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The Impact of Security on Physical Infrastructure in Africa: A Critical Evaluation

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Abstract

The security of physical infrastructure is a critical concern in Africa where infrastructure development is essential for economic growth and development. However, the relationship between security and physical infrastructure in Africa is complex and multifaceted. This study examines the impact of security on physical infrastructure in Africa, with a focus on the role of terrorism, insurgency, and other crimes in destroying critical infrastructure. Using a mixed-methods approach and combining quantitative data analysis with qualitative case studies, this research investigates the effects of security threats on various types of physical infrastructure, including transportation systems, energy facilities and communication networks. The findings highlight the significant economic, social and environmental costs of security-related infrastructure damage, as well as the need for integrated security and infrastructure development strategies to mitigate these risks. The study contributes to the existing literature on infrastructure development and security in Africa and provides recommendations for policymakers, infrastructure developers and security agencies to ensure the protection and resilience of critical infrastructure in the region.

Keywords:
Security, Physical Infrastructure, Africa, Terrorism, Infrastructure Development, Resilience.

Introduction

Infrastructure is critical for global development because improvements in the provision, availability and quality of infrastructure and services offered can lead to profound changes in the standard of living of the world population by facilitating access to energy, health, education, other social services and the labour market. Infrastructure also plays an important role in integrating rural territories in regional and international networks and in establishing urban-rural links, as well as bringing about an inclusive and sustainable transformation of the production, institutional and social spheres (AfDB, 2023). Mindful of these links, infrastructure has been incorporated into the Sustainable Development Goals (SDGs) of the 2030 Agenda of the United Nations as a crucial tool to improve the population's living conditions, promote greater social stability and create smart cities and territories that are more resistant and resilient to climate change.

The development of infrastructure in Africa is critical for fostering economic growth and improving the living standards of Africans. It contributes significantly to human development, poverty reduction and the attainment of the SDGs. Physical infrastructure in general consists of two parts as follows: economic infrastructure such as ICT, ports, roads, electricity and irrigation, and social infrastructure such as water supply, sewage systems, hospitals and school

facilities, among others goals (African Union, 2024). Africa still lags behind other regions on access to adequate transportation system, energy and digital infrastructure which are the areas of focus of this research.

For instance, African Development Bank (2023) Report indicates that 600 million people - half of Africa's population still lacked access to electricity and about 30 countries have chronic power outages compared to 70-90% in other parts of the developing world. The internet penetration rate is a mere 6% compared to an average of 40% elsewhere in the developing world. Roads are critical for the transportation of passengers and goods but only 43 percent of Africa's rural population has access to an all-season road, and just 53 percent of roads on the continent are paved, making transportation costs to be 100% higher adding 75% to the price of African goods. In terms of railway network, with an estimated density of 2.5 kilometers per 1000 square kilometers, Africa lies way below the global average (23 kilometers per 1000 square kilometers). Therefore, the continent's large infrastructure deficit is holding it back. The estimated financing requirement to close Africa's infrastructure deficit amounts to USD 93 billion annually. Together, underdeveloped infrastructure has been estimated to shave off at least 2 percent of Africa's annual growth. Fast tracking infrastructure development would therefore play a central role in improving competitiveness, facilitating domestic and international trade and enhancing the continent's integration into the global economy. Similarly, improved infrastructure could help eliminate some of the binding constraints to the realization of the benefits of globalization.

The impact of security on infrastructural development in the African continent is significant due to its critical nature as a component of economic growth and progress. The availability of adequate and suitable infrastructure in a tranquil and stable environment serves as a basis on which human development, poverty reduction and the attainment of the SDGs, in the continent, are built. In the past few years, investment in infrastructure across the continent has accounted for more than half of the improvements recorded in socio-economic growth. Some of the infrastructures under discourse include air and sea ports, roads, rail networks, energy and ICT.

While most of the countries on the continent are still struggling to get it right in terms of infrastructure, others stand out in areas of basic infrastructures which make life worthwhile for all. The availability or dearth of basic physical infrastructure across Africa is therefore predicated on the level of security and stability of the member states, among other factors. While some progressive states have experienced long sessions of relative peace and conducive environment for infrastructural development to thrive, others have experienced intermittent security threats and unstable governance structures that have stalled critical infrastructural development and at the extreme are states embroiled in internecine conflict resulting in arrested development and even destruction of hitherto existing physical infrastructure. Therefore, there is a nexus between security and sustainable infrastructural development particularly in Africa.

