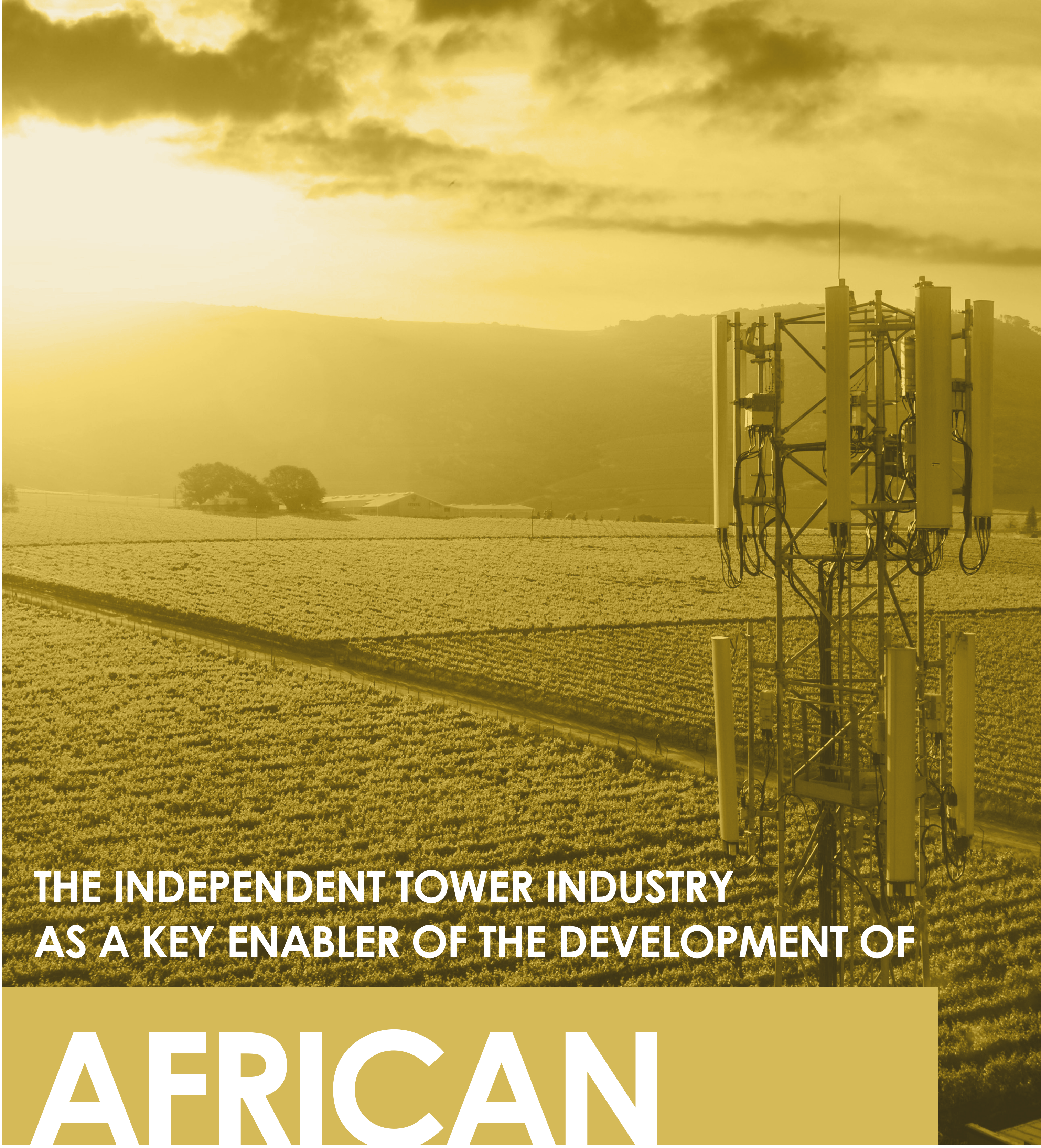

THE INDEPENDENT TOWER INDUSTRY AS A KEY ENABLER OF THE DEVELOPMENT OF AFRICAN TELECOMMUNICATIONS

TELECOM ADVISORY SERVICES

MARCH 2024

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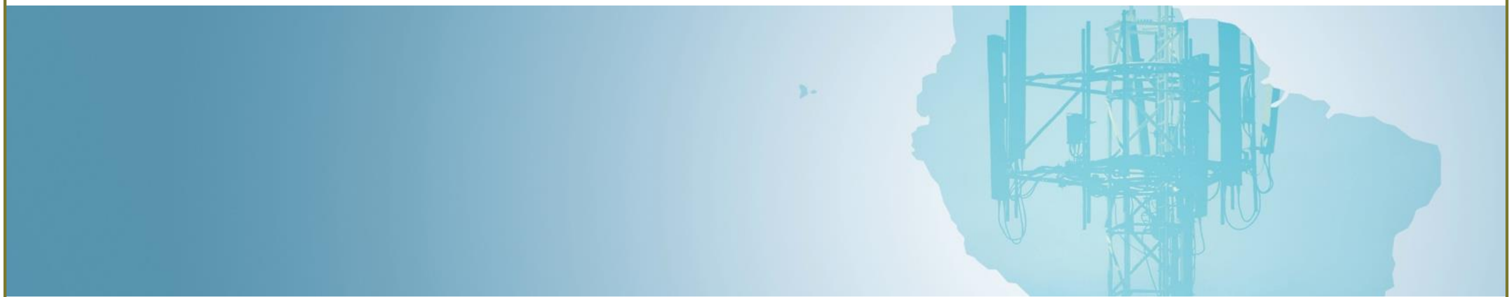

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This study was commissioned by SBA Communications and conducted between November 2023 and February 2024. It represents the authors' analyses and points of view. The authors would like to thank TowerXchange for its support in providing industry data.

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Executive Summary

The development of the African wireless industry over the past 20 years has been remarkable. The coverage of 3G and 4G networks enabling wireless broadband has been consistently increasing and is projected to approach high deployment by 2030. At 92.46%[1] of the population in 2023, the coverage of 3G in the African continent is already very advanced, in line with other developing regions and exhibiting little difference between North and sub-Saharan Africa (five percentage points). In parallel with progress on 3G deployment, the rollout of 4G reached 80.37% for the whole continent (or 1,187,181,000 population) in 2023, with 77.49% for sub-Saharan Africa and 99.23% in North Africa. On the other hand, 5G coverage remains embryonic, at 5.05% of the continent's population in 2023. By 2030, 3G deployment is forecast to reach 95.93% of the African population, while 4G will attain 87.56% and 5G is expected to reach 36.84%.[2]

Despite the significant increase in 3G and 4G coverage, as of 2023, 7.5% of the African population (or 111,377,000) still cannot access basic mobile broadband service (such as the one delivered through 3G network technology), while 19.6% (or 289,964,000 population) cannot access 4G networks (to receive what is appropriate service quality). Beyond the network's "supply gap," the digital divide principally results from the "demand gap," measured as the non-subscribing population residing in areas already served by broadband networks. Wireless broadband adoption measured as unique mobile broadband subscribers reached 30.36% in 2023,[3] which means that the "demand gap" (i.e., the population that could subscribe to mobile broadband because they are currently covered by networks) is 62.10%. The primary adoption barrier is limited-service affordability; in other words, the socioeconomic structure of African countries is still limiting adoption of the technology. Except for in Egypt, Morocco, Nigeria and South Africa, the price of the most economic data-only mobile broadband plan exceeds 2% of the monthly gross income per capita, a target stipulated by the ITU and UNESCO Broadband Commission for Sustainable Development.[4]

Future development of the wireless industry to increase network coverage and continue its modernization path to 5G is constrained by limited capital spending. African wireless operators invest a prorated US$6.27 per capita per year,[5] which is significantly below the world average (US$23.72) and even that of other developing regions (Latin America and the Caribbean: US$17.91; Asia Pacific: US$15.12). Apart from South Africa (US$24.43 per capita) and Morocco (US$15.01), operators in most African countries are constrained in terms of their capacity to invest. This situation highlights the importance conveyed by infrastructure sharing to facilitate future network rollout while enabling a reduction of the cost to serve.

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[1] GSMA Intelligence.
[2] In this context, the industry is starting to consider the sunset of 2G and the date for shut down of 3G.
[3] International Telecommunication Union ITU World telecommunication/ICT indicators (WTI database July 2023).
[4] https://www.broadbandcommission.org/advocacy-targets/.
[5] Calculated from International Telecommunication Union ICT Price Baskets, historical data series, Apr 2023 release, https://www.itu.int/en/ITU-D/Statistics/Pages/ICTprices/default.aspx in folder "Download the historical data 2008-2022."

Passive infrastructure sharing has been and will continue to be a critical factor driving network deployment. In fact, econometric analysis conducted in this study validates the positive effects of passive infrastructure sharing for Africa. For example, a country with an initial digital divide of 69.64% (African regional average) would undergo the following effects if infrastructure sharing were to be mandated by regulators:

- Unique mobile broadband users would increase 14.63% (a combined effect of increasing rural coverage and reducing CAPEX and OPEX, which, in turn, could be transferred to lower prices).
- The increase in unique users would generate an increase in gross domestic product (GDP) per capita of 4.82% to materialize over a span of eight years, which implies, assuming a compound annual growth rate, an annual increase of 0.59% in GDP per capita as a direct outcome of this policy.

Policies mandating infrastructure sharing could also play a pivotal role in facilitating the development of 5G technology. In addition, active sharing can result in additional benefits, particularly in fulfilling rural coverage.

In this context, the contribution of the independent tower industry is particularly relevant. As of 2023, wireless tower deployment in the 14 African countries this study focuses on[6] reached over 172,000.[7] In parallel with the growth in the tower stock, the tower sector has been gradually evolving toward an increased share of independent players. A view of the African tower industry structure indicates that 44% of the tower stock is already run by independent companies.[8] When compared with other regions, Africa is a fairly developed independent tower company market, behind only the Americas (48%). The gradual divestiture of African mobile network operators (MNOs) of their tower infrastructure and the combined development of MNO-owned and independent tower companies in the continent raise the question of the impact of tower ownership on future industry development. In other words, is the growing share of independent tower "specialists"[9] associated with improved industry performance, as measured by capital efficiency, network deployment, service adoption and quality?

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[6] Angola, Congo Democratic Republic, Egypt, Ethiopia, Ghana, Kenya, Mozambique, Morocco, Nigeria, Rwanda, South Africa, Tanzania, Uganda, Zambia.

[7] *TowerXchange's Sub-Saharan African Guide-Q3, 2023); TowerXchange (2023). TowerXchange's Middle East and North Africa Guide-Q3, 2023.*

[8] This percentage should increase with Vodacom's carve-out of Mast Services.

[9] The study of value chain transitions across industry life cycles indicates that at the early stage of industry development, firms need to manufacture their own inputs, they must persuade customers to shift purchases to their own products and they must design specialized equipment. This leads to value chain integration, where firms control all stages. However, over time, as independent middlemen become more knowledgeable of the technology and as reliability increases, the incentive to maintain a forward market presence decreases. With this, value chain fragmentation emerges around scale-efficient "specialists."

The empirical evidence developed in this study provides a positive answer to this question, supported both by correlational and econometric analyses. From a correlational standpoint, African countries with more than 40% of tower stock owned by independent tower companies and tower deployment in excess of 150 per million population (Kenya, South Africa, Nigeria, Ghana and Zambia considered to be country leaders) exhibit higher wireless industry performance metrics than those with less than those figures. They have:

- Better 4G coverage and access: Country leaders depict 8.09 percentage points higher than the rest of the countries (89.69% vs. 81.59%).
- Faster network speed: Wireless broadband is 35% faster among country leaders than the rest (43.94 Mbps vs. 32.60 Mbps).
- More investment: Capital spending is 130% higher in country leaders (US$8.82 per capita vs. US$3.83 per capita).
- Better affordability: Wireless broadband services price as percent of monthly gross national income (GNI) per capita represents less than one half in country leaders relative to the rest of the countries (1.99% vs. 4.62%).
- Higher adoption of mobile broadband service: Country leaders exhibit 7.42 more percentage points in terms of broadband adoption than the rest (34.79% vs. 27.36%).
- More intense competition: Wireless competition is 24% more intense in country leaders than in the rest (30% less concentration).

These correlations have also been validated by econometric analyses, stipulating the causality between the deployment of independent tower companies and wireless industry development. An increase in the number of independent towers by 10% in any of the 14 African countries in the study sample:

- Leads to an increase in 4G coverage levels of at least 5.95%.
- Is associated with an increase in wireless broadband adoption levels of 3.29%.
- Is linked to an increase in service quality levels (measured as mobile broadband download speed) of 5.07%.
- Is associated with an increase in mobile market competition levels (measured as a decrease in the Herfindahl–Hirschman Index, which assesses industry concentration — a lower index depicts more intense competition) of 1.38%.
- Drives an improvement in the level of mobile affordability (measured as a decrease in mobile broadband service price relative to the monthly GNI per capita) of 7.82%.

Given this robust evidence, it would be important for African countries — governments and regulators alike — to support the development of the independent tower industry. This effect is, however, contingent upon several regulatory and public policy initiatives. In other words, regulatory and policy variables play an important role in the development of the independent tower company sector beyond the willingness of the private sector to invest, notably facilitating their investment leverage and returns to both the public and private sectors.

A review of the research literature and interviews with regulators and policymakers have led to the identification of several policy and regulatory initiatives that can contribute to the development and sustainability of an independent tower sector:

- **Passive infrastructure regulatory framework:** This is defined as the laws, regulations, agreements, or best practice models that establish and recognize the role of the passive infrastructure provider, defined as an actor that can install infrastructure facilities for a network, such as dark optical fiber, ducts, poles, towers and masts, among others. Given that in some countries the figure of the passive infrastructure provider is not fully specified, it is important to define it so that its operation is not subject to a discretionary and ad hoc decision by regulatory authorities.

- **Specific tower regulation:** This refers to the issuance of a law, regulation or technical standard that defines the parameters for the installation or deployment of telecommunications infrastructure, mainly towers, masts and antennae for mobile services. It may, for example, establish the obligations and technical details that network operators or infrastructure providers must comply with in order to place, share and co-locate their structures. It is also crucial that the standards include a chapter on the relationship between operators and infrastructure providers in the event of controversies or technical issues that could be mediated by the standards or the regulatory authorities.

- **No need for service concession of tower operators:** A concession is a grant of rights, land or property by a government or local authority to a private company that has the exclusive right to operate, maintain and invest in the facility under conditions of significant market power. Common concession agreements take place in the water supply, transportation highways and mining industries. The construction of a cell tower does not rely on a public good, as in the prior cases. Therefore, tower operations should not be ruled by a concessionary framework. Moreover, the tower industry is not a natural monopoly requiring a concessionary regime, like in the case of power transmission and railways.[10] From a positive standpoint, in some countries, approval processes for the operation of passive infrastructure providers are determined by simply registering with regulatory agencies, which provides speed in the deployment of infrastructure, a need that is emphasized in the need for fast permit approvals.

- **Regulatory harmonization between central government and municipalities:** This is related to clearly defined functions between the regulations issued by the central government in the technical field for the operation of radio equipment and the municipal ordinances, enacted by local authorities, which refer to land use and urban

[10] Kerf, M. "Concessions for Infrastructure: A Guide to Their Design and Award." World Bank Technical Paper no. 399, 1998.

planning obligations. These regulations should be complementary so that there is no duplication of obligations or conflicts on the part of network operators or infrastructure providers.

- **Need for fast permit approvals driven by consistent and reasonable time frames:** If network operators or passive infrastructure providers require the issuance of licenses or permits for the development of their activities, there should be expedited procedures, such as simple records of operation and infrastructure deployment. Often, there are processes that operators or infrastructure providers have to comply with that are not concentrated on a single entity. For example, there are environmental permits, public consultation processes, infrastructure sizing, and compliance with tourist and residential zones, among others, that are also linked to the administrative response of the competent authority within a time interval that delays the construction of the sites.

- **Establishment of a cap on fees and taxes, and rights of construction:** Fees and taxes, also referred to as the "cost of compliance," have an impact on the tower business case. In general terms, most macroeconomic research literature has found that taxation regimes play an important role in driving capital flows, when controlling for economic development and currency fluctuations. In this context, tower deployment is affected by the fiscal burden imposed by municipalities in the form of specific fees with the purpose of either limiting deployment of infrastructure or increasing revenues. Sometimes these fees become recurrent and even subject to annual increase defined on an ad hoc basis. Without making any judgment about the need of municipalities to collect revenues to support the delivery of public services, it is also the case that by increasing the pretax cost of tower deployment, local authorities limit the capacity for the wireless industry to support the connectivity needs of their populations with an impact on economic development.

- **Regulations to prevent over-deployment:** Tower over-deployment, in many cases driven by straight financial speculation, is a feature of some African countries. The negative consequences of this situation are environmental and economic. Focusing on the latter, a simplified financial model developed for this study indicates that, on average, unless a single tower is not supporting the radios and antenna of more than one operator (preferably three), its profitability is questionable, especially in rural settings over a 10-year time horizon.[11] On this basis, governments should promote policies and regulatory frameworks preventing over-deployment while fostering sharing, especially in rural areas.

- **Implement policies to promote development of infrastructure to be shared for deployment of 5G:** The deployment of 5G will require significant expansion of the level of densification of radios and antenna arrangements at the street level to achieve

[11] As an exception, low-cost poles can be designed to profitably support a single operator.

useful coverage in some high data traffic spaces. Considering the layered architecture of wireless networks that necessitates both macro sites and small cell sites, it is estimated that by 2030 between 2 and 3 times the current number of sites will be required. In the context of these deployments, zoning regulation will become critical to address over-deployment, reduce permit approval process, for access to public buildings and right of way at market prices.

- **No need of price regulations of tower company contracts with service providers:** In economic terms, price regulation is normally justified when markets fail to produce competitive prices. In the past, price regulation has been applied in the telecommunication sector to meet efficiency (under scarcity conditions) and equity objectives (fair access to an essential service). Similarly, interconnection prices have been regulated at times to ensure anti-competitive behavior of incumbent telecommunications carriers at times of market liberalization. None of these conditions apply to contracts between a provider of infrastructure and a service provider. Prices to be charged between an independent tower company and wireless operators should not be regulated because: (i) they reflect contracts between private parties based on agreed upon prices, (ii) they do not reflect excessive or unconscionable pricing of an essential good and (iii) they would represent a disincentive to invest in infrastructure.

- **Define long-term guarantees in regulations and permits:** Heavy initial CAPEX for tower deployment should be accompanied by relatively stable and predictable rules to ensure profitability and reinvestment. Stability and predictability of regulatory frameworks are critical industry requirements.

These policy and regulatory prescriptions have been undertaken by countries that could be considered as benchmarks of good practices when it comes to development of the telecommunications and passive infrastructure sharing industries: South Korea, the United Kingdom and the United States. As such, these countries:

- Have specific laws to regulate the deployment of passive infrastructure.
- Recognize that tower sharing remains a critical enabler to improve coverage in rural areas.
- Do not require independent tower companies to register with the regulatory authorities to begin operations.
- Have enacted laws that are in harmony with local ordinances, light procedures for construction permits and references to construction fees that are known to infrastructure operators.
- Do not have pricing regulations for shared infrastructure.
- Present information that promotes the deployment of networks for new technologies such as 5G and small cells.
- Have plans or manuals of good practices that make it possible to supplement or complement the regulatory frameworks that promote the orderly construction of shared telecommunication infrastructure.

While a few African countries have already adopted some of these prescriptions, most currently lag. Among the specific regulatory initiatives that were surveyed in the legal and regulatory framework regarding infrastructure development in Africa, it can be noted that:

- All countries except Ethiopia and Mozambique include the passive infrastructure provider as a figure for the operation of independent towers; and many have a specific standard on the subject.
- Independent tower companies currently operate in all countries except Ethiopia, Morocco and Mozambique. However, in all of them, they are required to apply for some form of registration in order to obtain a passive operator license. In those three countries, authorization is a discretionary regulatory decision because they do not have a well-defined licensing framework.
- Only Kenya and Ghana can be considered to have national standards harmonized with local ordinances, although in South Africa, the National Policy on Rapid Deployment of Electronic Communications Networks and Facilities applies only to telecommunications licensees, not tower companies.[12] In most countries there are general standards that do not precisely establish the technical mechanisms of deployment (distance, height, co-location or mimicry) coexisting with ordinances that regulate exclusively the civil construction of the building (building permit, land fees, landscape environment). In other words, the national regulators leave the local authorities free to determine the processes for civil permits or the establishment of fees.
- Aspects related specifically to tower installation should include clear guidelines to prevent deployment of duplicative infrastructure as a way to avoid over-deployment. In this regard, Ghana, Kenya, Morocco, Rwanda, Uganda and Zambia contain guidelines for the construction and sharing of towers considering these requirements that encourage efficiency in the deployment and occupation of structures.
- Only South Africa, Tanzania, Uganda and Zambia have implemented "light" regulatory processes for the deployment and operation of passive infrastructure; the other countries have permitting procedures in place, although, in practice, they delay the construction of a site.
- Egypt, Ghana, Kenya, Kenya, Nigeria, Rwanda, South Africa, Tanzania, Uganda and Zambia have established procedures and reference tables that determine the use of space or land for tower deployment and licensing fees, respectively.
- In all countries, it is preferred that infrastructure lease prices be negotiated between the parties; however, in the event of disputes between operators or suppliers, the regulatory authorities may intervene to resolve the conflict by setting maximum ceilings for these fees.

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[12] In September 2022, the national department responsible for local government published the Standard Draft By-Laws for the Deployment of Electronic Communications Facilities. Municipalities are encouraged to adopt the ordinance to harmonize and fast-track telecom infrastructure deployment.

- Only Egypt, Kenya and Zambia have related plans in the development of passive infrastructure for the adoption of new technologies such as 5G.

A summary of these characteristics is presented in table A. Each regulatory component was ranked, and an overall score was calculated to determine the level of advancement of the regulatory framework.[13]

Table A: Regulatory Characteristics for Passive Infrastructure Deployment

	COUNTRY													
DIMENSION	ANG	DRC	EGY	ETH	GHN	KEN	MAR	MOZ	NIG	RWA	SUD	TAN	UGA	ZAM
Passive Infrastructure Regulation	Yes	Yes	Yes	No	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes
Specific Regulation for Tower Industry	Yes	Yes	Yes	No	Yes	Yes	No	Partially	Yes	Yes	Yes	Yes	Yes	Yes
No Need for Concession of Tower Operators	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Nationally Harmonized Deployment	Partially	Partially	Partially	No	Yes	Yes	Partially	Partially	Partially	Partially	Partially	Partially	Partially	No data
Need for Fast Permit Approvals	Partially	No	No	No	Partially	Partially	Partially	Partially	Partially	Partially	Yes	Yes	Yes	Yes
Establishment of Caps on Fees & Taxes	Partially	No data	Partially	No data	Yes	Partially	Partially	Partially	Partially	Partially	Partially	Partially	Yes	Yes
No Need for Contract Price Regulation	Partially	Yes	Yes	No	Yes	Yes	Yes	No data	Yes	Partially	Yes	Yes	Yes	Yes
Policies to Promote Development of 5G	No	No	Yes	Partially	Partially	Yes	No	No	No	No	Partially	No	No	Yes
Future Infrastructure Sharing Plans	No	No	Partially	No	Partially	Yes	No	Partially	Partially	Yes	Partially	Partially	Partially	Yes
Rules to Prevent Duplicity (Distance, Co-Location)	Partially	Partially	Partially	No data	Yes	Yes	Yes	Partially	Partially	Yes	Partially	Partially	Yes	Yes
Long-Term Guarantees in Regulations	Yes	No data	Yes	No data	Yes	Yes	No data	No data	Yes	Yes	Yes	Yes	Yes	Partially
Sharing Best Practice Manuals	No	No	No	No	No	Yes	No	No	No	No	No	No	No	No
OVERALL REGULATORY LEVEL	Partially	Partially	Partially	No	Yes	Yes	Partially	Partially	Partially	Partially	Yes	Yes	Yes	Yes

YES · NO · PARTIALLY · NO DATA

Source: Telecom Advisory Services interviews and data compilation

Countries depicting a regulatory score higher than 0.70 were assigned a high level of development (Ghana, Kenya, South Africa, Tanzania, Uganda and Zambia). Countries with a score between 0.40 and 0.70 were determined to be in intermediate development (Angola, Democratic Republic of the Congo, Egypt, Morocco, Mozambique, Nigeria and Rwanda). Only Ethiopia scores were under 0.40.

[13] Details are included in Chapter 6.

In summary, the development of an independent tower industry has been fundamental for the development of telecommunications in African countries, considering the high level of service penetration. In that sense and given the expanded potential for tower sites for supporting edge computing, network distribution nodes for both fiber and wireless networks, and future generation of alternative energy, it is imperative that governments enhance policies and regulations to generate the right kind of incentives for the development of the sector. The successful development of the wireless and independent tower industries is intrinsically linked. Independent tower companies are critical to enable the future deployment of 5G given the ongoing CAPEX pressures affecting mobile network operators. Regulators and policymakers should recognize this and support their development.

1. INTRODUCTION

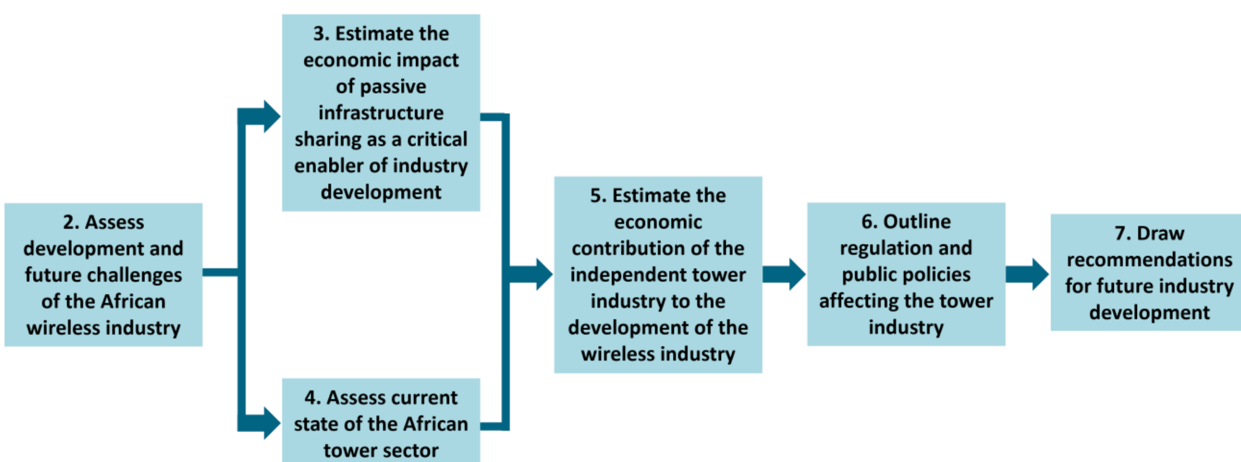
The development of the African wireless industry over the past 20 years has been remarkable. Coverage of 3G and 4G networks enabling wireless broadband has been consistently increasing and is projected to approach advanced deployment by 2030. Passive infrastructure sharing promoted by independent tower companies has been a critical factor driving network deployment. Similarly, the tower industry will be a key lever in enabling the development of 5G networks.

Nevertheless, the industry is still facing wireless adoption barriers resulting from limited-service affordability: In other words, the socioeconomic structure of African countries is limiting adoption of the technology. Contrary to what occurs in other global regions, 5G deployment will take place even before the digital divide barrier is addressed. This situation highlights the importance conveyed by the tower industry to facilitate future network rollout while enabling cost reduction.

This study explores the trends and underlying economics that make this possible. On this basis, it develops a range of recommendations to continue building on infrastructure sharing based on the development of the independent tower sector to accelerate innovation, propel capital spending in new technologies and tackle the African digital divide. The study analyzes, and conclusions are based on, a subset of North and sub-Saharan African countries,[14] although in some cases a continent-wide perspective is included for reference.

The analytical structure of this study is organized around six central chapters, chapters 2 through 7 (figure 1-1).

Figure 1-1. General study framework



[14] Angola, Congo Democratic Republic, Egypt, Ethiopia, Ghana, Kenya, Mozambique, Morocco, Nigeria, Rwanda, South Africa, Tanzania, Uganda and Zambia.

Chapter 2 provides an analysis of the current development of the African wireless industry, comparing it with selected advanced and developing economies along variables such as capital spending, network deployment, service affordability and quality. While highlighting the advances in the sector, the assessment also depicts areas where wireless services still show gaps. In this context, Chapter 3 brings into focus the contribution of infrastructure sharing to wireless industry development supported by econometric analyses. Drilling down on the infrastructure sharing stage of the telecommunications value chain, Chapter 4 examines the state of development of the African tower industry, examining its deployment and industry structure, in particular its ownership structure. This assessment serves as a backdrop to understand whether ownership of tower companies matters in terms of their contribution to the performance of the telecommunications sector, which is addressed in Chapter 5. This is supported by a correlational analysis and through econometric models demonstrating the causal relationship between an increase in the number of independent tower companies and several mobile industry indicators (increase in 4G coverage, mobile broadband adoption growth, service quality enhancement, the increase in mobile competition in the mobile market and the improvement in the affordability levels of mobile service). The empirical analyses in Chapters 3 through 5 set the stage for outlining regulatory and policy prescriptions — in other words, what needs to happen in the policy arena to maximize the development and sustainability of an independent tower industry? This is the topic of Chapter 6, which builds on an assessment of the state of regulation in the continent and a compilation of best practices in this domain in advanced economies. Chapter 7 complements this analysis with a brief forward-looking view of the tower industry and how regulators could enrich the ecosystem with the emergence of a green and digital player. Finally, Chapter 8 draws the study conclusions and recommendations.

2. DEVELOPMENT AND FUTURE CHALLENGES OF THE AFRICAN WIRELESS INDUSTRY

The African wireless industry has shown significant progress in the last two decades. Coverage of 3G is almost ubiquitous, while 4G network deployment is close to achieving a similar status. Service quality, as measured by speed and latency, has also improved significantly in recent years. Accordingly, the gap that separates the continent from advanced world economies has considerably reduced in the past decade and is forecast to continue progressing in the next decade.

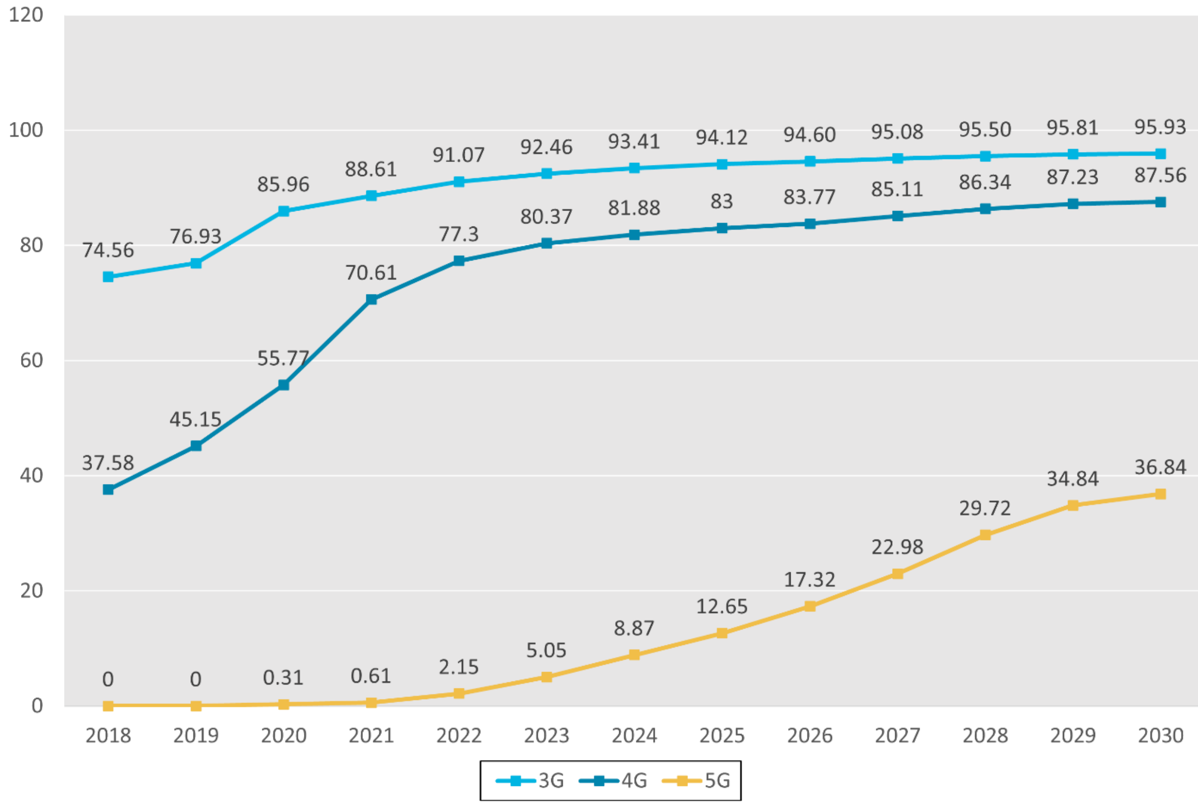
That said, the industry is still confronted with important challenges. The lack of coverage remains significant in rural areas, in key transportation highways and even in some of parts of the biggest cities in the region. While 5G service has been officially launched in many African countries and spectrum is becoming available in most nations, this technology remains a future possibility for the continent. Furthermore, while mobile broadband adoption is widespread, affordability remains a key factor limiting access to the internet and digital mobile services for the base of the sociodemographic pyramid. Finally, while certain structural conditions such as low average revenue per user (ARPU), still constrain the level of capital spending, the African lag with respect to other regions in terms of capital investment remains a worrying factor considering the development challenges.

This mixed view of progress and future challenges will be explained in detail in this chapter and serve as background analyses to emphasize the importance of infrastructure sharing, particularly the development of a healthy and thriving independent tower industry. The following assessment comprises an aggregate view of 14 countries, a disaggregated perspective at the country level and a comparison of indicators by country. In addition, in some cases, a continent-wide assessment is included for reference.

2.1. The state of 3G, 4G and 5G networks rollout

The African wireless industry has almost completed 3G deployment and is in the process of transitioning to full 4G coverage. By 2030, 3G deployment will reach 95.93% of the population, while 4G will attain 87.56% and 5G is expected to reach 36.84% (graphic 2-1).

