban-industrial development synergy. The term "special economic zones" (SEZs) covers a broad range of zones, such as free-trade zones,

export-processing zones, industrial parks, economic and technology-development zones, high-tech zones, science and technology parks, free ports, enterprise zones, and others (Zeng, 2016). Whilst it is not commonly categorised as a type of infrastructure, infrastructure development is an essential aspect of the zone development, including roads, power, water, and factory sheds.

SEZs can generate immediate and static impacts, such as a boost in employment and exports. More significantly, it can potentially drive more dynamic impacts in terms of structural change, technology and skills transfer, and other socioeconomic benefits (Farole, 2011). It is often considered that these longer-term development impacts have provided the most robust rationale for promoting SEZs, with substantial public resources devoted to related infrastructure development and generous incentives offered to enterprises investing in them (Alcorta and Tesfachew, 2020).

Different sources offer varying estimates regarding the current number of SEZs on the African continent. In fact, there are challenges to obtaining reliable data that distinguish fully operational zones from those that have not hosted firms yet. In addition, SEZs encompass a variety of types, making it difficult to have consistent and standardised calculations from diverse national contexts. Moreover, the prevalence of single-enterprise zones across the continent, which may or may not be counted separately, further complicates these estimates. According to the latest report from UNCTAD (2021), 37 of 54 African countries have established at least one SEZ by law. Figure 2.32 highlights selected African countries with significant numbers of SEZs based on estimates from both UNCTAD and the Africa Economic Zones Organisation (AEZO).

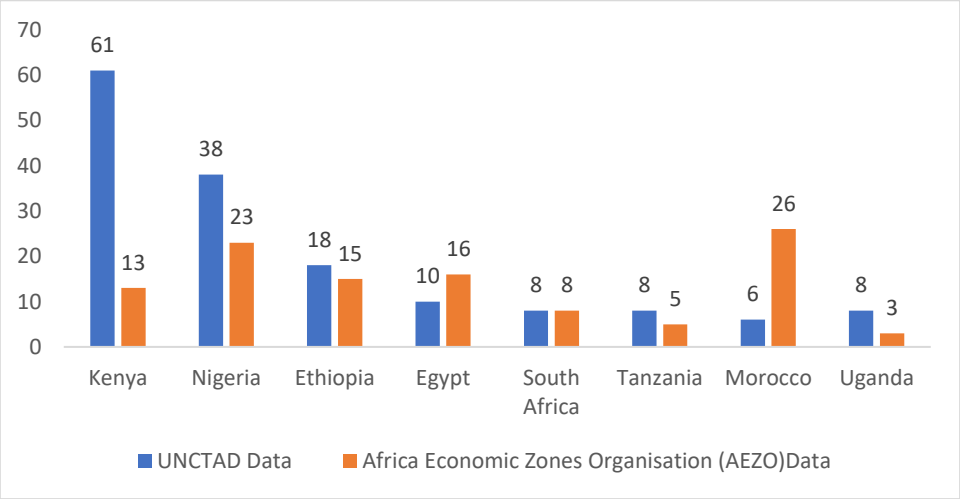


Figure 2.3.2. A selection of African countries with significant numbers of SEZs, 2021. Source: UNCTAD, 2021, recreated by the author

In general, the number of SEZs in Africa has increased steadily in the last two decades. On one side, countries with mature SEZ programmes are seeking to expand further and diversify their zone portfolio through the development of new SEZs. This is the case in Egypt, Morocco and South Africa, which have gradually increased SEZ numbers over the past two decades.

Ethiopia has also been a notable case in scaling up SEZs – though more rapidly during the period from 2010 to 2020. On the other side, many other African countries have recently established their first SEZs to attract FDI and promote industrial restructuring. For example, Guinea launched its first SEZ in Boke in 2017, near the border with Guinea-Bissau, intending to create a logistical hub for its agriculture and mineral industries.

A notable characteristic of SEZs is their degree of sectoral specialisation or the lack thereof. The overwhelming majority of African SEZs (89 per cent) are multi-activity zones, meaning they do not concentrate on a single sector but instead accommodate a range of industrial activities. For example, all nine operational SEZs in Cameroon are multisectoral, with firms engaged in diverse industrial activities, including agribusiness and steelworks in the Douala Bonabéri Industrial Zone, as well as wood processing and oil in the Yaoundé-Sud Industrial Zone. Similarly, Ghana's Tema Free Zone and Kenya's Athi River Export Processing Zone host a wide array of industrial activities.

In contrast, only 10 per cent of African SEZs are specialised, focusing on specific sectors (like agriculture or manufacturing) or industries (such as garments, automotive or electronics). Specialised zones can be found in Morocco, including the Tanger Automotive City, which concentrates on the automotive sector; the Casablanca Midparc Free Zone, focusing on aeronautics; and both Rabat Technopolis and Oujda Technopolis, targeting technology-intensive industries. Ethiopia has set up 13 industrial parks, with ten dedicated to the textile and garment sectors, two for construction, and one – the Kilinto Industrial Park – focused on pharmaceuticals (UNCTAD, 2021). Tanzania's strategy encompasses the establishment of Integrated Agro-Industrial Parks (IAIPs) and Special Agro-Industrial Processing Zones (SAPZs) to serve as key hubs for agricultural transformation by attracting investments in agro-processing and value addition.

In the global context of delivering SDGs and adapting to climate change, a recent survey of 39 African zones revealed that many zones have started incorporating sustainability principles. About environmental services, 64 per cent of zones reported conducting environmental inspections, and 45 per cent provide dedicated facilities for waste management and assist companies in incorporating environmental rules and regulations into their zone operations. More than a third of zones offer recycling services and alternative energy sources. The concept of "eco-industrial parks" has also been promoted in the continent by international institutions such as UNIDO and the World Bank in recent years. A critical aspect is using green infrastructure, including renewable energy, central waste-treatment facilities, and conducive zoning and land use (Oqubay, 2024).

Nevertheless, the general experiences of SEZs in Africa have not yet delivered the expected developmental outcomes. Very few African zones appeared to make substantial progress in unleashing the dynamic potential to facilitate structural transformation (Farole, 2011; Zeng, 2015). Most failed to generate significant improvements in investment, employment, and exports in relation to their internal targets and by international comparison. In those countries that have achieved some of the above, the quality of investments and employment, or its sustainability, remained a significant concern. One of the possible explanations comes down to poor timing in which the emergences of 'factory Asia', the expiration of the multi-fibre arrangement, and the consolidation of the global production network have all led to the African zone programmes being subject to increased international competition during the 1980s and

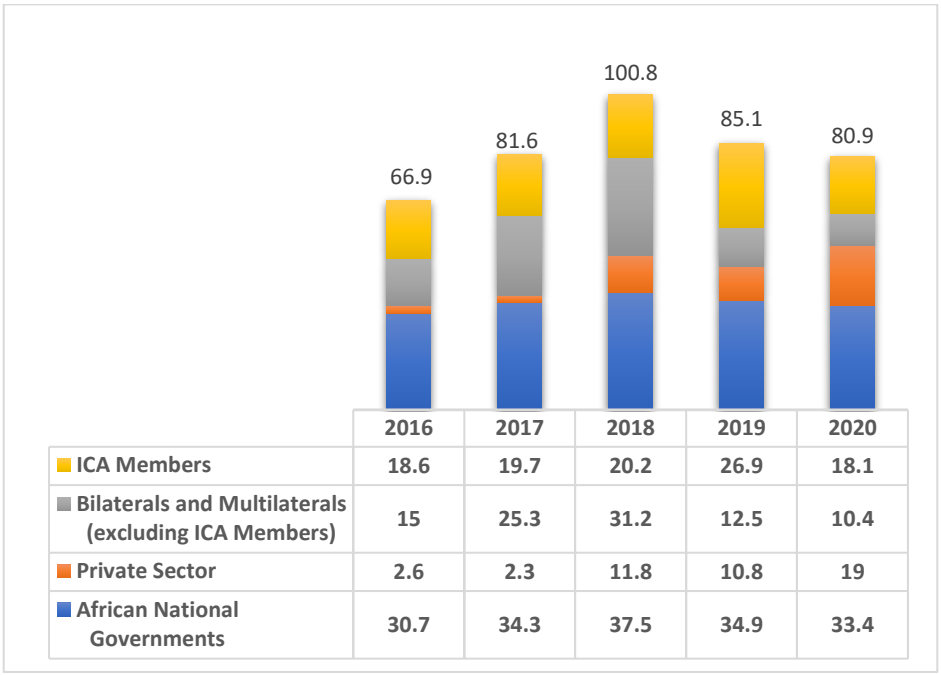
1990s. Research also suggests that, more importantly, domestic political economy has resulted in underperformance – problems such as inadequate knowledge and distorted incentives have created gaps in implementation and enforcement (Yuan & Eden, 1992; Farole & Moberg, 2014; Andreoni, Boys, & Therkildsen, 2022).