For instance, Seychelles, a tropical island in the East of Africa that enjoys relative peace and stable government is among the top African countries in physical infrastructure development as a result of its significant strides. Though the country has the smallest population in Africa, it has a well-established infrastructure system that attracts investments and visitors from across the globe which boost its economy. In Seychelles, 100% of the population has access to electricity while basic drinking water services are available to about 98% of the population. Furthermore, the country has 247 internet hosts which

provide efficient connection networks. The country Seychelles has 14 functional airports spread across its many cities while the number of road motor vehicles per 1000 inhabitants is estimated at around 149. In terms of telecommunications, it has good links with all parts of the world by satellite and telephone services on the islands of Maha, Praslin and La Digue (World Bank, 2024).

Similarly, Egypt has made significant progress in not just providing infrastructure but modernizing it in tune with current realities. This development has not only created more opportunities for its populace but also impacted their social well-being, ranking the country Egypt high in global indicators. Some of the most recent efforts by the Egyptian government in the provision of infrastructure are in the establishment of new railway lines, renovation of seaports and airports as well as improved road networks. The government has also built new power plants and expanded the country's Suez Canal. Egypt has a rail network of 5,085 kilometers which ranks it 109th in the world with 0.05 meters per inhabitant. In terms of its road quality, it has improved significantly over the years and has grown from the global position of 118th it occupied in the past to the present 28th in the entire globe and second in Africa. The country has been strategic in its infrastructure plan in the past few years as investments in that area increased steadily by 340%, or EGP 2.3 billion, since the 2016 fiscal year. This was evident in its spending which totaled $106.25 billion on infrastructure in less than two years throughout the country driven by public-private partnerships (AfDB, 2023). Over time, notwithstanding the intermittent military interregnum, infrastructure development in Egypt has mostly been driven by social, economic and environmental factors with the energy sub-sector being the most dynamic over the years. Rwanda and South Africa have, over the years, also invested heavily in infrastructural development, especially in areas of transportation, energy and ICT.

In countries ridden with insecurity like Sudan, Congo DR, Ethiopia, Somalia along with human casualties, the destruction of infrastructure is one of the most visible effects of the violent conflicts. Critical infrastructures are targeted and attacked for strategic reasons. Damage to infrastructures affects various aspects of economic and human developments by raising the cost of production, delaying movement of goods and aid, stalling effective communication and, in the case of water and sanitation infrastructures, triggering the spread of communicable diseases. Conflict also diverts investment and increases the cost of new infrastructure developments.

In some crisis prone parts of Nigeria, particularly in the North-Eastern geopolitical zone, Boko Haram internecine insurgency has not only disrupted infrastructure development but also damaged existing ones resulting in both poor economic growth and low levels of investment. Since the 2009 conflict, only 03 percent of the population had access to safe transportation and less than 30 percent to electricity while 90 percent reported difficulty accessing ICT. Meanwhile, the conflict has resulted in colossal damage to houses, roads, bridges, schools, health, public and energy facilities and telecommunications networks, among others. Road/Rail construction works were halted while investment stalled, putting planned improvements on hold. An estimated 75 percent of all ICT, water and sanitation infrastructure were destroyed. A World Bank (2024) assessment estimated the cost of conflict's damage to infrastructure and social services across North-Eastern Nigeria at nearly $9 billion ($6.9 billion in Borno, $1.2 billion in Yobe, and $829 million in Adamawa). Though reconstruction has already begun in some areas, progress has been uneven due to the threats.

Methodology

The discourse dwelt on three main indicators of physical infrastructure development in Africa economy, which are transport, energy and telecommunication to examine the nexus between them and security in Africa. In this study, reliance was placed on secondary data to derive conclusions. The secondary data was drawn from evaluation of global sources including peer-reviewed, grey literature, the INSPIRE package, the internet, textbooks, NISS archives and reports by international organizations, all focusing on the study. The synthesis of these secondary sources formed the basis for the conclusions and recommendations. As noted by Johnston (2017), employing existing data is a practical approach for researchers facing limitations in terms of time and resources. Additionally, Smith (2011) highlights cost-effectiveness and convenience as crucial advantages associated with secondary research.

Impact of Slave Trade and Colonialism on Infrastructure Development in Africa

Between 1400 and 1900, the African continent experienced four simultaneous slave trades. The largest and most well-known is the trans-Atlantic slave trade where, beginning in the fifteenth century, slaves were shipped from West Africa, West-Central Africa and Eastern Africa to the European colonies in the New World. The three other slave trades - the trans-Saharan, Red Sea and Indian Ocean slave trades were much older and pre-dated the trans-Atlantic era. During the trans-Saharan era, slaves were taken from South of the Saharan desert to Northern Africa. In the Red Sea slave trade, slaves were taken from inland of the Red Sea and shipped to the Middle East and India. In the Indian Ocean period, they were taken from Eastern Africa and shipped either to the Middle East and India or to plantation islands in the Indian Ocean.