Graphic 2-1. Africa network coverage (percent of population) (2018-2030)



Source: GSMA Intelligence[15]

Despite the significant increase in 3G and 4G coverage, as of 2023, 7.5% of the African population (or 111,377,000) still cannot have service supporting basic mobile broadband (such as the one delivered through 3G network technology), while 19.6% (or 289,964,000 population) cannot access 4G networks (for what is considered to be adequate service quality). That said, within the next seven years, the coverage gap will diminish while 5G networks will become a platform serving 36.8% of the population. The following section provides an assessment of past trends and a forecast of network deployment across all three wireless technologies.

2.1.1. The current and future state of 3G deployment

At 92.46% of the population, the coverage of 3G in the African continent is very advanced, in line with other developing regions (Latin America and the Caribbean with 97.52%, and Asia Pacific with 94.42%) and with little difference between North and sub-Saharan Africa (five percentage points) (table 2-1).

[15] GSMA Intelligence Database, https://data.gsmaintelligence.com/data.

Table 2-1. World: 3G coverage (percent of population)

	2018	2019	2020	2021	2022	2023	CAGR (2018-23)
World	92.90%	93.83%	94.43%	94.89%	95.40%	95.57%	0.57%
Africa*	74.56%	79.63%	85.96%	88.61%	91.07%	92.46%	4.40%
Sub-Saharan Africa**	76.66%	82.74%	86.69%	90.74%	92.85%	94.02%	4.17%
North Africa***	96.33%	98.18%	99.06%	99.06%	99.06%	99.06%	0.56%
Latin America and Caribbean	93.62%	94.16%	94.94%	95.46%	96.86%	97.52%	0.82%
North America	99.00%	99.90%	99.90%	99.90%	99.90%	99.89%	0.18%
Asia Pacific	93.51%	93.92%	94.17%	94.15%	94.42%	94.42%	0.19%
Western Europe	98.38%	98.38%	98.44%	98.48%	98.47%	98.56%	0.04%
Eastern Europe	95.02%	95.23%	95.32%	96.15%	96.69%	96.68%	0.35%
Arab States	97.16%	98.52%	99.16%	99.16%	99.22%	99.22%	0.42%
BENCHMARKS							
OECD	98.16%	98.40%	98.47%	98.46%	98.89%	98.96%	0.16%
United States	99.00%	100.00%	100.00%	100.00%	100.00%	100.00%	0.20%
Canada	99.00%	99.00%	99.00%	99.00%	99.00%	99.00%	0.00%
United Kingdom	99.48%	99.48%	99.48%	99.74%	99.74%	99.74%	0.05%
South Korea	99.00%	99.00%	99.00%	99.00%	99.00%	99.00%	0.00%

* Includes all the countries in the continent.
** Prorated average of Angola, Benin, Botswana, Burundi, Cameroon, Cote d'Ivoire, Kenya, Madagascar, Mozambique, Nigeria, Senegal, South Africa, Tanzania, Uganda, Zambia and Zimbabwe.
*** Prorated average of Algeria, Egypt, Morocco and Tunisia.
Sources: GSMA Intelligence; Telecom Advisory Services analysis[16]

As indicated in table 2-1, the distance between Africa and the advanced countries' benchmarks has significantly narrowed over the past six years. While in the past six years the African continent has been able to catch up with other regions in terms of 3G coverage, some countries among those assessed in this study still lag in terms of 3G deployment (table 2-2).

[16] "Telecom Advisory Services analysis" throughout the report refers to the analytical work conducted by the authors in the course of producing the report.

Table 2-2. Africa: 3G coverage (percent of population) (2018-2023)

	2018	2019	2020	2021	2022	2023	CAGR (2018-23)
Angola	85.00%	86.71%	88.46%	90.24%	92.06%	93.92%	2.02%
Congo Democratic Republic	53.10%	63.25%	65.00%	65.00%	70.00%	75.00%	7.15%
Egypt	99.00%	99.00%	99.00%	99.00%	99.00%	99.00%	0.00%
Ethiopia	65.45%	66.50%	94.00%	97.00%	99.00%	99.00%	8.63%
Ghana	88.45%	90.00%	91.00%	97.00%	98.00%	99.00%	2.28%
Kenya	92.00%	94.80%	94.80%	97.00%	99.00%	99.00%	1.48%
Mozambique	48.00%	56.10%	60.00%	64.73%	70.07%	75.85%	0.20%
Morocco	98.00%	99.00%	99.00%	99.00%	99.00%	99.00%	9.58%
Nigeria	79.51%	85.33%	92.36%	99.00%	99.00%	99.00%	4.48%
Rwanda	93.80%	95.16%	99.39%	99.39%	99.39%	99.39%	1.16%
South Africa	99.50%	99.50%	99.50%	99.50%	100.00%	100.00%	0.10%
Tanzania	52.00%	64.18%	69.47%	75.20%	81.39%	85.00%	10.33%
Uganda	73.75%	84.60%	88.02%	90.50%	93.00%	95.00%	5.19%
Zambia	64.70%	71.80%	76.19%	82.48%	89.27%	90.00%	6.82%
Africa (14 countries)	77.38%	81.91%	88.10%	91.16%	93.02%	94.17%	4.01%
Africa (total)	74.56%	79.63%	85.96%	88.61%	91.07%	92.46%	4.40%

Sources: GSMA Intelligence; Telecom Advisory Services analysis

As depicted in table 2-2, while 3G coverage in the study sample has reached 94.17% of the population, three countries (Congo Democratic Republic, Mozambique and Tanzania) exhibit a level of equal or under 85% and three (Angola, Uganda and Zambia) equal or under 95%. Accordingly, when factored by population, 57,415,000 Africans in the study sample still do not have access to 3G technology.[17]

When considering the forecast of deployment for the next seven years, 3G coverage for the study sample is expected to reach a level close to 96.72% (or 95.93% of the whole continent), with coverage in only two countries (Mozambique and Tanzania) expected to remain under 90% of the population (table 2-3).

[17] The difference between 57,415,000 and 111,377,000 presented above is that the latter represents all of Africa.

Table 2-3. Africa: 3G coverage (percent of population) (2023-2030)

	2023	2024	2025	2026	2027	2028	2029	2030	CAGR (2023-30)
Angola	93.92%	94.52%	95.00%	95.88%	96.93%	97.94%	99.00%	99.50%	0.83%
Congo Democratic Republic	75.00%	77.80%	80.00%	82.41%	85.06%	87.51%	89.30%	90.00%	2.64%
Egypt	99.00%	99.00%	99.00%	99.00%	99.00%	99.00%	99.00%	99.00%	0.00%
Ethiopia	99.00%	99.00%	99.00%	99.00%	99.00%	99.00%	99.00%	99.00%	0.00%
Ghana	99.00%	99.05%	99.00%	99.20%	99.45%	99.72%	99.92%	100.00%	0.14%
Kenya	99.00%	99.55%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	0.14%
Mozambique	75.85%	83.47%	88.87%	90.06%	90.20%	89.76%	89.16%	88.87%	0.07%
Morocco	99.00%	99.00%	99.00%	99.00%	99.11%	99.24%	99.37%	99.46%	2.29%
Nigeria	99.00%	99.00%	99.00%	99.10%	99.23%	99.36%	99.46%	99.50%	0.07%
Rwanda	99.39%	99.39%	99.39%	99.39%	99.39%	99.39%	99.39%	99.39%	0.00%
South Africa	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	0.00%
Tanzania	85.00%	85.00%	85.00%	85.00%	85.00%	85.00%	85.00%	85.00%	0.00%
Uganda	95.00%	97.36%	99.00%	99.37%	99.41%	99.27%	99.09%	99.00%	0.59%
Zambia	90.00%	90.06%	90.00%	90.00%	90.00%	90.00%	90.00%	90.00%	0.00%
Africa (14 countries)	94.17%	94.88%	95.39%	95.76%	96.11%	96.42%	96.64%	96.72%	0.38%
Africa (total)	92.46%	93.41%	94.12%	94.60%	95.08%	95.50%	95.81%	95.93%	0.53%

Sources: GSMA Intelligence; Telecom Advisory Services analysis

2.1.2. The current and future state of 4G deployment

In parallel with progress of 3G deployment, the rollout of 4G has reached 80.37% for the whole continent (or 1,187,181,000 population), with 77.49% for sub-Saharan Africa and 99.23% in North Africa. While deployment of 4G has progressed considerably, the continent still lags other developing regions (such as Latin America and the Caribbean, with 92.36%) and, particularly, advanced economies (e.g., the prorated average for OECD countries is 98.54%) (table 2-4).

Table 2-4. World: 4G coverage (percent of population)

	2018	2019	2020	2021	2022	2023	CAGR (2018-23)
World	87.57%	90.65%	92.62%	94.42%	95.29%	95.92%	1.84%
Africa	37.58%	45.15%	55.77%	70.61%	77.30%	80.37%	16.42%
Sub-Saharan Africa	42.49%	47.46%	57.82%	67.52%	74.15%	77.49%	12.77%
North Africa	63.46%	82.84%	91.71%	99.14%	99.17%	99.23%	9.35%
Latin America and Caribbean	81.98%	85.10%	87.26%	89.32%	91.36%	92.39%	2.42%
North America	98.98%	99.00%	99.00%	99.00%	99.00%	99.00%	0.00%
Asia Pacific	94.08%	96.55%	97.35%	98.07%	98.12%	98.51%	0.92%
Western Europe	97.69%	98.23%	98.67%	99.40%	99.51%	99.52%	0.37%
Eastern Europe	84.63%	91.95%	94.48%	95.52%	96.37%	96.57%	2.67%
Arab States	72.66%	86.66%	93.04%	98.67%	98.97%	99.22%	6.43%
BENCHMARKS							
OECD	96.45%	97.00%	97.63%	97.99%	98.45%	98.54%	0.43%
United States	98.98%	99.00%	99.00%	99.00%	99.00%	99.00%	0.00%
Canada	99.00%	99.00%	99.00%	99.00%	99.00%	99.00%	0.00%
United Kingdom	99.00%	99.00%	99.00%	99.58%	99.60%	99.60%	0.12%
South Korea	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	0.00%

Sources: GSMA Intelligence; Telecom Advisory Services analysis

The analysis of coverage of 4G by country allows the identification of countries in the study's sample where deployment still lags. As indicated in table 2-5, while 4G coverage in the study sample has reached 84.86% of the population (and 80.37% of the whole continent), four countries (Angola, Congo Democratic Republic, Mozambique and Tanzania) exhibit a level below 80% and two (Nigeria and Uganda) are under 95%. When factored by population, 149,189,873 Africans in the countries of the study sample still do not have access to 4G technology.

Table 2-5. Africa: 4G coverage (percent of population) (2018-2023)

	2018	2019	2020	2021	2022	2023	CAGR (2018-23)
Angola	8.00%	18.00%	23.60%	33.60%	44.05%	57.74%	48.48%
Congo Democratic Republic	11.00%	22.00%	25.70%	40.94%	60.96%	66.00%	43.10%
Egypt	52.47%	69.85%	84.91%	99.00%	99.00%	99.00%	13.54%
Ethiopia	3.26%	3.54%	26.48%	93.90%	96.00%	97.00%	97.11%
Ghana	48.30%	58.00%	71.70%	90.60%	99.30%	99.50%	15.55%
Kenya	55.00%	64.00%	92.80%	96.50%	98.00%	98.00%	12.25%
Mozambique	8.00%	25.20%	32.00%	42.75%	56.04%	65.45%	0.41%
Morocco	97.00%	99.00%	99.00%	99.00%	99.00%	99.00%	52.25%
Nigeria	44.73%	46.54%	60.10%	70.30%	78.40%	82.70%	13.08%
Rwanda	98.54%	99.00%	99.00%	99.00%	99.00%	99.00%	0.09%
South Africa	90.80%	95.70%	97.45%	99.00%	99.00%	99.00%	1.74%
Tanzania	28.00%	32.60%	38.10%	46.31%	55.00%	55.00%	14.46%
Uganda	21.56%	23.49%	40.45%	62.70%	79.00%	82.00%	30.63%
Zambia	40.20%	49.10%	57.95%	100.00%	100.00%	100.00%	19.99%
Africa (14 countries)	38.68%	44.98%	57.13%	75.53%	82.29%	84.86%	17.02%
Africa (total)	37.58%	45.15%	55.77%	70.61%	77.30%	80.37%	16.42%

Sources: GSMA Intelligence; Telecom Advisory Services analysis

The 4G coverage gap (80.37% for total Africa, 84.86% for the 14 countries in the study sample) is the result of several factors. While governments are aware of the need to close the gap, as reflected in mobile network operator (MNO) licensing and spectrum auction that pushes for national coverage, the network deployment economics hamper rural rollout. In many countries, operating models are not aligned enough with the capital spent for network build-out. Finally, while Universal Service Funds are key to underwriting rural deployment, the funds are not necessarily spent appropriately.

Considering the forecast of deployment for the next seven years, 4G coverage for the study sample is expected to reach a level close to 92.16%, with only two countries (Congo Democratic Republic and Tanzania) still under 90%. For the whole continent, coverage will reach 87.56% (table 2-6).

Table 2-6. Africa: 4G coverage (percent of population) (2023-2030)

	2023	2024	2025	2026	2027	2028	2029	2030	CAGR (2023-30)
Angola	57.74%	64.55%	70.00%	76.88%	84.67%	91.99%	97.39%	99.50%	8.08%
Congo Democratic Republic	66.00%	68.08%	70.00%	73.29%	77.23%	81.03%	83.88%	85.00%	3.68%
Egypt	99.00%	99.00%	99.00%	99.00%	99.00%	99.00%	99.00%	99.00%	0.00%
Ethiopia	97.00%	97.60%	98.00%	98.29%	98.56%	98.79%	98.94%	99.00%	0.29%
Ghana	99.50%	99.52%	99.50%	99.50%	99.50%	99.50%	99.50%	99.50%	0.00%
Kenya	98.00%	98.51%	99.00%	99.29%	99.56%	99.79%	99.94%	100.00%	0.29%
Mozambique	98.00%	98.51%	99.00%	99.29%	99.56%	99.79%	99.94%	100.00%	0.00%
Morocco	99.00%	99.00%	99.00%	99.00%	99.00%	99.00%	99.00%	99.00%	0.96%
Nigeria	82.70%	85.71%	88.00%	89.85%	91.73%	93.38%	94.55%	95.00%	2.00%
Rwanda	99.00%	99.00%	99.00%	99.00%	99.00%	99.00%	99.00%	99.00%	0.00%
South Africa	99.00%	99.00%	99.00%	99.00%	99.00%	99.00%	99.00%	99.00%	0.00%
Tanzania	55.00%	55.00%	55.00%	55.18%	55.41%	55.65%	55.84%	55.91%	0.23%
Uganda	82.00%	85.36%	88.00%	89.52%	90.89%	92.00%	92.73%	93.00%	1.81%
Zambia	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	0.00%
Africa (14 countries)	84.86%	86.35%	87.48%	88.63%	89.88%	91.02%	91.85%	92.16%	1.19%
Africa (total)	80.37%	81.88%	83.00%	83.77%	85.11%	86.34%	87.23%	87.56%	1.23%

Sources: GSMA Intelligence; Telecom Advisory Services analysis

2.1.3. The current and future state of 5G deployment

The rollout of 5G in the continent is still embryonic. Its deployment has reached 5.05% for the continent's population, with 9.40% for sub-Saharan Africa and 1.50% in North Africa. In the case of this technology, the distance between Africa and advanced economies is significant: In Western Europe, 5G has attained 77.05% population coverage and in North America it is 97.07% (table 2-7).

Table 2-7. World: 5G coverage (percent of population)

	2018	2019	2020	2021	2022	2023	CAGR (2020-23)
World	0.13%	5.19%	17.83%	28.54%	31.95%	37.85%	28.52%
Africa	0.00%	0.00%	0.31%	0.61%	2.15%	5.05%	153.50%
Sub-Saharan Africa	0.00%	0.00%	0.67%	1.28%	4.14%	9.40%	141.19%
North Africa	0.00%	0.00%	0.00%	0.00%	0.00%	1.50%	N/A
Latin America and Caribbean	0.00%	0.00%	1.31%	6.31%	10.93%	17.14%	135.64%
North America	0.00%	26.92%	75.50%	91.52%	95.88%	97.07%	8.74%
Asia Pacific	0.22%	4.05%	17.39%	28.60%	31.07%	37.75%	29.48%
Western Europe	0.00%	13.06%	31.84%	61.01%	70.67%	77.05%	34.26%
Eastern Europe	0.00%	0.54%	6.01%	11.96%	17.31%	22.10%	54.35%
Arab States	0.00%	7.37%	12.35%	17.14%	19.16%	22.65%	22.41%
BENCHMARKS							
OECD	0.64%	16.56%	42.11%	63.39%	70.88%	75.30%	21.38%
United States	0.00%	30.00%	79.00%	94.00%	97.38%	98.37%	7.58%
Canada	0.00%	0.00%	45.00%	70.00%	83.00%	86.00%	24.10%
United Kingdom	0.00%	25.00%	28.50%	46.00%	63.00%	75.00%	38.06%
South Korea	16.80%	93.00%	98.00%	98.00%	98.00%	98.00%	0.00%

Sources: GSMA Intelligence; Telecom Advisory Services analysis

The African lag in 5G deployment is not necessarily driven by spectrum availability. 5G spectrum auctions have taken place in recent years across many countries in the sample of this study (table 2-8).

Table 2-8: Africa: 4G and 5G spectrum auctions dates

Angola	3.3-3.7 GHz (4Q21)
Congo Democratic Republic	900 MHz; 1.8 GHz; 2.1 GHz; 2.6 GHz (2Q22)
Egypt	2.6 GHz (4Q20 & 1Q22)
Ethiopia	The government allowed the state operator to use spectrum without an auction (3Q23)
Ghana	The Republic of Ghana has decided not to auction 5G frequencies (3Q23)
Kenya	2.6 GHz (1Q22 & 3Q22)
Mozambique	800 MHz; 1.8 GHz; 2.6 GHz (4Q18)
Morocco	• Frequency consultations, including those for 5G, were scheduled for 2023, but there have been no recent advancements in this regard • 800 MHz; 1.8 GHz; 2.5 GHz (1Q15) • Upcoming 5G auction (2024-5)
Nigeria	• 900 MHz; 1.8 GHz (1Q21) • 3.5-3.6 GHz; 3.7-3.8 GHz (4Q21) • 3.5 GHz (4Q22) • 2.6 GHz (3Q23
Rwanda	In 2022, the Government of Rwanda moved away from technology-specific (2G, 3G, 4G) licenses and services to technology-neutral licenses and services
South Africa	• 700 MHz; 800 MHz; 3.4 GHz; 2.6 GHz; 3.5 GHz (1Q22) • 750 MHz; 800 MHz; 1.5 GHz; 2.3 GHz; 3.3 GHz (2024)
Tanzania	700 MHz; 2.3 GHz; 2.6 GHz; 3.5 GHz (4Q22)
Uganda	700 MHz; 800 MHz; 2.3 GHz; 3.3 GHz; 3.5 GHz; 5 GHz; 71 GHz; 81 GHz (3Q23)
Zambia	• 800 MHz (1Q21) • 800 MHz and 2.6 GHz (3Q22) • 3.2 GHz (4Q22); 700 MHz and 2.6 GHz (3Q22) • 3.3 GHz (4Q23); 3.5 MHz (2024)

Sources: GSA. Spectrum Auctions November 2023; Telegeography Communications Update; Airtel's financial statements; Telecom Advisory Services analysis

Consequently, as of September 2023, operators in nine (Angola, Ethiopia, Kenya,[18] Mozambique, Nigeria,[19] South Africa, Tanzania,[20] Uganda[21] and Zambia) of the 14 countries in the study sample had already launched service, while four are expected to launch soon (Democratic Republic of the Congo, Egypt, Ghana[22] and Morocco). That being said, coverage across African countries still remains embryonic (table 2-9).

Table 2-9. Africa: 5G coverage (percent of population) (2020-2023)

	2020	2021	2022	2023	CAGR (2022-23)
Angola	0.00%	0.00%	0.00%	2.00%	N/A
Congo Democratic Republic	0.00%	0.00%	0.00%	0.00%	N/A
Egypt	0.00%	0.00%	0.00%	0.00%	N/A
Ethiopia	0.00%	0.00%	2.00%	3.00%	50.00%
Ghana	0.00%	0.00%	0.00%	3.14%	N/A
Kenya	0.00%	0.00%	2.40%	4.98%	107.50%
Mozambique	0.00%	0.00%	0.00%	0.00%	N/A
Morocco	0.00%	0.00%	0.00%	2.32%	N/A
Nigeria	0.00%	0.00%	3.00%	9.31%	210.33%
Rwanda	0.00%	0.00%	0.00%	0.00%	N/A
South Africa	7.00%	13.66%	30.29%	47.28%	56.09%
Tanzania	0.00%	0.00%	0.00%	10.49%	N/A
Uganda	0.00%	0.00%	0.00%	0.00%	N/A
Zambia	0.00%	0.00%	1.00%	5.00%	400.00%
Africa (14 countries)	0.45%	0.87%	3.00%	6.83%	127.95%
Africa (total)	0.31%	0.61%	2.15%	5.05%	134.88%

Sources: GSMA Intelligence; Telecom Advisory Services analysis

5G coverage by country would indicate that, at 47.28%, South Africa is an outlier. MTN is rolling out 5G sites having deployed 483 so far, with plans to have covered 25% of the population by the end of 2023. Telkom has also entered the 5G competition having spent the last two years building out its 5G network capacity with 123 5G base stations operating. The coverage statistic of South Africa, reported by GSMA Intelligence as provided by operators, has been checked against Open Signal, although the metric reported by the latter is not strictly comparable to geographic coverage.[23] The platform reports that as of August 2023,

[18] Kenya is currently facilitating a limited 5G rollout, with 5G spectrum allocated to Safaricom after performing trials and building out its network. Airtel Kenya has been rolling out new sites for its 5G network, which is now available in 16 counties and installed on 490 sites.

[19] MTN has deployed over 700 5G sites providing 5G to 10% of the population, with a plan to reach 40% by 2025. 5G auction winning bidders will be awarded 10-year nationwide spectrum licenses and required to launch commercial 5G within 12 months of the license date. Airtel has now also launched commercial 5G services.

[20] Vodacom has launched the country's first 5G network and will extend coverage to 230 locations. Airtel Tanzania has also launched commercial 5G services in the main cities.

[21] Airtel and MTN won 5G frequencies in the government's auction. MTN Uganda has committed to upgrading all sites to 5G in Kampala. Airtel Uganda has begun plans to deploy 5G equipment at 50 sites in Kampala with a roadmap of upgrading 2,500 sites with 5G.

[22] MTN has already upgraded over 1,000 sites in preparation for 5G rollout under its Ambition 2025.

[23] As reported by Opensignal, "5G availability shows the proportion of time Opensignal users with a 5G device and a 5G subscription had an active 5G connection." And "Opensignal's availability metrics are not measures of a

5G availability for MTN was 10.9% of time and 7.8% for Vodacom.[24] Consequently, the coverage value of 5G in South Africa should be considered much lower than the one reported by GSMA Intelligence. In addition, the value reported by GSMA Intelligence might entail a so-called "LTE+" where download speeds are not significantly different from 5G.

When considering the forecast of deployment for the next seven years, 5G coverage for the study sample is expected to reach in 2030 a level close to 42.14%, and 36.84% for the whole continent (table 2-10).

Table 2-10. Africa: 5G coverage (percent of population) (2023-2030)

	2023	2024	2025	2026	2027	2028	2029	2030	CAGR (2023-30)
Angola	2.00%	2.56%	5.00%	12.20%	21.32%	30.36%	37.25%	40.00%	53.41%
Congo Democratic Republic	0.00%	0.00%	0.00%	0.00%	0.00%	16.34%	20.95%	22.80%	N/A
Egypt	0.00%	4.28%	8.58%	11.71%	14.91%	17.77%	19.80%	20.58%	N/A
Ethiopia	3.00%	3.95%	7.00%	14.60%	24.26%	33.84%	41.14%	44.06%	46.79%
Ghana	9.31%	15.09%	20.00%	24.30%	28.83%	32.92%	35.87%	37.00%	39.23%
Kenya	4.98%	11.42%	21.40%	38.05%	58.36%	78.15%	93.08%	99.00%	53.28%
Mozambique	0.00%	0.00%	0.00%	0.00%	0.00%	7.89%	10.11%	11.00%	65.08%
Morocco	2.32%	12.69%	25.55%	37.88%	50.14%	63.11%	73.35%	77.51%	N/A
Nigeria	9.31%	15.09%	20.00%	24.30%	28.83%	32.92%	35.87%	37.00%	21.79%
Rwanda	0.00%	0.18%	1.00%	3.08%	5.72%	8.36%	10.37%	11.17%	N/A
South Africa	47.28%	60.35%	67.12%	72.30%	76.99%	80.82%	83.40%	84.34%	8.62%
Tanzania	10.49%	19.30%	28.00%	38.72%	51.04%	62.69%	71.33%	74.72%	32.38%
Uganda	0.00%	0.97%	3.00%	6.99%	11.95%	16.83%	20.54%	22.01%	N/A
Zambia	5.00%	7.93%	10.00%	11.27%	12.40%	13.32%	13.93%	14.15%	16.02%
Africa (14 countries)	6.83%	11.33%	15.86%	21.27%	27.39%	35.31%	40.23%	42.14%	29.68%
Africa (total)	5.05%	8.87%	12.65%	17.32%	22.98%	29.72%	34.84%	36.84%	32.83%

Sources: GSMA Intelligence; Telecom Advisory Services analysis

network's geographical extent. They won't tell you whether you are likely to get a signal if you plan to visit a remote rural or nearly uninhabited region. Instead, they measure what proportion of time people have a network connection, in the places they most commonly frequent — something often missed by traditional coverage metrics. Looking at when users have a connection rather than where, provides us with a more precise reflection of the true user experience." https://www.opensignal.com/methodology-overview.

[24] https://www.opensignal.com/reports/2023/08/southafrica/mobile-network-experience.

2.1.4. The state of networks service quality

In parallel with the increase of network coverage, the continent has achieved substantial progress with regards to mobile broadband service quality, as measured by average download speed and service latency (table 2-11).

Table 2-11. Wireless service quality

	Mobile broadband average download speed (in Mbps)					Mobile broadband latency (in ms)				
	2020	2021	2022	2023	CAGR 2020-23	2020	2021	2022	2023	CAGR 2020-23
World	41	62	72	93	31.23%	32	30	30	29	-3.53%
North Africa	22	26	32	37	18.54%	31	29	29	28	-2.95%
Sub-Saharan Africa	17	22	28	40	32.40%	32	29	29	28	-4.49%
Latin America and the Caribbean	25	29	40	59	32.23%	34	32	31	32	-1.98%
North America	46	90	124	161	51.22%	36	32	32	31	-5.21%
Asia Pacific	49	72	80	105	29.22%	32	30	30	29	-3.58%
Western Europe	42	66	89	98	33.24%	32	30	30	29	-3.00%
Eastern Europe	29	38	47	56	24.84%	32	30	29	29	-3.14%
Arab States	34	54	67	81	33.32%	30	28	28	27	-3.29%
BENCHMARKS										
OECD	43	72	96	114	38.32%	33	32	31	31	-2.77%
United States	44	91	128	166	55.50%	37	33	32	31	-5.18%
Canada	68	86	90	119	20.77%	28	26	25	24	-5.33%
United Kingdom	35	79	98	88	36.56%	37	36	36	36	-1.61%
South Korea	109	189	244	312	42.00%	34	28	31	29	-5.35%

Sources: Speedtest Global Index, https://www.speedtest.net/global-index; Telecom Advisory Services analysis

As indicated in table 2-11, wireless broadband average download speed has increased at a 32.40% rate since 2020 for sub-Saharan Africa and 18.54% in North Africa, and latency has decreased by a 4.49% rate in sub-Saharan Africa and 2.95% in North Africa. These values indicate that, despite the significant progress in the region, the wireless broadband speed difference in relation to the OECD countries has widened in recent years, primarily due to the accelerated deployment of 5G technology in OECD countries.

2.2. Wireless broadband service adoption

Network coverage, as reviewed in the previous section, provides an indication of the so-called “supply gap.” The broadband supply gap is defined as the portion of the population that cannot access the service because of lack of coverage. However, the digital divide should consider not only the supply gap but also the demand gap, measured as the non-subscribing population residing in areas served by broadband networks.[25]

[25] R. Katz and T. Berry, *Driving Demand for Broadband Networks and Services* (London: Springer, 2014), 5-13.

This section presents adoption statistics for African countries from which it will be possible to estimate the demand gap and, consequently, the size of the digital divide in the continent. Wireless service adoption is measured by GSMA Intelligence through four metrics: (i) unique mobile subscribers, (ii) mobile broadband subscribers, (iii) connections and (iv) mobile broadband capable connections. *Unique mobile subscribers* are defined as users who purchase mobile services, but this excludes machine-to-machine connections and treats subscribers as a single adopting unit regardless of them having multiple connections (e.g., more than one SIM card). *Unique mobile broadband subscribers* are defined as unique users who have used internet services consuming mobile data (consequently excluding SMS, MMS and cellular voice calls) on their mobile device. Mobile broadband subscribers are treated as a single adopting unit regardless of them having multiple devices. *Connections* are defined as total unique SIM cards, excluding licensed cellular IoT, that have been registered on the mobile network. Accordingly, a subscriber can have multiple connections.[26] *Mobile broadband capable connections* are defined as mobile broadband unique SIM cards that have been registered on the mobile network in a device capable of receiving download speeds of 256 kb/s or greater. Mobile broadband includes 3G, 4G and 5G network technologies, regardless of whether prepaid or postpaid. In this case, connections differ from subscribers [metric (ii)] because a unique subscriber can have multiple connections. The most appropriate metric to understand service adoption in African countries is unique mobile broadband subscribers as it excludes non-user connections (e.g., IoT SIMs) and deducts duplicate SIM ownership. The only drawback of this metric is that it includes all three technologies (3G, 4G and 5G), whereby 3G is not totally suited for delivering broadband services due to its low speeds.

Wireless broadband adoption, measured as unique mobile broadband subscribers in the 14 countries selected for this study, has reached 30.36% (or 28.42% for the total continent) (table 2-12).

[26] Regulatory authorities commonly report connections to indicate the development of mobile services. However, this metric tends to over-report service adoption.

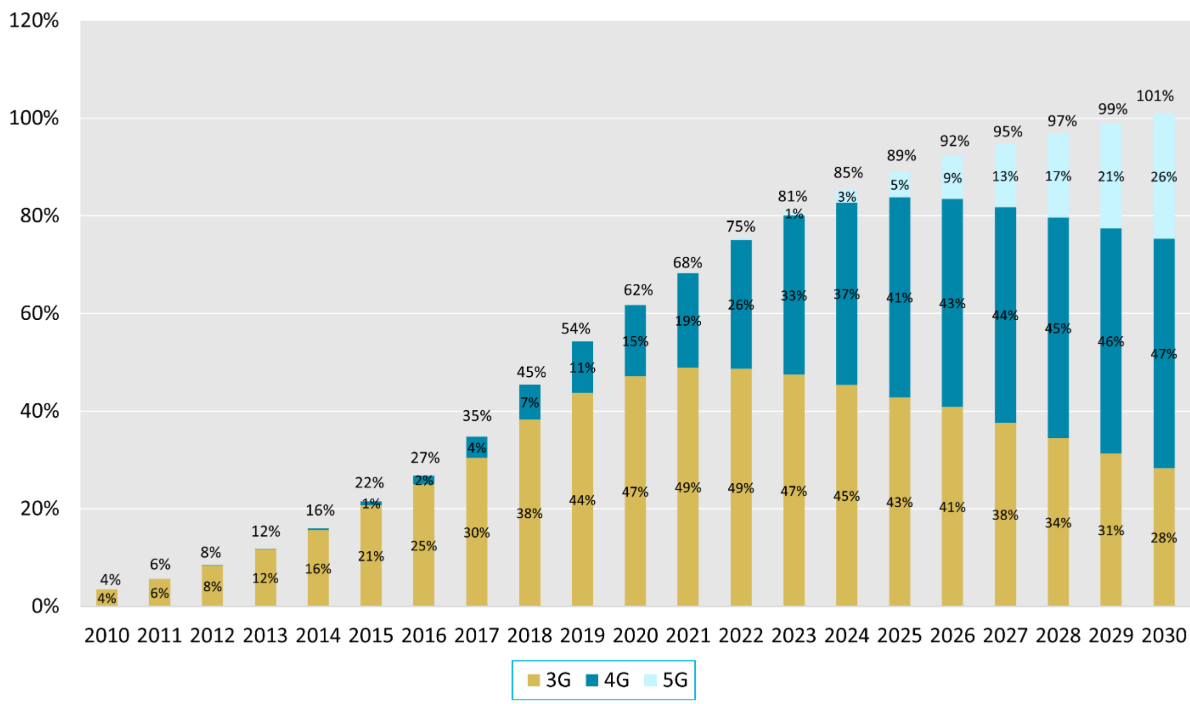
Table 2-12. Africa: Unique mobile internet subscribers (percent of population) (2018-2023)

	2018	2019	2020	2021	2022	2023	CAGR (2018-23)
Angola	13.45%	15.26%	18.40%	21.62%	23.85%	25.76%	13.87%
Congo Democratic Republic	10.21%	10.73%	11.27%	11.92%	12.80%	13.78%	6.18%
Egypt	36.73%	38.96%	41.38%	43.45%	47.13%	50.08%	6.40%
Ethiopia	9.11%	9.67%	10.21%	10.78%	11.46%	12.20%	6.03%
Ghana	20.87%	22.14%	23.70%	25.28%	27.40%	29.92%	7.47%
Kenya	25.46%	27.29%	29.11%	31.12%	33.52%	36.24%	7.32%
Mozambique	11.95%	13.59%	16.42%	19.29%	21.29%	23.01%	4.67%
Morocco	41.64%	43.71%	45.81%	48.06%	50.22%	52.31%	14.00%
Nigeria	21.47%	22.73%	24.28%	25.91%	27.60%	29.39%	6.48%
Rwanda	19.59%	20.79%	21.94%	23.20%	24.71%	26.38%	6.13%
South Africa	46.28%	48.16%	50.58%	53.40%	57.69%	61.51%	5.85%
Tanzania	14.50%	16.93%	19.49%	22.32%	25.55%	28.33%	14.32%
Uganda	19.66%	20.95%	22.20%	23.53%	25.16%	27.01%	6.56%
Zambia	14.60%	15.49%	16.34%	17.31%	18.46%	19.71%	6.19%
Africa (14 countries)	21.90%	23.26%	24.84%	26.48%	28.46%	30.36%	6.75%
Africa (total)	20.86%	22.10%	23.48%	24.95%	26.71%	28.42%	6.38%

Sources: GSMA Intelligence; Telecom Advisory Services analysis

While wireless broadband adoption has reached 28.42%, the technology mix has been changing significantly and is expected to continue shifting to 4G and 5G (graphic 2-2).