3. Enabling critical infrastructure projects: country potentials

Overall, substantial gaps widely exist in quantity, quality and network across various infrastructure sectors and countries in the continent. The insufficient provisions and poor qualities indicate a huge financial gap for infrastructure development. One estimate by the African Development Bank suggested that the continent's infrastructure needs amounted to US$130–170 billion a year, with a financing gap in the range of US$68–108 billion (ADB, 2018). At the sub-national level, the challenges of securing sufficient funding for critical projects in delivering connected and resilient cities are also enormous. Many municipalities overly rely on transfer from the national and regional governments in the context of budgetary constraints, high debt levels and poor creditworthiness (Haddaoui & Gulati, 2021).

3.1 Financing landscape: actors and instruments

Many actors are involved in financing and delivering infrastructure in Africa. In general, the African national government is still the principal funder, accounting for roughly between 35 and 50 per cent of all commitments between 2016 and 2020 (Figure 3.1). However, the national infrastructure budgets in African countries seldom rely solely on local revenues. International debt is typically integrated into their fiscal plans. Financing large-scale



	2016	2017	2018	2019	2020
ICA Members	18.6	19.7	20.2	26.9	18.1
Bilaterals and Multilaterals (excluding ICA Members)	15	25.3	31.2	12.5	10.4
Private Sector	2.6	2.3	11.8	10.8	19
African National Governments	30.7	34.3	37.5	34.9	33.4

Figure 3.1. Total commitments by sources, 2016–20 (US$ billions). Source: ICA reports, multiple years, complied by the author

infrastructure projects, such as railways, poses significant debt-related challenges for many African countries. The complexity of these projects often requires substantial investment,

which can lead to high levels of debt and financial instability, thereby damaging a country's credit rating and limiting access to future financing. Following the national governments, significant infrastructure finance actors in the continent also include multilateral and regional development banks, bilateral partners, and private sectors both within and outside Africa.[23]

Regarding multilateral and regional development banks, we can see that AfDB and the World Bank group have been the most significant players between 2015 and 2020, and their funding levels remained relatively stable over this period. Among the bilateral partners in the ICA partnership, France, Germany, and Japan have been the most significant contributors. It is noteworthy that South Africa has also been an important player. However, approximately 60–70 per cent of its commitments have been directed toward its own national projects (as indicated by ICA data for 2019 and 2020). Outside the ICA group, China stands out as the largest individual funder of Africa's infrastructure. Despite its substantial amount, past commitments from China have fluctuated considerably, going, for example, from US$3.1 billion in 2014 to US$20.9 billion in 2015 and down to US$5.9 billion in 2016. After peaking in 2018, Chinese funding has markedly decreased.[24] Following China, the Arab coordination group and India are also very important financers in the landscape.

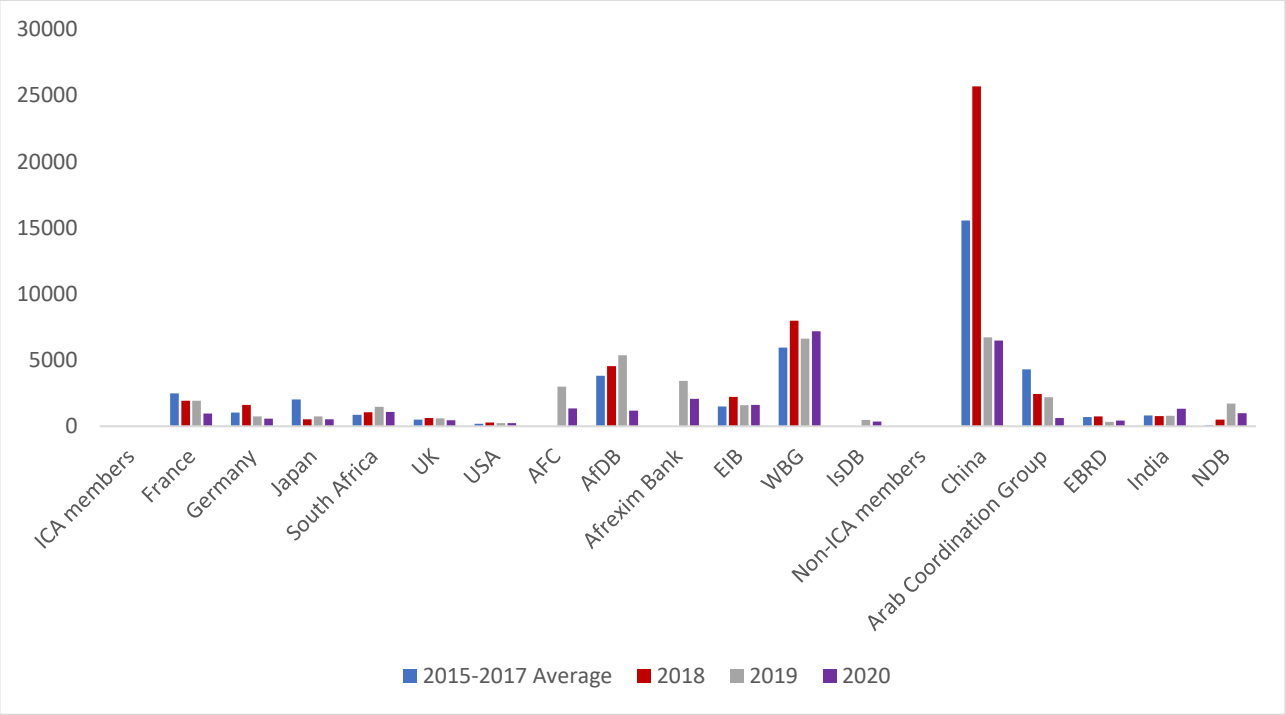


Figure 3.2. Total commitments by sources, 2016–20 (US$ millions). Major ICA members and non-ICA members. Source: ICA reports, multiple years, complied by the author

[23] The Infrastructure Consortium for Africa (ICA) is an initiative established in 2005 to support and facilitate infrastructure development across the African continent. The ICA plays a key role in coordinating funding efforts, mobilising resources, and fostering collaboration among stakeholders to address Africa's significant infrastructure needs. It is composed of several key members on the continent, including G8 countries, the African Development Bank (AfDB), the World Bank Group, the European Commission (EC), the Development Bank of Southern Africa (DBSA), and other multilateral Institutions.

[24] These year-to-year changes can be partly explained by Chinese funding of several very large projects, the timing of which depends on country needs and where multiple large commitments can occur in the same year. At the same time, various data sources define commitments in different ways, complicating the identification of the year of attribution. In general, we

Africa's infrastructure financing primarily relies on three types of instruments: debt (via loans and bonds), equity, and blended finance. There are also different types of loans, including commercial loans, concessional loans and grants.[25] Whilst traditionally dominated by grants and concessional loans, China's lending to Africa is increasingly commercial-oriented. Generally, the cost of debt tends to be lower than equity, with blended finance costs highly variable and dependent on its structuring. Loans and bonds are the most common forms of infrastructure financing in Africa.

For example, most African countries have lending facilities with multilateral organisations such as the World Bank. However, blended financing is increasingly important in the infrastructure finance space in Africa. There is growing attention towards public-private partnerships (PPPs) on the continent. Ranging from Build, Operate and Transfer (BOT) to management contracts, different types of PPP contracts have been developed and promoted to mobilise both expertise and capital resources, with the aim of more timely completion or better maintenance of infrastructure projects (Gottschalk & Sampath, 2021). In Africa, BOOs and BOT models are currently the most widely used forms of PPPs.