A number of characteristics of Africa's slave trades make them distinct from previous slave trades. First, the total volume of slaves traded was unprecedented. During the trans-Atlantic slave trade alone, approximately 15 million slaves were exported from Africa. Another 6 million were exported in the other three slave trades periods. These figures do not include those who were killed during the raids or those who died on their journey to the coast. The total effect of the slave trades, according to Patrick Manning (1983), was that by 1850, Africa's population was only half of what it would have been had the slave trades not taken place.

Africa experienced two major crises in its history; slave trade and colonialism. At a time of both events, Africa was integrated into global market in unequal and exploitative ways. However, slave trade in general and trans-Atlantic era in particular, which lasted for a long time, holds the lion share in underdevelopment of Africa. The four episodes of slave trade that lasted for over four centuries decimated the African human resources (over 15 million men, women and children - active population), resulting in the arrested economic and socio-cultural development of the continent.

Moreso, the scrambling and partitioning of Africa (1885 – 1914) resulted in the continent being subjugated and administered by seven colonial powers with different programs and posturing for economic development of the satellite states resulting in poor state of infrastructure (Mudock, 1959). For all purposes and intent, the construction of meagre infrastructure during the colonial era was primarily geared towards the economic needs of colonial powers. This meant that infrastructure and facilities such as roads, railways, energy and sea ports were constructed to fit into the extractive plans of the colonial powers instead of the local network and socioeconomic needs of the host country (Austen, 1979).

The second industrial revolution in Europe heightened the interest and motivation of the

colonial powers to besiege and plunder Africa because of the presence of abundant free human (labour), natural and mineral resources. Mineral resources such as coal, gold and diamonds were the initial attraction until the discovery of crude oil in commercial quantity and other precious minerals. Countries in Central and West Africa classified as resource rich areas as well as some other African nations such as Namibia, Zimbabwe and South Africa with ample mineral deposits witnesses unbridled excessive exploitation of resources resulting in significant ecological damages, extensive pollution and avoidable deaths (Curtin, 1969).

As African countries attained independence, colonial physical infrastructure began to deteriorate owing to the inability to invest in the construction, development, management and maintenance of infrastructure consistently and adequately. This situation was compounded by the rapid population growth, urbanization and increased rural urban migration that exerted pressure on infrastructures. Consequently, the demand for infrastructure became excessively greater than the supply, and foreign investors took advantage of this shortfall as it poses a profitable means of investment (Inikori, 2000; Austen, 1979; Mudock, 1959).

As a result of this, Africa rapidly blossomed into a vast construction site with numerous infrastructures most of which were poorly constructed "white elephant projects" including dams, railroads, ports, roads, power stations, steel rolling mills among others being built within a short period of time soon deteriorated and were abandoned. One of the major challenges faced by construction professionals then was the inability to incorporate alien innovations into the local construction industries. Also, foreign construction experts did not understand the local industry with the intention of modifying innovations to conform to local construction needs so as to meet individual nation's stipulated developmental goals (Wax, 1973). The foregoing inadequacies coalesced in stifling infrastructural development in Africa.

Impact of Conflict on Infrastructure Development in Africa

The history of Africa as a continent is replete with conflicts including inter-tribal wars and wars of insidious attrition waged by invading Arab and Europeans against tribal realms (Patrick, 1983). Since the attainment of independence particularly in the 1960's, series of civil wars had ensued in Africa including: Protracted Congo crises (1960 - …), Chad (1965 - 85), Nigeria (1967 - 70), Angola (1974), Liberia (1980 - 2003), Sudan (1995 - 1990), Somalia (1999 - 93), Burundi (1993-2005), Ethiopia/Eritria debacle (1998-2000 and ongoing), Rwanda (1994 – 1997 among others) and Sierra Leone (1991 - 2001). But Apart from civil wars, Africa has also witnessed a number of border and inter- state conflicts, insurgency, terrorism, military interregnum all of which disrupt meaningful developments

Over the years, these conflicts and governance deficits across the continent have resulted in the emergence of fragile states, arrested economic growth while some are currently embroiled in unending wars of attrition and others infested with terrorism among other plethora of insidious security threats. Thus, the infrastructure development differs markedly across African country groups. Because of the widely varying circumstances, distinguishing among upper middle income countries (Egypt, Libya, South Africa…), lower middle-income countries (Cape Verde, Nigeria, Ghana, Morrocco), resource rich countries with economies heavily reliant on petroleum or mineral revenues (like Nigeria, Angola, Algeria and Libya), fragile states enmeshed or emerging from conflict (like Côte d'Ivoire, Somalia, Sudan and the Democratic Republic of Congo), and the remaining low-income countries that are neither fragile nor resource

rich (like Senegal and Uganda) is helpful (World Bank, 2024).