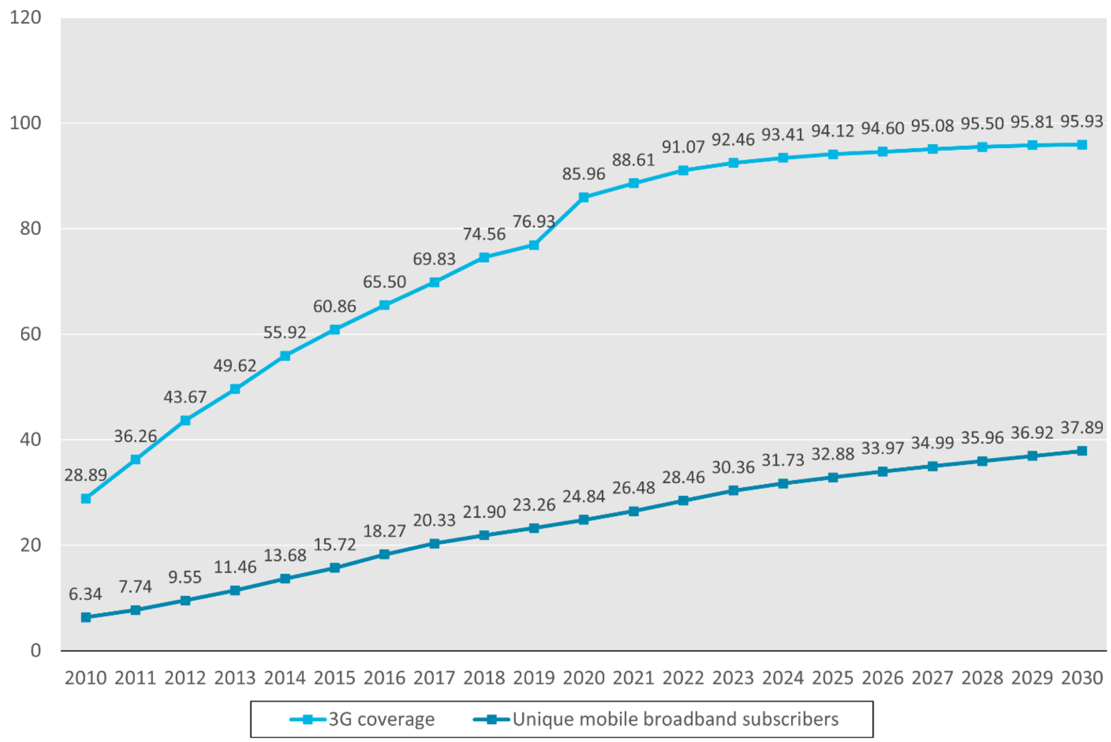
Graphic 2-2. Africa: Mobile connections by network standard (2010-2030) (in percentage)



Note: The percentage can exceed 100%, as an individual can have more than one connection.
Sources: GSMA Intelligence; Telecom Advisory Services analysis

The first indication of the size of the demand gap in Africa is to compare the trends in 3G coverage (the most extensive mobile broadband enabling technology) and unique mobile broadband subscribers (graphic 2-3).

Graphic 2-3. Africa: 3G network coverage vs. unique mobile broadband subscribers (2010-2030) (percent of population)



Sources: GSMA Intelligence; Telecom Advisory Services analysis

As depicted in graphic 2-3, in 2010, 3G coverage reached 28.89% of the population, but the total mobile broadband adoption peaked at 6.34%. Consequently, the demand gap amounted to 22.55%. By 2023, the mobile broadband demand gap had increased to 62.10 percentage points. Based on the forecast of coverage and adoption, the demand gap by 2030 will only diminish by 4 percentage points.

A large portion of the demand gap can be explained by limited affordability.[27] Mobile broadband affordability is measured by the price of the data-only mobile broadband basket[28] as percent of the monthly gross national income per capita. As stipulated for the affordability target formulated by the ITU/UNESCO Broadband Commission for Sustainable

[27] The other two factors explaining the demand gap are digital illiteracy and lack of relevant content to prompt consumer interest. See R. Katz and T. Berry, *Driving Demand for Broadband Networks and Services* (London: Springer, 2014). 16-23.
[28] This is the most economical offering provided by the carrier with the largest market share.

Development, by 2025, entry-level broadband services should be made affordable in low- and middle-income countries (LMICs) at less than 2% of monthly gross national income (GNI) per capita.[29] Several countries in the sample of African countries still lag this target as of 2022[30] (table 2-13).

Table 2-13. Africa: Price of the data-only mobile broadband basket as % of monthly GNI per capita (2022)

Angola	2.70%
Congo Democratic Republic	10.34%
Egypt	1.02%
Ethiopia	3.44%
Ghana	2.11%
Kenya	2.77%
Morocco	0.97%
Mozambique	9.35%
Nigeria	1.80%
Rwanda	2.97%
South Africa	1.76%
Tanzania	4.61%
Uganda	5.44%
Zambia	2.35%

Countries where the price of mobile broadband basket exceeds the Broadband Commission target

Source: International Telecommunication Union ICT Price Baskets, historical data series, Apr 2023 release, https://www.itu.int/en/ITU-D/Statistics/Pages/ICTprices/default.aspx in folder "Download the historical data 2008-2022"

As reported by the Broadband Commission, if the price of broadband is high relative to income, it results in an adoption barrier. This is confirmed in the 14 countries in the study sample. As depicted in graphic 2-4, the lagging subscriber growth in several African countries is mainly driven by the affordability barrier.

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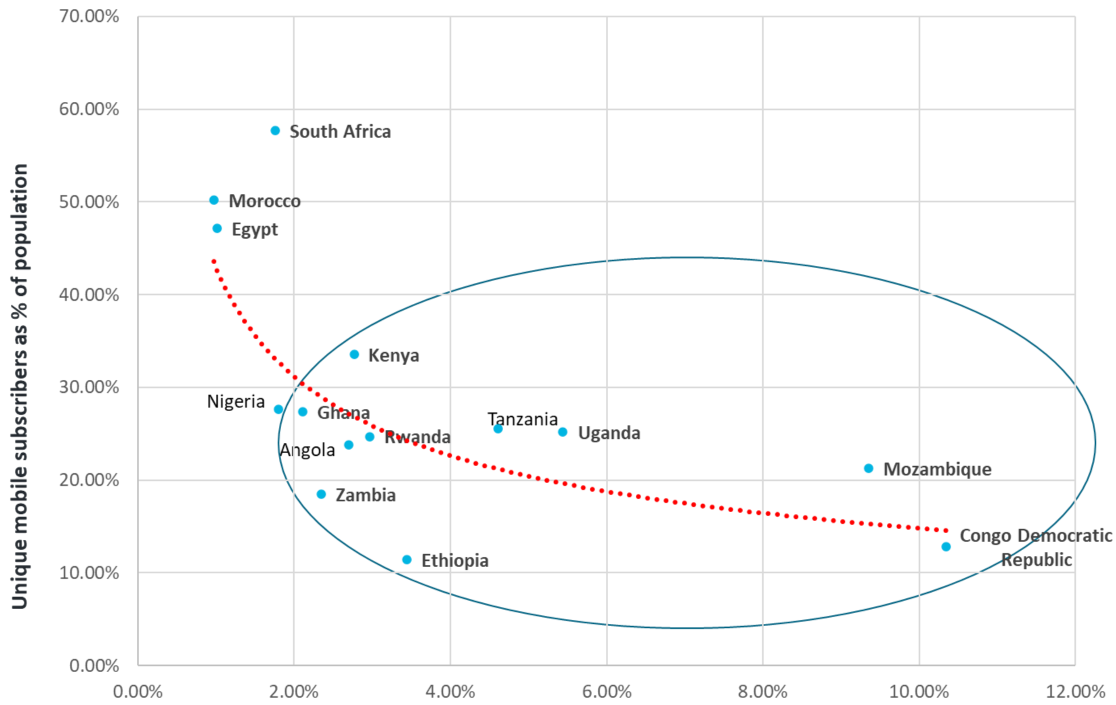
[29] "The State of Broadband: Digital Connectivity: A Transformative Opportunity," Broadband Commission for Sustainable Development (2023). https://www.broadbandcommission.org/publication/state-of-broadband-2023/.

[30] International Telecommunication Union ICT Price Baskets, historical data series, Apr 2023 release, https://www.itu.int/en/ITU-D/Statistics/Pages/ICTprices/default.aspx in folder "Download the historical data 2008-2022."

Graphic 2-4. Africa: Price of the data-only mobile broadband basket as % of monthly GNI per capita vs. unique mobile subscribers as % of population



Sources: International Telecommunication Union ICT Price Baskets, historical data series, Apr 2023 release, https://www.itu.int/en/ITU-D/Statistics/Pages/ICTprices/default.aspx in folder "Download the historical data 2008-2022"; GSMA Intelligence; Telecom Advisory Services analysis

As demonstrated in graphic 2-4, when the price of the most economic data plan exceeds 2.00% of the monthly GNI per capita, unique mobile subscriber penetration decreases significantly (Kenya, Ghana, Angola, Rwanda, Zambia, Ethiopia, Tanzania, Uganda, Mozambique and Congo Democratic Republic).

Beyond the affordability barrier, low adoption is also explained by limited rural use. While consistently declining, in 2022, 58% of sub-Sahara African and 34% of the Middle East and North Africa populations still resided in rural areas (table 2-14).

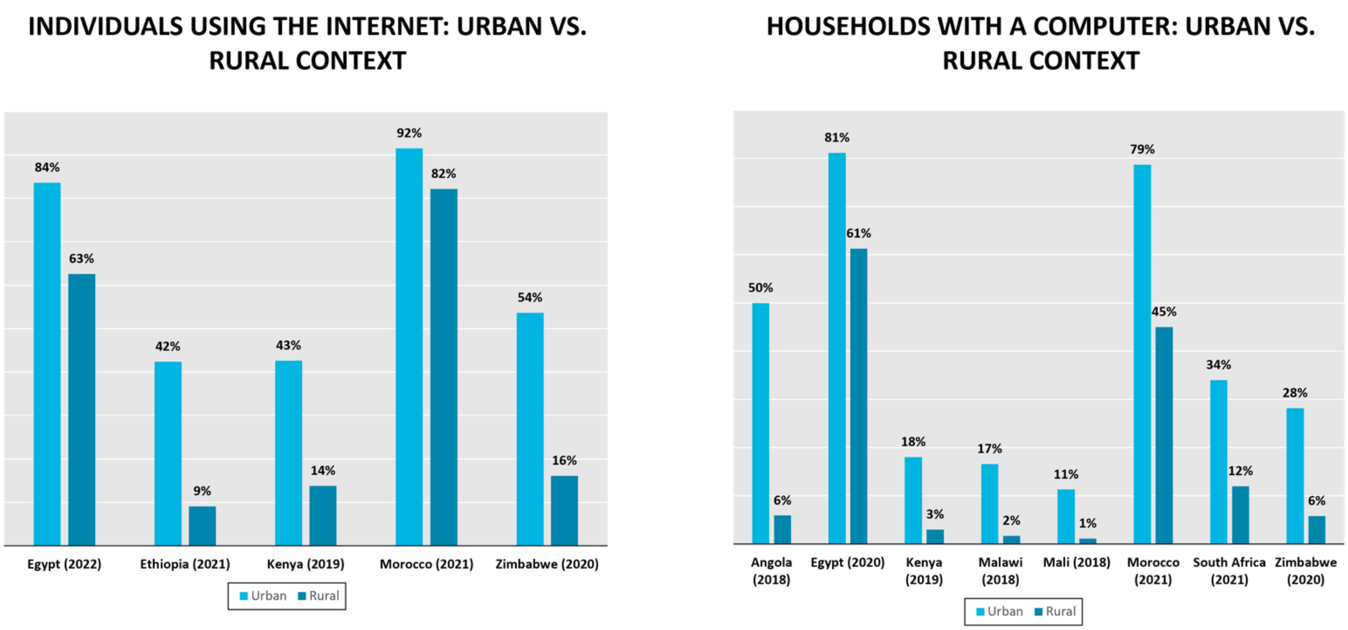
Table 2-14. Africa: Percent of population residing in rural areas (2022)

Angola	32%
Congo Democratic Republic	53%
Egypt	58%
Ethiopia	77%
Ghana	41%
Kenya	71%
Morocco	35%
Mozambique	62%
Nigeria	46%
Rwanda	82%
South Africa	32%
Tanzania	63%
Uganda	74%
Zambia	68%

Source: World Bank, World Development Indicators, https://data.worldbank.org/indicator/SP.RUR.TOTL.ZS?locations=ZG

Populations residing in rural areas are naturally impacted by limited network coverage but also low digital literacy. Both factors influence the difference in internet access and computer use between urban and rural areas, as reflected in multiple national household surveys (graphic 2-5).

Graphic 2-5. African rural vs. urban areas: Information technology adoption



Source: ITU World Telecommunication/ICT Indicators (WTI) Database 2023, in tab "ICT Household Access and Individual Use"; Telecom Advisory Services analysis

To sum up, affordability barriers, pockets of unserved population and limited digital literacy are the three factors explaining the broadband demand gap while the lack of coverage explains the supply gap. Both factors are combined to explain the African digital divide (table 2-15).

Table 2-15. Africa: Drivers of digital divide (2023)

	Population	3G not covered (supply gap)		3G covered but no mobile broadband adoption (demand gap)		Total digital divide
		Percent	Population	Percent	Population	
Angola	37,244,418	6.08%	2,264,461	68.16%	25,384,269	27,648,730
Congo Democratic Republic	103,943,962	25.00%	25,985,991	61.22%	63,635,041	89,621,031
Egypt	113,600,425	1.00%	1,136,004	48.92%	55,568,072	56,704,076
Ethiopia	128,123,390	1.00%	1,281,234	86.80%	111,206,680	112,487,914
Ghana	34,449,754	1.00%	344,498	69.08%	23,796,333	24,140,831
Kenya	55,651,809	1.00%	556,518	62.76%	34,924,415	35,480,933
Morocco	38,025,752	1.00%	380,258	46.69%	17,752,718	18,132,976
Mozambique	34,377,878	24.15%	8,302,258	52.84%	18,165,511	26,467,769
Nigeria	226,478,424	1.00%	2,264,784	69.61%	157,650,878	159,915,662
Rwanda	14,254,797	0.61%	86,954	73.01%	10,407,036	10,493,990
South Africa	60,717,358	0.00%	0	38.49%	23,370,767	23,370,767
Tanzania	68,428,590	15.00%	10,264,289	56.67%	38,781,822	49,046,110
Uganda	49,253,293	5.00%	2,462,665	67.99%	33,486,735	35,949,400
Zambia	20,852,217	10.00%	2,085,222	70.29%	14,656,695	16,741,917
Total	985,402,067	5.83%	57,415,133	63.81%	628,786,973	686,202,106

Source: Telecom Advisory Services analysis

The values in table 2-15 support several conclusions regarding the digital divide in the 14 countries that compose the study sample:

- On average, the primary driver of the digital divide is concentrated in the demand side. While still 5.83% of the population is not covered by 3G (the minimum service required for mobile broadband), 63.81% of those covered do not acquire the service.
- The sum of the supply side and demand side gap indicates that 69.64% of the population of the 14 countries (or 686 million) do not access mobile broadband.
- The largest concentration of population affected by the digital divide is situated in Nigeria (160 million) and Ethiopia (112 million).
- On the other hand, the countries less affected are South Africa (38.49% of the population) and Morocco (46.69%).

2.3. Wireless competition

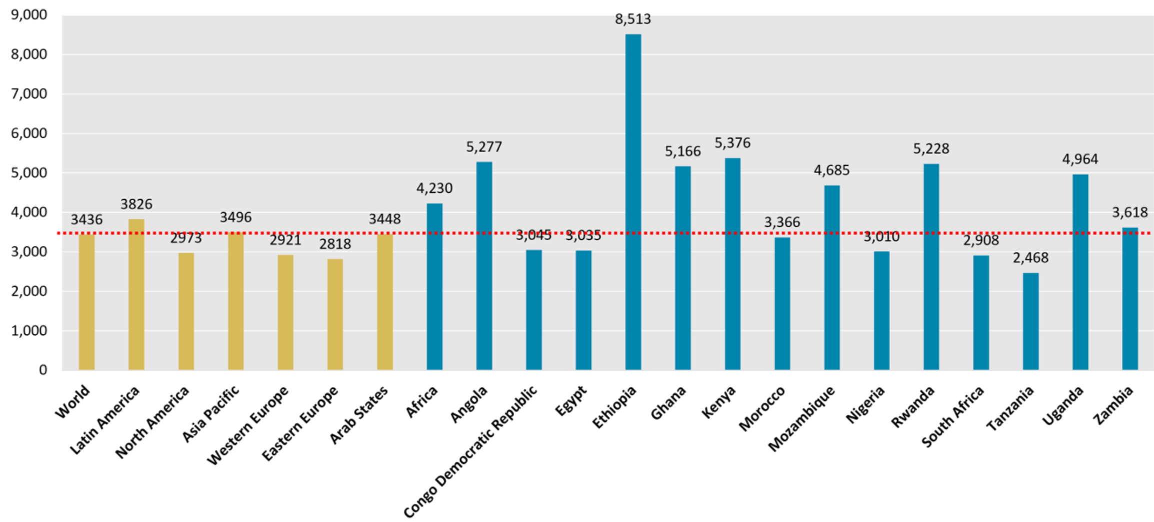
Economic analysis has shown that in capital-intensive industries such as telecommunications, there is an optimal degree of industrial concentration that generates benefits for consumers while ensuring sector sustainability. This postulate is supported for three reasons:

- Significant economies of scale of service providers.
- Operational efficiency of large operators.
- Increased infrastructure investment and deployment capacity.

In this sense, *sustainable competition* allows increasing the stimulus to capital investment to the extent that, in contrast to the open and unrestricted competition model, permits operators to benefit from an adequate rate of return. The argument is based on the premise that a certain level of market power is necessary to stimulate an adequate level of investment and innovation, beyond which the incentives to invest and innovate decline.[31] The degree of industry concentration can be measured using the Herfindahl–Hirschman Index.[32]

Competitive intensity in African countries varies significantly by country: Some countries present a high level of industry concentration while others reveal a too large number of operators. When compared with regional averages, the prorated average of the HHI for Africa is 4,230 (indicating moderate concentration), while some countries exhibit lower than the world average (3,436): Congo Democratic Republic, Egypt, Nigeria, South Africa and Tanzania (graphic 2-6).

Graphic 2-6. Africa vs. world regional averages: Wireless telecommunications Herfindahl–Hirschman Index (0-10,000)



Sources: GSMA Intelligence; Telecom Advisory Services analysis

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[31] This is the same argument that underlies the need for the system of intellectual protection through patents to secure investment and stimulate innovation.

[32] The number of industry players is inversely proportional to industry concentration. This metric is measured by the Herfindahl–Hirschman Index, which equates to the sum of the square of market shares of industry players (on a scale of 0 to 10,000), whereby the higher number indicates high concentration and the lower number depicts higher competitive intensity. The U.S. Horizontal Concentration Guide considers a market to be highly concentrated when the HHI is above 2,500 points. These metrics are based on competition models of advanced economies whose exclusive application does not consider one of the most important principles that should guide the supervision of competition models in emerging countries. The competition model to be defined in the telecommunications industry in emerging countries should aim to maximize the objectives of economic development and equity. Thus, effects such as increased coverage and quality of service, increased affordability for vulnerable populations and support for the digitization of productive processes should be considered in the definition of an optimal level of the HHI, which should be higher than that defined in advanced nations.

In general terms, the wireless industry in the region has moved toward *sustainable competition* during the last decade, closing the gap with high-income economies. When measured by the Herfindahl–Hirschman Index, South Africa and Tanzania depict higher competition than the U.S. or the OECD average. The main regional outliers, despite significant progress, remain Congo Democratic Republic, Ghana, Kenya, Mozambique, Rwanda and Uganda, where concentration remains high (table 2-16).

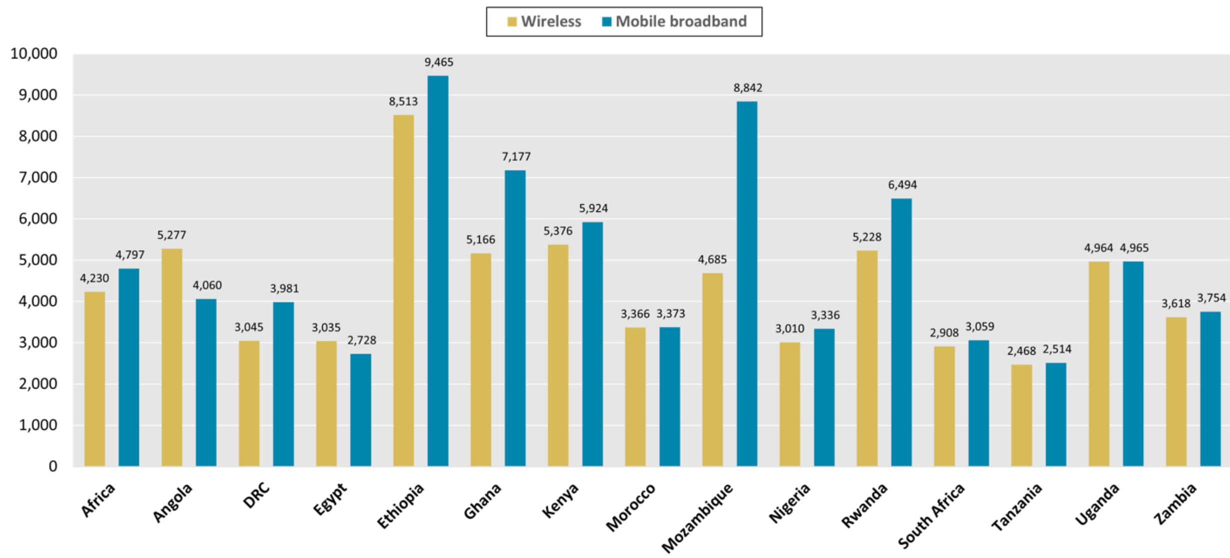
Table 2-16. Wireless services competition and returns

	Competition in wireless broadband (HHI)		ARPU US$ by subscriber	
	2023 broadband	Difference (2018-23)	2023	Difference (2018-23)
Africa (14 countries)	4,694	-348	$3.80	$0.89
Angola	4,060	-3,079	$19.97	$10.77
Congo Democratic Republic	3,981	-1,207	$3.07	$0.89
Egypt	2,728	100	$2.49	$0.95
Ethiopia	9,465	-535	$1.44	$0.31
Ghana	7,177	-1,757	$1.85	$0.61
Kenya	5,924	-1,536	$3.66	-$0.37
Morocco	3,373	-148	$4.66	-$0.87
Mozambique	8,842	-1,158	$3.44	$0.15
Nigeria	3,336	877	$4.44	$1.20
Rwanda	6,494	443	$1.88	$0.60
South Africa	3,059	-494	$5.21	$0.12
Tanzania	2,514	-1,690	$1.51	-$0.74
Uganda	4,965	1,186	$2.94	$0.41
Zambia	3,754	205	$2.45	$0.59
BENCHMARKS				
United States	3,067	184	$45.43	$2.57
Canada	2,246	-488	$39.12	-$1.41
United Kingdom	2,156	-607	$15.45	-$1.55
South Korea	3,366	-1,786	$22.89	$0.56
Philippines	3,668	-1,338	$2.01	-$0.13
OECD	3,138	-391	$22.02	$0.42

Sources: IMF WEO Database; GSMA Intelligence; Telecom Advisory Services analysis

When calculated against wireless broadband, market concentration increases in the DRC, Ethiopia, Ghana, Kenya, Mozambique, Nigeria, Rwanda, South Africa and Zambia given that there are fewer players actively offering service (graphic 2-7).

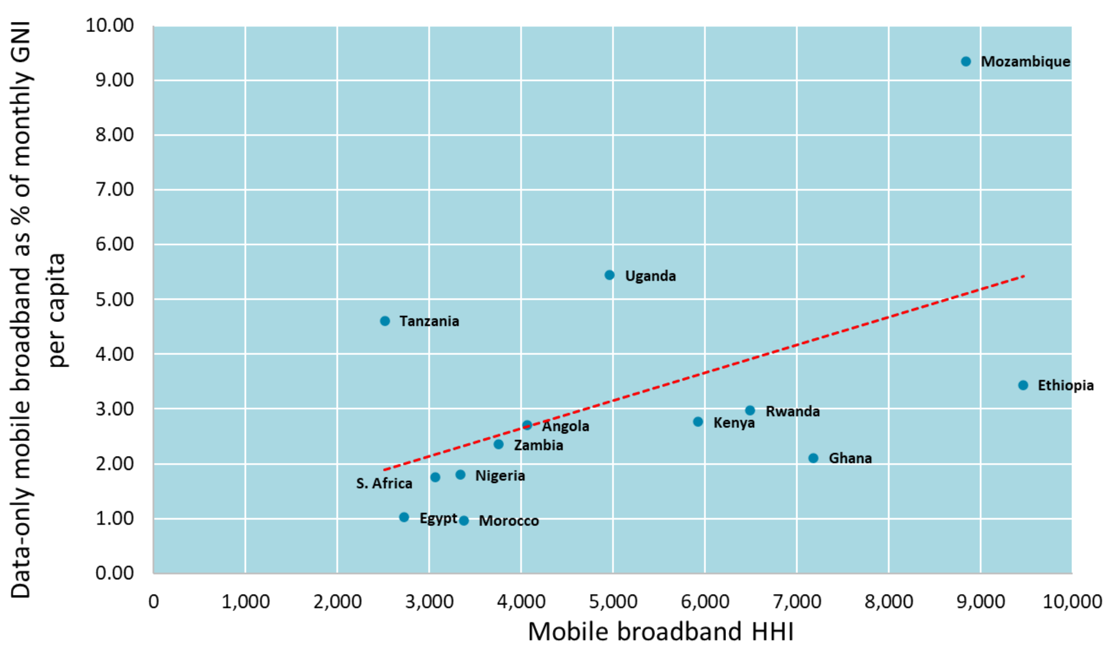
Graphic 2-7. Africa: Herfindahl–Hirschman Index of wireless telecommunications and mobile broadband



Sources: GSMA Intelligence; Telecom Advisory Services analysis

Except for Angola and Egypt, the market concentration increases when the HHI is calculated against mobile broadband market shares. As expected, higher industry concentration in mobile broadband is associated with higher prices for service offering (graphic 2-8).

Graphic 2-8. Africa: Wireless broadband Herfindahl–Hirschman Index vs. 4G pricing as percent of monthly GNI per capita (2022)



Sources: ITU World Telecommunication/ICT Indicators (WTI) Database 2023, in tab "ICT Household Access and Individual Use"; GSMA Intelligence; Telecom Advisory Services analysis

However, many countries exhibit an unsustainable wireless market structure anticipating further consolidation, as indicated by numerous recent exits (table 2-17).

Table 2-17. Africa: Wireless telecommunications market structure

	Number of operators	Wireless telecoms HHI	Exit/reduced market expectations
Angola	3	5,277	Delay of UNITEL privatization until 2025 (2023)
DRC	5	3,045	Smile is undergoing a restructuring plan due to non-financial viability (2022)
Egypt	4	3,035	Government is considering selling an additional stake of Telecom Egypt (4Q23)
Ethiopia	2	8,513	• No bidders for Ethiopia second wireless license (11/2023) • Orange pulled out of plans to acquire 45% of Ethio (11/2023) • No bidders for third telecom license (11/2023)
Ghana	5	5,166	• Exit of Expresso and Glo • Exit of Blu in 2Q21 • Airtel Tigo sold to the government • Vodafone sold 70% of Vodafone Ghana to the Telecel Group
Kenya	4	5,376	Telkom in default to American Tower
Mozambique	2	4,685	
Morocco	3	3,366	
Nigeria	9	3,010	Smile is undergoing a restructuring plan due to non-financial viability (2022)
Rwanda	3	5,228	Tigo acquired by AXIAN (1Q18)
South Africa	5	2,908	• Cell-C dismantled its network and sharing with MTN • Telkom South Africa ended talks with Axian/Afrifund consortium for selling of controlling interest • Exit by MVNO Lyca Mobile due to non-viability of business
Tanzania	7	2,468	SMART closed in 3Q19
Uganda	5	4,964	• AFRICELL closed 4Q21 • Under-subscription of AIRTEL IPO (11/2023) • Vodafone (AFRIMAX) closed in 2Q18 • Smile is undergoing a restructuring plan due to non-financial viability (2022)
Zambia	3	3,618	Vodafone (AFRIMAX) closed in 4Q19

Sources: GSMA Intelligence; Telegeography Communications Development; Development Telecoms, retrieved in: newsletter@developingtelecoms.com

2.4. Wireless capital spending

African wireless operators invest a prorated US$6.27 per capita, which is significantly below the world average and even several developing countries (table 2-18).

Table 2-18. Wireless CAPEX per capita (2023)

World	**$23.72**
Africa*	$6.27
Sub-Saharan Africa**	$7.04
North Africa***	$7.17
Latin America and Caribbean	$17.91
North America	$134.18
Asia Pacific	$15.12
Western Europe	$45.83
Eastern Europe	$21.06
Arab States	$19.47
African countries in study sample	$5.85
BENCHMARKS	
OECD	$68.36
United States	$141.07
Canada	$75.63
United Kingdom	$50.66
South Korea	$69.32

* Includes all the countries in the continent.
** Prorated average of Angola, Benin, Botswana, Burundi, Cameroon, Cote d'Ivoire, Kenya, Madagascar, Mozambique, Nigeria, Senegal, South Africa, Tanzania, Uganda, Zambia and Zimbabwe.
*** Prorated average of Algeria, Egypt, Morocco and Tunisia.
Sources: GSMA Intelligence; International Telecommunication Union ICT Price Baskets, historical data series, Apr 2023 release, https://www.itu.int/en/ITU-D/Statistics/Pages/ICTprices/default.aspx in folder "Download the historical data 2008-2022"; Telecom Advisory Services analysis

Not only is investment in the United States 24 times higher than the average of the 14 African economies (US$141.07 per capita vs. US$5.85 in 2023 in table 2-18), but it has also increased significantly, in line with a more intense use and uses of connectivity in the U.S. As expected, CAPEX per capita in the 14 countries under study is significantly low. Furthermore, it exhibits significant annual fluctuations reflecting capital availability obstacles of some operators. Except for South Africa and Morocco, all countries remain below US$10 per capita (table 2-19).

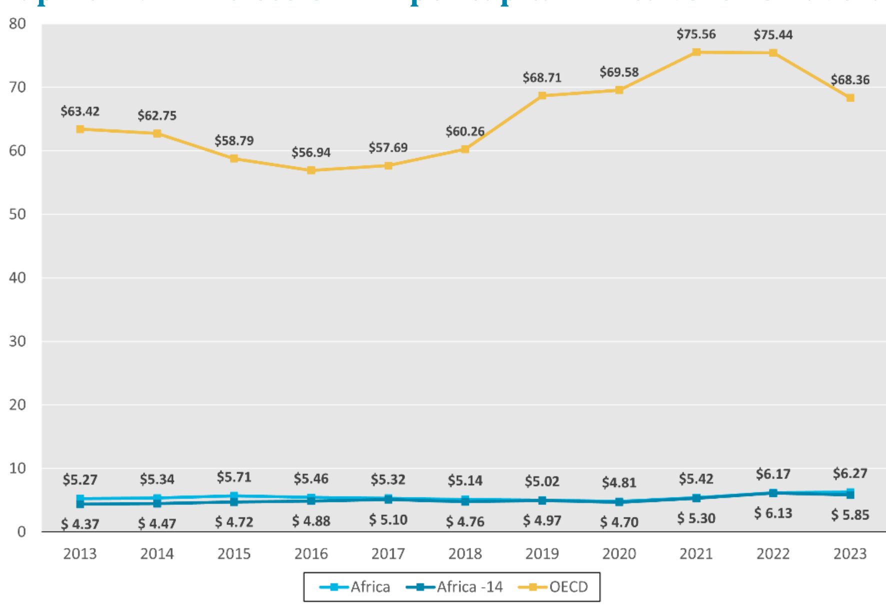
Table 2-19. Africa: Wireless CAPEX per capita (2013-2023)

Countries	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Africa	$5.27	$5.34	$5.71	$5.46	$5.32	$5.14	$5.02	$4.81	$5.42	$6.17	$6.27
Angola	$2.43	$3.06	$3.14	$3.94	$3.50	$1.70	$2.52	$3.90	$4.14	$3.20	$4.31
Congo Dem. Rep.	$1.17	$1.47	$1.16	$1.15	$1.38	$1.59	$1.93	$1.96	$2.29	$2.13	$2.29
Egypt	$2.55	$2.64	$2.56	$3.27	$3.65	$3.06	$3.11	$3.87	$3.90	$4.33	$4.04
Ethiopia	$1.20	$1.27	$1.29	$1.20	$0.58	$0.60	$0.91	$1.23	$2.84	$4.07	$2.29
Ghana	$3.72	$4.35	$4.34	$4.13	$5.79	$5.59	$4.98	$4.12	$5.06	$6.07	$7.84
Kenya	$5.58	$7.10	$6.80	$5.70	$5.39	$6.36	$5.73	$5.81	$6.04	$5.20	$5.71
Morocco	$19.18	$17.80	$21.12	$21.74	$22.83	$15.54	$15.89	$11.38	$14.29	$16.06	$15.01
Mozambique	$4.14	$8.12	$3.77	$4.82	$4.41	$4.51	$4.46	$4.43	$4.18	$3.74	$3.47
Nigeria	$3.21	$2.08	$1.39	$2.20	$3.58	$3.83	$3.81	$4.20	$4.66	$5.40	$6.04
Rwanda	$2.14	$2.80	$2.95	$2.11	$2.33	$1.59	$2.07	$1.85	$1.64	$1.87	$1.87
South Africa	$16.76	$16.31	$21.38	$22.86	$22.08	$21.56	$23.20	$19.29	$20.97	$26.36	$24.43
Tanzania	$2.61	$4.22	$4.67	$3.57	$2.85	$3.00	$3.56	$2.79	$2.67	$2.43	$3.03
Uganda	$1.80	$2.58	$3.35	$2.72	$2.65	$2.79	$3.43	$3.14	$3.37	$6.09	$3.56
Zambia	$3.10	$3.06	$6.45	$3.02	$2.79	$3.51	$3.28	$3.95	$4.00	$4.88	$3.54
Africa - 14	$4.37	$4.47	$4.72	$4.88	$5.10	$4.76	$4.97	$4.70	$5.30	$6.13	$5.85

Countries with year-on-year reduction
Source: GSMA Intelligence; Telecom Advisory Services analysis

There are certain environmental conditions that make it natural for capital spending levels in advanced economies to be higher. These are countries with higher per capita income, where carriers have a greater capacity to finance and make investments profitable. That being said, a matter of concern remains that, beyond the structural differences, the investment gap between Africa and other regions over the last decade is widening rather than narrowing (graphic 2-9).