Table 3.1. Types of PPPs that reached closure in 2019 and 2020/Africa

	2019	2020
Build, Operate and Transfer (BOT)	3	8
Build, Own and Operate (BOO)	17	10
Build, Rehabilitate, Operate and Transfer (BHOT)	3	1
Rehabilitate, Operate and Transfer (ROT)	/	1
Management Contract	3	1
Others	1	6
Total Number	27	27

Source: PPI Databased, World Bank

3.2 Financing landscape: sub-sectors

Between 2016 and 2020, the transport sector consistently received the largest portion of financial commitments, ranging from 32 to 42 per cent of the total annually (Figure 3.3). African governments contributed over half of the transport-related funding each year, such as 60 per cent (US$19.6 billion) in 2018, 55 per cent (US$18.7 billion) in 2019, and 54 per cent (US$18.6 billion) in 2020. Energy infrastructure investments peaked in 2018 at US$43.8 billion but decreased significantly in 2019 (US$25.9 billion) and 2020 (US$23.5 billion). China made the largest contribution in 2018, accounting for nearly 43 per cent of all commitments. In comparison, ICA members provided the highest share (50 per cent) of energy sector commitments in 2019 (US$13.1 billion) and 30 per cent (US$7 billion) in 2020. Overall, the energy and transportation sectors have attracted most financial commitments in Africa's infrastructure development (Figure 3.4).

can see that China's financing constitutes most of the total commitment by bilateral and multilateral (excluding ICA members). Fluctuations in China's contributions significantly influence the proportion of commitments by non-ICA members over time.

[25] Grants are sometimes categorised separately from loans as a distinct form of aid due to their zero-interest nature.

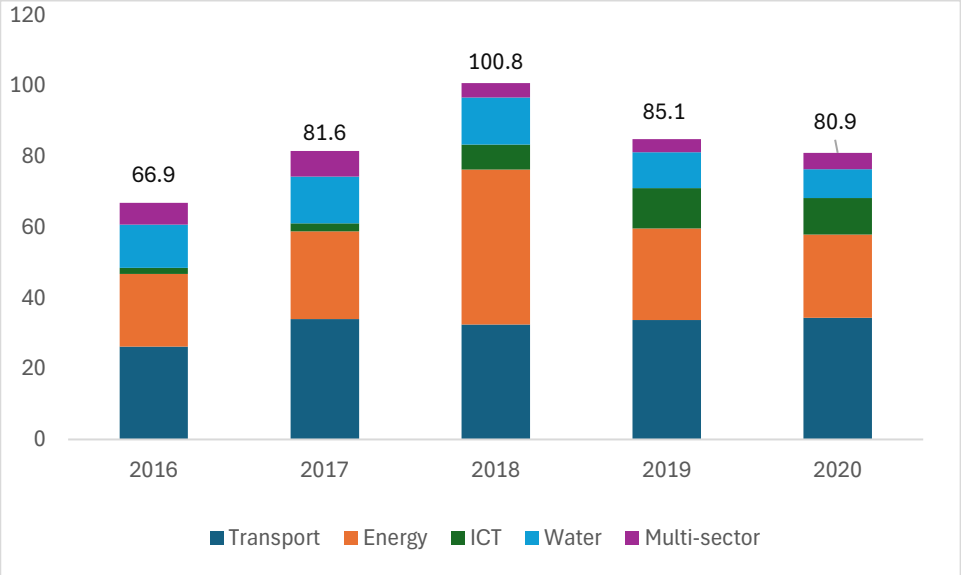


Figure 3.3. Total commitments by sub-sectors, 2016–20 (US$ billions). Source: ICA reports, multiple years, created by the author

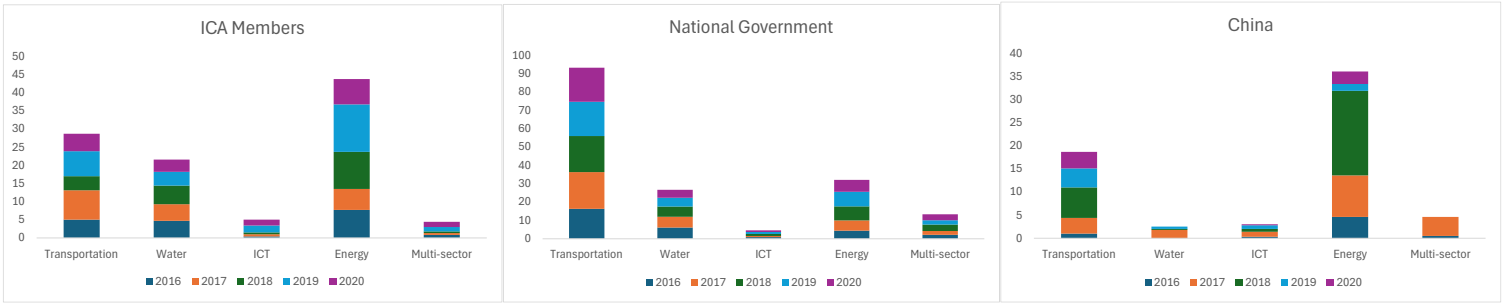


Figure 3.4. ICA members/national government/China commitment trends by sector (US$ billions), 2016–20
Source: ICA reports, multiple years, created by the author

Commitments to the ICT sector increased markedly from the 2017 level of US$2.3 billion, reaching US$11.4 billion in 2019 and US$10.4 billion in 2020. The private sector contributed the largest share. For example, 61 per cent (US$6.9 billion) of 2019 ICT commitments and 63 per cent (US$6.5 billion) of 2020 commitments have come from the private sector. The private sector has been able to sustain and even boost its investment flows in this sector, showing that robust demand continues. In fact, as the continent rapidly urbanised with population growth in both urban and rural areas, private interest in Africa's infrastructure development has been an unevenly moving picture.

Despite overall contributions still being relatively small, areas such as ICT development, port projects, urban mass transit, and energy generation have attracted substantial private investments. Between 2010 and 2022, African port projects with private sector participation received the highest level of investment globally, amounting to US$13 billion. Some of the most significant examples include the US$1 billion Port of Banana project in DRC, which has attracted investors from the UK and the Middle East, and the Lekki Deep Sea Port in Nigeria (US$1.05 billion), with investments from China and Singapore. Another notable example is

the Cairo Public Monorail System (US$5bn), which seeks to tackle mass urban transport in the capital of Egypt (AFC, 2024; World Bank, PPI database).

About the water and sanitation sector, relatively smaller but consistent financial commitments were seen between 2016 and 2020. However, its share has been declining – from an average of 16 per cent of total commitments between 2016 and 2018, to just 10 per cent in 2020. This trend may indicate an increasing funding gap in the sector. According to the 2022 ICA report, the annual financing gap for water infrastructure was estimated at US$46 billion to US$56 billion in 2019, significantly larger than the gaps for transport (US$4 billion to US$16 billion) and energy (US$4 billion to US$19 billion). In terms of the source of commitments, ICA members, followed by the national government, have been the most significant contributors.

3.3 Infrastructure financing: sub-regions[26] and country potentials

As the densest sub-region in the continent, Western Africa received the highest level of funding commitments between 2018 and 2020 – US$25.7bn in 2018, US$25.5bn in 2019 and US$22.3bn in 2020, respectively.[27] Nearly half of total commitments to West Africa went to energy, a sector with a significant access gap (ICA, 2022). Regarding external sources, ICA members allocated between 24 and 38 per cent of their total commitments to Western Africa, making it the largest recipient compared to other sub-regions. Among ICA members, multilateral development banks such as the World Bank and regional financial institutions prioritised Western Africa. Bilateral partners like France also directed more than half of their commitments to the region (as indicated in data provided by ICA in 2019 and 2020). China has made significant contributions to Western Africa as well, although the exact figures and share may vary depending on the year and data sources.