By far, the most daunting infrastructure challenges are those facing the fragile states. The recent security threats affecting these countries usually resulted in the destruction or dilapidation of their infrastructures In conflict torn countries like Sudan, Somalia, the Democratic Republic of Congo (DRC), among others, about 50 percent of infrastructure assets needs rehabilitation. The fragile states' infrastructure spending needs are huge, particularly when measured against the size of their economies. Such countries would, on average, need to devote 37 percent of their GDPs to infrastructures. With their difficult environments, they attract relatively little external financing, capturing only 10 percent of overseas development assistance and 6 percent of private capital flows allocated to infrastructure. In addition to their huge financing burden, the fragile states do not use their current resource envelope well. They underspend on maintenance and have inefficient service providers (AfDB, 2023).

Fragility exacerbates formidable obstacles to increasing infrastructure and improving efficiency and wider access in infrastructure service provision, including in the following ways:

Conflict leads to the physical destruction of infrastructure assets either as a deliberate military strategy or because of the difficulties of continuing maintenance.

- Ongoing conflict also creates security problems for contractors which together with a lack of local human and institutional capital (for instance a weak local private sector to undertake construction activities) raises costs and the difficulties of implementation.
- The environment for private sector investment (particularly large scale investments that involve substantial sunk costs) becomes prohibitively risky because of the weakness of the rule of law, limited ability to enforce contracts and the risk of rent-seeking behaviour once sunk costs have been incurred.
- Weak governance arrangements, political competition to secure the benefits of infrastructure investment for particular client groups, and corruption are likely to undermine the effectiveness and efficiency of public investments and the prospects for sustaining maintenance expenditures.
- For local level infrastructure, the threat of violent conflict or tensions between and within communities can prevent effective collaboration in planning, construction or maintenance of infrastructure.

As far back as 2018, research involving Bofinger, titled "Africa's Missing Billions: International Arms Flows and the Cost of Conflicts," estimated that armed conflicts in Africa waste approximately $18 billion annually. This staggering figure not only impedes development but also inflicts immense human tragedy. The cumulative cost of conflicts between 1990 and 2005 amounted to a staggering $300 billion, mirroring the total international aid received during the same period. A more specific study by Mckinsey Global Institute (2023) reveals that Sudan spent $41 billion on the Darfur conflict. This amount included $30.5 billion spent on arms, $2.6 billion in foregone lifetime earnings of the deceased, $4.1 billion in infrastructure damage, and $6.5 billion in war impacts on GDP. This relentless hemorrhaging of resources deprives the continent of the means to improve infrastructure development and the livelihoods of its people. A recent World Bank (2024) publication revealed that, over the past fifty years, Africa has lost more than US$1 trillion due to insecurity. This staggering sum is equivalent to all official development assistance received during the same period.

The erosion of resources due to illicit financial flows reflects systemic governance challenges that need urgent attention.

Furthermore, the poor state of infrastructure occasioned by conflict in many parts of Africa compounds the challenges. An African Development Bank study (2023) highlighted that suboptimal infrastructure reduces national economic growth by two percentage annually. Business productivity is also severely impacted with reductions of up to 40%. This, despite Africa's abundant mineral and natural resources, positions the continent as the region with the lowest productivity levels globally. One challenge that seldom gets enough attention in connection to infrastructure is the complexity of working in conflict and post-conflict environments. Over half of the 39 countries currently classified as fragile and conflict-affected states (FCAS) are in Africa. Given that many mega projects undertaken by development partners extend across multiple countries, the likelihood that projects will include an FCAS is significant.

The effects of armed conflicts on economies can never be understated. Physical infrastructure is the bedrock of connectivity and productivity growth, enabling countries from such regions to leverage their resource endowment fully and integrate into global supply and industrial value chains. African sub-regions that are hit by armed conflicts have the worst physical infrastructure, and besides, the movement of goods and people in such zone is strenuous. It is one of the reasons why the continent has continued to lag in economic and industrial development (World Bank, 2024). Furthermore, AfDB (2023) traces a combination of state weakness/poor governance, corruption, ineffective delivery of essential services, competition over natural resources, inequality and a sense of marginalization as contributory to poor African economic development which resonates in general infrastructural deficit.

Thematic Overview of some Critical Regional Infrastructure Development in Africa

For the purpose of this paper, our area of focus includes transportation (Ports, Roads, Railway and Airports), energy and telecommunication infrastructures respectively.

Transportation Infrastructure

Africa's transport sector faces series of pressing challenges across roads, railways, airports and seaports. While the ports sector has witnessed a formidable expansion with cargo and containers handling capacity additions across African seaboards, the rest of the value-chain remains fragmented and under-developed. Road networks are limited with an uneven distribution and poor quality, especially in sub-Saharan Africa. Railways struggle with underinvestment, low usage and technological disparities, limiting their efficiency and connectivity.