Graphic 2-9. Wireless CAPEX per capita: Africa vs. OECD average



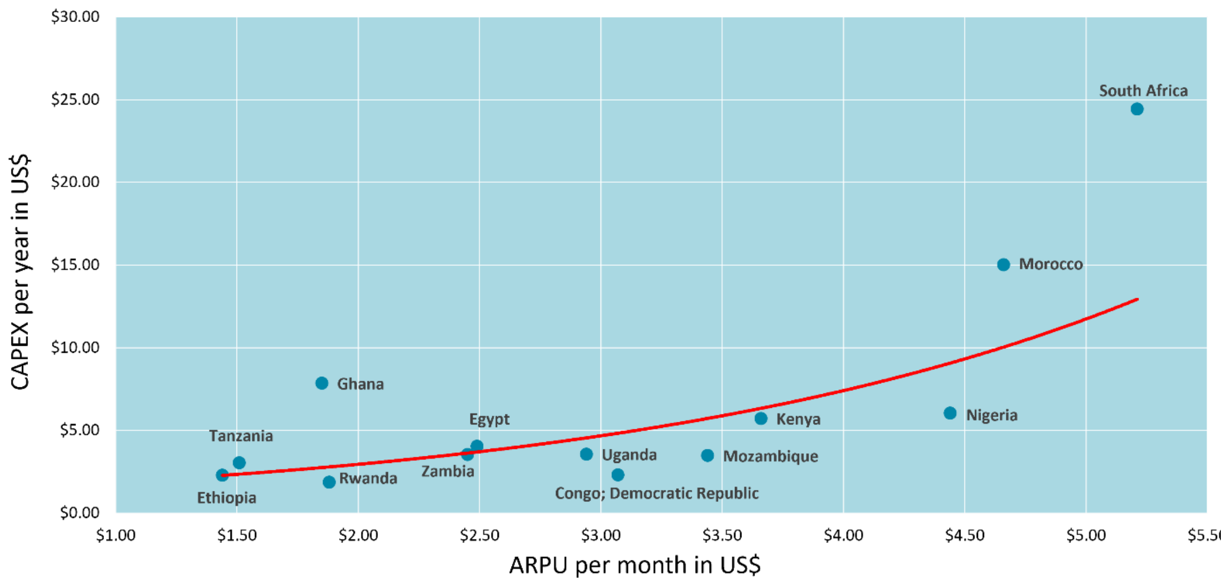
Sources: GSMA Intelligence; Telecom Advisory Services analysis

Increasing competition and falling ARPUs are two ingredients of the low investment (measured by operators CAPEX) in the wireless industry in Africa. Frequently, carriers invest in migrating their networks to 4G but they do not increase their revenues to compensate for the additional spending. In addition, ARPU is under pressure by low-cost service providers.[33]

On average, the CAPEX by revenue ratio for Africa is 15.9%, which is a financially sustainable metric. However, in some countries the ratio appears to be well beyond a financially sustainable standard: in Angola it is 33.1%, Botswana 22.6%, Congo 31.7%, Gabon 39.5%, Niger 26.5% and Nigeria 25.1%.[34]

In the aggregate, the lower ARPUs, the less CAPEX (graphic 2-10).

Graphic 2-10. Africa: Wireless ARPU vs. mobile CAPEX (2021)



Sources: GSMA Intelligence; Telecom Advisory Services analysis

In addition, lower capital spending in some countries is driven by unsustainable competition. Moderate competition is conceived as the model that allows the stimulus to capital investment to be increased to the extent that, in contrast to the open and unrestricted competition model, the operator can assume an adequate rate of return. This is based on the premise that a certain level of market power is necessary to stimulate an adequate level of investment and innovation[35] from the seminal work of Philippe Aghion and his collaborators on the concept of the so-called "inverted U."[36] This establishes that the relationship between

[33] See the case of Halotel in South Africa.
[34] Source: Calculations from GSMA Intelligence.
[35] This is the same premise that underpins the need for the system of intellectual protection through patents to secure investment and stimulate innovation.
[36] Aghion, P., Bloom, N., Blundell, R. Griffith, and Howitt, P. "Competition and Innovation: And Inverted-U Relationship." *Quarterly Journal of Economics* 120(2) (2005): 701-728. Actually, the idea of the inverted-U

competition and innovation is not linear, but rather resembles an inverted "U" that describes that innovation and investment increase with the growth of competition up to an optimal point of moderate competition, after which, if competition intensifies, the incentive to innovate (and therefore to invest, as an intermediate variable) begins to diminish. The reason for this dynamic relationship is that, if the expectation of higher profitability is the cause of the incentive to innovate, the indiscriminate increase in competition (and the consequent reduction in profitability) reduces the incentive to innovate. The objective is to determine the optimal point of competition that maximizes the incentives to innovate and invest.

Based in part on high economies of scale, competition among a limited number of vertically integrated operators would be moderate and therefore close to the optimal concentration point that maximizes investment and innovation. Even if competition is known to be an important factor in market dynamics to promote investment and innovation, the nature of the telecommunications sector (with large fixed and sunk costs) makes this relationship complex. Returning to the optimal point of industry concentration argued by the "inverted U" theory, economic research has sought to determine what is the optimal number of participants in a market that maximizes static (pricing) and dynamic (innovation) efficiencies while ensuring a certain degree of profitability for the sector. Starting with Selten, who stipulated that "four is too few and six is too many,"[37] the range has been progressively revised over the years until Huck et al. lowered such thresholds, stating that four players may be too many (i.e., could lead to a suboptimal market outcome).[38] Consequently, the optimal market structure in the telecommunications sector, in terms of maximizing consumer surplus, economic impact and industry sustainability, is approximately three infrastructure operators. This number of players ensures sufficient competitive intensity to generate a maximum amount of consumer welfare (lower prices, but more importantly, good services). Therefore, the "inverted U" theory helps clarify the link between the number of firms and the generation of economic efficiencies.

Empirical evidence supports this. For example, for mobile telecommunications, Friesenbichler has found an inverse-U relationship between concentration and investment, claiming that there is an optimal level of concentration.[39] In particular, he argues that, in fragmented markets, a higher level of concentration may be desirable to encourage investment. Similarly, Houngbonon and Jeanjean[40] find a U-inverted relationship between

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relationship between competition and innovation was first identified by Scherer, F. "Market Structure and the Employment of Scientists and Engineers." *American Economic Review*, 57(3) (1967): 524-531.

[37] R. Selten, *A simple model of imperfect competition, where 4 are few and 6 are many*. Inst. f. Math. Wirtschaftsforschung and. Univ. Bielefeld, 1973.

[38] S. Huck, H.T. Normann, and J. Oechssler. Two are few and four are many: number effects in experimental oligopolies. *Journal of economic behavior & organization*, *53*(4) (2004): 435-446.

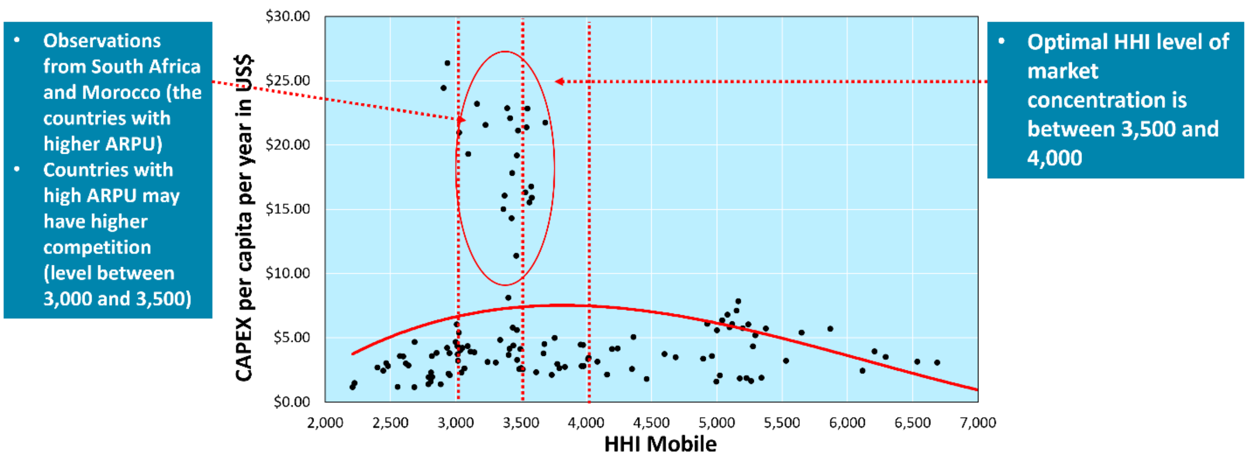
[39] Friesenbichler, K. S. (2007). *Innovation and Market Concentration in Europe's Mobile Phone Industries. Evidence from the Transition from 2G to 3G* (No. 306). WIFO Working Papers.

[40] Houngbonon, G. V. and Jeanjean, F. "What Level of Competition Intensity Maximizes Investment in the Wireless Industry? *Telecommunications Policy* 40(8) (2016): 774-790.

the margin obtained by mobile operators and the level of investment, with a sample of 2,770 observations for the period 2005-2012. According to the authors, investment is maximized when gross profits represent between 37% and 40% of operators' revenues. These thresholds can be expected to be higher in the case of countries with a higher level of risk (e.g., exchange rate), as in Latin American countries. On the other hand, Genakos et al. analyze the impact of the number of operators in the mobile market, the entry and exit of operators, as well as the effect of the degree of concentration on investment, using OECD data for the period 2006-2014.[41] The evidence found by the authors suggests that a 10% increase in the HHI increases investment per operator by more than 20%. Meanwhile, Jeanjean (2013) found evidence that when competitive intensity is very high, firms may invest below desirable amounts, because the expectation of returns on investment is deteriorated.[42] Kang et al.[43] have found a positive relationship between market concentration and investment level in the mobile segment in China.

The annual values of the Herfindahl–Hirschman Index and annual CAPEX per capita between 2013 and 2023 for the 14 African countries under study indicate the existence of an inverted "U" (graphic 2-11).

Graphic 2-11. African countries: CAPEX per capita vs. HHI mobile telecommunications (2013-2023)



* Ethiopia is excluded as it was a monopoly until 2021, with low CAPEX per capita.
Sources: GSMA Intelligence; Telecom Advisory Services analysis

From graphic 2-11 it is evident that the inverted U is present in Africa, also confirming the existence of an optimum concentration level. The series reaches its maximum at the level between 3,500 and 4,000. Linked to the optimal level of concentration, another relevant

[41] Genakos, C., Valletti, T., & Verboven, F. "Evaluating market consolidation in mobile communications." *Economic Policy*, *33*(93) (2018), 45-100.
[42] Jeanjean, F. "Incentives to Invest in Improving Quality in the Telecommunications Industry." *Chinese Business Review*, *12*(4) (2013): 223-241.
[43] Kang, F., Hauge, J. A., and Lu, T. J. "Competition and Mobile Network Investment in China's Telecommunications Industry." *Telecommunications Policy* 36(10-11) (2012): 901-913.

aspect is the number of operators that maximizes the dynamic efficiencies of a market, which is usually set at three. The exceptions to the model are South Africa and Morocco, two countries where higher ARPUs warrant the highest level of CAPEX at less concentration levels (between 3,000 and 3,500).

Considering the need to fund the complete rollout of 4G and the deployment of 5G, Africa's lag in terms of capital investment is a worrying factor. Regardless of future projections, the situation in 2020 in terms of the comparative deployment of next-generation technologies confirms that the lag in investment translates into a gap in the deployment.

2.5. Conclusions

To conclude, despite the remarkable progress, it is important to highlight the high degree of heterogeneity in the development of Africa's wireless industry. Among the positive trends are:

- Nearly total deployment of 3G (only Congo Democratic Republic, Mozambique and Tanzania are below 90%).
- High coverage of 4G in most countries, closing the gap with advanced economies (8 of the 14 countries have coverage higher than 95%).
- Some advances in 5G deployment in South Africa, Tanzania, Nigeria and Zambia.
- High adoption fueled by affordability in high- and middle-income countries (Angola, Egypt, Morocco and South Africa).
- Increasingly competitive wireless sector in most countries is driving wireless broadband prices down in many countries.

Regarding the challenges:

- Remaining coverage gaps in Angola, Congo Democratic Republic, Mozambique, Nigeria, Tanzania and Uganda.
- Embryonic development of 5G with several economic challenges.
- Limited coverage and wireless broadband adoption in rural areas.
- Low service penetration driven by limited affordability principally in the Democratic Republic of the Congo, Mozambique, Uganda, Tanzania and Ethiopia.
- Over-fragmentation of wireless service providers creates unsustainable competition in Tanzania, Uganda, South Africa, Nigeria, Ghana and the DRC.
- CAPEX limited by low ARPU and unsustainable competition.

Along these lines, a factor instrumental in the positive developments of the industry has been passive infrastructure sharing as a way of controlling capital spending and operating expenditure. Chapter 3 analyzes econometrically the causal relation between passive infrastructure and the different indicators of industry performance.

3. PASSIVE INFRASTRUCTURE SHARING: A CRITICAL ENABLER OF THE AFRICAN WIRELESS TELECOMMUNICATIONS INDUSTRY DEVELOPMENT

Passive infrastructure sharing of telecommunications infrastructure can be fulfilled through multiple operating and business models.[44] In the wireless segment, at its most basic level, it entails the sharing of the geographic location of stations, whereby all network components at the site belong to each operator. This model essentially saves the cost of leasing or purchasing a site, although it is difficult sometimes to find a fixed location that suits all operators. The next level of wireless passive sharing involves towers, where each operator deploys its own equipment and has control over it. In this case, while the sharing agreement is signed between two or more operators, they might include third-party independent companies acting as neutral hosts. Costs can be significantly reduced when operators share physical assets and transport networks. In this scenario, sharing can be managed by the site owner, who acts as a landowner for the operators who lease the site. The owner may be an operator sharing the site or an independent tower company that provides the infrastructure. In the wireline sector, passive sharing could include the use of ducts provided by an infrastructure operator (electric utility, water company, subways, etc.) or a pole from an electric utility that charges a fixed amount by pole attachment.

The rationale for infrastructure sharing is quite straightforward. Its economic justification has already been validated by empirical research. For example, Claussen et al. examined how outsourcing of a core service affects firm performance in the context of the mobile telephony industry, covering 50 mobile network operators in 28 countries during 2000-2009.[45] The authors found that mobile network operators decrease costs, increase revenues and improve their profitability by outsourcing mobile network operation services. In cumulative terms, up to four years after the outsourcing agreements were implemented, the ratio of Earnings Before Income Taxes and Depreciation (EBITDA) to revenues increases by about eight

[44] Passive sharing refers to the sharing of physical space, for example by buildings, sites, masts, cabinet or power, where networks remain separate. Active sharing extends to the electronic components of the network and the radio spectrum, according to different models. Under the radio access network (RAN) model, the shared equipment includes base stations, Node B, base station and radio network controllers, and may extend to feeder cables and antennas, leaving the transmission network and the core network to be operated independently. Under this model, operators control the cells in their core network and have a separate operation. The backhaul sharing model adds a transmission channel to the shared RAN infrastructure. This approach is useful to accelerate deployment and focus on providing quality services. Under the backhaul sharing scenario, several options exist: the backhaul can be deployed by a joint venture of the participating mobile operators or by a third party that would deploy and operate the infrastructure and offer it to the operators through a "platform as a service" model. The highest level of sharing is that of core network sharing, where the Home Location Register, the billing platform and the value-added systems can be shared. See: Berec (2018). *Berec report on infrastructure sharing*. BoR (18) 116. https://www.berec.europa.eu/sites/default/files/files/document_register_store/2018/6/BoR_%2818%29_116_BEREC_Report_infrastructure_sharing.pdf.

[45] J. Claussen, T. Kretschmer and D. Oehling. *Performance implications of outsourcing in the mobile telecommunications industry* (2012). SSRN-id1997390.

percentage points. In the review of empirical literature on outsourcing IT management and its impact on telecom operations — a concept more akin to active infrastructure sharing — Patil and Patil confirm evidence on the impact of infrastructure sharing on savings in operating expenditures, investment, competitive position, and risk and returns (among many others).[46] The GSMA added to these same strategic and commercial effects, offering a positive contribution to improving environmental sustainability.[47]

More recently, Houngbonon et al. put forward an analysis showing how infrastructure sharing can accelerate digital connectivity at lower cost (especially in the least developed markets where returns to investment can be limited), reduce investment costs and operating expenses for investors and operators, and increase their balance sheet sustainability, while also benefiting consumers by enhancing competition, lowering prices and raising service quality.[48] Similarly, Cabello et al. even projected that infrastructure sharing would increase by up to 16 percentage points by 2030, driven on the one hand by the growing market share of infrastructure companies (naturally more prone to sharing than mobile network operators), which is expected to reach over 67% for total sites; and on the other hand by a higher level of network sharing as public spaces become more easily available and agreements are made with other sectors, such as utilities.[49] Along those lines, Wang and Sun, focusing on the China's mobile telecommunications industry, showed that telecommunication infrastructure sharing promotes the total industry network investment.[50] Along those lines, Houngbonon et al. demonstrated through a difference-in-differences approach that the acquisition of towers by independent companies from mobile operators led to a significant reduction in the price of mobile connectivity and, consequently, an increase in adoption of mobile broadband.[51] Similarly, Katz et al. demonstrated based on microdata analysis of Latin America broadband access that network sharing in rural areas is associated with an increase in fixed broadband adoption from 20% per household to 30.30%.[52]

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[46] Patil, S. and S. Patil. A review of outsourcing with a special reference to telecom operations. *Procedia-Social and Behavioral Science*. 133 (2013): 400-416.

[47] GSMA (2018). *Enabling Rural Coverage Regulatory and policy recommendations to foster mobile broadband coverage in developing countries*. Tech. rep.

[48] Houngbonon, G, Rossotto, C., and Strusani, D. *Enabling a Competitive Mobile Sector in Emerging Markets Through the Development of Tower Companies*. EM Compass Note 104 (June 2021), Washington, D.C.: International Financial Corporations.

[49] Cabello, S., Rooney, D., and Fernandez, M. *Nuevas dinámicas de la gestión de infraestructura en América Latina*. SMC+, 2021.

[50] L. Wang, L. and Q. Sun. (2022). *Market Competition, Infrastructure Sharing, and Network Investment in China's Mobile Telecommunications Industry*. https://www .mdpi.com/2071-1050/14/6/3348.

[51] Houngbonon, G., Ivaldi, M., Palikot, E., Strusani, D. *The impact of shared telecom infrastructure on digital connectivity and inclusion*. Toulouse School of Economics Working Paper No. 1427, April 2023.

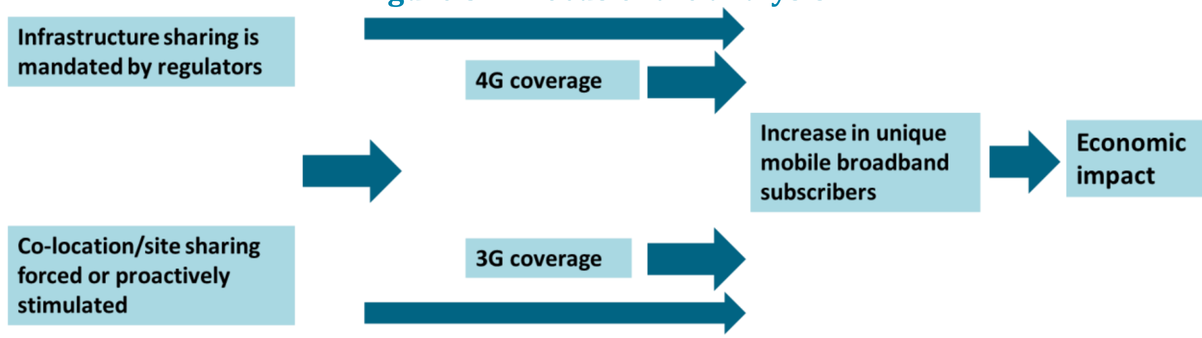
[52] Katz, R., Callorda, F., Iglesias Rodriguez, E., Puig Gabarro, P., Dalio, M., García Zaballos, A. *Impacto del uso compartido de infraestructura en la adopción de tecnologías digitales*. Washington, DC: Banco Interamericano de Desarrollo, 2023.

The focus of this chapter is to add to the empirical literature, demonstrating that passive infrastructure regulation has an impact on the development of the wireless industry in Africa and, in turn, to economic development. We first introduce the theoretical framework and describe the data upon which the analysis will be based. Following this, we present the results of the empirical modeling and, on these bases, discuss the implications.

3.1. Theoretical framework

As mentioned, the objective of this analysis is to demonstrate the relationship between improved infrastructure sharing regulation and ultimately economic performance (figure 3-1).

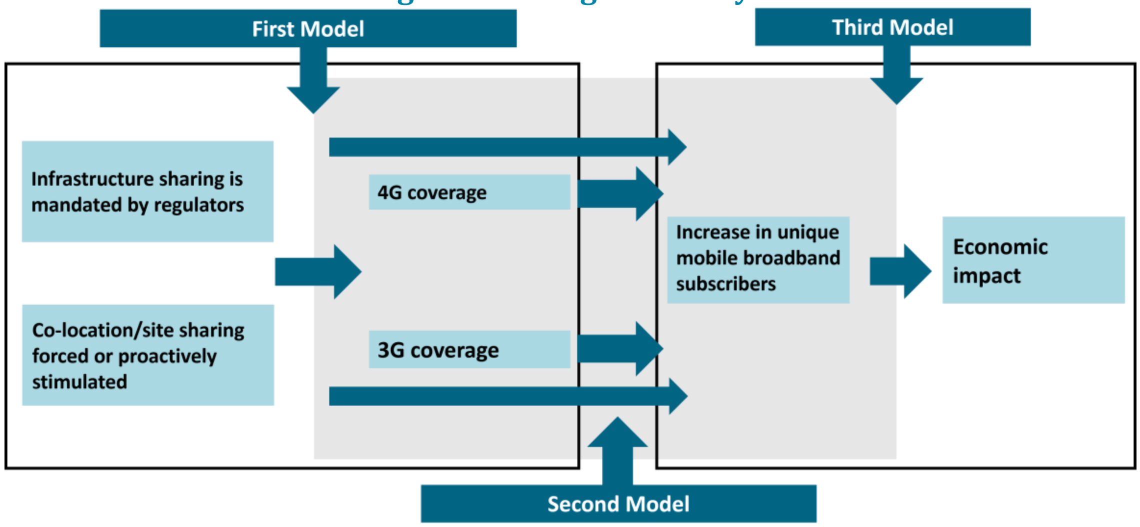
Figure 3-1. Focus of the analysis



Source: Telecom Advisory Services

To show this causal relationship, we divide the problem into stages. First, we analyze the relationship between a regulation that mandates infrastructure sharing by the regulator or that forces or proactively encourages site sharing and the level of 3G/4G coverage (first model). Then, in a second stage, the relationship between an increase in 3G/4G coverage and an increase in unique mobile broadband users is quantified (second model). Finally, the relationship between an increase in the number of unique mobile broadband users and an enhancement in economic indicators (third model) is estimated (figure 3-2).

Figure 3-2. Stages of analysis



Source: Telecom Advisory Services

The first model relies on information published by the International Telecommunication Union (ITU) in the "ICT Regulatory Tracker." This database presents information from 2007 to 2022, compiled from answers to questionnaires sent annually to regulators in each country on various regulatory issues. Based on the responses to these questionnaires, the ITU codes the results for each question at two levels:

- No: 0.
- Yes: 1.

Out of the universe of available questions, we only consider those that cover the subject of infrastructure sharing:

1. Is infrastructure sharing (towers, radio bases, poles, ducts, etc.) mandated or proactively encouraged?
2. Is co-location/site sharing forced or proactively stimulated?

The first question refers to the presence or not of infrastructure sharing, which is a step ahead of operators who simply share their sites, and involves sharing more passive components such as towers, base stations, poles, ducts and facilities maintenance, as well as increasing the productivity of resource use. The second question is focused on co-location/site sharing, which is the simplest form of sharing and refers to the allocation of some passive network equipment at the same site. As a result, wireless operators share the same physical complex and install masts, antennas, cabinets and backhaul at separate sites.

In terms of quantitative analysis, we chose to work with two alternative model specifications:

- In the first model, only Question 1 was used to identify the impact of infrastructure sharing.
- In the second model, only Question 2 was used to identify the impact of co-location, the simplest form of sharing.

We aim to estimate the impact of both variables on coverage (3G and 4G). In the second model, we seek to identify the impact that may arise from sharing through channels other than increased coverage, such as improvements in affordability or service quality that will stimulate the adoption by new users.

The countries included in the analysis are the 14 African countries in the study sample: Angola, DRC, Egypt, Ethiopia, Ghana, Kenya, Morocco, Mozambique, Nigeria, Rwanda, South Africa, Tanzania, Uganda and Zambia. The analysis period covers the period from 2010 to 2022,[53] for a total of 182 observations.

Based on these data, the first econometric model proposes to evaluate the relationship between the answer to the question of infrastructure sharing mandate or co-location/site sharing being forced or proactively encouraged and the level of 3G/4G coverage in each country (based on GSMA Intelligence data). For this purpose, we specify a simple regression that determines the effect on the level of 3G/4G coverage of residing in a country with infrastructure sharing or co-location/sharing (treatment):

$$Coverage\ 3G/4G = \beta_0 + \beta_1 . Treatment_{it} + Area_i + \beta_4 . X_{it} + \mu_{it} \quad (1)$$

Where,

- Coverage 3G/4G: percentage of population covered by 3G/4G.[54]
- Treatment:
  - 1 where ITU data indicates that infrastructure sharing (towers, radio bases, poles, ducts, etc.) is mandated//site co-location is obliged forced or proactively stimulated.
  - 0 if policy does not exist.
- Area: fixed effect for each country included in the regression.
- X: GDP per capita for control purposes.

[53] Despite the existence of data since 2007 in the ITU database, only data from 2010 are considered, as inconsistencies were found in the dataset in the prior years.
[54] GSMA Intelligence.

Moving onto the second model of analysis, which seeks to quantify the relationship between an increase in 3G/4G coverage and an increase in unique mobile broadband users, the following regression model is proposed:

$$ln(Unique\ MBB\ Adoption) = \beta_0 + \beta_1.Treatment_{it} + \beta_2.ln\ Coverage\ 3G_{it} + \beta_3.ln\ Coverage\ 4G_{it} + \beta_4 Area_i + \beta_5 Year_t + \beta_6.X_{it} + \mu_{it}$$

Where,

- Unique MBB adoption: unique mobile broadband subscribers for countries and years with at least 10% of adoption.[55]
- Treatment:
  - 1 where ITU data indicates that infrastructure sharing (towers, radio bases, poles, ducts, etc.) is mandated//site co-location is obliged forced or proactively stimulated.
  - 0 if policy does not exist.
- Coverage 3G/4G: percentage of population covered by 3G/4G.[56]
- Year: fixed effect for each year included in the regression.
- X: GDP per capita used for control purposes.

Finally, to estimate the relationship between an increase in the number of unique mobile broadband users and an improvement in economic indicators (third model), the elasticity coefficients of the model included in Katz et al. are used.[57]

3.2. Econometric model results

This section presents the results of the econometric models presented in the previous section in a sequential fashion.

Impact of infrastructure sharing on 3G/4G coverage

We first present the results of the econometric regressions that analyze the relationship between a regulation that mandates infrastructure sharing or proactively forces or stimulates site sharing and the level of 3G/4G coverage (figure 3-3).

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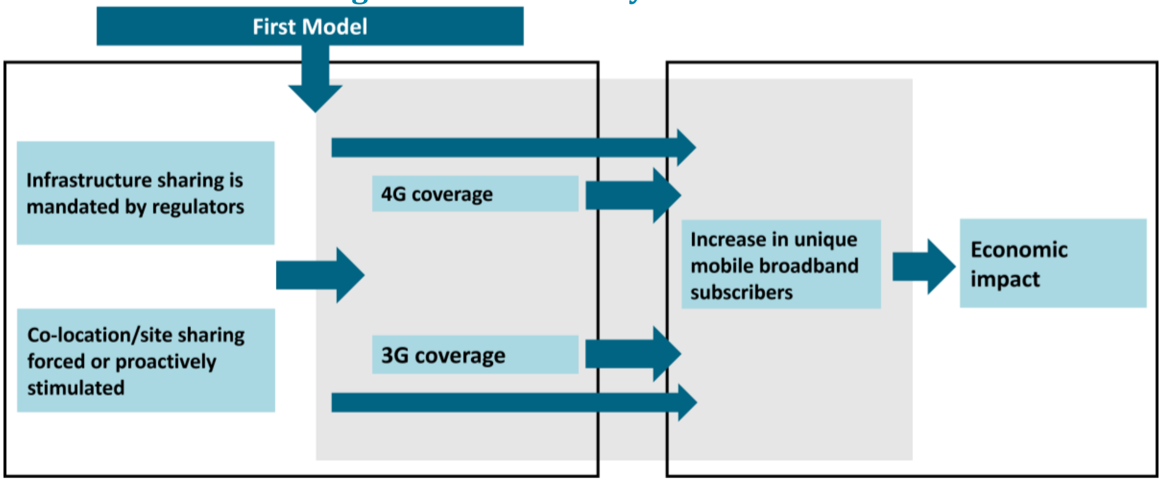
[55] GSMA Intelligence.
[56] GSMA Intelligence.
[57] R. Katz., F. Callorda, and J. Jung. *The impact of digital transformation on the economy - Econometric Modelling.* (Geneva: International Telecommunication Union, 2024).

Figure 3-3. First analysis module



Source: Telecom Advisory Services

The first model tests the impact of the introduction of treatment (understood as the regulation that mandates infrastructure sharing or forces or stimulates the co-location or sharing of sites). The model estimates that in countries where site co-location is obliged or stimulated, 3G coverage is 24 percentage points higher while 4G coverage is 33 percentage points higher. The result is higher for mandated sharing: 52 percentage points for 3G and 53 percentage points for 4G (table 3-1).

Table 3-1. Econometric models to estimate the effect on 3G/4G coverage of sharing infrastructure regulation

Coverage	3G		4G	
	(a)	(b)	(a)	(b)
Sharing mandated	0.5196***		0.5279***	
	(0.1027)		(0.1625)	
Site co-location		0.2438***		0.3281***
		(0.0662)		(0.1014)
Ln (GDP per capita)	0.3690***	0.3083***	0.3829***	0.3172**
	(0.0810)	(0.0832)	(0.1283)	(0.1275)
Fixed effects	Country	Country	Country	Country
Years	2010-2022	2010-2022	2010-2022	2010-2022
Countries	14	14	14	14
Observations	182	182	182	182
R^2	0.4922	0.7009	0.2233	0.3255

Note: ***, **, * significant at 1%; 5% and 10% respectively.
Source: Telecom Advisory Services analysis

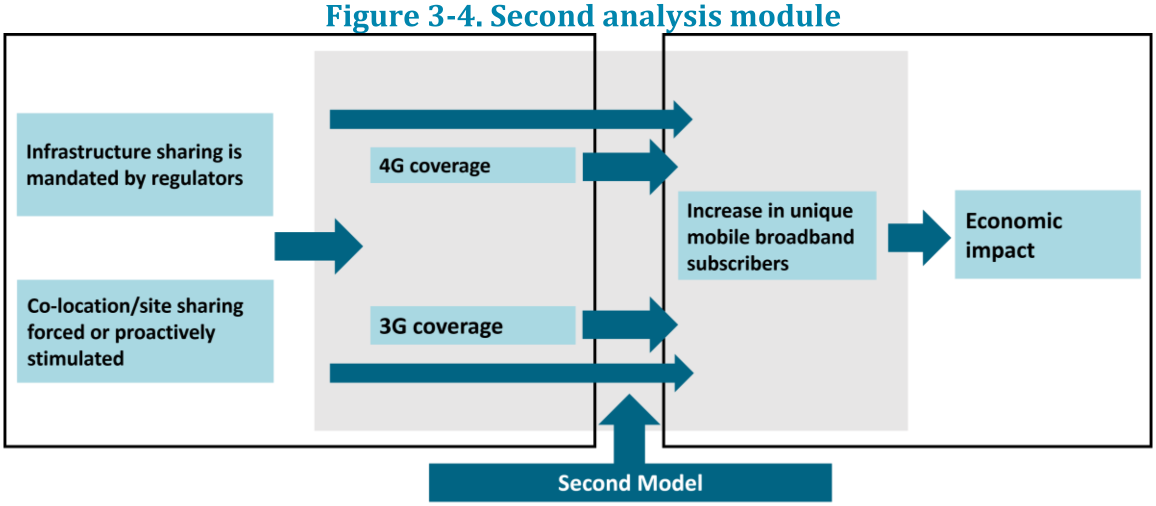
As a result, the model specified for the period 2010-2022 demonstrates that regulatory policies favoring infrastructure sharing have played a significant role in the expansion of 3G and 4G network coverage in the 14 African countries of the study sample. That said, given the current coverage levels reaching 94.17% for 3G and 84.86% for 4G, there is limited scope for significant growth in 3G and 4G coverage. Nevertheless, the results suggest that enhancements in regulatory frameworks could aid in marginally closing the existing coverage gap, especially in rural areas.