After Western Africa, Northern Africa and Eastern Africa also received substantial commitments. Within the ICA group, EIB and Germany have shown a pattern of favouring Northern Africa. Non-ICA members like the Arab Coordination Group also prioritised the Northern Africa region, especially supporting the transport sector. Private sector commitments in Northern Africa are also on the rise. In Eastern Africa, transportation remains a key investment area, comprising 54 and 62 per cent of the region's total funding commitments in 2019 and 2020, with much of this funding provided by national governments and ICA members. In the Southern African region, South Africa holds the largest share of financing commitments, despite being the most advanced economy in the area. This is largely supported by contributions from the private sector and its own national resources.

Despite having the smallest GDP among Africa's sub-regions, Central Africa received the lowest levels of investment commitments, dropping from US$7 billion in 2018 to US$5.3 billion in 2020. Analysis of its infrastructure landscape further shows that it remains the least developed region on the continent for infrastructure development. The African Development Bank (AfDB) and the World Bank have been the primary contributors to commitments in the sub-region, followed by China. For instance, China committed US$683 million in 2019, representing 14 per cent of the total.

[26] The ICA reports classify Mauritania within the Northern Africa region and Rwanda within the Central Africa region. It also designates South Africa separately from the Southern African region.

[27] Note: this is based on the calculation of ICA reports that separate South Africa from the broader Southern African region, given the substantial funding South Africa has received. Otherwise, the Southern African region is the sub-region that received the highest level of funding commitments between 2018 and 2020.

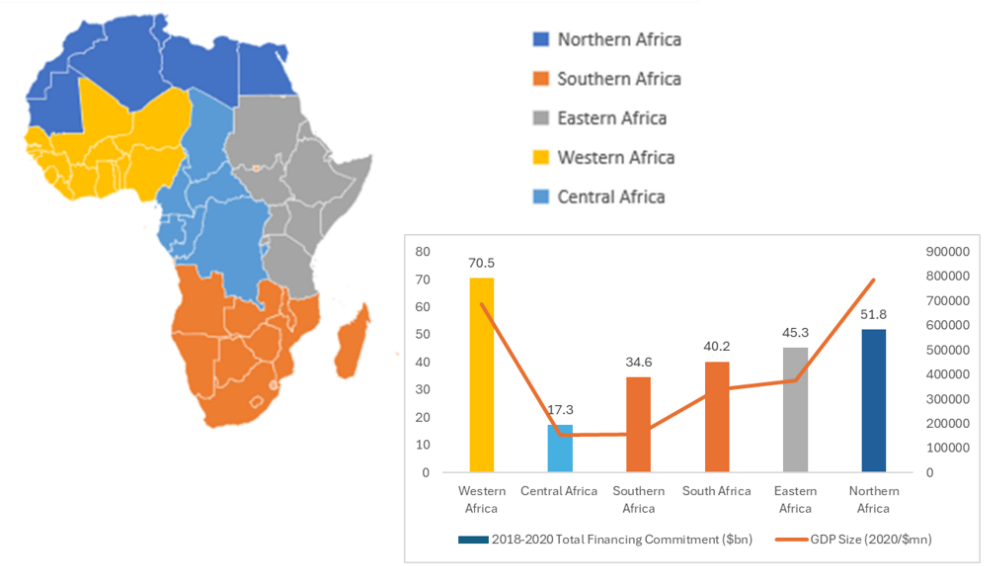


Figure 3.5. Distribution of funding by sub-regions. Source: ICA reports, multiple years; GDP data based on World Bank, compiled by the author

As discussed, current financing for African infrastructure comes from 1) the government's expenditure based on fiscal revenue and guaranteed borrowings; 2) external sources, notably ICA members and China; and 3) the private sector. As such, we investigate data available for each source to assess the country's potential for enabling critical infrastructure development in the continent. As Figure 3.6 shows, South Africa, Egypt, Tanzania, Ethiopia, Uganda, Côte d'Ivoire, Nigeria, Morocco, Cameron, Angola and Zambia have the largest budget allocations for infrastructure in 2020. In addition, countries like Kenya, Tunisia, Algeria, Senegal and Sudan are also investing substantially in infrastructure development.[28] It's essential to combine the picture of current budget allocation with the countries' borrowing capacities for future spending. We use the debt-to-revenue ratio as an indicator to evaluate their ability to take on additional debt. The analysis reveals that countries such as Sudan, Zimbabwe, Ghana, Zambia, Egypt, Sierra Leone and Guinea-Bissau all have high levels of debt-to-revenue ratios,

[28] Since GDP and infrastructure budget allocation by national governments data are sourced from different entities, each with potentially varying calculation methods, there are limitations to examining the Budget Allocation/GDP ratio in detail, which could offer additional insights. Nevertheless, we can broadly compare the focus on infrastructure investment across African countries relative to their economic sizes.

with Sudan being the most severely impacted. This could pose significant challenges for their potential to borrow in the future.

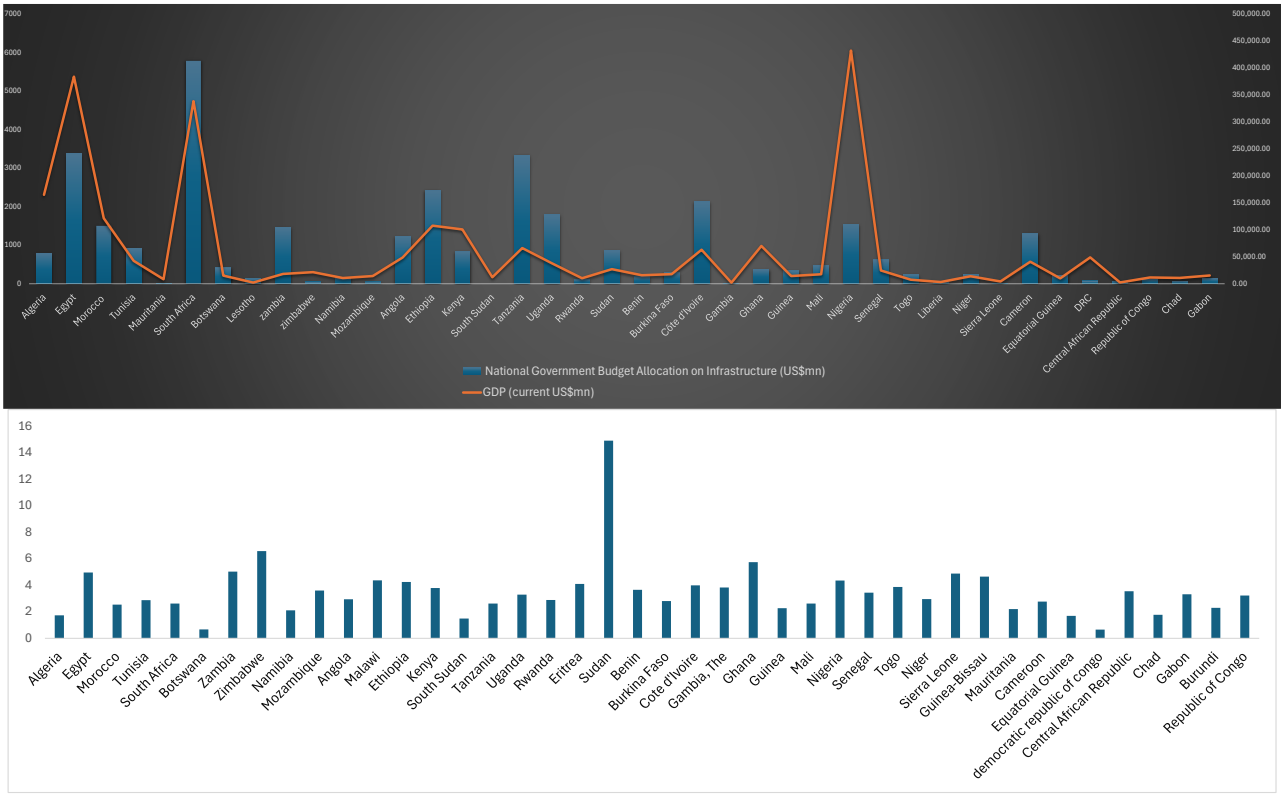


Figure 3.6. National government budget allocation on infrastructure (US$ millions, 2020) & debt/revenue ratio (by countries, 2023). Source: Above: ICA reports, multiple years; data on Sudan is from the national budget report, GDP data is from the World Bank, based on 2020 data, compiled by the author. Below: IMF database, based on the available country data on gross debt (% of GDP) and revenue (% of GDP) in 2023, compiled by the author