Ports Infrastructure

Between 2010 and 2022, port projects with private sector participation were the highest in the world, totaling some $13 billion. Investments have led to the emergence of new regional ports and mega-hubs such as Tanger Med in Morocco which overtook South Africa's Richards Bay in cargo volumes in 2021. These investments have also facilitated substantial growth in handled traffic, with total container throughput Africa rising from 24.5 million TEUs to 35.8 million TEUs between 2011 and 2021 (World Bank, UNCTAD, AFC Research, 2023a).

In 2022, both Abidjan TC2 in Côte d'Ivoire and Lekki LCT/Phase 1 in Nigeria were commissioned, followed by Tema T3 in Ghana in 2023. There was further expansion with the introduction of new terminals such as Cotonou BT/T5 in Benin, Onne AMPT in Nigeria, Kribi Container Terminal (KCT) Phase 2 in Cameroon, Matadi Gateway

Terminal (MGT) Phase 2 in the Democratic Republic of Congo (Congo, DRC), Banana Phase 1 also in the DRC, and Luanda LMT in Angola. Additionally, ports such as Egypt (port Said), Togo (Lome port), Morocco (tanger-Med), Gabon (Owendo and Gentil ports), Senegal (Dakar port), Kenya (Mombasa harbour), South Africa (Durban harbour, port Elizabeth and six other commercial ports) and Djibouti (Djibouti port) have experienced growth driven by robust domestic economic performances and their linking with Europe, the far East, the Persian Gulf and the Horn of Africa as well as connections to landlocked countries of Africa (World Bank, 2024).

There are also investment platforms with international development partners on new port projects across Africa including: Senegal (ports of Dakar and Ndayane greenfield), Egypt (Sokhna), Somaliland (Berbera), Tanzania (Dar es Salaam port), Ghana (Takoradi Port), South Africa (Durban Container Terminal Pier 2), Kenya (Lamu Container Terminal (Berths 1-3), Lamu SEZ, and Kenya (Mombasa Ports (Berths 11-14) and Mombasa Port Container Terminal 1). Others are the expansion of the Burutu Port in Delta state, the development of the Ondo Multi-Purpose Deep Seaport, and the creation of the Snake Island Terminal in Lagos, all I Nigeria structured as Public-Private Partnerships (PPPs) (AU, 2024).

Road Network Infrastructure

Africa's logistics infrastructure, including railways, roads and airports, has not seen a corresponding level of development, resulting in a fragmented and under-developed network. Despite its critical role in facilitating trade, Africa's road network remains largely undeveloped, poorly maintained and inadequate. In contrast to the bustling activity witnessed in the ports sector, other segments of logistics such as railways, roads and airports have struggled to attract investments and meaningfully interest the private sector. Consequently, project activity in these areas has remained relatively subdued, contributing to significant logistics bottlenecks throughout the continent. Roads play a critical role in Africa's infrastructure landscape, facilitating 80% of the continent's goods traffic and 90% of passenger traffic. Improving access to high-quality roads is imperative to driving economic and social development across urban and rural areas alike (AU, 2023). Despite its vital importance to Africa's economy and growth potential, the continent's road network faces significant challenges, primarily uneven distribution across countries and communities, as well as poor quality.

According to research conducted by Hassan (2023), Africa's total paved road network spans approximately 680,000 kilometres which is six times smaller than that of India, a country with a similar population but only one-tenth the land area. Notably, the continent's most developed economies, particularly South Africa and Algeria, account for a disproportionate share of the paved road network, comprising 40% of the entire network. This disparity in road infrastructure extends to Africa's global standing, where despite occupying 20% of the world's land mass, Africa's paved road network accounts for just 1.5% of the global total. Although the picture changes slightly when considering road density, with island nations in eastern Africa emerging as leaders, sub-Saharan Africa's road density still significantly lags behind other regions.

With an average of almost 2.3 kilometers per 100 square kilometers, sub-Saharan Africa falls far behind Asia where India averages 138 kilometers per 100 square kilometers and ASEAN countries average 29.5 kilometers per 100 square kilometers. Both quantity and quality metrics underscore the urgent need for strategic investment in African road infrastructure. The low levels of road density translate to an unequal distribution of paved networks between rural and urban

communities. Rural areas are particularly underserved with many existing roads being unpaved, hindering vehicle travel and impeding goods flows, thus limiting economic opportunities – especially for farmers. According to the Africa Transport Policy Programme, high transport costs account for 40% of the final price of goods in Africa (World Bank, 2023).