These findings gain added significance when considering the future development and widespread adoption of 5G technology. In this context, a regulatory environment that promotes infrastructure sharing could be pivotal, not only in replicating the success witnessed in the expansion of 3G and 4G networks but also in addressing the unique challenges posed by 5G deployment. Given the higher costs and technological complexities associated with 5G, effective infrastructure sharing could mitigate these challenges, leading to more efficient and cost-effective network rollouts. Additionally, such regulatory policies might accelerate the provision of 5G services, particularly in underserved or economically unviable areas, thereby potentially transforming the digital landscape.

Impact of 3G and 4G coverage on mobile broadband adoption

This section presents the results of the econometric regressions that assess the relationship between an increase in 3G and 4G coverage and the direct impact of the introduction of regulatory measures mandating infrastructure sharing or promoting co-location on an increase in unique mobile broadband users (i.e., adoption) (figure 3-4).

Figure 3-4. Second analysis module



Source: Telecom Advisory Services

The first version (column a) of the second econometric model presented in table 3-2 estimates that in countries where co-location is forced or proactively stimulated, mobile broadband adoption is 14.06% higher compared to countries without that policy. The second version (column b) of the model in table 3-2 estimates that in countries where mandated sharing exists, mobile broadband adoption is 14.63% higher compared to countries without that policy. These results are indicative of the direct effect of the regulation on unique mobile broadband users, attributable to enhanced service quality (more download speed, lower latency) and affordability among other factors beyond mere coverage.

Table 3-2. Econometric models testing the impact of coverage and regulation on mobile broadband unique subscribers

Ln (adoption mobile broadband unique subscribers)	Coefficients	
	(a)	(b)
Sharing mandated		0.1463**
		(0.0712)
Co-location	0.1406**	
	(0.0587)	
Ln coverage 3G	0.3133***	0.2959***
	(0.0626)	(0.0652)
Ln coverage 4G	0.0427***	0.0503***
	(0.0150)	(0.0150)
Ln (GDP per capita)	-0.0432	-0.0562
	(0.0526)	(0.0530)
Fixed effects	Country & Year	Country & Year
Years	2011-2022	2011-2022
Countries	14	14
Observations	104	104
R^2	0.954	0.954

Note: ***, **, * significant at 1%; 5% and 10% respectively.
Source: Telecom Advisory Services analysis

In real terms, a 10% increase in 3G coverage yields an increase in mobile broadband adoption of 2.96%/3.13%, while a 10% increase in 4G coverage yields an increase in mobile broadband adoption of 0.43%/0.50%. This implies that, if 3G coverage increases from 80% to 90% of the population, the number of unique users will increase from 30.36% (assuming that this is their initial level) to 31.48%/31.55%. Similarly, if 4G coverage increases from 80% to 90% of the population, the number of unique users will increase from 30.36% (assuming that this is their initial level) to 30.52%/30.55% (see table 3-2).[58]

In the context of the 14 African countries analyzed, the current adoption rate of unique mobile broadband users stands at 30.36%. The introduction of mandated sharing regulations is projected to significantly boost this adoption rate. Specifically, it is estimated that such regulatory changes could lead to a 14.63% increase in adoption, potentially raising the overall rate to approximately 34.80%. This anticipated growth is in addition to the natural increase expected from ongoing economic development and technological advancements in these countries.

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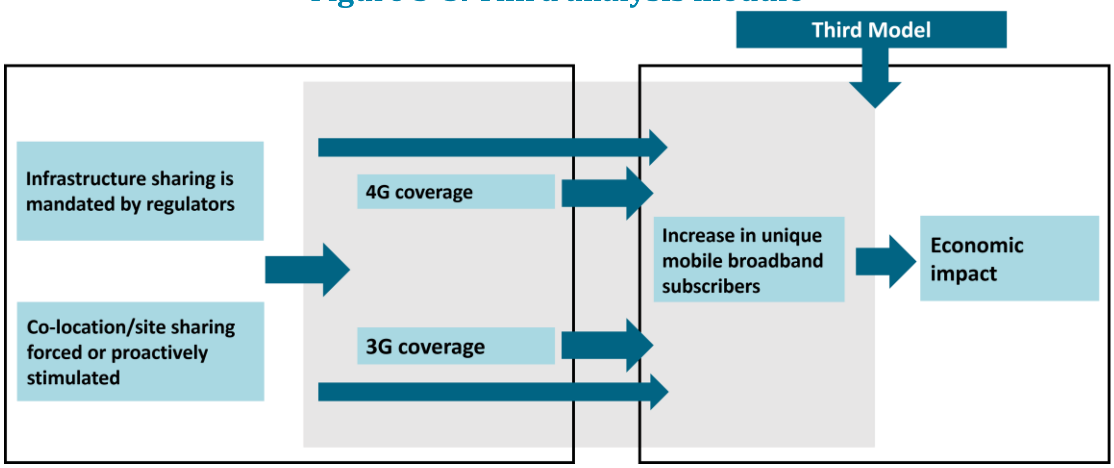
[58] Because the metric for unique mobile broadband users is measured by users with at least 3G technology, there is a greater impact of an increase in 3G coverage in relation to 4G coverage.

The primary drivers of this projected increase in adoption rates are improvements in service affordability and quality, which are direct consequences of the mandated sharing regulations. The data used in the econometric model suggests that this incremental effect would likely unfold over a period of seven to eight years.

Impact of mobile penetration and economic growth

This section presents the results of the econometric regressions that assess the relationship between an increase in the number of unique mobile broadband users and an improvement in economic development (figure 3-5).

Figure 3-5. Third analysis module



Source: Telecom Advisory Services, LCC

For this module we rely on the coefficient of the Katz, Callorda and Jung model, for Africa,[59] which shows that a 10% increase in mobile broadband adoption generates a 3.29% increase in GDP per capita[60] (table 3-3).

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[59] R. Katz, F. Callorda, and J. Jung. *The impact of digital transformation on the economy - Econometric Modelling.* (Geneva: International Telecommunication Union, 2024).

[60] The negative association between GDP and the adoption of mobile broadband in the second equation could be explained by the fact that in low-GDP countries, mobile broadband is generally the only option for internet access due to the underdevelopment of fixed networks. This coefficient is positive in all other continents.

Table 3-3. Econometric model of the economic impact of an increase in mobile broadband subscribers on GDP per capita

Variables of mobile broadband model	2024 study
GDP per capita	
Mobile broadband penetration	0.3292***
Gross fixed capital formation	0.0521***
Education	-0.0089
Mobile broadband subscriber penetration	
Mobile penetration	0.3678***
Rural population	1.8398***
GDP per capita	-0.8595***
Mobile broadband ARPU	-0.0248
HHI mobile broadband	0.1672***
Mobile broadband revenue	
GDP per capita	5.0226***
Mobile broadband ARPU	1.1426***
HHI mobile broadband	-0.3320***
Mobile broadband adoption growth	
Mobile broadband revenue	-0.3679**
Observations	1,422
Country fixed effects	Yes
Year and quarter fixed effects	Yes
R^2	0.988

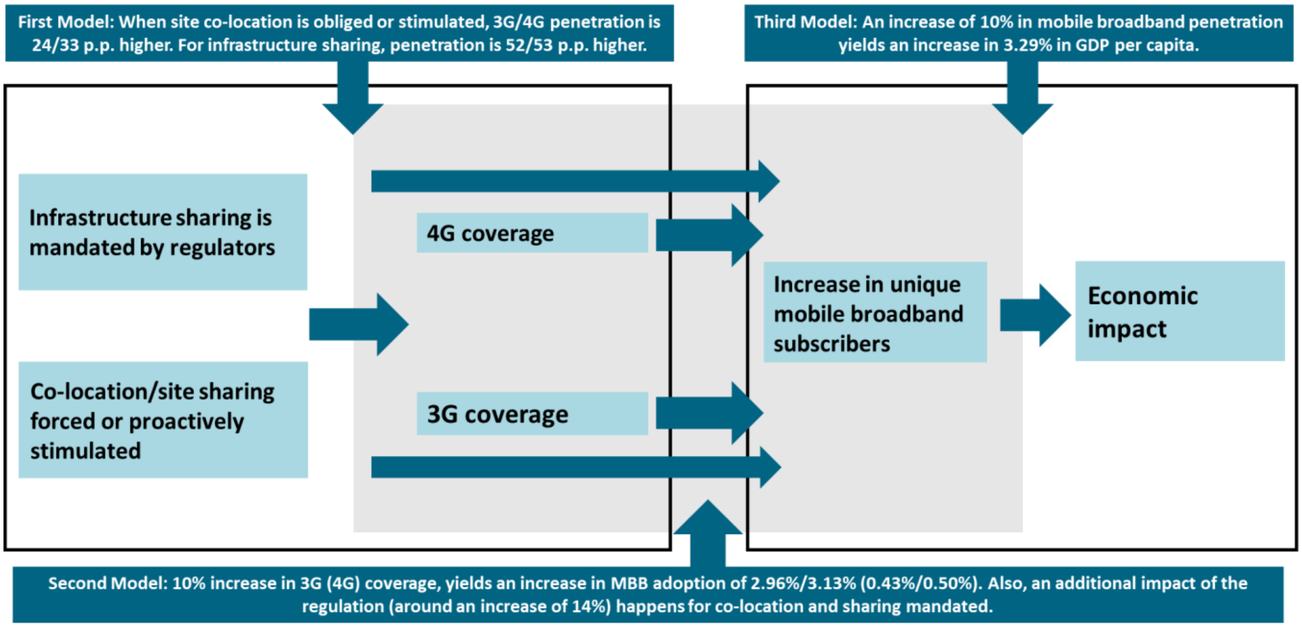
Notes: ***, **, * significant at 1%; 5% and 10% respectively.
All variables are expressed in logarithms.
Source: Katz, Callorda and Jung (2024)

In our previous analysis, we demonstrated that the implementation of mandated sharing regulation in the mobile broadband sector is projected to increase the rate of unique users from 30.36% to 34.80%, representing a substantial rise of 14.63%. Further, delving into the econometric model results presented in table 3-3, we estimate that such a policy would generate an economic impact amounting to a 4.82% growth in GDP per capita (calculated as 0.3262 multiplied by 14.63%). Given that this impact is expected to materialize over a span of eight years, this implies, assuming a compound annual growth rate, an annual increase of 0.59% in GDP per capita as a direct outcome of this policy.

3.3. Conclusions

Based on the previous results, we estimate the positive effects of site co-location and infrastructure sharing have been validated on the basis of positive estimations to the three sequential effects (figure 3-6).

Figure 3-6. Impact of econometric models testing the infrastructure sharing effect on the economy



Source: Telecom Advisory Services, LCC

For interpretation purposes, a country with an initial digital divide of 69.64%[61] (regional average in Africa) would undergo the following effects because of the mandate of infrastructure sharing by regulators:

- As a direct impact of mandating infrastructure sharing, unique mobile broadband users would increase 14.63%, from 30.36% to 34.80%.
- The increase in unique users would generate in turn an increase in gross domestic product (GDP) per capita of 4.82% to materialize over a span of eight years; this implies, assuming a compound annual growth rate, an annual increase of 0.59% in GDP per capita as a direct outcome of this policy.

Similarly, a country with a similar digital divide estimate would undergo the following effects because of introducing co-location/site sharing forced or proactively stimulated:

- As a direct impact of enacting site sharing, unique mobile broadband users would increase 14.06%, from 30.36% to 34.36%.
- The increase in unique users would generate in turn an increase in GDP per capita of 4.63%.[62]

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[61] The sum of the supply and demand gaps presented in Table 2-15 in chapter 2.

[62] In the analyzed period of models presented in Table 3-1, the changes in mandated sharing policy and the stimulation of co-location often occurred together. Hence the similarity of the results.

It is important to note that the results do not account for effects stemming from further increases in coverage, especially considering the already high levels of 3G and 4G coverage present in the analyzed countries. However, these policies could play a pivotal role in facilitating the development of 5G technology, whose economic impact is yet to be determined. The potential for these regulatory measures to catalyze the adoption and expansion of 5G networks presents an area for future research, particularly in assessing the subsequent economic implications. In addition, active sharing can result in additional benefits, particularly in fulfilling rural coverage.[63]

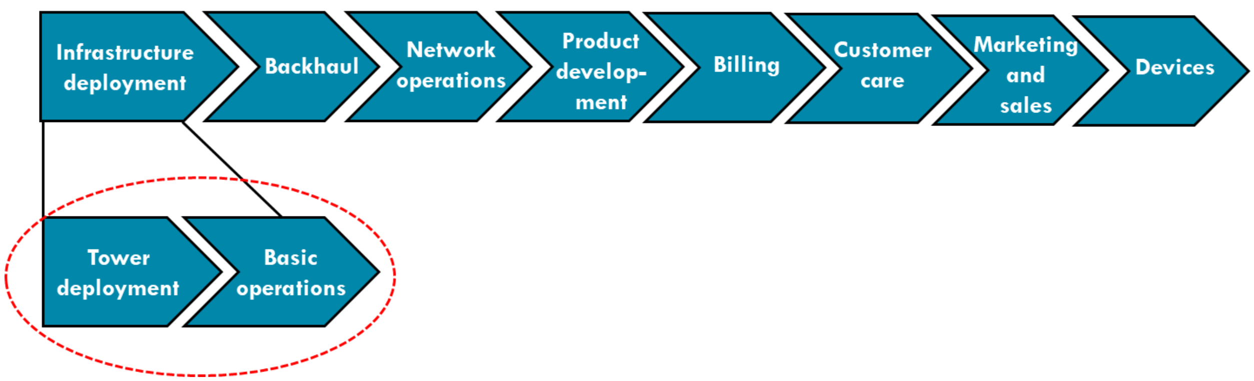
In conclusion, these econometric models have provided empirical evidence of the positive impact of infrastructure sharing on the development of the wireless industry, service adoption and economic development. We will now focus on a particular segment of infrastructure sharing: wireless towers.

[63] See Parallel Wireless linking with Nigerian network as a service (NaaS) provider Hotspot Network Ltd to extend 2G and 4G coverage to previously unconnected rural sites throughout Nigeria using Open RAN solutions (Tanner, J. "Parallel Wireless supplies Open RAN sites for rural Nigeria," *Developing Telecoms*, January 15, 2024).

4. THE CURRENT STATE OF THE AFRICAN TOWER INDUSTRY

In the past 15 years, the wireless telecommunications industry has witnessed the emergence of what in economic terms is labeled as "value chain specialists": independent wireless towers. The general study of value chain transitions across industry life cycles indicates that at the early stage of industry development, young firms need to manufacture their own inputs, they must persuade customers to shift purchases to their own products and they must design specialized equipment. This leads to value chain integration, where firms control all stages. However, over time, as independent middlemen become more knowledgeable of the technology and as reliability increases, the incentive to maintain a forward market presence decreases. With this, value chain fragmentation emerges around scale-efficient specialists.[64] Such has been the case in the wireless telecommunications sector (figure 4-1).

Figure 4-1. Emergence of the tower industry



Independent tower players have become value chain specialists leveraging economies of scale and experiencing curve efficiencies, allowing telecommunications operators to focus on their core businesses while reducing cost to serve. This trend has been particularly prevalent in Africa.

In addition to the emergence of tower specialists, based on the peculiarities of energy supply, Africa is witnessing an additional fragmentation of the value chain, through the emergence of energy service companies (ESCOs), which invest their own capital to acquire energy equipment and sell energy back to telecom site owner, be it an MNO or a towerco. As of 2020, Africa accounted for 19,333 ESCO sites (or approximately 40% of the world deployment).

[64] Stigler, G. "The Division of Labor Is Limited by the Extent of the Market." *Journal of Political Economy* LIX, no. 3 (1951), 185-93.

4.1. Tower deployment

As of 2023, wireless tower deployment in the 14 countries this study focuses on reached over 172,000[65] (table 4-1).

Table 4-1. Africa: Tower deployment (2016-2023)

	2016	2017	2018	2019	2020	2021	2022	2023	CAGR 2016-23
Angola	2,500	2,500	2,518	2,518	3,318	3,352	3,830	4,254	7.89%
Congo Democratic Republic	4,350	4,350	4,289	4,365	4,613	4,897	5,099	6,220	5.24%
Egypt	19,000	20,704	22,704	22,704	23,438	24,989	24,989	25,389	4.23%
Ethiopia	6,600	6,600	7,037	8,000	7,760	7,300	7,800	10,200	6.42%
Ghana	5,983	5,983	5,936	6,637	6,565	6,726	7,368	7,563	3.40%
Kenya	6,600	6,600	6,629	7,591	7,777	8,391	9,400	9,766	5.76%
Morocco	17,000	17,000	19,054	19,054	19,685	21,042	21,042	21,042	3.09%
Mozambique	4,400	4,400	4,400	4,400	4,463	4,600	4,600	4,600	0.64%
Nigeria	29,122	29,113	28,655	30,653	31,571	35,615	39,314	39,392	4.41%
Rwanda	1,300	1,300	1,300	1,300	1,300	1,523	1,756	1,806	4.81%
South Africa	25,000	30,485	28,451	30,262	31,598	28,349	27,863	24,883	-0.07%
Tanzania	8,412	7,394	8,263	8,318	8,164	7,815	8,133	7,992	-0.73%
Uganda	3,485	3,520	3,603	3,816	4,098	4,284	4,660	5,313	6.21%
Zambia	2,300	2,300	2,300	2,300	3,135	3,174	3,419	3,462	6.02%
Total	136,052	142,249	145,140	151,919	157,486	162,057	169,273	171,882	3.40%

Source: TowerXchange's Sub-Saharan African Guide-Q3, 2023; TowerXchange's Middle East and North Africa Guide-Q3, 2023; Telecom Advisory Services analysis

According to table 4-1, cell tower stock in Africa grew from 136,052 in 2016 to 171,882 in 2023 (a compound annual growth rate of 3.40%). In this context, Angola (7.89%), Ethiopia (6.42%) and Uganda (6.21%) exhibit the greatest dynamism with the highest compound annual growth rates of installed towers since the mid 2010s. In the rest of the 14 countries that are the focus of this study, tower deployment has grown at a compound rate ranging between -0.73% (Tanzania) and 6.02% (Zambia).

A comparative assessment of tower density provides an indication of different deployment patterns across countries: Morocco exhibits 553 towers per million wireless subscribers, South Africa exhibits 410, while, at the other end of the distribution, the Democratic Republic of the Congo has 60 and Ethiopia 80 (graphic 4-1).

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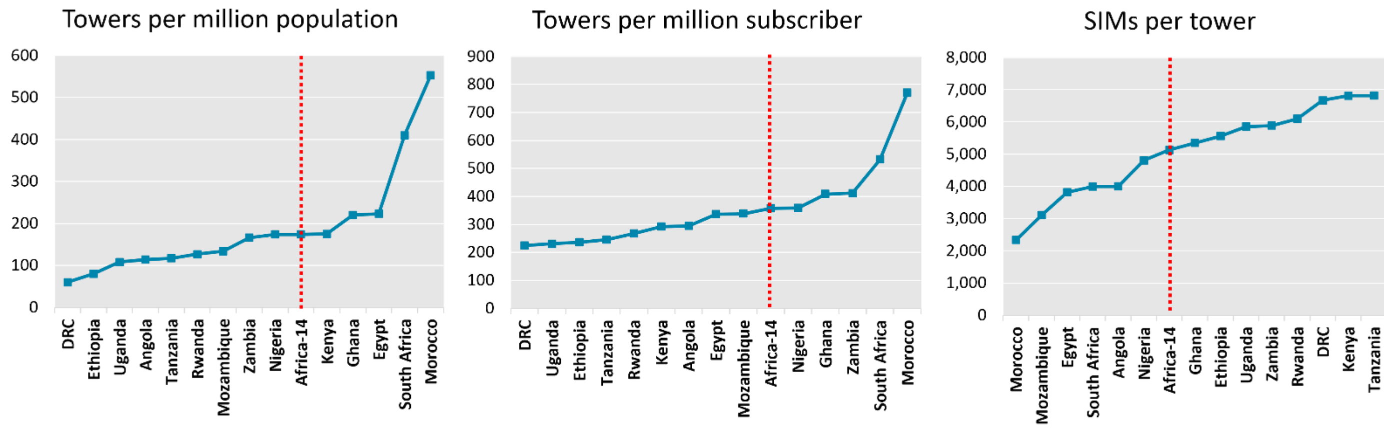
[65] We do not distinguish between types of towers. Ground-based towers are typically freestanding structures and are more prevalent in less densely populated areas. Rooftop towers are (usually) set up on pre-existing buildings and are typically located on the roof, roofing pavement or high windows. EY-Parthenon. *The economic contribution of the European Tower sector: a report for the European Wireless Infrastructure Association* (February 2022).

Graphic 4-1. Africa: Tower density indicators (2023)



Note: Africa-14 is a prorated average by population.
Sources: TowerXchange's Sub-Saharan African Guide-Q3, 2023; TowerXchange's Middle East and North Africa Guide-Q3, 2023; GSMA Intelligence; Telecom Advisory Services analysis

These differences in tower deployment density across countries are driven by three factors:

- From a structural standpoint, tower deployment is driven by an increase in subscribers and traffic per SIM card. Towers represent the anchor infrastructure of cells, which typically need to increase by subdivision to meet the increase in traffic.

- Another structural factor driving growth in tower stock is technology migration. The radio frequency propagation of spectrum bands varies, which means that rollout of 3G and 4G services requires new towers from the original 2G stock. The most prominent case in point of this effect is 5G, which has a significant impact on cell densification.

- While the economics of tower sharing are straightforward, competitive dynamics among operators sometimes lead them to avoid sharing to prevent rivals from increasing coverage. In this context, infrastructure becomes a barrier to entry, forcing competitors to deploy redundant facilities if they want to compete. This behavior has been studied in the context of platform-based competition.

- In addition, growth in towers could be driven by intensive entry of competitors in the tower sector. Driven by the attractiveness of returns, new investors might be driven to deploy towers, albeit within a small territory, particularly if at a later point in time, they sell them to a dominant player, a strategy known as "hit and run." A clear example of this effect is that the South African tower market comprises a total of 41 players of which 35 control only 891 of the total of 24,883.

- Finally, differences in tower density patterns could be somewhat influenced by regulatory factors such as preventing the deployment of duplicative infrastructure between towers. As a countering factor, driven by environmental considerations, regulators can impose some rules preventing duplicate deployment between towers.

A view of tower density over time allows placing specific timing and countries when a particular jump in deployment emerges (table 4-2).

Table 4-2. Africa: Towers per million population (2016-2023)

	2016	2017	2018	2019	2020	2021	2022	2023
Angola	84	81	79	77	98	96	106	114
Congo Democratic Republic	53	51	48	48	49	50	51	60
Egypt	189	201	217	213	216	227	223	223
Ethiopia	62	60	62	69	65	60	62	80
Ghana	200	196	190	208	202	203	218	220
Kenya	136	133	131	147	148	157	172	175
Morocco	481	476	528	522	534	565	559	553
Mozambique	156	152	147	143	141	141	138	134
Nigeria	152	149	143	149	150	165	178	174
Rwanda	108	105	102	100	98	112	126	127
South Africa	442	535	493	518	535	475	463	410
Tanzania	152	129	140	137	130	121	122	117
Uganda	88	86	85	87	91	92	97	108
Zambia	135	131	127	123	163	161	168	166
Total	163	166	166	169	171	172	176	174

Source: TowerXchange's Sub-Saharan African Guide-Q3, 2023; TowerXchange's Middle East and North Africa Guide-Q3, 2023; Telecom Advisory Services analysis

According to data in table 4-2, the rapid increase in tower deployment was driven by significant growth in several countries. Notably, Angola has shown a remarkable increase from 84 towers in 2016 to 114 towers in 2023 (36% growth). Similarly, Kenya's numbers rose from 136 in 2016 to 175 in 2023 (29% growth), and Ethiopia displayed a substantial growth from 62 in 2016 to 80 in 2023 (29% growth), although in this last case, the increase has been driven by market liberalization. The total number of towers across all listed countries has steadily increased each year, from 163 in 2016 to 174 in 2023, indicating a clear trend of telecommunications infrastructure expansion on the continent.

Looking forward, we expect tower deployment in Africa to continue growing. Even if the current ratio of unique subscriber/tower is stabilized, at least 56,831 new towers should be installed between 2023-2030. This estimate does not include additional effects to be generated by 5G rollouts (table 4-3).

Table 4-3. Africa: Tower projection

Country	Tower stock 2023	Unique mobile subscribers 2023 (in million)	Towers per million unique mobile subscribers	Unique mobile subscribers 2030 (in million)	Tower stock 2030	Growth in towers 2023-2030
Angola	4,254	14,425,268	295	19,364,405	5,711	1,457
Congo Democratic Republic	6,220	27,741,491	224	36,235,380	8,124	1,904
Egypt	25,389	75,249,768	337	102,188,860	34,478	9,089
Ethiopia	10,200	43,132,349	236	55,439,167	13,110	2,910
Ghana	7,563	18,531,231	408	24,272,554	9,906	2,343
Kenya	9,766	33,461,971	292	49,805,748	14,536	4,770
Morocco	21,042	27,306,488	771	35,987,149	27,731	6,689
Mozambique	4,600	13,619,335	338	17,807,229	6,014	1,414
Nigeria	39,392	109,767,088	359	149,533,684	53,663	14,271
Rwanda	1,806	6,738,591	268	8,905,774	2,387	581
South Africa	24,883	46,794,376	532	54,698,299	29,086	4,203
Tanzania	7,992	32,520,940	246	46,939,574	11,535	3,543
Uganda	5,313	22,977,363	231	33,695,525	7,791	2,478
Zambia	3,462	8,403,804	412	11,261,886	4,639	1,177
Africa-14	171,882	480,670,063	358	646,135,234	228,713	56,831

Sources: TowerXchange's Sub-Saharan African Guide-Q3, 2023; TowerXchange's Middle East and North Africa Guide-Q3, 2023; GSMA Intelligence; Telecom Advisory Services analysis

This estimate is consistent with analysts' projections. Mordor Intelligence estimates that the Africa telecom towers market size in terms of installed base is expected to grow from 199 thousand units in 2023 to 249.65 thousand units by 2028, at a CAGR of 4.63% during the forecast period (2023-2028).[66]

4.2. Growth of the independent tower sector

In parallel with the growth in the installed base and confirming the value chain trend toward the emergence of "specialists," the sector has been gradually evolving toward an increased share of independent players reaching in the African countries under study 40%[67] of the installed base (graphic 4-2).[68]

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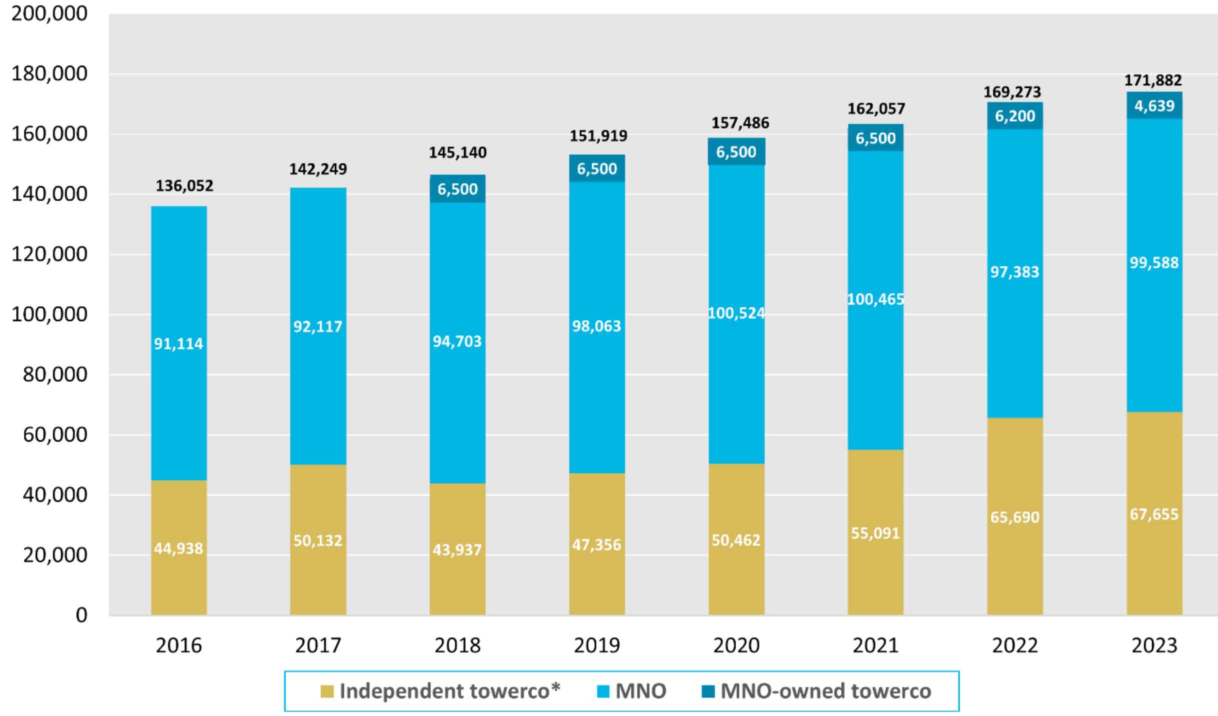
[66] Mordor Intelligence. *Africa Telecom Towers and Allied Market Size* (2023).
[67] In the total sub-Saharan Africa, the percentage owned by independent towercos is 44%.
[68] This percentage should increase with Vodacom's carve-out of Mast Services, which would result in a transfer of ownership of 9,500 additional towers.

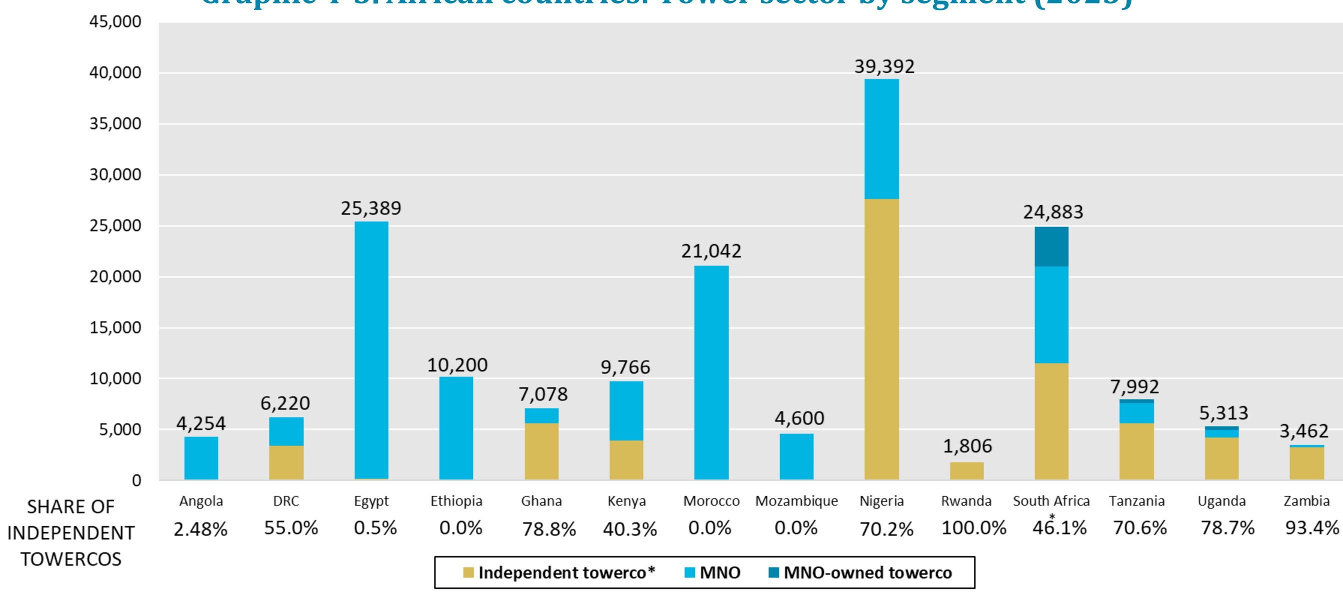
Graphic 4-2. Africa: Tower sector by segment (2016-2023)



* Includes 485 public towers in Ghana as of 2023.
Sources: TowerXchange's Sub-Saharan African Guide-Q3, 2023; TowerXchange's Middle East and North Africa Guide-Q3, 2023; Telecom Advisory Services analysis

Part of this trend has been driven by the tower divestiture by MNOs. However, not all African countries under study include independent tower companies (graphic 4-3).

Graphic 4-3. African countries: Tower sector by segment (2023)



* Telkom will close the sale of Swiftnet to a consortium of equity investors.
Sources: TowerXchange's Sub-Saharan African Guide-Q3, 2023; TowerXchange's Middle East and North Africa Guide-Q3, 2023; Telecom Advisory Services analysis

For example, independent tower companies do not exist in Egypt, Ethiopia, Morocco or Mozambique. That said, the trend toward independents to become the dominant segment throughout the continent is clear (table 4-4).