Turning to the external source, we use PIDA's infrastructure project database to estimate the commitments of ICA members, the Global Development Policy Center's Global China project database to estimate commitments of China, and the World Bank's PPI project database on private sectors, regarding both project numbers and their value terms.[29] There are currently 372 active projects from PIDA, ranging from transportation to water.[30] Tanzania, DRC and Cameroon have the largest PIDA projects on record, followed by countries like Zimbabwe, Kenya, Republic of Congo, Uganda, Burundi, Côte d'Ivoire, Mali, Niger, Mozambique, Nigeria, Zambia, Chad and Central African Republic. In Tanzania, DRC and Cameroon, transportation projects dominate, with an additional focus on electricity and ICT initiatives. For example, in Tanzania, significant projects include the Dar es Salaam–Chalinze–Morogoro road upgrade and the Standard Gauge Railway from Dar es Salaam to Mwanza. In Cameroon, both Douala

[29] It is noteworthy that some mega-projects, such as Lekki Deep Sea Port, have been recorded in both databases, given the projects' significant investments and different sources of financial commitments they may engage.
[30] The Program for Infrastructure Development in Africa (PIDA) is a continental initiative adopted by all African countries to mobilise resources to transform Africa with modern infrastructure. The projects identified and prioritised under PIDA are often presented to the ICA and its members as investment opportunities. The database has recorded 409 projects, of which 372 are active. 63 projects are cross-border projects which involve more than one country.

Port and Kribi Port are expected to be upgraded, as well as the construction of the Cameroon-Chad Railway.

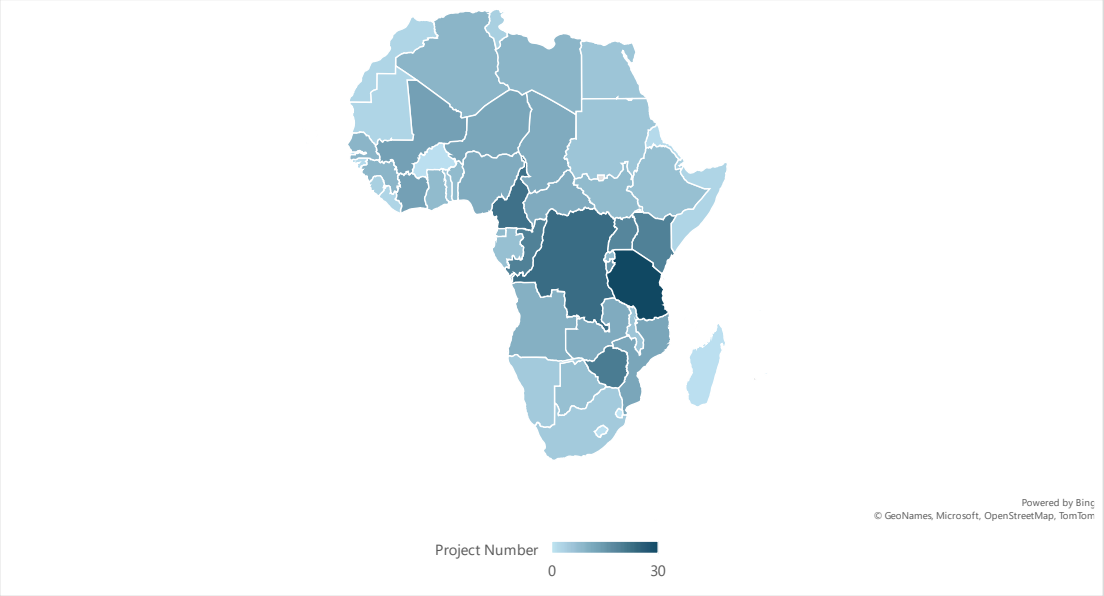


Figure 3.7. Distribution of PIDA infrastructure projects (by numbers of projects). Source: PIDA Project Dashboard

Among the 124 projects with available data on capital costs,[31] DRC, Kenya, Uganda, Tanzania, Mozambique, Zambia, and Zimbabwe lead in high-value infrastructure projects in the pipeline, largely due to costly hydropower, railway, and port developments. For example, the DRC's Inga 3 Hydropower Plant, estimated at US$18 billion, aims to generate 11,050 MW at the Inga site with transmission lines within the DRC and beyond. Currently in the permitting stage, it is set to be developed by AEE Power SA, China Three Gorges, Fortescue Future Industries, and Sinohydro. Mozambique, Zambia and Zimbabwe are also pursuing hydropower projects to harness energy from the river: Mozambique has signed a US$5 billion hydro-project agreement with a French-led consortium, aiming for a 1,500 MW capacity in its first phase, while Zambia and Zimbabwe plan to retender the Batoka Gorge hydropower project, valued at US$5 billion and expected to generate 2,400 MW. Additionally, a US$2 billion port expansion at Maputo, Mozambique, is underway, supported by Dubai's DP World and South Africa's Grindrod group.[32] High-value standard gauge railway projects across East African nations, including Uganda, Kenya, Rwanda and Tanzania, also feature in the PIDA agenda, with values ranging from US$2.3 billion to US$4.4 billion, most of which are still in the project structuring or tendering stages.

For projects funded by China, we focus on those recorded from 2019 onwards, as China's financial commitments have varied over the years, reaching a peak in 2018.[33] Among 95 infrastructure projects, Côte d'Ivoire has the largest share, with 16 projects on record. Most of

[31] The database uses the indicator of CAPEX Cost US$ (million).
[32] Nevertheless, there is potential competition for these ongoing hydropower projects, given they are all currently aimed at the Southern African market.
[33] This database only records Chinese loans to Africa; as such, it may underestimate the infrastructure engagements of China in some African countries.

them are transportation projects, such as a dry port in Ferkessédougo and a road project from Touba to Saoula. Following Côte d'Ivoire, Ghana, Uganda, Senegal and Angola have also hosted a significant number of projects. The notable examples range from railway projects in Ghana and rural Electrification projects in Uganda to the National Broadband Project in Angola. In terms of project value,[34] Egypt leads with four projects totaling US$3,916.64 million. The New Cairo City Central Business District stands out, backed by a Chinese loan of US$2,167.50 million, marking the most significant Chinese financing since 2019. Alongside Egypt, Côte d'Ivoire, Nigeria, Ghana and Uganda are the top five countries in terms of high-value infrastructure projects financed by China. Notably, Nigeria has had three major projects since 2019: the US$973 million Lagos-Kano Railway (Kaduna-Kano Section), the US$629 million Lekki Deep Water Port, and a US$392.53 million airport expansion.

Using the same time from 2019 to the present, the World Bank has tracked a total of 195 projects across Africa with private participation.[35] South Africa ranks first with 18 projects, while Kenya, Egypt and Morocco each have 11 projects, tying for second place. Côte d'Ivoire, DRC and Mozambique are followed by nine private sector-led projects each. In terms of the project value, Egypt, again, has largely overtaken others to take the lead. A project that received the lion's share is the Cairo Public Monorail Transit System, which has a commitment of investments as high as US$ 5.02 billion. Following Egypt, Nigeria and South Africa rank next, each securing over US$3.5 billion in private infrastructure commitments. The significant projects include Nigeria's Ajaokuta–Kaduna–Kano Natural Gas Pipeline (US$2.6 million) and Lekki Deep Sea Port (US$1.05 million); as well as South Africa's Kenhardt solar PV & battery

Table 3.2. PPI infrastructure project landscape in Africa (2019–24)

Countries with the largest project numbers	Countries with the largest investment Amount (US$ millions)
South Africa (18)	Egypt (8854.6)
Kenya (11)	Nigeria (3979.2)
Egypt (11)	South Africa (3799.5)
Morocco (11)	Côte d'Ivoire (2292.6)
Côte d'Ivoire (9)	DRC (2215)
Mozambique (9)	Morocco (1999.2)
DRC (9)	Ghana (1670)
Nigeria (8)	Mozambique (1595.9)
Senegal (8)	Senegal (1561.4)

Source: World Bank

storage facility (US$959.6 million) and Redstone Concentrated

[34] Measured in value of loans (US$ million).
[35] The World Bank's Private Participation in Infrastructure (PPI) Database tracks project information with private participation across the globe since 1990.