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, the largest in the world. Currently, Africa's ambitions are focused on connecting its major economic and urban centers. The Priority Action Plan (PAP) of Programme for Infrastructure Development in Africa (PIDA) aims at achieving this by targeting approximately 30,700 kilometers of modern highways by 2040 of which 16,066 kilometers have been completed since the early 2010s. Much of the focus is on finalising the Trans-African Highway Network designed to enhance the continent's connectivity. Nevertheless, constrained public funding poses a risk to the development of most proposed projects. African governments burdened by high public debt have become less inclined to provide the viability gap funding (VGF) and sovereign guarantees required to initiate road projects. Meanwhile, the distance between countries coupled with topographical obstacles such as mountain ranges, deserts, and equatorial forests make road network connectivity among African countries difficult. However, recent developments within major African economies reflect a growing commitment by African governments to reassess their Private Public Partnership (PPP) frameworks for road projects (AU, 2023).

Railway Infrastructure

While plans have been on the table for years to move goods and people from roads to railways, Africa's railway network remains sparse and fragmented. Historically, the development of Africa's railroad infrastructure was closely intertwined with colonial industrial and logistical policies which efficiently served the purpose well. However, today the railway sector grapples with a host of interconnected challenges: inadequate investment, low usage levels and incompatible technology. Ambani (2023) shows that Africa's railway network remains relatively small, spanning approximately 87,000 kilometers across a continental surface area of over 29 million square kilometers. To put this into perspective, India covers only 11% of Africa's surface area but boasts a rail network equivalent to about 75% of Africa's. The existing rail capacity is predominantly concentrated in the northern and southern regions, mirroring the distribution of other infrastructure assets. Notably, thirteen sub-Saharan countries have no operational rail network, with half of them being landlocked.

Moreover, the quality of the network has deteriorated due to insufficient maintenance, with some lines exceeding a century in age, rendering them uncompetitive against modern highways developed to link key economic corridors. Several lines, such as the Dakar-Bamako axis, are currently inactive while other national networks such as those in Nigeria, Ghana, Uganda and Togo suffer from under-performance and or vandalised due to neglect and lack of rehabilitation (Modern Railway Services in Africa, 2022).

World Bank (2024) reiterates that the dearth of passengers and freight deprives the network of cash, leading to further deterioration of services and diminishing attractiveness to businesses and passengers alike. For instance, in Ghana, the rail network transported approximately two million tons of cocoa, timber, bauxite, manganese, and other minerals in the late 1960s. However, by 2018, only roughly 750,000 tons of manganese freight were transported by rail. Similarly, the Senegal-Mali railway, which once transported 1.5 million tons of freight at its peak, ceased operations entirely in 2018 following floods.

Among the busiest networks in Africa, alongside South Africa and Swatini, are Mauritania, Gabon and Mozambique. However, Modern Railway Services in Africa (2022) notes that most of these networks average less than 500,000 traffic units per kilometer of route, a measure of network density. Different systems across the continent utilise a variety of track gauges, with Northern, Eastern and certain parts of West Africa predominantly utilising old meter gauge and new standard gauge railways (SGR), while Southern Africa primarily relies on Cape gauge networks. This diversity in track gauges and ubiquitous conflicts further complicates the expansion of railroads and the movement of goods across different regional networks.

Due to the variation in gauges, technical standards, axle loads and specifications of African railway networks, the development of interconnected and interoperable railway systems poses significant challenges. While regional integration efforts have commenced in Southern and Eastern Africa through the construction of new rail lines and the extension of existing tracks, rail integration in the West is largely absent. Achieving connectivity in this region would depend on initiatives such as the reopening of the Dakar-Bamako line and the extension of the Togo line and the Abidjan- Ouagadougou line to create a ring through Niger to Nigeria (Modern Railway Services in Africa, 2022).

Airport Infrastructure

Africa's airport infrastructure has witnessed continued expansion in recent years. However, it still falls short of global standards and handles only a modest volume of freight. While Africa's aviation sector has witnessed significant growth over the past two decades, it remains comparatively small on a global scale and faces notable challenges, most importantly a poor safety record and inadequate infrastructure.

According to World Bank, UNCTAD, AFC Research (2023a) Report, between 2015 and 2023, the overall air transport capacity in sub-Saharan Africa saw a notable increase from an estimated 47 million seats to 105 million, boasting an average annual growth rate of nearly 6%. It further stated that Africa's share of global air transport measured by the number of kilometers travelled by paying passengers, remains the smallest in the world and is projected to continue in the foreseeable future. Despite witnessing robust growth over the past decade, from 2.2 million tons per kilometer in 2015 to 4.2 million in 2023, Africa's air freight levels still lag significantly behind those of the Middle East (34 million tons) and Asia (65 million tons). Moreover, the establishment of air cargo hubs has been limited to specific regions where economies exhibit greater diversification, such as Egypt, South Africa, Ethiopia and Kenya. Several factors hinder investments and growth in the African aviation sector. The relatively high cost of air travel, stemming from low passenger volumes, coupled with stringent air space regulations and elevated passenger and airport taxes, present significant challenges. However, the overriding concern for the industry is safety, exacerbated by subpar infrastructure quality and operational standards in air traffic control and ground communications. Consequently, the aviation sector in Africa has witnessed limited private sector investment in recent years and the emergence of regional cargo hubs, especially in North, East and South Africa, though its air cargo transport remains far below that of the rest of the world.