Table 4-4. Africa: Tower ownership (2016-2023)

Country	Tower type	2016	2017	2018	2019	2020	2021	2022	2023
Angola	MNOs	2,500	2,500	2,500	2,500	3,280	3,280	3,730	4,150
	MNO-owned co	0	0	0	0	0	0	0	0
	Independent	0	0	18	18	38	72	100	104
DRC	MNOs	2,518	2,514	2,522	2,576	2,400	2,400	2,400	2,800
	MNO-owned co	0	0	0	0	0	0	0	0
	Independent	1,832	1,836	1,767	1,789	2,213	2,497	2,699	3,420
Egypt	MNOs	19,000	20,666	22,666	22,666	23,400	24,951	24,951	25,251
	MNO-owned co	0	0	0	0	0	0	0	0
	Independent	0	38	38	38	38	38	38	138
Ethiopia	MNOs	6,600	6,600	7,037	8,000	7,760	7,300	7,800	10,200
	MNO-owned co	0	0	0	0	0	0	0	0
	Independent	0	0	0	0	0	0	0	0
Ghana	MNOs	1,824	1,776	1,500	1,500	1,500	1,500	1,500	1,500
	MNO-owned co	0	0	0	0	0	0	0	0
	Independent	4,159	4,207	4,436	5,137	5,065	5,226	5,868	6,063*
Kenya	MNOs	5,400	5,400	4,706	5,556	5,600	5,771	5,826	5,826
	MNO-owned co	0	0	0	0	0	0	0	0
	Independent	1,200	1,200	1,923	2,035	2,176	2,620	3,574	3,940
Morocco	MNOs	17,000	17,000	19,054	19,054	19,685	21,042	21,042	21,042
	MNO-owned co	0	0	0	0	0	0	0	0
	Independent	0	0	0	0	0	0	0	0
Mozambique	MNOs	4,400	4,400	4,400	4,400	4,463	4,600	4,600	4,600
	MNO-owned co	0	0	0	0	0	0	0	0
	Independent	0	0	0	0	0	0	0	0
Nigeria	MNOs	6,550	6,550	6,550	6,550	6,550	9,392	11,750	11,750
	MNO-owned co	0	0	0	0	0	0	0	0
	Independent	22,572	22,563	22,105	24,103	25,021	26,224	27,564	27,642
Rwanda	MNOs	0	0	0	0	0	0	0	0
	MNO-owned co	0	0	0	0	0	0	0	0
	Independent	1,300	1,300	1,300	1,300	1,300	1,523	1,756	1,806
South Africa	MNOs	20,000	20,000	18,200	19,700	20,638	16,874	10,200	9,500
	MNO-owned co	0	0	6,500	6,500	6,500	6,500	6,200	3,900
	Independent	5,000	10,485	3,751	4,062	4,460	4,974	11,463	11,483
Tanzania	MNOs	4,830	3,919	4,768	4,760	4,447	2,555	2,555	1,940
	MNO-owned co	0	0	0	0	0	0	0	409
	Independent	3,582	3,475	3,495	3,558	3,718	5,260	5,578	5,643
Uganda	MNOs	492	792	800	800	800	800	800	800
	MNO-owned co	0	0	0	0	0	0	0	330
	Independent	2,993	2,728	2,803	3,016	3,298	3,484	3,860	4,183
Zambia	MNOs	0	0	0	0	0	0	229	229
	MNO-owned co	0	0	0	0	0	0	0	0
	Independent	2,300	2,300	2,300	2,300	3,135	3,174	3,190	3,233
Total	MNOs	91,114	92,117	94,703	98,063	100,524	100,465	97,383	99,588
	MNO-owned co	0	0	6,500	6,500	6,500	6,500	6,200	4,639
	Independent	44,938	50,132	43,937	47,356	50,462	55,091	65,690	67,655

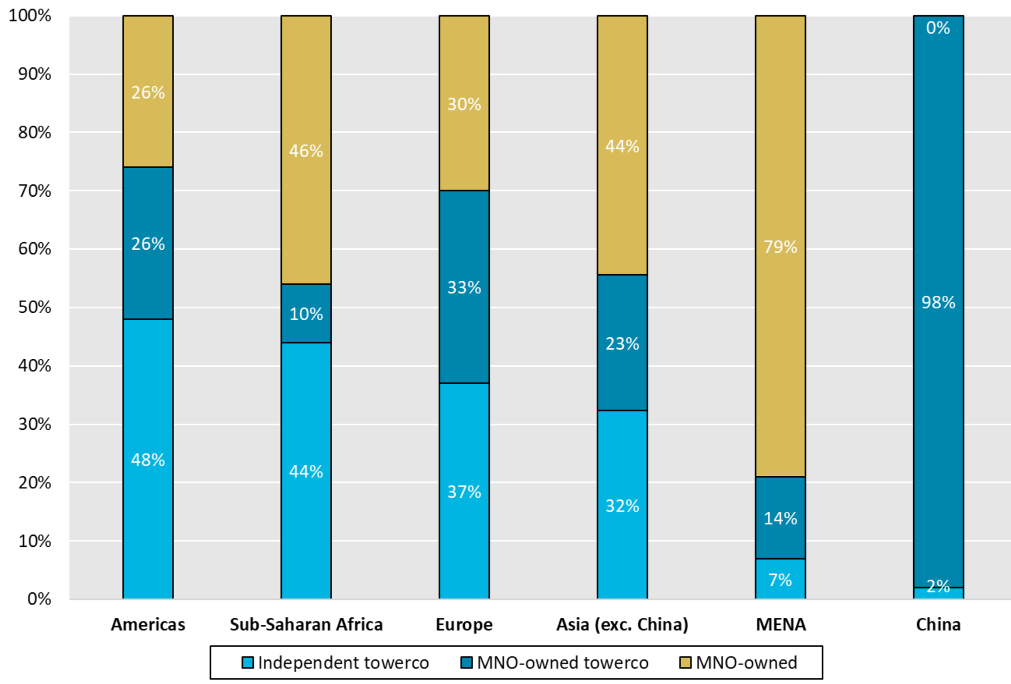
* Includes 485 state-owned towers

Source: TowerXchange's Sub-Saharan African Guide-Q3, 2023; TowerXchange's Middle East and North Africa Guide-Q3, 2023; Telecom Advisory Services analysis

A view of tower industry structure in the 14 African countries under study indicates that a regional average of 39.36% of the installed base is run by independent companies. However, this share ranges from high (Rwanda, Zambia, Ghana, Uganda, Tanzania and Nigeria) to low (Ethiopia, Morocco, Mozambique, Egypt and Angola), with some countries presenting a more balanced share (DRC, South Africa and Kenya).

When compared with other regions, the percentage owned by independent tower companies is behind only the Americas (graphic 4-4).

Graphic 4-4. Share of towers managed by tower companies (2023)



Source: TowerXchange's Sub-Saharan African Guide-Q3, 2023; TowerXchange's Middle East and North Africa Guide-Q3, 2023; Telecom Advisory Services analysis

The gradual divestiture of African MNOs of their tower infrastructure and the combined development of MNO-owned towercos and independent companies in Africa raise the question of the impact of tower ownership on industry development. In other words, is the share of independent tower "specialists" related to industry performance, as measured by capital efficiency, network deployment, service adoption and quality? Can the positive contribution of the independent tower sector be quantitatively proven as the benefit of infrastructure sharing was in Chapter 3. This will be the subject of the next chapter.

5. THE INDEPENDENT AFRICAN TOWER INDUSTRY: AN ASSET FOR DEVELOPMENT OF THE WIRELESS TELECOMMUNICATIONS SECTOR

Chapter 4 provided evidence of the shifts occurring in Africa regarding tower industry structure, in particular the emergence of the independent tower sector. Are the shifts in tower ownership having an impact on industry performance? In economic terms, does the emergence of a "specialist" sector focused exclusively on passive infrastructure have an impact of the wireless industry value chain?

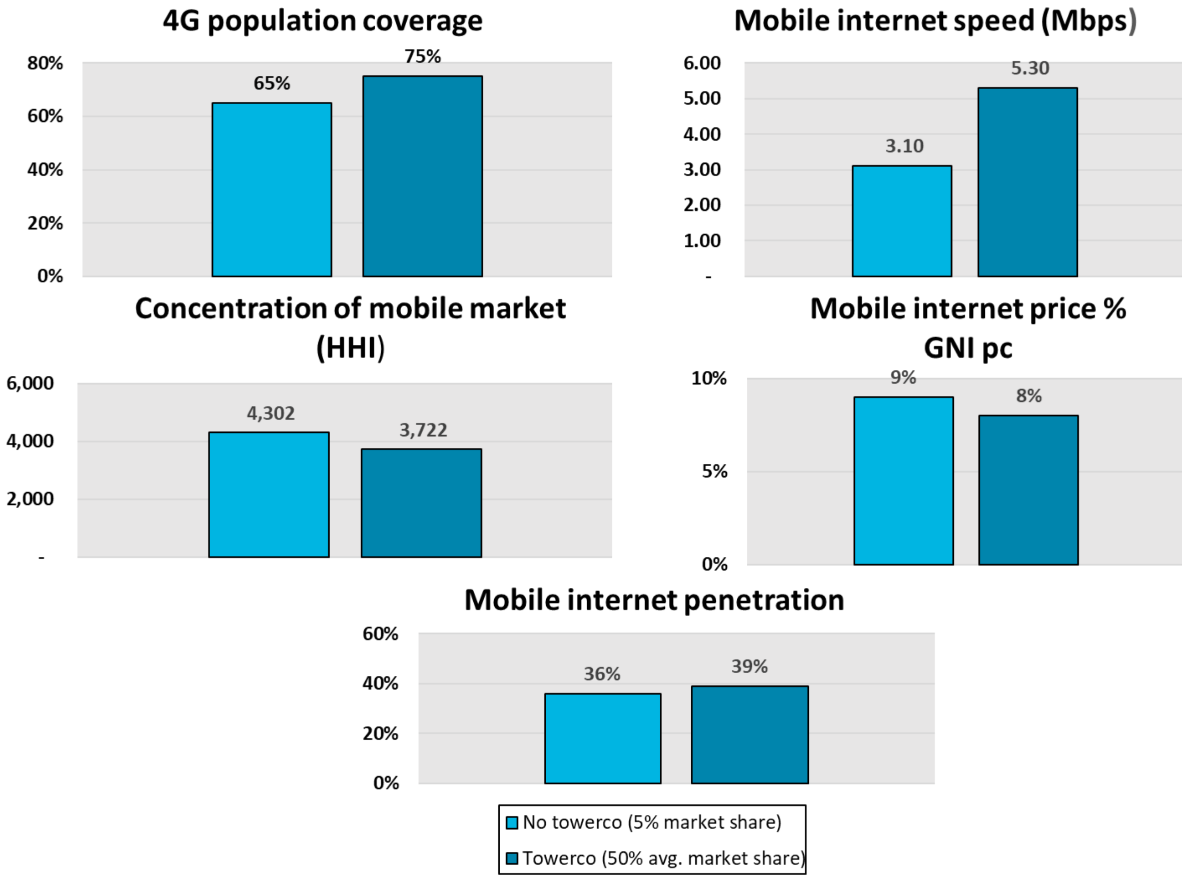
There are two main approaches to answering these questions. A correlation-based approach divides a sample of countries between those that witness a sizable growth of the independent tower company sector and those that do not and measures a series of metrics that assess the development of the wireless industry. If industry/connectivity is more developed in countries with sizable presence of tower companies, then it can be concluded that there is some association. However, correlation cannot be assumed to be causation (in other words, that tower company sector emergence leads to higher development of the wireless sector). For this purpose, an econometric modeling is required, which is the second approach. This chapter provides the two sets of analyses: a correlational one in section 5.1 and the econometric one, based on regression analysis, in section 5.2.

5.1. The emergence of the tower company sector and its impact on industry deployment — a correlational analysis

The only empirical research on this subject existing until now was published by economists of the World Bank's IFC. Houngbonon et al. analyzed 56 towerco markets calculating the correlation between the market success of the towerco business and the development of mobile connectivity markets.[69] The study defines towercos as "specialized companies focused on the management of mobile network infrastructure such as towers and small cell sites," although it does not differentiate between joint ventures between mobile network operators, independent companies, and joint ventures of independent entities and MNOs. Despite this lack of differentiation among ownership of tower companies, the study indicates that there is a positive correlation between the market success of the towerco business and the development of mobile connectivity markets. For example, the analysis provides evidence that in those markets where the penetration of the towerco business model is deeper (namely a market share over 50% vs. countries with a market share lower than 5%), 4G population coverage is 10 percentage points higher; median download speed is 2.2 Mbps higher; the price of mobile internet, in percentage of monthly income, is 1 percentage point lower; and markets are 13% less concentrated (graphic 5-1).

[69] G. Houngbonon, C, Rossotto, and D., Strusani. *Enabling a Competitive Mobile Sector in Emerging Markets Through the Development of Tower Companies*. EM Compass Note 104 (June 2021), Washington, D.C.: International Financial Corporations.

Graphic 5-1. Towercos and mobile connectivity



Source: G. Houngbonon, C, Rossotto, and D., Strusani. *Enabling a Competitive Mobile Sector in Emerging Markets Through the Development of Tower Companies*. EM Compass Note 104 (June 2021), Washington, D.C.: International Financial Corporations.

We have replicated this analysis for Africa, enhancing the definition of towercos (differentiating between MNO-owned and independents) including the metric of towers per capita. Based on these two metrics, the African countries in the study sample were categorized in two groups: leaders (where share of towers owned by independent players is higher than 40% and towers per million population exceeds 150) and the rest of the countries (where the independent tower company share is below 40% and towers per million population is under 150) (table 5-1).

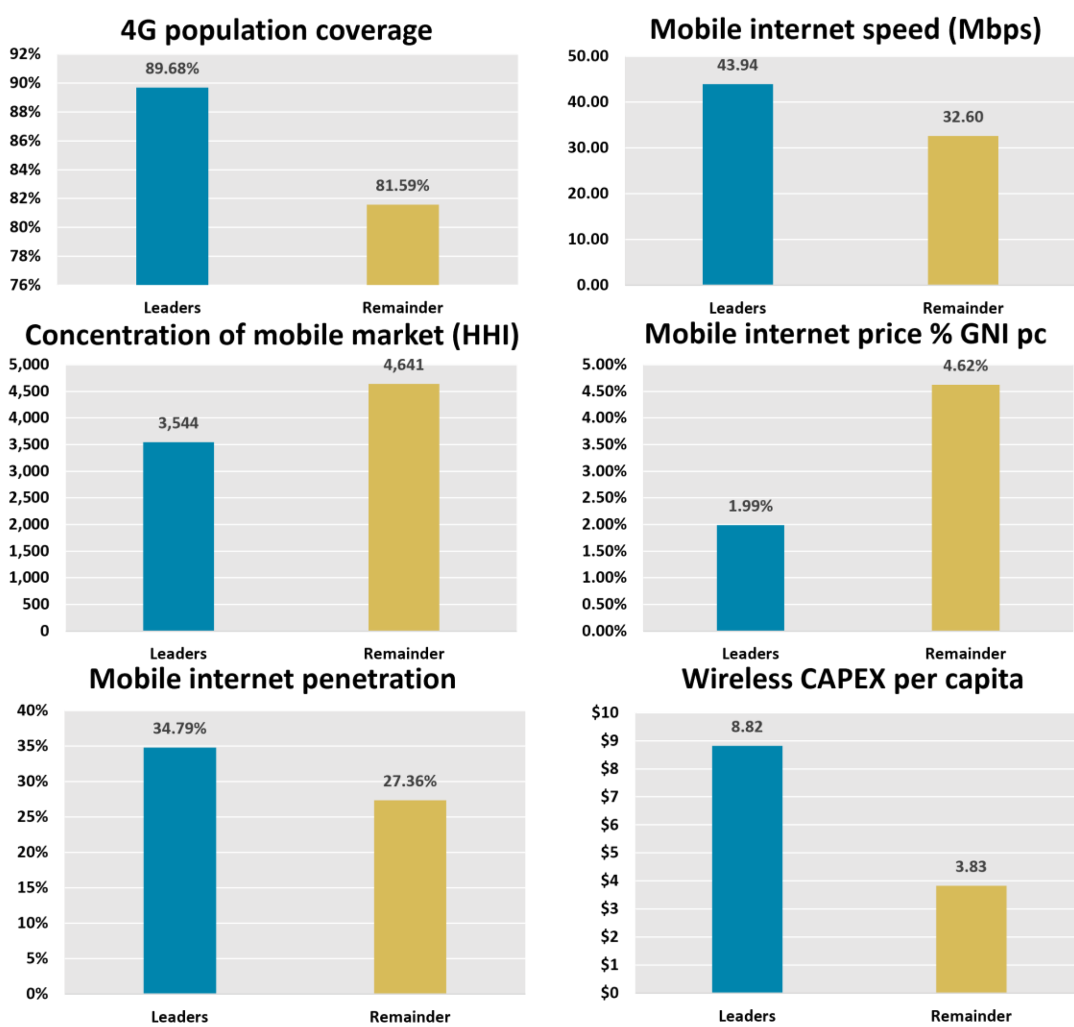
Table 5-1. Country groupings by independent towercos development

	Leaders	Remainder
Share of independent tower companies	>40% of towers owned by independents	<40% of towers owned by independents
Tower per million population	>150 towers per million	<150 towers per million
Countries	Kenya, South Africa, Nigeria, Ghana, Zambia	Ethiopia, Morocco, Mozambique, Egypt, Angola, DRC, Tanzania, Uganda, Rwanda

Source: Telecom Advisory Services analysis

A visual analysis of the economic impact of the tower industry indicates that countries with a larger share of independent towercos and higher tower deployment exhibit higher industry performance metrics than the rest (graphic 5-2).

Graphic 5-2. Africa: Towercos and wireless industry development



Source: Telecom Advisory Services analysis

The African analysis demonstrates an association between independent tower companies share of total plant and improved industry performance metrics (in some cases higher than those calculated in the IFC study):

- Better 4G coverage and access: Country leaders depict 8.09 percentage points higher than the rest of the countries (89.69% vs. 81.59%).
- Faster speed: Wireless broadband is 35% faster among country leaders than the rest (43.94 Mbps vs. 32.60 Mbps).
- More investment: Capital spending is 130% higher in country leaders (US$8.82 per capita vs. US$3.83 per capita) than the remaining countries.
- Better affordability: Wireless broadband services price as percent of monthly gross national income (GNI) per capita represents less than one half in country leaders relative to the rest of the countries (1.99% vs. 4.62%).
- Higher adoption of mobile broadband service: Country leaders exhibit 7.42 more percentage points in terms of broadband adoption than in the rest (34.79% vs. 27.36%).
- More intense competition: Wireless competition is 24% more intense in country leaders than in the rest (30% less concentration).

These results are in line with those from the aforementioned global analysis by Houngbonon et al.[70] However, these associations are based on correlations; our analysis requires a causal assessment, which is presented in the econometric modeling of the next section.

5.2. An econometric analysis of the impact of the independent African tower industry

The objective of this analysis is to go beyond the previous correlational analysis and demonstrate the causal relationship between an increase in the number of towers owned by independent companies on several mobile industry indicators. In particular, we test, through different econometric models, the impact of an increase in the number of total towers, independent towers and MNO-owned towers on industry performance. Among the dependent variables to be considered, we include the increase in 4G coverage, the increase in mobile broadband adoption, quality enhancement of mobile service as measured through mobile broadband download speed, the increase in competition in the mobile market and the improvement in the affordability levels of mobile service (figure 5-1).

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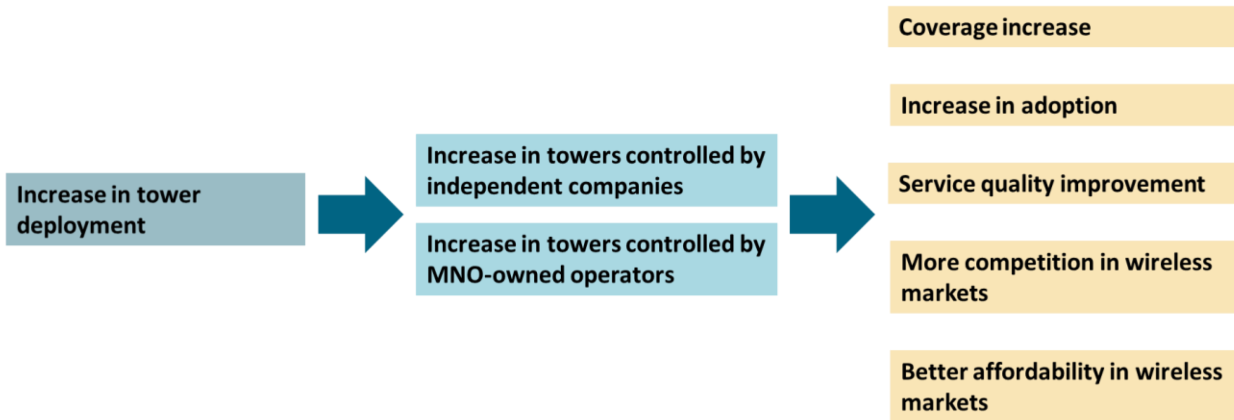
[70] G. Houngbonon, C, Rossotto, and D., Strusani. *Enabling a Competitive Mobile Sector in Emerging Markets Through the Development of Tower Companies*. EM Compass Note 104 (June 2021), Washington, D.C.: International Financial Corporations.

Figure 5-1. Focus of the analysis



Source: Telecom Advisory Services

We first introduce the theoretical framework guiding the analysis and describe the data the analysis will be based on. Following this, we present the results of the empirical modeling and, on these bases, discuss the implications.

Theoretical framework

To quantify the relationship between tower deployment and mobile sector performance, we first built a set of econometric models where the different dependent variables (4G coverage, mobile broadband adoption, quality of mobile service measured through mobile broadband download speed, level of competition in the mobile market and the level of affordability of mobile service) are explained by the number of towers (independent towers and MNO towers) and GDP per capita and a year fixed effect. The natural logarithm is taken on both sides of the equation to obtain results that indicate the relationship between a 1% increase in the independent variable (number of towers) and a percentage increase in the dependent variables (mobile market indicators).

$$\ln(Dependent\ variables) = \beta_0 + \beta_1.\ln(Number\ of\ Towers)_{it} + \beta_2.(Country)_{it} + \beta_2.Xit + \mu_{it} \quad (1)$$

The following indicators are included in the econometric model:

- Dependent variables:
  - Coverage: percentage population covered by 4G.[71]
  - Adoption: unique mobile internet subscribers.[72]
  - Quality: average mobile broadband download speed.[73]

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[71] GSMA Intelligence.
[72] GSMA Intelligence.
[73] Speedtest Global Index. https://www.speedtest.net/global-index; Telecom Advisory Services analysis.

    - Affordability: cost of a basic mobile broadband connection as a percentage of per capita income.[74]
    - Competition: wireless market concentration, HHI.[75]
- Number of towers (source: TowerXchange).[76]
    - MNO towers.
    - Independent towers.
- X: GDP per capita for control purposes and a year fixed effect in one model.

This model is based on data for the 14 countries under study: Angola, DRC, Egypt, Ethiopia, Ghana, Kenya, Morocco, Mozambique, Nigeria, Rwanda, South Africa, Tanzania, Uganda and Zambia. The available data covers the period from 2016 to 2023.

The econometric model allows testing the hypotheses presented in the theoretical framework. Also, through a mean difference test, we analyze whether the results found for the independent tower models are statistically different or not in relation to the MNO-owned tower models.

Impact of independent tower deployment on 4G coverage

According to the models presented in table 5-2, an increase in the number of independent towers of 10% is associated with an increase in 4G coverage levels of 5.95%. Independent tower operators (mainly Africa Mobile Networks (AMN) and NuRAN Wireless Inc., rural specialists) are helping to expand coverage in rural areas that are not served by mobile network operators. On the other hand, the coefficient for MNO-owned towers is 3.27%, which means that the impact is 0.27 percentage points higher for independent towers. The non-significant impact of MNO-owned towers indicates that only independent towers promoting sharing are a contributor to 4G coverage (table 5-2).

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[74] International Telecommunication Union ICT Price Baskets, historical data series, Apr 2023 release, https://www.itu.int/en/ITU-D/Statistics/Pages/ICTprices/default.aspx in folder "Download the historical data 2008-2022."
[75] GSMA Intelligence.
[76] TowerXchange's Sub-Saharan African Guide-Q3, 2023; TowerXchange's Middle East and North Africa Guide-Q3, 2023; Telecom Advisory Services analysis.

Table 5-2. Impact of tower deployment on 4G coverage

Ln (coverage)	MNO towers	Independent towers
Ln (towers)	0.3279433	0.5945456***
	(0.2337416)	(0.1380095)
Ln (GDP pcap)	2.40645***	1.522717***
	(0.3307409)	(0.3520356)
Fixed effects	Country	Country
Years	2016-2023	2016-2023
Countries	13	11
Observations	85	82
R^2	0.4571	0.4725

Note: ***, **, * significant at 1%, 5% and 10% critical value respectively.
Source: Telecom Advisory Services analysis

Table 5-3. Test of difference of means between the independent tower model and the MNO tower model

	Mean difference
Difference	0.26660230***
95% interval	0.20768391
	0.32552068

Note: ***, **, * significant at 1%, 5% and 10% critical value respectively.
Source: Telecom Advisory Services analysis

The verified and statistically significant impact of only independents in explaining 4G coverage could confirm that when an operator spins off its towers into a company it continues to own, it does not mean that it would necessarily be willing to accept sharing the infrastructure with a competitor. In other words, tower spin-offs into an MNO-owned entity is primarily a financial move aimed at capitalizing on the momentum of tower properties while reducing the MNO capital constraints.

Impact of independent tower deployment on mobile broadband adoption

An increase in the number of independent towers of 10% is associated with an increase in wireless broadband adoption levels of 3.29%. In addition, it is also found that adoption increases by 1.84% for a 10% increase in MNO towers, which means that the impact is 0.14 percentage points higher for independent towers. However, as shown in the case above, the non-significant impact of MNO-owned towers indicates that only independent towers promoting sharing contribute to adoption (table 5-4).

Table 5-4. Impact of tower deployment on mobile broadband adoption

Ln (adoption)	MNO towers	Independent towers
Ln (towers)	0.1840036	0.3285697***
	(0.1244583)	(0.0466108)
Ln (GDP per capita)	0.6271056***	0.5070954***
	(0.15399)	(0.1208226)
Fixed effects	Country	Country
Years	2016-2023	2016-2023
Countries	13	11
Observations	98	85
R^2	0.1916	0.5692

Note: ***, **, * significant at 1%, 5% and 10% critical value respectively.
Source: Telecom Advisory Services analysis

Table 5-5. Test of difference of means between the independent tower model and the MNO tower model

	Mean difference
Difference	0.144566***
95% interval	0.116348
	0.172784

Note: ***, **, * significant at 1%, 5% and 10% critical value respectively.
Source: Telecom Advisory Services analysis

The difference in statistical significance between independently owned towers and MNO-owned ones is a consequence of the differential impact in explaining coverage.

Impact of independent tower deployment on mobile broadband quality of service

An increase in the number of independent towers of 10% is associated with an increase in service quality levels (measured as mobile broadband download speed) of 5.07%. In addition, it is also found that the quality-of-service increases by 1.43% for a 10% increase in MNO-owned towers, although this coefficient, while having the right sign, is not statistically significant (table 5-6).

Table 5-6. Impact of tower deployment on mobile broadband service quality

Ln (speed)	MNO towers	Independent towers
Ln (towers)	0.1432481	0.5069423***
	(0.2668055)	(0.1392435)
Ln (GDP per capita)	1.6563***	1.18169***
	(0.3695046)	(0.3754291)
Fixed effects	Country	Country
Years	2017-2023	2017-2023
Countries	13	11
Observations	73	61
R^2	0.2687	0.4286

Note: ***, **, * significant at 1%, 5% and 10% critical value respectively.
Source: Telecom Advisory Services analysis

The non-significant impact of MNO-owned towers indicates that only independent towers promoting sharing are a contributor to download speed.

Table 5-7. Test of difference of means between the independent tower model and the MNO tower model

	Mean difference
Difference	0.363694***
95% interval	0.288796
	0.438591

Note: ***, **, * significant at 1%, 5% and 10% critical value respectively.
Source: Telecom Advisory Services analysis

The impact of 0.36 percentage points is higher for independent towers. Independent tower operators may have lower overhead costs compared to MNOs, allowing operators to allocate resources more efficiently for network improvement, including upgrading equipment and technology to support faster download speeds.

Impact of independent tower deployment on mobile competition

An increase in the number of independent towers of 10% is associated with an increase in mobile market competition levels (measured as a decrease in the Herfindahl–Hirschman Index) of 1.38%. Additionally, it is found that MNO towers yield a non-statistically significant impact on wireless competition, although the sign of the coefficient is correctly negative (table 5-8).

Table 5-8. Impact of tower deployment on wireless industry competition

Ln (HHI mobile)	MNO towers	Independent towers
Ln (towers)	-0.0238616	-0.1378487***
	(0.0569289)	(0.0441409)
Ln (GDP per capita)	-0.2321178***	-0.2865327***
	(0.0821676)	(0.102581)
Fixed effects	Country & year	Country & year
Years	2016-2023	2016-2023
Countries	13	11
Observations	98	85
R^2	0.1324	0.2529

Note: ***, **, * significant at 1%, 5% and 10% critical value respectively.
Source: Telecom Advisory Services analysis

The impact of independent towers on competition is 0.11 percentage points higher than MNO towers as indicated in the following table.

Table 5-9. Test of difference of means between the independent tower model and the MNO tower model

	Mean difference
Difference	-0.113987***
95% interval	-0.129016
	-0.098957

Note: ***, **, * significant at 1%, 5% and 10% critical value respectively.
Source: Telecom Advisory Services analysis

The lack of statistical significance on the coefficient linking tower deployment and mobile competition is consistent with what was mentioned in Wik Consulting's report on competition dynamics of tower and access infrastructure companies:

> *"Sharing physical infrastructure should in theory support competition in networks and services and boost the business case for VHCN deployment by reducing costs. However, infrastructure sharing, in areas where duplication is viable, can also limit incentives to compete on coverage and quality (and may thus be restricted under competition law), while concerns can also arise around wholesale access terms to infrastructure (price and in some case discrimination) where there are limited alternatives available."*[77]

[77] I., Godlovitch, J. Knips, S. Strube, C. Wernick, S. Tenbrock, and S., Hocepied. "Study on the Evolution of the Competition Dynamics of Tower and Access Infrastructure Companies Not Directly Providing Retail Services. BoR (23) (December 7, 2023): 206. https://www.berec.europa.eu/system/files/ 2023-12/BoR%20%2823%29%20206_Rev1_Study_towernetco_PUBLIC_0.pdf.

In other words, the impact of towercos on mobile competition, while positive, depends on the geographic context.

Impact of independent tower deployment on mobile broadband affordability

An increase in the number of independent towers of 10% is associated with an improvement in the level of mobile affordability (measured as a decrease in service price relative to the monthly GDP per capita) of 7.82%. The coefficient for MNO towers is not significant indicating that only independent towers promoting sharing are a contributor to affordability (table 5-10).

Table 5-10. Impact of tower deployment on mobile broadband affordability

Ln (affordability)	MNO towers	Independent towers
Ln (towers)	-0.089959	-0.7821445***
	(0.3473055)	(0.203349)
Ln (GDP per capita)	-0.4084492***	-0.2951259
	(0.3818442)	(0.448151)
Fixed effects	Country	Country
Years	2016-2022	2016-2022
Countries	13	11
Observations	85	74
R^2	0.0167	0.2180

Note: ***, **, * significant at 1%, 5% and 10% critical value respectively.
Source: Telecom Advisory Services analysis

The impact of independent towers on affordability is 0.69 percentage points higher than MNO towers as indicated in the following table.

Table 5-11. Test of difference of means between the independent tower model and the MNO tower model

	Mean difference
Difference	-0.692185***
95% interval	-0.783073
	-0.601297

Note: ***, **, * significant at 1%, 5% and 10% critical value respectively.
Source: Telecom Advisory Services analysis

Independent tower operators may have lower overhead costs compared to MNOs, reducing the cost and the price of the service.

5.3. Conclusions and implications

The evidence presented in this chapter has been consistent across both the correlational and econometric analyses.

As stated at the end of section 5.1, from a correlational analysis standpoint, African countries with a larger share of independent tower companies and higher tower deployment (Kenya, South Africa, Nigeria, Ghana and Zambia) exhibit higher performance metrics than the rest of the countries:

- Better 4G coverage and access: Country leaders depict 8.09 percentage points higher than the remaining countries (89.69% vs. 81.59%).
- Faster speed: Wireless broadband is 35% faster among country leaders than the rest (43.94 Mbps vs. 32.60 Mbps).
- More investment: Capital spending is 130% higher in country leaders (US$8.82 per capita vs. US$3.83 per capita).
- Better affordability: Wireless broadband services represent one half of costs in terms of per capita in country leaders relative to the rest of countries (1.99% vs. 4.62%).
- Higher adoption of mobile broadband service: Country leaders exhibit 7.42 more percentage points in terms of broadband adoption than in the rest (34.79% vs. 27.36%).
- More intense competition: Wireless competition is 24% more intense in country leaders than in the rest (30% less concentration).

From a regression analysis standpoint, the causality between independent tower companies and wireless industry development has also been proven:

- An increase in the number of independent towers of 10% leads to an increase in 4G coverage levels of at least 5.95%.[78]
- An increase in the number of independent towers of 10% is associated with an increase in wireless broadband adoption levels of 3.29%.[79]
- An increase in the number of independent towers of 10% is associated with an increase in service quality levels (measured as mobile broadband download speed) of 5.07%.
- An increase in the number of independent towers of 10% is associated with an increase in mobile market competition levels (measured as a decrease in the Herfindahl–Hirschman Index, which measures industry concentration — a lower index depicts more intense competition) of 1.38%.

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[78] This is directionally consistent with G. Houngbonon, M. Ivaldi, E. Palikot, and D. Strusani. *The impact of shared telecom infrastructure on digital connectivity and inclusion*. Toulouse School of Economics Working Paper No. 1427 (April 2023), who, based on worldwide sample, conclude that tower sharing deals have a statistically significant impact on 3G and 4G coverage in the year of the transaction as well as in the following years. The effect amounts to an 8.5 percentage point increase in 3G coverage within two years of the transaction, which corresponds to 13%, and a 7.8 percentage point increase in the case of 4G for 13.1%.

[79] This is not consistent with G. Houngbonon, M. Ivaldi, E. Palikot, and D. Strusani. *The impact of shared telecom infrastructure on digital connectivity and inclusion*. Toulouse School of Economics Working Paper No. 1427 (April 2023) since they find the uptake on mobile internet to be not significant. This could be because their time of treatment is only two years.

- An increase in the number of independent towers of 10% is associated with an improvement in the level of mobile affordability (measured as a decrease in service price relative to the monthly GDP per capita) of 7.82%.

Given this evidence, it would be important for African countries to maximize the development of the independent tower industry. This effect is, however, contingent upon several regulatory and public policy initiatives. In other words, the regulatory and policy variables play an important role in the development of the independent tower company sector beyond the willingness of the private sector to invest. The next chapter will focus on some of these variables and assess where the region is relative to their fulfillment.

6. REGULATION AND PUBLIC POLICIES AFFECTING THE TOWER INDUSTRY: A KEY REQUIREMENT

Chapter 5 quantitatively demonstrated the causal relationship between the growth of an independent tower sector and the development of the wireless industry across all relevant indicators, ranging from competition and investment maximization to service coverage affordability and quality. Considering this evidence, it is relevant to examine whether the current regulatory frameworks and public policies in Africa favor the development of the sector. The methodology followed in this case is to outline a list of regulatory and policy requirements that are critical to foster the development of the sector. Once formalized, the list is validated through the examination of international best practices. Finally, we examine the state of such frameworks for the 14 African countries under study.