Solar Thermal Power (CSP) plant (US$826.3 million). Beyond these leading countries, Côte d'Ivoire, DRC, Morocco, Ghana, Mozambique, Senegal, Kenya and Gabon have also attracted substantial private investments in various infrastructure projects.

3.3 Construction

In addition to financing, the delivery of critical infrastructure projects also requires timely and high-quality construction. Indeed, the construction sector is pivotal to a country's economy, making substantial contributions to GDP and employment while enabling essential infrastructure development. Africa's construction sector is booming. For example, in countries like Ethiopia, construction contributed 72.5 per cent of sectoral value-added between 2016 and 2021. In Ghana, the approximately US$8 billion Ghanaian construction sector has accounted for more than 15 per cent of the nation's annual GDP in recent years (ADB, 2022). According to Deloitte's report on Africa Construction Trends, [36] the transportation, energy/power, and real estate sectors have comprised the largest share of construction activities across the continent between 2017 and 2021, both in terms of the number of projects and overall project value. Within the real estate sector, commercial real estate dominates in both project numbers and value compared to industrial and residential real estate

[36] The Deloitte Africa Construction Trends report has monitored infrastructure and capital project activities across Africa since 2012, with the most recent report published in 2021.

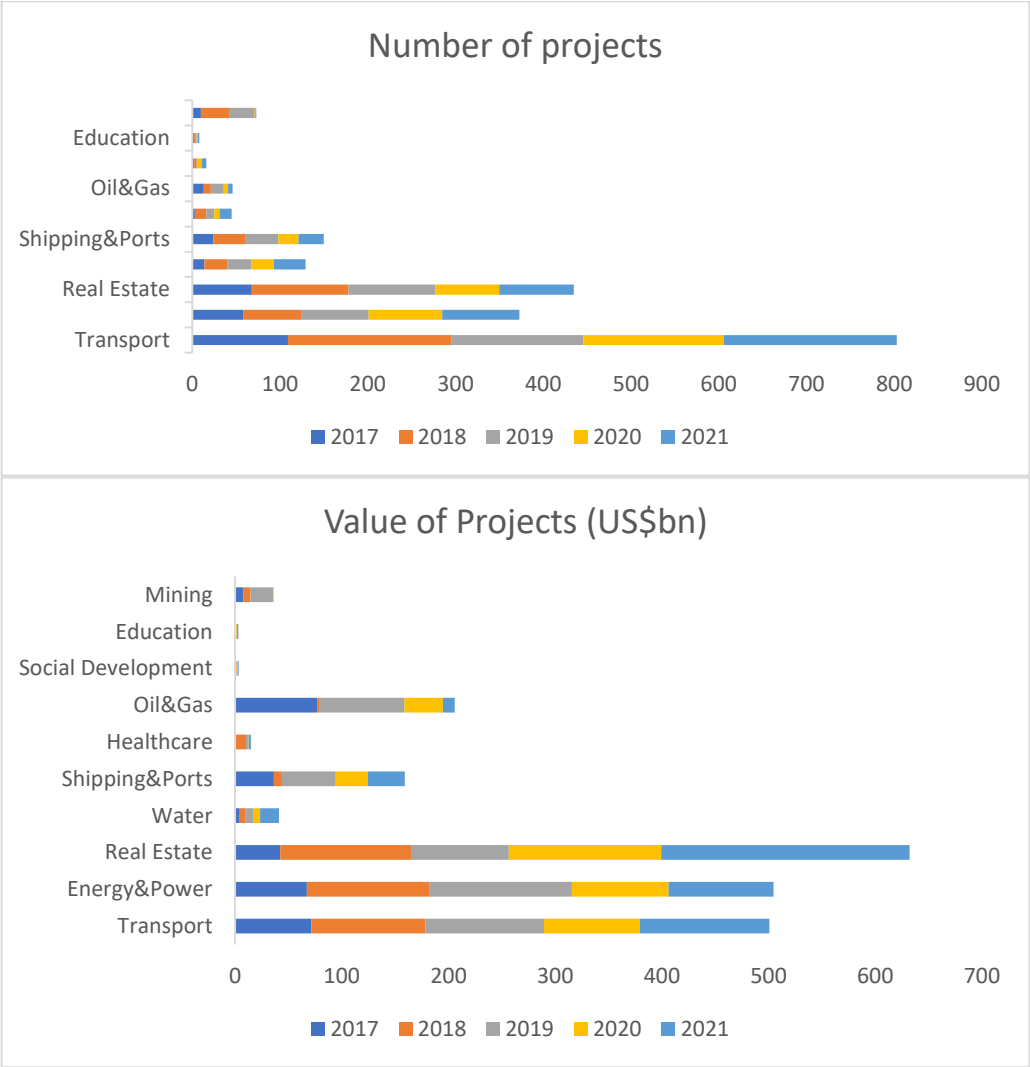


Figure 3.8. The distribution of Africa's construction activities. Source: Deloitte reports, multiple years; compiled by the author

Among major contractors on the continent, China, private domestic companies,[37] and EU countries have been the primary players in constructing Africa's infrastructure projects from 2017 to 2021. China led with an average market share of 30.16 per cent over this period, followed by private domestic firms with 25.5 per cent, and EU countries with 13.6 per cent. Beyond these top three, consortia[38] (notably since 2020) other Asian countries[39] have also played significant roles in delivering infrastructure projects across Africa. By looking further into the dynamics of sub-regions, Chinese contractors have a particularly strong presence in East and Central Africa, with average market shares of 49.7 and 40.7 per cent respectively, from 2017 to 2021. Chinese contractors also have a notable presence in Southern and

[37] Private Domestic firm refers to an African construction firm or financial institution headquartered in the same African country where it is constructing a project.
[38] Consorta refer to two or more construction companies or governments holding an equal split of a project's ownership, building activities, or funding activities.
[39] The report's coverage of other Asian countries has evolved over the years. Generally, it includes contractors from Asia, such as Japan, Singapore, Macau, South Korea, India and Turkey.

Western Africa, with average shares of 26.9 and 25.6 per cent. In contrast, China's market share in Northern Africa is comparatively lower, averaging only 9.4 per cent over the same period.

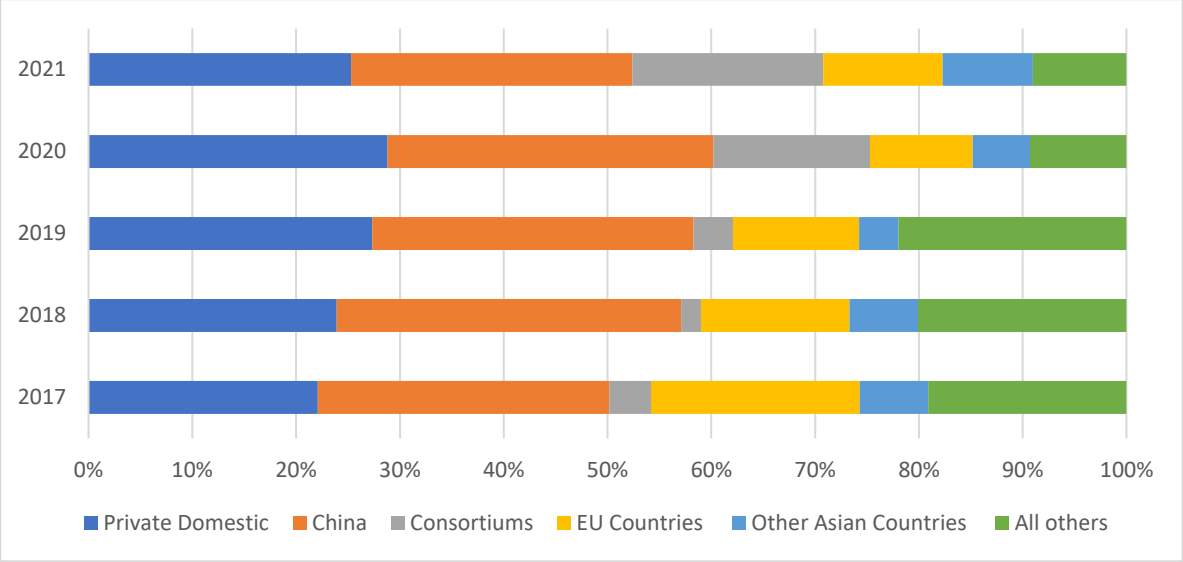


Figure 3.9. Building percentage share of major contractors (by project numbers). Source: Deloitte reports, multiple years; compiled by the author