Africa has only two large airports that currently handle more than 10 million passengers a year which are Cairo and Johannesburg and no mega airport, defined as airports that handle 33 million passengers or more. In comparison, Asia has about 30 mega airports, including three in India alone which has a similar population with Africa. In response, several African countries are

actively investing in upgrading airports to enhance their capacity, facilities and compliance with international standards. Notable projects include the construction of new airports in East Africa, such as Uganda's Kabaale International Airport in Hoima and Rwanda's Bugesera International Airport. The latter operates under a 25-year concession agreement involving Mota-Engil and Aviation Travel and Logistics Holdings Ltd. Additionally, Angola opened the new Dr. António Agostinho Neto International Airport (AIAAN) in Luanda at the end of 2023, a $3 billion project funded by the government but managed under concession to the private sector. Several other countries are exploring airport privatisation efforts to modernize and expand existing facilities. Nigeria is actively pursuing this privatization for its major hubs in Lagos, Abuja, Kano and Port Harcourt while Kenya has expressed intentions to construct a state-of-the art passenger terminal at Nairobi's Jomo Kenyatta International Airport (JKIA) through a Public-Private Partnership (PPP) framework (AfDB, 2023).

Energy Infrastructure

Africa has the world's largest energy deficit, and its economies largely rely on expensive, inefficient and polluting sources of energy. Primary energy consumption is the lowest in the world, both in total and per capita, and energy supply is growing too slowly to keep up with demographic growth. While Africa is home to 18% of the world's population, it accounts for less than 6% of global energy use. Measured against the other continents, it consumes the least, both in total and per capita, and is the most energy poor. Its energy deficit affects hundreds of millions, hampers development, and keeps industrialisation rates low because electricity is expensive and unreliable across most of sub-Saharan Africa. Primary energy consumption was only 14.2 gigajoules per capita in 2022, four times lower than in developing markets in South and Central America, and almost five times lower than the Asia-Pacific region (IEA, 2023).

In the absence of electricity, most African households consume waste and biomass energy sources such as firewood, charcoal and agricultural residues – which make up most of all energy consumed on the continent. Left with refineries that are old, small and often uneconomical, the continent also supplies its transport sector with expensive and imported petroleum products. Last but not the least, electricity infrastructure is plagued by inefficiencies and power losses, leaving industries to suffer from unreliable and expensive electricity supply. This scenario contrasts severely with the potential of the continent to access and generate modern and sustainable energy by tapping into its vast solar and hydraulic potential and its abundance of natural gas. For instance, Africa has 60% of the world's best solar resources but only 1% of solar generation capacity. Natural gas reserves in sub-Saharan Africa could also easily support 400 GW of power generation capacity – while replacing dirty and polluting diesel, coal and HFO – yet installed capacity in the subregion stands barely above 20 GW. Overall, Africa's growth in electricity generation capacity has averaged more than 2% a year over the 2012-2022 period, below the world average of 2.5%. Meanwhile, demographic growth has averaged 2.42% per year over the past 30 years, meaning gains in incremental energy generation are barely able to keep up with population growth. As a result, the energy deficit persists and more than half of the people on the continent live without reliable access to electricity (Energy Institute, 2023).

Some progress has been made, but at the current rate, none of the 2030 targets of ensuring access to affordable, reliable, sustainable and modern energy for all will be met. The latest Energy Progress Report of the World Bank (2024), Energy Agency (IEA) (2023), Energy Institute, (2023), Mckinsey Global Institute, (2023) and Africa Economic

Zones Organization (AEZO) (2021) note that to reach universal access globally by 2030, annual growth in electrification needs to by one percentage per year from 2021 onward, instead of the 0.6 percentage growth achieved between 2019 and 2021. If efforts do not improve, 660 million people (560 million in Sub-Saharan Africa) will still not have access in 2030.