6.1. Regulations and policies ensuring the tower industry sustainability

A review of the research literature and interviews with regulators and policymakers have led to the identification of 12 types of initiatives that can contribute to the development and sustainability of an independent tower sector:

- Passive infrastructure regulatory framework.
- Specific tower regulations.
- No need for concession of tower operators.
- Regulatory harmonization between central government and municipalities.
- Need for fast permit approvals.
- Establishment of caps on fees and taxes, and rights of construction of towers.
- No need of price regulations of tower company contracts with service providers.
- Policies to promote development of infrastructure sharing for present and future technologies, in particular 5G.
- Future infrastructure sharing plans.
- Regulations to prevent over-deployment.
- Long-term guarantees in regulations and permits.
- Sharing best practice manuals.

Each type is explained in detail in turn.

Passive infrastructure regulatory framework

A passive infrastructure regulatory framework is composed of laws, regulations, agreements or best practice models that establish the figure of passive infrastructure provider, defined as an actor that can deploy infrastructure facilities for a network, such as dark optical fiber, ducts, poles, towers and masts, among others. When the figure of the passive infrastructure provider is not fully specified, its operations might be subject to discretionary decision by the regulatory authorities on an ad hoc basis.

Tower regulatory framework

A tower regulatory framework is composed of a law, regulation or technical standard that defines the parameters for the installation or deployment of telecommunications infrastructure, mainly towers, masts and antennae for mobile services. It may, for example, establish the obligations and technical details that network operators or infrastructure providers must comply with in order to place, share and co-locate their structures. It is also crucial that the standards include a chapter on the relationship between operators and infrastructure providers in the event of controversies or technical issues that could be mediated by the standards or the regulatory authorities.

No need for service concession of tower operators

A concession is a grant of rights, land or property by a government or local authority to a private company that has the exclusive right to operate, maintain and invest in the facility under conditions of significant market power. Common concession agreements take place in the water supply, transportation highways and mining industries. The construction of a cell tower does not rely on a public good, as in the prior cases. Therefore, tower operations should not be ruled by a concessionary framework. Moreover, the tower industry is not a natural monopoly requiring a concessionary regime, like in the case of power transmission and railways.[80] On a positive note, in some countries, approval processes for the operation of passive infrastructure providers are determined by simple registrations with regulatory agencies, which provide speed in the deployment of infrastructure. However, it should be clear that a simple registration process should not open the way for further sector regulation.

Regulatory harmonization between central government and municipalities

This issue is related to clearly defined functions between the regulations issued by the central government for the operation of radio equipment and the municipal ordinances, enacted by local authorities, which refer to land use and urban planning obligations. These regulations should be complementary so that there is no duplication of obligations on network operators or infrastructure providers. In some African countries, infrastructure regulation is affected by the authority of municipalities to issue land use permits. In other countries there are urban planning rules issued by the central administration to which operators must adhere for infrastructure siting.

At present, many municipalities have constitutional autonomy to grant installation permits for antennas and rights of way for fiber rollout. Accordingly, they can interfere with the provision of telecommunications/internet services that are under federal authority. Frequently, in many countries of the continent, local regulations are imposed over federal authority, becoming very restrictive, not transparent, bureaucratic and even irrational for

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[80] Kerf, M. "Concessions for Infrastructure: A Guide to Their Design and Award." World Bank Technical Paper no. 399, 1998.

obtaining municipal permits. Local governments or municipalities exercise power by applying their own interpretations about non-ionizing radiation and fix their own limitations on the establishment of over-deployment rules and tower heights, use of public spaces or how environmental impact should be measured. This has meant that there are countless laws that regulate elements that are quite standard and common (table 6-1).

Table 6-1: Main regulations on local infrastructure deployment

Administrative	Environmental	Health	Technological
• Request for unnecessary or excessive information • Request for information by multiple institutions • Lack of regulatory uniformity • Lack of regulations or ignorance • Lack of knowledge regarding the Good Practice code • Absence or extension of deadlines • Establishment of public consultation • Lack of regulation regarding rights of way • Lack of continuity for local decisions • Disproportionate or disparate rates • Lack of legal certainty in appeal processes	• Regulation to prevent tower deployment • Minimum area requirement • Land use restriction • Designation of special places • Excessive camouflage requirements • Authorization by aeronautical authorities • Prohibition in places of cultural and heritage conservation • Prohibition on the use of land that is under rural or natural preservation	• Lack of exposure limit regulations for non-ionizing radiation • Lack of dissemination of current regulations and international recommendations • Approval of different exposure limits and control procedures • Use of different exposure limits depending on the area • Request for studies by multiple institutions • High periodicity in the delivery of radiation reports	• Obligation for towerco to apply to municipalities in order to conduct any technology upgrades from 4G to 5G • Prohibition of shared use • Obligation of operators to prepare their infrastructure for shared use • Lack of differentiation between macro and small cells • Establishment of different rates per technology

Source: CAF/Analysys Mason (2017)[81]; compilation by Telecom Advisory Services

These barriers increase the opportunity cost for deploying passive infrastructure, increasing the cost of deployment. Municipal jurisdictions can become a "choke" point in terms of processing authorizations or imposing extremely high contributions from tower companies. In other infrastructure areas (e.g., ports), the national authorities are increasingly gaining jurisdictional leverage over local governments. The concept at play in this case is "vertical policy coherence." Under this term, a national imperative, such as addressing the digital divide or deploying 5G for industry development reasons, overrides a local government consideration. Several approaches are being implemented to address dual jurisdiction in the field of infrastructure development.

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[81] Summarized by the authors based on Analysys Mason (2017). *Mobile Broadband Expansion: a report for CAF*.

Need for fast permit approvals driven by consistent and reasonable time frames

In the event that network operators or passive infrastructure providers require the issuance of licenses or permits for the deployment of their facilities, there should be expedited procedures, such as simple records of operation and infrastructure deployment. Often, there are processes that operators or infrastructure providers have to comply with that are not concentrated within a single entity. For example, there are environmental permits, public consultation processes, infrastructure sizing and compliance with tourist zones, among others, that are also linked to the administrative response of the competent authority within a time interval that delays the construction of the sites.

Establishment of caps on fees and taxes, and rights of construction of towers

Fees and taxes, also referred to as the "cost of compliance," have a significant impact on the business case of infrastructure deployment. Fiscal obligations applied to infrastructure providers are those that usually affect the resources available for capital expenditure (investment in network deployment or even on research and development). Since taxes tend to raise the required pretax rate of return of capital invested, the aggregate capital stock in a given economy depends on the effective tax rate. These contributions can be general taxes or industry specific.

In general terms, most macroeconomic research literature has found that taxation regimes play an important role in driving capital flows, when controlling for economic development, unemployment and currency fluctuations.[82] Accordingly, when a firm must make an investment decision, taxation plays a significant role. Taxes affect both the incentives of a company to make investments and reduce the supply of funds available to finance them. Several empirical studies indicate that, all things being equal, marginal and average tax rates have a negative effect on investment decisions. Research has shown that a reduction of corporate income taxation determines, over time, an increase in the level of gross fixed capital formation.[83] These effects can be expected to be more important in emerging market economies, where investment needs are greater. Katz and Callorda (2019) provided empirical evidence on the impact of taxation on network investment in the United States. They assessed the impact of taxation on the level of telecommunications and cable industry investment in a model that included data from all U.S. states, plus adding several specific state case studies. According to the econometric models developed by the authors, a decrease of 1 percentage point in the average weighted state and local sales tax rate affecting

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[82] J. Slemrod, (1990). Tax effects on Foreign Direct Investment in the United States: evidence from a cross-country comparison, in A. Razin and J. Slemrod eds. *Taxation in the Global Economy*, Chicago: University of Chicago Press, 79-117 (1995); M. Devereux, and H. Freeman, H. The impact of tax on foreign direct investment: empirical evidence and the implications for tax integration schemes, *International Tax and Public Finance,* 2: 85-106; N., Billington. The location of foreign direct investment: an empirical analysis, *Applied Economics,* 31: 65-76 (1999).

[83] Talpos, I. and Vancu, I. Corporate Income Taxation Effects on Investment Decisions in the European Union, *Annales Universitatis Apulensis Series Oeconomica*, 11 (1) (2009): 513-518.

initial equipment purchases (from 4.58% to 3.58%) would increase investment by 1.97% over the current levels.[84]

In this context, tower deployment is affected by the fiscal burden imposed by regulatory authorities and/or municipalities. Sometimes these fees become recurrent and even subject to annual increases defined on an ad hoc basis, although the rate and type of levy varies significantly across countries and even municipalities (table 6-2).

Table 6-2. Africa: Regulatory and municipal fees (2024)

Country	Taxes and fees	Amounts
South Africa*	Property taxes	If towers are located on a leased site, they do not incur property taxes
	Full environmental impact assessment (EIA)	Ranges from approximately ZAR45,000.00 to ZAR170,000.00 (US$2,391.00-US$9,000.00)
	Civil Aviation Authority permit	Permit fee of ZAR1090.00 (US$58.00)
	Building plan	• The cost structure/fees for building plans are determined by each municipality and typically range from ZAR600.00 to ZAR12 000.00 (US$32.00-US$638.00) • On average, the cost is approximately R3000.00 (US$212) per building plan in South Africa
Tanzania	Environmental impact assessment (EIA)**	One-time fee of US$1,588
	Tanzania Civil Aviation Authority (TCAA)**	One-time fee of US$298
	Building permit (BP)**	Ranges between $199 to $1191 per permit and is issued by each municipal, each having its own fee structure
	TCRA royalties***	Payable to the licensing authority — Tanzania Communications Regulatory Authority (TCRA) (1% of revenue paid quarterly)
	UCSAF service levy***	Payable to a fund established to facilitate access to communication services — Universal Communications Service Access Fund (UCSAF) (1.25% of revenue paid monthly)
	City service levy***	These are the municipality levies but paid centrally to the President's Office, Regional Administration and Local Government (PO-RALG) for easy administration (0.3% of turnover paid quarterly)

* Towercos are not subject to the telecom regulatory regime in South Africa and, as a result, there are no recurring regulatory or levies that need to be paid as a percentage of revenue. Additionally, towercos are not taxed on any items beyond income taxes.
** One-time fees associated with obtaining approval and permits for constructing or installing towers. These fees are paid to relevant authorities to ensure compliance with local regulations and standards during the construction process.
*** Ongoing taxes imposed by the government on the operation and revenue generated per site. Unlike building permit fees, tax fees are recurring and contribute to the government's revenue.
Source: Compiled by Telecom Advisory Services from interviews

[84] Katz, R. & Callorda, F. *Assessment of the economic impact of taxation on communications investment in the United States*. A report to the Broadband Tax Institute. New York: Telecom Advisory Services (2019).

Without making any judgment about the need of municipalities to collect revenues to support the delivery of public services, it is also the case that by increasing the pretax cost of tower deployment, local authorities limit the capacity for the wireless industry to support the connectivity needs of their populations. Since network deployment drives wireless broadband adoption, an extremely high taxation and construction rights burden hampers the tower deployment business case and limits deployment and economic growth. In addition, the extreme variety of fees and rates by municipality imposes an additional burden on the tower company in terms of determining project feasibility on a case-by-case basis, which adds to the cost of doing business.

No need of price regulations of tower company contracts with service providers

Price regulation is the practice of governments dictating how much certain commodities or products may be sold either in the retail marketplace or at other stages in the production process. In economic terms, price regulation is normally justified when markets fail to produce competitive prices. Price regulation has been applied in the telecommunication sector to meet efficiency (under scarcity conditions) and equity objectives (fair access to an essential service). Similarly, interconnection prices have been regulated at times to ensure anti-competitive behavior of incumbent carriers at times of market liberalization.

None of these conditions apply to price regulation between a provider of infrastructure and a service provider. Prices to be charged between an independent tower company and wireless operators should not be regulated for multiple reasons:

- Contracts between service providers and tower companies for leasing of tower space are enacted between private parties on the basis of agreed upon prices.
- Price determination does not reflect excessive or unconscionable pricing of an essential good (also called "price gouging"[85]).
- Regulating prices of tower access represents an additional disincentive to invest in infrastructure. Regulation of access terms and prices affect the return an infrastructure owner can expect to receive as a result of its investment efforts. In economic terms, the nature of ex post access regulation has an impact on ex ante incentives to invest.[86]

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[85] Price gouging is a term referring to when a seller spikes the prices of goods, services or commodities to a level much higher than is considered reasonable or fair and is considered exploitative, potentially to an unethical extent.

[86] Cave, M., Majumdar, S. and Rood, H. "Regulation and Infrastructure Competition." https://www.acm.nl/sites/default/files/old_publication/publicaties/7859_relationship_accesspricing_infrastructure_260301.pdf.

Policies to promote development of infrastructure sharing for present and future technologies, in particular 5G

The deployment of 5G will require an important expansion of the level of densification and antenna arrangements to have useful coverage in some high data traffic spaces (e.g., shopping centers, train stations, busy streets and avenues, highways, stadiums, industrial parks, etc.). Cell densification will require the installation of significant quantities of small cells, which are not necessarily installed on specific roofs or towers but rather on the sides of buildings, on poles or on street infrastructure. The capacity of these cells will generally be limited to a couple of frequencies.

In this context, zoning regulation will become critical. Small cells are installed on light poles or utility posts, with height of approximately 15 meters, not higher than 10% of neighboring structures, and do not require civil engineering or new structures. That being said, they require some regulation to prevent over-deployment:

- Minimum distance of 50 meters among 15-meter poles and 100 meters for heights higher than 15 meters.
- Right-of-way regulation should be limited to small cells of up to 15 meters.
- Minimum distance between small cells should also be applied in the case of private property.
- Siting in public buildings and rights of way should be offered at market prices.
- Permits for small deployment must include the authorization for laying down backhaul fiber.
- Small cell regulation should not discriminate against macrocells or cellular towers.
- Permits for micro and small cells should be delivered in no more than 30 days, but permits are not required in cases where the radios are attached to an existing urban structure (buildings).

Future infrastructure sharing plans

This need is linked to the capacity of regulatory agencies or public policymakers to plan and develop projects or plans in the regulatory agenda focused on expanding coverage, deploying infrastructure and removing barriers to infrastructure construction. In cases where countries do not have specific guidelines for infrastructure deployment, it is important that regulators envision revising the regulatory framework in the short term to stimulate the infrastructure leasing and sharing market. In light of this need, regulatory agencies should consider international best practices to promote harmonized and efficient infrastructure development.

Regulations to prevent over-deployment

Tower over-deployment, in many cases driven by straight financial speculation, is a feature of some African countries. The negative consequences of this situation are environmental and economic. Focusing on the latter, a simplified financial model developed for this study indicates that, on average, unless a single tower is not supporting the equipment of more than one operator (preferably three), its profitability is questionable, especially in suburban and rural settings over a 10-year time horizon.[87]

The model estimates the economics and financials of a single tower following two business models (tower and ground rent, and tower and turnkey power solution) deployed in two different settings (urban and rural) under three market conditions:

- Tenant ratio: estimate revenues from one, two, three and four operators.
- Time horizon: from 1 to 10 years.
- Regional disparities: urban, suburban and rural.

Assumptions are made based on industry experience in the region about capital required to build a tower, operating expenditures,[88] depreciation rates, taxes and cost of capital. It is important to note that, while a 25% tax rate was included in the financial analysis, it corresponds to conventional corporate levies, hereby excluding additional municipal fees and permits that can add to the fiscal burden. On this basis, the model projects free and accumulated cashflows and net present value to provide metrics of profitability. The net present value for the three environments under consideration are presented in table 6-3.

Table 6-3. Africa: Net present value (10 years — without terminal value)

	Tower and ground rent		Tower and turnkey power solution	
Number of operators	Urban	Rural	Urban	Rural
One	($46,986.19)	($44,103.64)	($120,079.20)	($211,295.39)
Two	$8,766.93	$9,954.32	$19,974.56	($21,332.14)
Three	$57,646.06	$58,833.45	$142,292.91	$152,654.62
Four	$106,525.18	$107,712.58	$259,206.35	$298,522.96

Source: Industry interviews; Telecom Advisory Services analysis

As indicated in table 6-3, the business case of a single tower is highly contingent upon the number of operators served by the infrastructure. In all settings, the NPV if only one tenant were to be served is always negative, while two MNOs in a rural deployment of a tower and turnkey power solution is also negative. This situation drives a related perverse effect: under these financials, tower providers not subject to quality of construction certification would underinvest in capital to improve their return. With this derived effect, the wireless industry and, ultimately, the consumer welfare would be negatively affected. This is why it is

[87] As an exception, low-cost poles can be designed to profitably support a single operator.
[88] OPEX is subject to a wide variance driven by its energy costs. It is estimated that energy represents around 50% of the total operating costs for cell sites that are located off-grid or rely on unreliable grid connections. The majority of off-grid/unreliable grid cell sites are still dependent on diesel, an input that is affected both by transportation costs and crime. Some sources estimate that pilferage can, under extreme circumstance, account for 30% of diesel costs.

important to develop a whole cycle of permitting, deployment and construction under consistent processes and reasonable time frames.

The policy and regulatory implications of the financial analysis are clear:

- Unless distance between towers and sharing mechanisms are not formalized from a regulatory standpoint, the long-term viability of independent tower infrastructure is questionable in suburban and rural settings. The financial metrics exhibit a significant change from 1 to 2 tenant ratios.
- Heavy initial CAPEX should be accompanied by relatively stable and predictable rules to ensure profitability and reinvestment. While the financials are calculated over a 10-year time frame, stability and predictability of regulatory frameworks are critical industry requirements.
- Regional disparities in urban, suburban and rural settings should drive the need to develop regulatory frameworks and policies that account for different economics in order to ensure a consistent deployment effort. For example, it would be advisable to establish incentives to facilitate deployment in rural and remote geographies to have a positive impact on reduction of the digital divide (tax reductions, import duty exemptions, among others).

On this basis, governments should promote policies and regulatory frameworks preventing over-deployment while fostering sharing especially in rural areas:

- Regulation encouraging the co-location of telecommunications equipment on existing infrastructure.
- Regulation and/or guidelines encouraging sharing of infrastructure.
- Regulation with determination of guidelines for the construction of towers to prevent proliferation of structures.

Beyond the strictly over-deployment prevention mechanisms, governments should encourage the fulfillment of quality requirements, such as construction guarantees that certify the quality of tower construction. In an indirect fashion, this ruling would prevent some of speculation incurred around tower deployment.

Long-term guarantees in regulations and permits

The tower industry sector is capital-intensive, with significant amounts of resources invested upfront. As shown in the economic-financial modeling presented above, a full monetization of CAPEX tends to occur after several years, if not a full decade. These financials, compounded by the relatively high volatility of African countries — in terms of economic growth, inflation and financial variables (notably exchange rates) — strongly recommend a predictable and stable regulatory and institutional framework to smooth the ups and downs and foster long-term domestic and international investment.

Sharing international infrastructure sharing best practices

This need is fulfilled by the adoption of best practice guides or the development of evaluation studies on possible barriers to the deployment of infrastructure, from which recommendations could be adopted by municipalities to encourage the expansion of telecommunications networks. In some countries, it is important to note that while the central government regulatory bodies do not have powers over space and land use, they can make recommendations and propose the obligations that municipalities place on network operators or infrastructure providers.

6.2. International best practices

The regulations and policies focused on fostering the development of a sustainable independent tower sector were validated through a study of international best practices. Information was compiled for South Korea, the United Kingdom, Canada and the United States.

Infrastructure sharing in South Korea

South Korea is a country with an orderly regulatory system and forward-looking telecommunications policies. In this regard, the Telecommunications Business Act[89] establishes as “common telecommunications services,” among others, the leasing of telecommunications line equipment and facilities. It also states that “telecommunications line equipment and facilities” are constituted by a set of means and all the facilities attached thereto. Equipment and facilities are defined as ducts, common utility lines, poles, cables, stations or other equipment needed by telecommunications operators acquired by signing a contract.

Beyond the Telecommunications Business Act, the construction of ICT infrastructure is also regulated by the Information and Communication Construction Business Act,[90] where information and communications construction projects mean for the installation, maintenance and repair of information and communications facilities, and other related works. In this law, an “information and communications construction enterprise operator” is defined as an entity that manages a construction enterprise responsible for certifying the quality of the construction of a structure as established by local authorities.

Infrastructure sharing takes place when a telecommunications common carrier receives a request for “joint use” of radio facilities from other carriers. In such cases, the prices for joint use by the common telecommunications business operators to be determined and publicly announced by the Minister of Science, ICT and Future Planning (MISP) will be calculated and adjusted in a fair and reasonable manner. Although price regulation is not determined in the

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[89] https://bit.ly/3dZfdkJ.
[90] https://bit.ly/3PJxJKV.

sharing or leasing agreements, the procedures and methods for paying such prices, and the scope and guidelines for the conditions, procedures, methods and calculation of prices for joint use, will be determined and publicly announced by the MISP.

If necessary for the installation of lines, antennas and related facilities for telecommunications services, a telecommunications joint venture operator may use a third party's land, or buildings and structures attached thereto, and surface. In such cases, the telecommunications joint venture operator shall first consult with the owners or occupants of the land in question. If the consultation does not lead to an agreement or is not carried out, the telecommunications common carrier operator may use the land of a third party in accordance with the Law on Acquisition of Land for Public Works[91] while compensation for it shall be established.

Infrastructure sharing in the United Kingdom

Mobile services in the United Kingdom are regulated by the Communications Law of 2003.[92] While local administrations oversee issuing permits for civil structures for telecommunications equipment, local authorities cannot prohibit the installation of new infrastructure or impose rules to prevent over-deployment. However, operators or tower companies must submit to local authorities detailed project description and location information that may be subject to comments in a public consultation process.

Although the deployment of new technology infrastructure (small cells) is encouraged through the exemption of permits for structures whose height does not exceed 6 meters, the calculation of fees for active equipment differs according to the type of technology, being higher in the case of small cells.

In addition, a code of good practices[93] specifies the requirements for the authorization of a civil installation that complements the regulations on access to infrastructure[94] where the figure of physical infrastructure is specified.

Finally, tower deployment taxes and fees are regulated through a unified referential rate ("business rates") that represents a tax for the location of infrastructure, which is set by Parliament and cannot be modified by municipalities.

Infrastructure sharing in Canada

Canada is one of the countries where plans and standards related to telecommunications infrastructure installation processes have been enacted. In addition, the telecommunications

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[91] https://bit.ly/3wQz3Fm.
[92] https://bit.ly/3eiF735.
[93] https://bit.ly/3wQFdVQ.
[94] https://bit.ly/3CQEwQj.

authority has established a guide to assist land use authorities in the development of protocols for the location of antenna systems.[95] Moreover, the use of public infrastructure for network deployment is also permitted.

As in the U.K., there are initiatives to promote the development of high-speed networks through the Telecommunications Regulatory Policy CRTC 2016-496.[96] The Customer Procedure Circular CPC-2-0-03[97] (Radiocommunications and Broadcasting Antenna Systems) establishes the conditions for tower deployment and sharing. It encourages stakeholders to consider sharing an existing antenna system, modifying or replacing a structure, if necessary, with the objective of extending coverage in a harmonized manner. In addition, Customer Procedure Circular CPC-2-0-17[98] (license conditions for mandatory roaming and antenna tower and site sharing, and to prohibit exclusive site arrangements) determines the procedure for requesting and responding to requests for mandatory shared access between operators.[99]

Finally, in the 2020 final report of the Broadcasting and Telecommunications Legislative Review Panel,[100] it is recommended among others that the CRTC (Canadian Radio-television and Telecommunications Commission) should have operational oversight of the antenna siting process, including managing interaction with municipalities and land use authorities (Recommendation 36). It also requires the CRTC to consult with the relevant municipality or other public authority before exercising its discretion to grant permits to construct telecommunications facilities. In addition, the CRTC is empowered to review and revise the terms and conditions of access to provincially regulated utility support structures to ensure non-discriminatory arrangements (Recommendation 37), although this authority is not exercised in practice.

Infrastructure sharing in the United States

The Telecommunications Law of 1996 establishes the parameters upon which infrastructure sharing is regulated. In addition, it determines the regulatory power that each state has for the installation of mobile infrastructure; furthermore, it establishes that states must adhere to the deadlines for the resolution of a permit application as determined by the central authority.

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[95] https://bit.ly/3RPlv59.
[96] https://bit.ly/2xJh8AW.
[97] https://bit.ly/3Qej2zU.
[98] https://bit.ly/3efp9Xk.
[99] While Bell and Telus have essentially split the country and share active infrastructure in their respective regions, they have historically defended against sharing of their sites with other operators (Rogers, Freedom) as a competitive advantage.
[100] https://bit.ly/3RbTa9d.

Along the same lines, the rule to accelerate the deployment of wireless broadband by removing barriers to infrastructure investment,[101] promotes the deployment of small cells (declaring them exempt from evaluations or permits) and establishes a process with deadlines for the review of new construction applications and co-location requests. Along those lines, the FCC issued guidance DA 19-277[102] establishing specific rules regarding the amount of time it might take to review and approve the wireless infrastructure siting permit. It establishes two new review periods for small wireless facilities (60 days for co-location in existing structures and 90 days for new construction) and provides between 90 and 150 days for small wireless facilities.

Separately, the rule implementing the obligation of state and local governments to approve certain wireless facility modification requests under Section 6409(a) of the Spectrum Act of 2012[103] clarifies several key elements that determine whether a modification request qualifies as an eligible facility request that a state or local government must approve within 60 days for the purpose of promoting infrastructure replacement toward 5G.

Finally, the creation of a database with information on available public infrastructure at the federal level, including location and tariffs, to promote location in areas of interest to operators has also been recommended.

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The review of international experience in benchmark countries has validated that the six areas should be considered to contribute to the development and sustainability of an independent tower sector (table 6-4).

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101 https://bit.ly/2vjaErO.
102 https://bit.ly/3RgyCMw.
103 https://bit.ly/3eetUQV.

Table 6-4. International best practices by country

Best practice	Countries
No need for concession and fast permit approvals	• A third of country benchmarks do not require registration with the regulator to begin operations • A third of the benchmark countries in the sample have laws that are in harmony with local ordinances, light procedures for construction permits and references to construction fees that are known to infrastructure operators • National regulations cover technical aspects of tower installation that are complied with by municipalities (United Kingdom, South Korea)
Regulation to prevent over-deployment	• All countries have plans or manuals of good practices that make it possible to supplement or complement the regulatory frameworks that promote the orderly construction of telecommunication structures • Regulations to encourage sharing and co-location while controlling the proliferation of infrastructure (United States, United Kingdom, South Korea) • Standardized construction permit regime and national guidelines for infrastructure fee collection (United States, United Kingdom)
Cap on fees and taxes	Codes of good practices or incentives of the central administration that guide the processes of the municipalities (United States, United Kingdom, South Korea)
Policies to promote development of infrastructure to be shared in view of deployment of 5G	A third of benchmark countries present information that promotes the deployment of networks for new technologies such as 5G and small cells
Price regulation	A third of benchmark countries do not have pricing regulations to fix the infrastructure leasing relationship between infrastructure operators and service operators
Long-term guarantees in regulations and permits	A third of benchmark countries have specific laws to regulate the deployment of passive infrastructure

Source: Telecom Advisory Services analysis

6.3. The state of regulation and public policies impacting the African tower industry

The assessment of regulation and public policies impacting the African tower industry was conducted based on two inputs: (i) desk research of regulatory and public policy frameworks and (ii) interviews with regulators to validate the information researched and obtain further input on the current situation.

The analysis focuses mainly on four aspects: (i) the normative regulating permits for passive infrastructure providers, (ii) the process of national and local (municipal or district) harmonization of administrative procedures for the siting of towers, (iii) the tariff regime for the use of public spaces and (iv) the status and outlook of regulatory framework of the tower industry. These four aspects are related to the strengths and weaknesses that enable or inhibit the deployment of infrastructure and, therefore, the advanced development of mobile services. This assessment also sought to identify possible regulatory initiatives at the national or municipal level that could have a negative impact on the economies of scale of the physical infrastructure deployment business model.

The following is a summary of the main conclusions that have been compiled for the 14 African countries under study: Angola, Democratic Republic of the Congo, Egypt, Ethiopia, Ghana, Kenya, Morocco, Mozambique, Nigeria, Rwanda, South Africa, Tanzania, Uganda and Zambia.[104] Each country's framework is assessed in light of the best practices identified above.

Angola

Angola has only one towerco, ANTOSC, which operates just over 100 sites, restricted by scale due to its self-financing structure. All of the four market MNOs retain ownership of their tower network and there have not been any previous attempts to sell towers.

Angola's Law on Electronic Communications and Information Society Services (Law 23/11), enacted in 2011,[105] addressed various regulatory aspects of telecommunications, including the obligation for infrastructure sharing among passive infrastructure providers, especially tower infrastructure:

- The law encourages the sharing of infrastructure among telecommunications operators to optimize resource use and reduce environmental impact. This includes sharing towers, masts and other related structures.
- Operators must comply with specific site and construction regulations for tower infrastructure. This includes adherence to safety standards, environmental impact assessments and urban planning requirements.
- Operators are required to obtain relevant licenses and permits for the construction and operation of tower infrastructure. This process involves coordination with various government bodies and adherence to national telecommunications policies.
- The law mandates regular maintenance and safety inspections of tower infrastructure to ensure reliable service and public safety. Operators are responsible for the upkeep and repair of their towers.

Building on this law, the Presidential Decree 166/14, Regulation for Infrastructure Sharing,[106] established in its article 13 that one of the models for infrastructure sharing is through an *infrastructure service provider*, establishing the concept of a "multiservice license" that allows this type of players to operate. It should be noted, as well, that Article 1 of the Decree 166/14 defines the need to rationalize investments in electronic communications infrastructure, avoiding unnecessary or non-redundant duplications. That said, rules related to non-duplicity of tower infrastructure or mimicry were not addressed in the norm. In summary, the key strengths of the Presidential Decree 166/14 are related to: (i) the need to promote infrastructure sharing among telecom operators to optimize the use

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[104] Detailed information is included in the Appendix.

[105] Electronic Communications Act, https://www.inacom.gov.ao/fotos/frontend_1/editor2/lei_23_de_2011-20_de_junho_de_2011.pdf.

[106] Infrastructure Sharing Regulations, https://www.inacom.gov.ao/fotos/frontend_1/editor2/decreto_presidencial_no_166_14-9_julho_de_2016-22_de_novembro_de_2017.pdf.

of resources, (ii) the imposition of compliance with safety, environmental impact and urban planning standards for site deployment and tower construction, (iii) the need to issue relevant licenses and permits for the construction and operation of tower infrastructure, (iv) the provision for safety inspection of tower infrastructure to ensure reliable service and public safety, (v) coordination with various government agencies and compliance with national telecom policies, among others.

The 2014 decree is complemented by the Presidential Decree 108/16 of May 25, 2016,[107] which refers to the General Regulations for Electronic Communications. This initiative establishes that the licenses issued by the regulatory body have a term of 10 years, renewable for equal periods, upon request to the authority. Regarding infrastructure leasing rates, they need to be agreed between the parties and, in case of disputes, the regulatory agency may intervene to solve possible technical or economic inconveniences. In the same line of the tariff regime, article 102 sets forth the obligation for payment of fees by parties entering into contract. The fees are updated according to certain parameters reviewed by the Ministry of Communications and Finance.

Despite these three regulatory instruments, entry of the new mobile network operator Africell in 2022 raised some issues in light of the increase in the demand for infrastructure sharing. For example, Africell Angola reported difficulties in negotiating infrastructure sharing with Unitel, which led Africell to invest more than initially planned in its own cellular facilities in the capital, Luanda. These challenges underscore the complexity of effectively implementing infrastructure sharing policies in practice.[108]

The Angolan regulatory framework lacks definition in aspects related to mimicry, distance between towers and land use fees, while nothing is specified in relation to the attributions of each municipality. The Infrastructure Sharing Law would seem to have national attribution, but no mention is made of the role of local governments. The only passing mention regarding non-duplicity establishes the importance of reducing environmental impact and the responsibility of infrastructure operators or providers to take charge of the location and disposal of sites. Finally, while the Angolan government identified the 3.5 GHz band for the deployment of 5G technology, there is no mention in regulatory frameworks of the development of regulations to encourage the deployment of structures such as microcells. Other aspects, such as future plans to improve the current tower regulation or the issuance of sector evaluation studies, have not been defined by the telecommunications authority.

To sum up, the strengths of the Angolan regulatory framework are:

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[107] https://www.inacom.gov.ao/fotos/frontend_1/editor2/decreto_presidencial_no_108_16_de_2_de_maio.pdf.
[108] https://developingtelecoms.com/telecom-technology/wireless-networks/
13141-unitel-and-africell-clash-over-infrastructure-sharing-in-angola.html.

- The administrative procedure for the multiservice license has an online window for the request or application to become an infrastructure provider.
- Infrastructure sharing is the only figure that allows both sharing and leasing between independent operators and operators of electronic communications services.
- There is a committee (INFRACOM[109]) made up of several government entities and telecommunications companies and coordinated by the regulatory agency (INACOM) under the guidance of the Ministry of Telecommunications to manage and make infrastructure sharing requests viable. INFRACOM can intervene in negotiations for infrastructure sharing in cases of unreasonable refusal to share, to impose sharing or to mediate in case of a dispute.

Some of the areas of improvement are related to:

- Harmonization with local governments for the implementation of codes of good practices for infrastructure mimicry.
- Establishment of clear rules for accepting or denying sharing — there have been several delays or impediments to infrastructure sharing with incoming wireless operators.

Democratic Republic of the Congo

There are five towercos in the Democratic Republic of the Congo (DRC). In addition to conventional players (Helios Towers, AMN, Eastcastle Infrastructure and TowerCo of Africa), NuRAN offers rural NaaS support for rural areas.

The telecommunications sector, including the stakeholders in charge of provisioning passive infrastructure, is overseen by the Congolese Regulatory Authority for Posts, Telecommunications and Information Technology (ARPTC). The DRC Law No. 20/2017, enacted on November 25, 2020, governs the telecommunications sector, including passive infrastructure, such as telecom towers. General authorizations for telecommunications operations require companies to operate freely, but under state and ARPTC control. These companies must be registered under Congolese law, with no other restrictions. Key aspects of this law include: (i) requirement to share basic telecommunications infrastructure, which is in the public domain of the state, (ii) registration obligation for telecommunications operation, (iii) obligation to provide access to interconnection for operators with significant market power, among others.

Along these lines, wireless operators are required to share infrastructure to support competition and land use planning. The ARPTC can enforce specific obligations for both passive and active infrastructure sharing, as well as access to alternative infrastructure in the event that the players do not initially reach an agreement. On this basis, wireless operators independently negotiate commercial agreements and conditions, which are then

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[109] Comité Coordenador de Infraestruturas de Comunicações Eletrónicas.

reported to the minister and the regulatory authority. The ARPTC suggests the sharing conditions, which are set out in a ministerial order.