Compared to China, private domestic companies hold a more dominant position in the Northern and Southern African construction markets, accounting for 35 and 33.7 per cent of construction activities, respectively. They also have a significant share in the Western African region (an average of 24.6 per cent between 2017 and 2021), though less significantly in the Eastern African market (an average of 11.9 per cent between 2017 and 2021) and almost no presence in the Central African region. EU countries, once dominant in Africa's construction market, have gradually reduced their share over the past decade. Nonetheless, they remain relatively significant, especially in Central Africa and Northern Africa, with average shares of 18.5 and 16 per cent from 2017 to 2021.

There are also some other key construction players emerging in different sub-regions.[40] Middle Eastern and Asian contractors, such as those from South Korea and Turkey, hold notable shares in Northern Africa, while Western African firms are active in their home region, and South African companies participate in the Southern African market. South African companies, along with Turkish companies, also play important roles in the Central African region. In the Eastern Africa region, contractors from Japan, India and the Middle East have each accounted for some building share over recent years.

[40] The Deloitte reports categorise Sudan and South Sudan as part of the Northern Africa region, Rwanda and Burundi within the Eastern Africa region, and Mauritania within the Western Africa region.

While Chinese construction companies have the strongest presence in Africa, they typically do not disclose a geographical breakdown of their international sales. However, due to China's strategic economic interests and substantial financial support from Chinese banks, Africa is estimated to be the largest market for China's overseas construction activities. According to Deloitte, other major global players on the continent include Hyundai E&C, VINCI, and Bouygues, which lead their overseas operations in the region. For example, VINCI reported sales in Africa of approximately US$1.8 million in 2022 and 2000 million in 2023, including water business in Uganda and Tanzania, road construction and maintenance business in Côte d'Ivoire, Niger, Chad and Benin, as well as building construction work in Morocco.

Table 3.3. A selection of Chinese-constructing projects across African countries

	Project names	***Contractors***	***Project value (US$)***
Ghana	Port Upgrade of Takoradi	China Harbor Engineering Company	475 million
Tanzania	Tabora – Kigoma Railway	China Civil Engineering Construction Corporation and China Railway Construction Corporation	2.2 billion
South Africa	Mtentu Bridge	China Communications Construction Company	270 million
Egypt	Green Hydrogen and Ammonia Plant (in Suez Economic Zone)	Energy China	6.75 billion
DRC	63km Kinshasa Ring Road 900km road upgrade in Lualaba Province, 230km road upgrade between Kananga and Kalamba Mbuji	Sinohydro, China Railway Construction Corporation	7 billion

Source: multiple online sources and construction news; compiled by the author

4. Conclusion

4.1 Readiness, potentials and strategies

Section 2 presents a comprehensive overview of various types of infrastructure development across the continent, highlighting their quantity, quality and networks in shaping the readiness of different countries and sub-regions for transformation. Overall, South Africa and countries in Northern Africa (excluding Libya) lead in infrastructure development within Africa. Nonetheless, these countries still face challenges across different infrastructure types.

For example, the ports in South Africa have steadily lost competitiveness on the global stage, and issues with water insecurity in the country are also intensifying. Morocco has opportunities to strengthen public urban transit, expand air freight, and improve regional connectivity through its road and rail networks. Egypt, hosting several of Africa's largest cities, also faces challenges in urban public transportation and could advance its ICT infrastructure to lead in the digital economy. Tunisia, meanwhile, has lagged in port development, and Algeria could further tap into its potential for expanding air traffic. More broadly, the Northern Africa region commonly faces mounting pressure on water resources due to the combined effects of topography, rapid urbanisation, and climate change.

In comparison to the Northern African region, most Sub-Saharan African regions are grappling with far more severe infrastructure challenges. Especially landlocked countries in Western, Eastern and Central Africa, such as Niger, Chad, Central African Republic, South Sudan and Burundi, consistently rank among the lowest performers across nearly every infrastructure category. In some cases, there has also been a lack of available data throughout the years, highlighting the depth of the challenges these countries face.

Certain countries and sub-regions have excelled in specific domains, yet they may fall behind in others. For example, Togo showcases strong growth in its ports but has no advantage in other types of infrastructure development. Likewise, Namibia holds some regional strengths in digital infrastructure. In some instances, significant efforts are being made to advance areas where it lags. For instance, already a continental leader in air traffic and data capacity, Kenya is also making notable progress in expanding its electricity infrastructure.

A more comprehensive picture is revealed by combining the analysis of the project landscape. Firstly, although South Africa and Northern African countries are already leaders in infrastructure development on the continent, their current advantages are likely to be further strengthened. On one side, these countries have allocated substantial domestic financial resources to infrastructure development in relative terms; on the other, major external financiers demonstrate strong investment interest, both in the number and value of projects. Specifically, Egypt and Morocco are still leading the Northern African group. Although Egypt's rising debt may limit its future capacity for infrastructure spending, private investments and external funding remain particularly robust in areas like urban transportation/construction, ports, submarine cables, renewable energy, and green hydrogen.

In Western Africa, Nigeria has demonstrated sub-regional strengths in air traffic, data capacity, and paved road density. It has also been proactive in developing SEZs. However, the country faces a significant challenge with its electricity deficit, exacerbated by a growing population and rapid urbanisation. With a large portion of funding for electricity infrastructure directed towards Western Africa, Nigeria is expected to make steady improvements. Additionally, Nigeria has recently attracted considerable investments from the private sector and external financiers like China in its ports, airports and railway projects.

While Côte d'Ivoire may not display significant strengths in its current infrastructure landscape compared to Nigeria, it distinguishes itself with numerous ongoing projects and the highest infrastructure budget allocation among West African countries in 2020. It also holds the third-largest GDP and the highest GDP per capita in the sub-region. In addition, it has received substantial financing from China, PIDA, and the private sector across all infrastructure sectors.

Likewise, Senegal is not currently at the forefront in the region but is making rapid progress in its infrastructure development, driven by decent government budgets and external resources, particularly from China and the private sector. Significant projects are underway in the fields of electricity and ICT. Moreover, as the second-largest Western African economy in the sub-region regarding GDP size, Ghana also receives substantial infrastructure investment from China and the private sector, despite its governmental resources being relatively modest compared to others in the region.

Eastern Africa showcases a progressive but more evenly moving picture with its major-sized economies. Ethiopia, Kenya and Tanzania all exhibiting some established strengths with their existing infrastructure development in different aspects. Ethiopia, Tanzania and Uganda have all allocated considerable government resources to infrastructure projects. These countries share comparable borrowing capacities, though Ethiopia faces relatively higher debt challenges than the others. In recent years, Kenya, Tanzania and Uganda have attracted greater attention from external sources for infrastructure financing. Prominent projects include the Sino-Uganda Mbale Industrial Park in Uganda, the Nairobi expressway in Kenya and the Standard Gauge Railway in Tanzania.

In Southern Africa (excluding South Africa) and Central Africa, the main infrastructure players, based on government resource allocation, are Zambia, Angola and Cameroon. However, Zambia's rising debt may limit its borrowing capacity, potentially affecting investment in future infrastructure projects. Overall, Central Africa has struggled to keep pace with infrastructure development, with most current projects in the region funded by PIDA. Nonetheless, Cameroon has attracted significant external resources from PIDA, while DRC is receiving substantial investment from both PIDA and private sectors.