While energy poverty remains mostly unchanged across the continent, it continues to grow in Central Africa. Between 2010 and 2021, the number of people in Africa without access to electricity grew by 26 million. The largest access deficit in the region is currently in the Democratic Republic of the Congo where 76 million people live in the dark. In Nigeria, despite the vast resources, 86 million people are without access to electricity thereby making it the world's largest absolute electricity access deficit. Beyond electricity, access to modern and reliable energy is even more scarce. Nowhere is this more evident than in clean cooking with 64% of Africans currently relying on dirty cooking fuels. As a result, almost one billion people use gathered wood, biomass, agricultural and animal waste as cooking fuel, with the devastating impact on public health. Sub-Saharan Africa represented only 25% of the global access deficit in clean cooking in 2010 but represents 41% of the world's largest share as at 2023. Access is shrinking and the rate of those using dirty fuels is increasing by nearly 20 million people per year without a corresponding increase in the access rates. If nothing is done to provide cleaner cooking alternatives, 1.67 billion Africans will be using wood and charcoal for cooking by 2050 (Mckinsey Global Institute, 2023).

To bridge the energy deficit, in 2022, Ministers and high-level representatives from the Democratic Republic of Congo, Ghana, Kenya, Malawi, Morocco, Nigeria, Rwanda, Senegal, Uganda and Zimbabwe issued the Kigali Communique advocating for the pursuit of a modern energy minimum of 1,000 kWh/capita consumption as a realistic target for the continent in the short and medium-term (IEA, 2023).

Telecommunication Infrastructure

Over the past two decades, rapid expansion of subsea cable networks has unlocked access to significant international bandwidth for African markets, driving internet penetration and the expansion of digital services across the continent. While hundreds of millions of Africans have been brought online, middle mile and last-mile infrastructure remain limited while regional networks are yet to be built across several parts of the continent. Limited regional infrastructure and network deficiencies contribute to high costs of connectivity that price most Africans out of the digital world.

The past twenty years led Africa to have significant installation of subsea cables that made inbound international internet bandwidth easier and faster to access. After Guinea-Bissau connected to the ACE submarine cable in 2023, all African coastal countries now have at least one subsea cable landing, except for Eritrea. For receiving markets, subsea cables have a direct impact on connectivity, enable faster internet speeds and reduce internet prices. Equinao, for instance - the latest cable that landed in Africa in 2023 - is expected to increase internet speeds five-fold in Nigeria by 2025 and three-fold in South Africa and Namibia. By the same year, internet prices should drop in each country between 16 and 21%, resulting in an increase of internet penetration by 7% in Nigeria and South Africa, and by 9% in Namibia. In view of these submarine cables, growth in Africa's internet bandwidth between 2019 and 2023 far outpaced Asia and Latin America - 44% to 32% and 31% respectively (Matt Walker & MTN Consulting, 2024).

By the end of 2022, total inbound international bandwidth into Africa reached 36.7 Tbps, split between 12.9 Tbps to North

Africa and 23.8 Tbps to sub- Saharan Africa where South Africa, Kenya and Nigeria account for a concentrated two-thirds of all volumes. This figure is significantly higher than previous years, registering a threefold increase in only four years, but very low compared to available design capacity. In theory, total design capacity from the 33 submarine cables connected to sub- Saharan Africa could provide well over 800 Tbps - yet less than 24 Tbps was supplied to the region by the end of 2022 (Hamilton Research 2023, IFC 2022).

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. Most coastal countries only have one landing station and very few cables extend all the way to South Africa. Most networks pass through Africa on their way to Europe but their landing in places like Djibouti or Egypt has historically played a limited role in connecting the continent. Analysis points to a lack of redundancy and diversity of routes and an overreliance on single-path connectivity solutions (CISCO, 2023).

Such vulnerability comes to light during cable disruptions caused by problems like natural disasters as recently experienced across the Atlantic coast in March 2024. Safeguarding Africa's internet backbone against such risks calls for additional subsea routes but also alternative access like cross-border fiber links that can enhance connectivity, improve stability and offer alternatives to submarine cables. Despite significant growth in broadband penetration in the past decade, affordability constraints continue to price out hundreds of millions of Africans from accessing the digital world. Broadband remains too expensive for most and explains the persisting deficit in digital services and connectivity across the continent where only 40% internet access (George & Atkinson, 2024, Hamilton Research. 2023).

Conclusion

Private sector investment opportunities in Africa's infrastructure are huge and work to identify the projects is underway though issues of insecurity should be tackled headlong. Regulatory reforms have also been identified as critical to the realization of the expected investment flows. It has been clearly noted that there are infrastructure deficiencies in all subsectors. Inefficiencies in implementing infrastructure projects as earlier observed account for USD 17 billion annually and improving the capacity of African countries will help minimize these costs. In this regard, the donor community should play a greater role in African development while evolving innovative robust financing mechanisms. Notably, traditional sources of financing infrastructure development remain important but private investment is critical in closing the current gaps and meeting future infrastructure demands in Africa.

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