In general, we can see that different sub-regions and countries in the continent have different paces for their infrastructure development, with different levels of industrial base in a broader context of rapid urbanisation. Alignment between infrastructure policy, urban policy and industrial vision is especially important in enabling structural transformation in diverse development contexts on the continent. Indeed, different industries and sectors require different types of infrastructure in terms of quantity, quality and network. While reaching a certain level of infrastructure threshold is important, equally vital, if not more so, is coordinating the development of various types of infrastructure in strategic locations to meet the needs of industrial growth and restructuring.

For example, developing agro-processing industries may particularly require better coordination between irrigation and transportation systems, and a vision of a digital economy demands synergy between ICT and electricity. In some countries, these synergies have not yet taken place between their existing infrastructure landscape, ongoing projects and envisioned trajectory. This misalignment is concerning, but addressing it may require a deeper understanding of the specific spatial-temporal context, not just at the national level but also at the regional and local levels, including sub-regions, cities, and surrounding rural areas. In the following sub-section, we explore the infrastructure challenges at each significant spatial level to discuss the opportunities, constraints and priorities for the continent in developing the connection between urbanisation and industrialisation, thereby guiding the research direction forward.

4.2 Enabling the urbanisation-industrialisation nexus through infrastructure development: continental challenges

Different types of infrastructure have developmental impacts in supporting production at different spatial levels to enable the synergy of urban-industrial development and structural transformation. However, the existing landscape has indicated that these developmental impacts, such as improved accessibility, mobility and connectivity, have not yet been fully delivered through infrastructure development on the continent.

At the rural-urban interface (including peri-urban areas), access to essential services, such as transportation, water, electricity and the internet, is often lacking. Many local roads are not paved or well-maintained in countries like Tanzania, Ethiopia and Malawi. Water infrastructure across the continent has also remained inadequate, with funding shortfalls widening in comparison to other types of infrastructure development. A significant portion of investments has been directed toward electricity infrastructure, improving accessibility in some African countries. Nevertheless, a substantial gap remains in many areas, especially remote places. Improved accessibility may not directly translate into productivity, as some of the progress has been achieved through off-grid solutions. The transmission and distribution network remain underdeveloped and underfunded. Similarly, the continent has witnessed a surge of investment in recent years in digital infrastructure, especially from the private sector. However, these investments have largely targeted mobile networks over fibre networks, which could more effectively enhance productivity, and have been concentrated in densely populated areas rather than remote regions.

The accessibility challenges are also pronounced for establishing and operating SEZs in the continent, which are usually located in the urban peripheries for manufacturing or rural areas for agro-processing. Structural transformation towards higher value or productivity is essential for sustained growth and poverty alleviation in Africa, with SEZs or Industrial Parks seen as a potentially important tool for achieving this. Many African countries have scaled up their SEZs/Industrial Parks in the last decade, such as Morocco and Ethiopia, or begun to experiment with SEZs to attract FDI and promote industrial restructuring, like Guinea.

Unlike their Asian counterparts, most African SEZs have underperformed so far regarding employment and exports. Moreover, they barely generate transformative effects, including making local linkages and spillover knowledge. On one side, productivity in SEZs has been compromised by infrastructure bottlenecks such as unreliable supply of water and electricity, as well as inefficient logistics. On the other, insufficient connections with existing local economies have meant that a majority of African SEZ enclaves are marked by spatial and economic segregation. Amid the green transition, a new wave of eco-industrial parks has emerged across Africa, aligning production with international sustainability standards. This shift presents businesses with new challenges of adapting to green manufacturing and sustainable agriculture, requiring them to integrate these practices into existing operations.

At the intra-urban level, productivity is highly dependent on the efficiency of the transport system to move labour and consumers. As cities grow larger and more complex, the relationship between mobility and productivity becomes increasingly significant, influencing everything from individual job performance to the overall economic output of the city. Across the African continent, urban transport and mobility challenges are pronounced with poor road networks, rising levels of motorisation and congestion, high transportation costs, long

commuting times, and the dominance of informal systems such as paratransit (which are often overcrowded and poorly regulated). Surveys suggest that lower-income households in Nairobi and Lagos pay 15–54 per cent of their income on travel, which can negatively impact their disposable incomes, and limit their job opportunities and skills development, thereby increasing economic inequality (UN-Habitat, 2013). In South African cities, the average commute by bus is 74 minutes each way, which also has negative consequences on individual productivity and well-being (Statistics South Africa, 2014).

As such, it is essential to invest in formal and affordable public transportation infrastructure that can potentially reduce travel time and congestion, leading to increased productivity and sustainability. However, the introduction of formal mass transit has not been a straightforward process in many African cities. Whilst some mega-cities, such as Dar es Salaam, Addis Ababa and Abuja, have started to establish their BRT, light rail or metro systems with grand visions from policymakers, their modal share for individual travel has been extremely low, compared to other modes. Without being well-integrated into the existing network, many of them fail to operate efficiently and reinforce the informality and fragmentation of the urban mobility system in many African cities.

At the city-regional level, productivity depends on the city's role in the national urban system and its connectivity to regional and international markets. In theory, a functional system of cities consists of a major city with an international outlook, and smaller cities that complement it by hosting productive activities requiring the lower costs associated with smaller size or proximity to inputs such as agriculture and natural resources. Infrastructure development, especially the transportation network, affects the global position of major cities, inter-city connections and the division of functions among cities. In recent years, the "ports race" in Africa has led to substantial capacity increases at several African ports, elevating the global competitiveness of the countries and cities that host them. However, this growth has not resulted in more efficient or integrated regional logistics supply chains. The rest of the network – including inadequate road infrastructure, inefficient rail systems, and limited airport capacity – continues to drive up logistics costs, posing challenges to the continent's efforts in industrialisation and economic diversification.

Especially at the regional level, roads and railways are essential infrastructure development in shaping connectivity and boosting productivity. Although railways historically dominated regional logistics, roads now account for most of the goods transportation and passenger movement across the continent. Railways continue to be built and receive upgrades on key export routes, particularly in the Eastern African region, which has stronger political will at regional and national levels to push the agenda forward. In more populous or wealthier countries like Nigeria, Morocco and South Africa, urban and inter-city rail systems have also been introduced to serve passengers. Nevertheless, owing to pricy construction costs, advanced technology requirements, and the complexity of integrating various track gauges, widespread expansion of railways to transform cross-border connectivity and inter-city connection at the continental level is unlikely soon. In comparison, highways, expressways, and toll roads may present a more practical approach to increasing regional connectivity and integration more widely. However, comparatively high construction costs (relative to other regions globally), public resistance to toll fees, currency and exchange rate risks, and an underdeveloped local construction sector remain major obstacles to ramping up road networks across Africa.

4.3 Learning from history, looking to the future

Historically, neither the pit-to-port model nor state-led initiatives have spurred transformative development across Africa. Infrastructure projects like railways, ports, and dams were often standalone mega-projects that made limited contributions to fostering dynamic and productive economies. Today, Africa's infrastructure landscape is more interconnected, but it still falls behind global standards, with significant gaps in transportation, electricity, water and ICT infrastructure. A range of external actors – including multilateral development banks, bilateral partners, and private sector entities – continue to play a pivotal role in shaping infrastructure development on the continent. In partnership with national political elites, these actors promote large-scale initiatives such as railways, SEZs, and urban mass transit systems.

While these critical projects hold the potential to support the synergy between Africa's industrialisation and urbanisation, they often experience significant delays from initiation to completion, highlighting persistent challenges in the continent's infrastructure financing and construction. Furthermore, despite their capacity to improve connectivity, mobility, and productivity in theory, their practical implementation and developmental outcomes have often been underwhelming. To gain a deeper understanding of these challenges on the ground, it is crucial to explore and examine the political economy surrounding infrastructure projects. Future research shall address the institutional factors that shape the design and execution of relevant policies and critical projects, ensuring that infrastructure development more effectively facilitates sustainable structural transformation.

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