Beyond these features, the 2017 law does not include specific regulations to leverage infrastructure deployment. No harmonization information is defined between national and local standards for network deployment. Nor is the existence of standards related to mimicry or distances between towers, among others, specified. Regarding the tariff regime, the technical and economic agreements for infrastructure sharing are to be signed between the parties. Finally, the law does not specify whether wireless carriers or infrastructure providers are obliged to pay land use fees or licenses for their operation. Regarding the deployment of future technologies such as 5G, while there are some operators that are conducting initiation tests based on existing infrastructure, no standards or policies have been defined to encourage the development of specific structures for this technology.

Egypt

The largest barrier to towerco activity in Egypt has been the regulatory environment, which has so far struggled to license towercos and facilitate tower sharing among the MNOs. The legal framework to regulate infrastructure deployment in Egypt are the Telecommunications Law (Telecom Regulation Law No. 10 of 2003[110]) and the Regulatory Framework for the Establishment and Leasing of Telecommunication Towers,[111] which establish general policies and deployment terms, respectively. These regulations are national in scope, which means that local land use agreements are not defined.

This regulatory framework also defines the process for obtaining a license for tower siting company operations. These are issued by the National Telecommunications Regulatory Authority (NTRA) for a period of 15 years, also entailing a commitment to build up to 6,000 new sites in three years. In addition, this license requires payment of a one-time upfront fee and an annual payment of 0.5% of annual revenues as a contribution for the development of R&D&I. In addition, other economic requirements are linked to the license application, as license applicants must own and operate at least 5,000 towers (not necessarily in Egypt), have a minimum of three years of experience in wireless infrastructure development and have a portfolio valued at more than EGP 3 billion (~US$187 million), with revenues exceeding EGP 200 million (~US$12.5 million) in the last two years. While contribution limits can be set by the central administration, they are still limiting the development of sharing infrastructure due to the nature of economic obligations. The biggest barrier to tower activity in Egypt has been the regulatory environment, which has so far had difficulties in licensing towers and facilitating tower sharing among network operators. However, one such player, Telecom Egypt, is currently in the stages of selling towers for 2,740 sites, 1,500 of which are brand new, and the rest are rooftops.

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[110] https://www.tra.gov.eg/wp-content/uploads/2020/11/Law-No-10-of-2003.pdf.
[111] https://shorturl.at/dGHV6.

In the contractual domain, the leasing of shared sites between operators and infrastructure providers is done by agreement between the parties, while no specific rules are defined for the payment of land use fees to local administrations. That said, within the specific guidelines and regulations, the infrastructure deployment process involves ensuring compliance with various technical, safety and operational standards established by the NTRA, although aspects related to distance between towers, mimicry or co-location requirements are not specified.

Egypt's telecommunications regulator has been developing a legal framework to allocate 5G spectrum, while several operators have invested in the expansion of the mobile network and a fiber optic backbone. Egypt has been identified as a key market for microcell deployments to support 4/5G densification due to its large urban environments. While still in the development stage, Egypt has plans to deploy fourth-generation smart cities with 38 new smart cities under construction. Its main strength is the recognition of new technologies as key elements for planning guidelines for the development of smart cities, which, of course, will need to be boosted through the deployment of infrastructure such as microcells.

The main weaknesses of the current regulatory framework of the Egyptian tower industry are related to (i) multiple technical and economic requirements and (ii) lack of specification of rules for urban planning, mimicry and orderly infrastructure deployment.

Ethiopia

The Ethiopian telecommunications sector is undergoing significant developments, triggering the deployment of tower infrastructure. The Ethiopian government is contemplating allowing private investment in telecom towers; according to information gathered, the decision should have been made by early 2023 but was delayed. This move is part of broader efforts to liberalize and privatize various industries, including the telecommunications sector, historically monopolized by the state. In this regard, the Ethiopian Communications Authority (ECA), established in 2019, plays a crucial role in the transition to promote a more competitive market. The regulatory body is responsible for issuing licenses to private telecom operators and regulating the telecom sector.

The only legal tool framing this process is the Communications Services Proclamation No.1148/2019. The ECA awarded Safaricom Ethiopia the first private sector operator license in the country. The government is soliciting bids for a third operator license to boost telecommunications competition in the market. The entry of a third wireless operator, a possibility not firm as of yet, would further support the case for the regulator to issue a tower license. Ethiopia needs substantial investment to expand its network. With approximately 7,000 cellular towers currently, the ECA estimates a demand for more than 9,000 towers,[112]

[112] International Trade Administration. "Market Intelligence: Ethiopia Telecom and Internet Services," 2022. https://www.trade.gov/market-intelligence/ethiopia-telecom-and-internet-services.

which highlights a significant investment and development opportunity in telecommunications tower infrastructure.

In addition to opening up investment in tower infrastructure, Ethiopia is focusing on sharing telecommunications infrastructure. For example, to increase coverage, the ECA brokered a tower and power sharing agreement between network operators Safaricom and Ethiotel. It is important to mention that, due to limited electrical connectivity throughout the country, many sites remain off-grid, and those that are connected must contend with the technical barrier at charging stations, which triggers a great demand for energy solutions. In terms of the development of new technologies, toward the development of 5G and the fulfillment of the Ethiopia Digital Strategy 2025, Safaricom has invested heavily in expanding its telecommunications network after its launch and is committed to its development over the next 10 years, with funding from the World Bank to support the rollout of the 4G and 5G networks.

In sum, Ethiopia is still in an initial stage of development of a tower industry, although it is worth mentioning its intention to open the market to private companies. In this context, considering that no future plans or policies have been established to regulate this market or to evaluate the barriers that the country has in terms of site expansion, the weakness of the current context is the great weight and discretion that the regulatory authority has to issue licenses for the development of a future tower sector.

Ghana

The regulation of the telecommunications tower industry in Ghana is overseen by the National Communications Authority (NCA), which was instituted in the National Communications Authority Act of 1996 (Act 524[113]). This body is responsible for the overall regulation of the telecommunications industry, including matters relating to tower companies.

While the available sources do not detail specific legislation focused exclusively on tower companies, the regulatory framework governing telecommunications is the Electronic Communications Act of 2008 (Act 775[114]), which also applies to companies developing passive infrastructure. This includes guidelines and requirements related to licensing, operations, mandatory infrastructure sharing and compliance with national telecommunications policies. In that sense, the role of the NCA includes ensuring compliance with these regulations and overseeing activities such as the construction, operation and maintenance of telecommunications infrastructure, including tower deployment.

Under the Act, the NCA issues a Tower Infrastructure License under the figure of “facilities” to construct and maintain passive communications infrastructure facilities for lease, rental

[113] https://ghanalegal.com/laws_subdomain/acts/id/176/national-communications-authority-act/.
[114] https://nca.org.gh/wp-content/uploads/2023/04/NCA-Electronic-Communications-Act-775.pdf.

or sale to licensed Operators or Communications Service Providers registered or authorized by the NCA. This should be done in accordance with the regulations of the Department of Town and Country Planning, the Lands (Statutory Permits) Act, 1963 (Act 186) and any other relevant law. In terms of the obligations underlying the issuance of the passive infrastructure license, the regulator has levied a fee of between US$14,000 and US$21,000, depending on the number of towers to be deployed by the operator.

Due to challenges related to tower siting and public consultation processes, health, mitigation and safety issues, the NCA encouraged the development of new guidelines for the deployment of towers and antennas[115] and the licensing of new companies to provide passive telecommunications tower services. Under the NCA Tower Guidelines, both existing operators and new entrants must first explore co-location opportunities before deploying their own towers. The rule requires that all towers 46 meters or more in height must be 400 meters apart, and, for structures less than 46 meters, a minimum distance of 300 meters between them must be considered.

Regarding the deployment of infrastructure for new technologies such as 5G, it is important to note that Ghana, according to the Ministry of Communications and Digitalization,[116] intends to promote the approval of a consortium to establish a shared neutral infrastructure to offer 4G and 5G services. The main motivation lies in the market dominance of the operator MTN and its low penetration in 4G, which is intended to be corrected through the implementation of this measure.

In summary, the main strengths of the regulatory framework in Ghana are based on (i) the determination of specific guidelines to avoid tower duplicity, (ii) the existence of a general framework for the deployment of nationwide networks that is consistent with urban planning through laws of national jurisdiction and (iii) a scheme that promotes sharing agreements between wireless service providers. The weakness of the framework is apparent in the lack of foresight for the issuance of future guidelines related to the deployment of new technologies, although it could be inferred that the measure of promoting a neutral infrastructure consortium for 4G and 5G could guarantee an orderly infrastructure expansion scheme.

Kenya

Infrastructure regulation in Kenya is heavily influenced by the country's Vision 2030, a development program aimed at boosting the information and communication technology sector. The Ministry of ICT, Innovation and Youth Affairs is responsible for formulating, administering, managing and developing policies in the sector, while the Communications Authority of Kenya (CA) is responsible for implementing these policies.

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[115] Guidelines for deployment of communication towers and antennas. https://nca.org.gh/wp-content/uploads/2024/01/GUIDELINES-FOR-DEPLOYMENT-OF-COMMUNICATION-TOWERS-AND-ANTENNAS.pdf.

[116] Ministry of Communications and Digitalization. https://moc.gov.gh/2023/08/29/ghana-to-establish-a-neutral-shared-infrastructure-company-to-deliver-nationwide-4g-5g-services-ursula-owusu/.

The Information and Communications Act Chapter 411 - 2020 Revision[117] has several guidelines regarding infrastructure licensing and co-location. Framed within this bill, in August 2020, the Ministry published the National ICT 2020 Policy Guidelines,[118] known as Sector Policy, which seeks to facilitate universal access to ICT infrastructures and services throughout the country. This policy emphasizes the creation of infrastructures that support data centers, the Internet of Things, machine learning and local manufacturing, promoting a secure and innovative ecosystem. In point 6.1.2 of these policies, it also encourages infrastructure sharing and co-location for efficient resource utilization. This document determines a clear vision, in at least four aspects: (i) the future planning to be developed by the authority to design an integrated infrastructure plan, (ii) to set up an infrastructure registry to boost co-location, (iii) to review the National Broadband Strategy to ensure high speed connectivity and (iv) to work between the central government and the authorities of each county to develop a harmonized guide for the determination of implementation guidelines and single central charges.

To build, own and operate infrastructure in Kenya, it is necessary to obtain a license issued by the regulatory body. There are different types of licenses depending on the nature of the infrastructure and the proposed activity, including licenses for network facilities providers, submarine cable landing rights, international gateway systems and services, and for contractors supplying, installing and maintaining communications infrastructure. Interconnection regulations in Kenya reflect the government's emphasis on infrastructure sharing and co-location. These regulations govern the form and content of interconnection agreements, access and facilities, and require all interconnection agreements to be submitted to the authority for approval.

According to Section 27 and 77 of the Information and Communications Act, with the issuance of the license, the infrastructure operator or provider undertakes obligations such as the payment of fees and other matters deemed appropriate by the Regulatory Commission. In the same vein and taking into consideration the harmonization mandates in the deployment charges of the structures in the National ICT Policy, it could be inferred that, currently, each county is working with the central administration for land use planning. On the other hand, the remuneration for the services they provide will be an agreement between the parties as deemed described in their license. According to Article 78 of the same law, the times and conditions under which a license is issued include a period of analysis and publication in the official Gazette, which has a defined process for administrative management. However, the terms could be considered agile due to the amount of time used to generate the corresponding operating resolutions.

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[117] https://www.ca.go.ke/sites/default/files/CA/Statutes%20and%20Regulations/Kenya-Information-and-Communication-Act-1998.pdf.

[118] https://www.ca.go.ke/sites/default/files/CA/Statutes%20and%20Regulations/National-ICT-Policy-Guidelines-2020.pdf.

Article 85-A of the Information and Communications Act establishes that co-location in sites and facilities may be made upon agreement between the operators. When no agreement on co-location is reached, licensees may refer the matter to the Regulatory Commission for a decision. The commission has also issued two additional instruments: (i) Guidelines for Undertaking ICT Infrastructure works[119] and (ii) Code of Practices for the Deployment of Communications Infrastructure,[120] which establish, among other things, compliance with environmental, health and occupational safety, infrastructure construction, mimicry and co-location.

In summary, the main strengths of the tower sector regulatory framework in Kenya are (i) a regulatory framework that promotes infrastructure sharing between operators and infrastructure providers and (ii) support and planning for development and innovation in the ICT sector through local and national regulatory harmonization for the adoption of new technologies. The framework weaknesses are (i) limited agility in complying with administrative procedures for licensing or permits, notwithstanding that the policy guidelines establish a goal for efficiency in these processes and (ii) standardization of land use charges and planning between the central administration and the different counties.

Morocco

According to TowerXchange,

> *"Infrastructure sharing in Morocco is poor and operators have a history of building their own networks, leading to over-deployment. This makes Morocco an attractive market for co-location."*[121]

The regulation of Morocco's telecommunications sector is overseen by the National Telecommunications Regulatory Agency (ANRT). The main instrument guiding this process is the Moroccan Telecommunications Law No. 24-96, which regulates the establishment and operation of telecommunication networks, including tower infrastructure through the figure of alternative infrastructure operator. Detailed in Article 1, paragraph 23, this role is defined as any legal person under public or private law (including network operators) that "owns infrastructure or rights capable of supporting or contributing to the support of telecommunication networks, without being able to carry out by itself the activities of public telecommunication network operator."[122]

Article 7 of the law establishes that an alternative infrastructure operator may, after addressing its own needs, lease or transfer the excess capacity to an authorized public

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[119] https://www.ca.go.ke/sites/default/files/2023-06/Guidelines-for-Undertaking-ICT-Infrastructure-Works.pdf.
[120] https://www.ca.go.ke/sites/default/files/CA/Industry%20Codes%20of%20Practice/Code-of-Practice-for-the-Deployment-of-Communications-Infrastructure-in-Kenya.pdf.
[121] TowerXchange (2023). *Meetup MENA 2024 Demand Forecast* (November), page 10.
[122] Consolidated version of law n° 24-96 on postal and telecommunications services (in French).

network operator. The refusal to share or lease must be justified. Article 22 formalizes the aspects related to the payment of fees for the temporary occupation of the public domain. Finally, Article 22, paragraph 4, establishes the permits for operators to install their infrastructure, with some general guidelines for undergrounding, support and mimicry. In accordance with the interpretation of Article 22, paragraph 3, the operator must comply with minimum requirements for the construction of infrastructure, established by the regulatory body and the corresponding local offices. This partially addresses the need for harmonization between national legislation and the competencies of each municipality. However, Morocco does not have any specific regulation for the tower industry.

ANRT is a key player in shaping the envisioned telecommunications landscape, particularly with the deployment of 5G technology. As of 2023, Morocco was in the evaluation and testing stages of 5G, with its launch scheduled for a later date. ANRT, for its part, adopted general guidelines for the development of the telecommunications sector in 2019 and has been instrumental in defining the framework for 5G. This includes evaluating and approving frequency bands for 5G deployment by operators such as Maroc Telecom, Orange and Inwi, although it does not define specific aspects related to the deployment of infrastructure required for this type of technology.

In general, the strengths of the Moroccan regulatory framework are based on (i) the stipulation of a passive infrastructure provision figure without the need for a licensing process similar to that of a network operator and (ii) the existence of a very specific law in terms of general guidelines that encourages infrastructure sharing and leasing. However, main weaknesses are related to the lack of effectiveness in the application of infrastructure sharing approaches and the lack of interest of network operators to co-locate their structures, even when there is regulation that encourages it.

Mozambique

The telecommunications sector in Mozambique is regulated through the Telecommunications Law No. 4/2016[123] and supervised by the Mozambique Communications Regulatory Authority (INCM). One of the principles of this law set forth in Article 6 promotes investments and infrastructure sharing. Along the same lines, Article 36 of the same bill mandates sharing among operators. In addition, the installation of networks is subject to licensing and permits from other local authorities. Likewise, these municipalities must provide the necessary assistance for the implementation of infrastructure without prejudice to the provisions of the Local Authorities Law.

The law's Regulation 65/2018[124] regulates the sharing of telecommunications infrastructure and other network resources and establishes in its Article 5 that the construction of sites

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[123] https://www.incm.gov.mz/index.php/legislacao/legislacao-telecomunicacoes/132-lei-das-telecomunicacoes/file.
[124] https://www.incm.gov.mz/index.php/legislacao/legislacao-telecomunicacoes/160-regulamento-de-partilha-de-infra-estrutura-de-telecomunicaçoes-e-outros-recursos-de-rede/file.

must be in accordance with the instruction manual approved by the regulatory authority. That being said, no formal document is defined for such purpose. Although neither the law or the regulations establish the figure or licensing for the operation or construction of towers, Article 16 of Regulation 65/2018 determines the negotiation for the sharing of passive infrastructure, while the economic agreements for aspects related to the leasing of infrastructure are prioritized through contracts between the parties. Likewise, the establishment of rates is left to local authorities. It is important to note that Article 20 of Regulation 65/2018 establishes that the Universal Access Service Fund shall promote the construction and implementation of new passive and active infrastructure with priority given to rural areas or areas without coverage.

As to aspects related to future planning, Resolution No. 43/2017[125] on the National Broadband Strategy promotes as a strategic objective the extension of the national backbone for which infrastructure sharing should be encouraged. Finally, even though 5G networks were launched in Mozambique in 2023, the aspects that encourage the development of infrastructure for the adoption of this new technology have not been generated. The only tool that would apply in this case is the infrastructure sharing regulation, regardless of the technology.

One of the strengths of the tower regulatory framework in Mozambique is the existence of a proactive approach to modernizing the telecommunications industry through the determination of general infrastructure sharing frameworks. Meanwhile, the sector's main weaknesses are focused on (i) the inexistence of neutral infrastructure providers with which network operators can share infrastructure, (ii) the lack of a standard or manual for tower deployment, such as distances to prevent over-deployment or mimicry, and (iii) partial harmonization of technical and economic regulatory responsibilities between national and local authorities.

Nigeria

The Nigerian Communications Commission (NCC), established by the Nigerian Communications Act of 2003,[126] is the regulatory body which, according to Section 4 (d) and (o), is responsible for (i) promoting competition in the facilities provider (passive infrastructure) market, (ii) promoting infrastructure sharing and (iii) providing regulatory guidelines in this regard. In addition, the Commission is responsible for issuing licenses for the provision of infrastructure under the interconnection regime, as framed in Article 99 paragraph (f). That said, according to Article 135, the provider is responsible for obtaining the corresponding location permits from local governments. In this sense, the harmonization of rules between the central government and municipalities is partial as they are unlinked, and municipalities lack national guidelines to follow. Likewise, as indicated in Article 136,

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[125] https://www.incm.gov.mz/index.php/legislacao/legislacao-telecomunicacoes/137-estrategia-nacional-de-banda-larga-1/file.

[126] https://ictpolicyafrica.org/en/document/m5vlov3ljum.

paragraph 4, the technical and economic agreement for the leasing of infrastructure must be established between the parties, although the Commission may intervene in cases of disputes.

The specific regulations governing the infrastructure co-location market are determined by the Guidelines on Collocation and Infrastructure Sharing.[127] The most important aspects established in the guidelines are related to: (i) the definition of basic offers by the operators owning the infrastructure and (ii) the determination of reference prices for knowledge of the economic aspects of leasing. That being said, issues related to the establishment of distance for the construction of towers or mimicry are not covered in this guide.

Although the government has been promoting projects for the development of infrastructure in rural areas by relying on the Universal Service Fund, no detailed future plans have been defined to face the connectivity challenges and improve the infrastructure sharing and co-location conditions that are currently defined in the country. Despite this, it is important to note that the Federal Ministry of Communications, Innovation & Digital Economy's strategic plan[128] includes a Public Policy for Digital Infrastructure to increase investment in the sector by 15% per year until 2025.

The main strength of this regulatory scheme is linked to the determination of specific guidelines for infrastructure sharing and co-location. On the other hand, one challenge lies in the high cost of obtaining site approvals (such as urban planning permits) from state and local governments, along with the lengthy process, which delays the implementation of sites to meet the proposed quality of service targets. Additional weaknesses relate to (i) the lack of complete technical and economic harmonization between national and local standards and (ii) lack of policies that encourage the development of adequate infrastructure for new wireless technologies.

Rwanda

In Rwanda, the regulatory framework for the siting of telecommunications infrastructure is determined by government policies and the oversight of the Rwanda Utilities Regulatory Authority (RURA). The main legal tool governing this infrastructure is the Law No. 24/2016[129] governing information and communication technologies. According to Article 40 of the mentioned legislation, four categories of operators can obtain network infrastructure licenses to provide infrastructure to the companies that own and operate electronic communications networks. This license has a 15-year term and is renewable for the same period of time. In addition, the regulatory authority is in charge of determining the sector's licensing costs. Along the same lines, Article 71 establishes mandatory infrastructure sharing

[127] https://engineersforum.com.ng/wp-content/uploads/2020/09/Legal-Guidelines_Collocation_and_Infrastructure_Sharing.pdf.
[128] https://fmcide.gov.ng/wp-content/uploads/2023/11/blueprint.pdf.
[129] https://rura.rw/fileadmin/Documents/ICT/Laws/Law_governing_Information_and_Communication_Technologies_in_Rwanda.pdf.

between operators and providers, for which the regulatory agency must establish guidelines to regulate this market.

Article 68 of the law determines that the installation of any communications infrastructure on any public or private land must be in accordance with the relevant laws to facilitate rights of way. Such applications must also obtain approvals from other central and local government departments. In other words, harmonization between national and local standards is not fully established, considering that each local authority may establish the corresponding land use values.

In addition, Rwanda has enacted a document for guiding siting and sharing of telecommunications infrastructure.[130] The document formulates guidelines such as (i) protecting the environment without restricting infrastructure deployment, (ii) reducing land use without changing the aesthetics of the landscape, (ii) maximizing network facilities as well as capacity and backbone, among others, and (iv) incentivizing the passive infrastructure market to optimize the use of facilities for various network operators. On the technical side, the guide contains general construction guidelines regarding mimicry, maximum tower heights, distances between towers, civil aviation regulations, urban and rural planning, signaling, inspection, structure removal and pricing methodologies, among others. Finally, the document establishes the dispute resolution mechanisms that market players must take into account for infrastructure leasing. However, the main economic agreement mechanism is the negotiation between parties within a clearly established range between two methodologies: (i) price comparison and (ii) evaluation of investment and maintenance costs.

It is important to note as well that the Rwandan government has established the use of the Universal Access Fund (UAF) for allocation in the construction of towers for the expansion of rural coverage.[131]

As part of the adoption of new technologies and future plans, Rwanda adopted a new National Broadband Policy and Strategy[132] in October 2022. The plan highlights that the government aims to ensure that all operators have the capacity to deploy advanced broadband networks in 4G and 5G technology. It also aims to boost competition in services by leveraging the introduction of mobile virtual network operators and the promotion of infrastructure sharing in passive and active resources.

The main strengths of passive infrastructure market regulation in Rwanda include (i) a very broad general law for the determination of general guidelines for the construction and sharing of infrastructure, (ii) a guideline document that limits tower over-deployment and

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[130] https://rura.rw/fileadmin/Documents/docs/GUIDELINES_FOR_SITING_AND_SHARING_OF_TELECOM_BTS_INFASTRUCTURE.pdf.

[131] https://researchandmarkets.com/reports/4480184/rwanda-telecoms-mobile-and-broadband.

[132] https://rura.rw/fileadmin/Documents/ICT/Laws/National_Broadband_Policy_and_Strategy__October_2022.pdf.

(iii) the existence of short-term planning processes to update the shared infrastructure regulation. Meanwhile, the weaknesses are related to (i) inadequate harmonization between local and national standards, as well as the determination of clear processes for permit approval, both at the technical and economic levels, and (ii) failure to update standards for the deployment of infrastructure in new technologies.

South Africa

South Africa is the most competitive telecommunications market on the continent with 32 towercos. The communications regulatory framework does not require a specific license for the establishment and operation of telecommunications towers. There is no separate license category for the development of passive infrastructure deployed by an independent tower company. However, the Independent Communications Authority of South Africa (ICASA) has not yet directly addressed whether these companies are regulated and require electronic conditions services licenses (ECNS).

The Electronic Communications Act No. 36 of 2005,[133] in its Article 44, establishes the general guidelines for leasing of electronic communications facilities. In this part it is defined that sharing and leasing agreements are required to define, at least, the following aspects: (i) duration time, (ii) service quality levels, (iii) rates and charges for leasing, (iv) dispute resolution and (v) access and security of the infrastructure, among others. This only applies to actual tower space sharing and applies to operators that are regulated/licensed with ICASA. It is also important to recognize that Article 21 of the same law determines the obligation to develop guidelines for the rapid deployment and provision of electronic communications facilities through coordination between the Ministry of ICT, the Ministry of Provincial and Local Government, the Ministry of Territorial Affairs, the Ministry of Environmental Affairs and other relevant institutions. This guidance should address, at a minimum, (i) the process for obtaining any necessary permits, authorizations and infrastructure approvals from other necessary governmental authorities, including the criteria necessary to qualify for such permits, and including economic aspects of infrastructure occupancy and (ii) the resolution of disputes that may arise between a licensee of electronic communications network services and any landowner, in order to satisfy the public interest in the rapid deployment of networks.

In 2010, the ICASA issued the Electronic Communications Facilities Leasing Regulations,[134] which determines aspects related to infrastructure sharing and co-location — specifically, mechanisms such as availability, quality of service, security, physical access to sites, billing procedures, payment terms, processing for dispute resolution, fines and violations that operators must observe. However, no aspects related to distances preventing over-deployment or mimicry have been developed.

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[133] https://www.gov.za/sites/default/files/gcis_document/201409/a36-050.pdf.
[134] https://www.icasa.org.za/uploads/files/Electronic-Communications-Facilities-Leasing-Regulations-33252.pdf.

Tower companies are not compelled to register. The National Policy on Rapid Deployment of Electronic Communications Networks and Facilities[135] is only applicable to licensees, since towercos currently do not fall under the licensing regime.

National harmonized deployment is partial in South Africa. In September 2022, the national department responsible for local government published the Standard Draft By-Laws for the Deployment of Electronic Communications Facilities.[136] Municipalities are encouraged to adopt the ordinance, to harmonize and fast-track telecom infrastructure deployment.

South Africa has some policies that promote the development of 5G (stipulated in the National Policy on Rapid Deployment), although this is not applicable to towercos.

With regard to planning for the passive infrastructure market, no future plans or studies have been defined to evaluate the state of the sector. While the ICASA completed a 5G spectrum auction, no specific regulations have been developed with regards to the promotion of infrastructure for this technology; it is inferred that the same rules on sharing and co-location apply.

The main strengths of the passive infrastructure regulation are (i) a framework that encourages leasing and sharing without the need to extend licensing to passive infrastructure players and (ii) a general law that promotes the harmonization of national and local regulations through the determination of general technical and economic processes for deployment. The only weakness is linked to the failure to update regulations, mainly to encourage the deployment of infrastructure in new technologies.

Tanzania

The main legal tool is the Electronic Communications and Postal Act[137] in a revised version as of 2022. This legal framework contemplates in its Article 29, numeral 1 and 2, to establish that the Tanzania Communications Regulatory Authority (TCRA) is in charge of (i) supervising agreements for the co-location and sharing of infrastructure among network facilities licensees, (ii) issuing procedures for the negotiation of access to infrastructure and (iii) determining standards for infrastructure sharing, among others. Along the same lines, Article 5 of the same law establishes that any provider that installs any element or combination of elements of physical infrastructure used for connection to other service networks must obtain a network facilities license. On the other hand, according to Article 161 of the law, paragraphs (a) and (c), each network facilities licensee is responsible for seeking the consent of a local governmental authority or public agency regarding the procedures required for the installation of structures. In addition, the local authority is

[135] https://www.gov.za/sites/default/files/gcis_document/202304/48346gon3236.pdf.
[136] https://www.ellipsis.co.za/wp-content/uploads/2022/09/Standard-by-laws-for-deployment-of-electronic-communications-and-facilities-Comments-invited-1.pdf.
[137] https://www.tcra.go.tz/download/sw-1670493092-The%20Electronic%20and%20Postal%20Communications%20Act%20R_E%202022.pdf.

responsible for establishing payments or fees for the use of land. Likewise, it is the responsibility of the network facilities provider to ensure the security and proper management of the infrastructure.

The Access, Co-location and Infrastructure Sharing Regulation of 2018[138] contains aspects related to: (i) the procedure for sharing requests, (ii) minimum compliances for sharing, (iii) co-location agreements and (iv) observation of standards for the construction of structures; however, it does not analyze issues related to mimicry or distances necessary to totally avoid the over-deployment of networks. Article 17 of the same regulatory instrument specifies that the economic obligations for co-location and infrastructure sharing will be negotiated between the parties.

With respect to future sharing regulation forecasts, it is important to note that the regulatory authority issued a revision of the Sharing Regulation in 2022[139]; however, it is mainly related to exceptional spectrum sharing with no mention of the tower industry. That being said, it should be noted that the Universal Service Fund is critical for the promotion of infrastructure sharing.

In terms of infrastructure development for the adoption of new technologies, Tanzania has allocated spectrum for the launch of the country's first 5G network with a limited deployment of 230 5G sites, but no guidelines have been issued for the proper incentivization of 5G structures such as small cells.

The main strength of the regulatory framework is driven by a regulatory framework that encourages leasing, co-location and sharing through a licensing structure that is different from that of a network operator. On the other hand, the framework's main weaknesses are based on (i) the limited coordination of central and local governments for the issuance of infrastructure development permits and (ii) lack of guidelines to encourage co-location and infrastructure sharing for the adoption of new technologies.

Uganda

The main regulatory body for the telecommunications sector is the Uganda Communications Commission (UCC), which operates under the Uganda Communications Act of 2013.[140] In this Act, Section 5, subsection 1y, states that the Commission shall promote and encourage infrastructure sharing and the generation of guidelines for such purposes. Moreover, in Article 22,

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[138] https://www.tcra.go.tz/download/sw-1619086468-The%20Electronic%20and%20Postal%20Communications%20%28Access,%20Co-Location%20and%20Infrastructure%20Sharing%29%20Regulations,%202018.pdf.

[139] https://www.tcra.go.tz/uploads/documents/sw-1669103346-GN%20644%20-%20THE%20ELECTRONIC%20AND%20POSTAL%20COMMUNICATIONS%20(ACCESS,%20CO-LOCATION%20AND%20INFRASTRUCTURE%20SHARING)%20(AMENDMENT)%20REGULATIONS,%202022%20(1).pdf.

[140] https://www.ucc.co.ug/wp-content/uploads/2023/10/UCC-Act-2013.pdf.

it is determined that the permit for the construction of towers requires a Public Infrastructure Provider (PIP) license, which authorizes its holder to establish and maintain infrastructure for the provision of communications services.

The UCC has also issued the 2021 Guidelines on Infrastructure Deployment and Sharing.[141] In its introductory section, the Commission recognizes that the construction, operation and/or maintenance of communications infrastructure is often very costly, and that leasing of communications network infrastructure currently represents a significant portion of the overall costs of a typical service provider in the communications sector. The main objectives of this guide are related to: (i) fostering a strategy for infrastructure deployment and leasing, (ii) facilitating coordination among market players for sharing and co-location, (iii) minimizing the visual impact and cost of civil works, and (iv) promoting technical efficiency in the provision of infrastructure. Articles 10 and 11 of these guidelines determine the parameters and procedures upon which operators may request co-construction or access to infrastructure. The most important ones are related to the responsibility for construction safety, distances for prevent over-deployment and applicable charges for the negotiation of infrastructure leases between the parties.

Likewise, the license description document[142] and requirements for its application[143] establish as a general characteristic a permit fee of US$2,500 and an annual contribution that can range from US$60,000 or 2% of annual profits.

A fundamental aspect to take into account is the harmonization between national guidelines and local attributions. Thus, Article 17 of the Guidelines determines that the UCC will collaborate and coordinate with the relevant authorities for the granting of civil works applications within reasonable time periods. In addition, the use of infrastructure, land and government buildings for the siting and co-location of sites is encouraged.

In terms of 5G expansion, in practice, both MTN Uganda and Airtel Uganda have been working on the implementation of this technology. This includes the construction of new telecom towers within the framework of current regulations and guidelines.

Regarding future plans, it is important to mention that the National Broadband Policy 2018[144] concluded that it was necessary to have a comprehensive framework to facilitate the development of infrastructure and ensure the sharing and complementarity of private networks. Thus, Article 9-3 of the Sharing Guidelines establishes that each operator must submit an annual deployment plan to be approved and evaluated by the regulator.

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[141] https://www.ucc.co.ug/wp-content/uploads/2023/10/THE-UGANDA-COMMUNICATIONS-COMMISSION-GUIDELINES-ON-INFRASTRUCTURE-DEPLOYMENT-AND-SHARING.pdf.

[142] https://www.ucc.co.ug/wp-content/uploads/2023/10/DESCRIPTION-OF-TELECOM-LICENSES-AND-AUTHORISATIONS.pdf.

[143] https://www.ucc.co.ug/wp-content/uploads/2023/10/LICENSE-APPLICATION-REQUIREMENTS-FOR-THE-NEW-TELECOM-LICENSES.pdf.

[144] https://ict.go.ug/wp-content/uplo ads/2019/05/National-Broadband-Policy-Booklet.pdf.

In summary, the strengths presented in Uganda are (i) a telecommunications tower regulatory framework defined on the basis of a licensing regime that promotes the expansion of coverage and (ii) the establishment of figures that encourage efficiency, such as co-construction and occupation of spaces belonging to the central government.

The main weakness observed is that specific regulations for the deployment of new technologies such as 5G still are not detailed. In addition, in the area of fees, no specific information is defined regarding harmonization and coordination with local governments for obtaining permits.

Zambia

According to the Information and Communication Technology Act of 2009, the Zambia Information and Communications Technology Authority (ZICTA) plays a crucial role in regulating the construction of infrastructure. Thus, Article 44 of the Act determines that a licensee installing infrastructure on public or private land must negotiate a co-location agreement with another licensee requesting access to the site.

Along the same lines, the ZICTA is mandated to issue an authorization for the installation of network facilities that comply with international standards. Thus, according to the Licensing Guide for Electronic Communications of 2022, Article 1, the Network License permit allows the construction of infrastructure for the availability of network operators.[145] However, no information has been found on whether this license is the only enabling permit before the central state and local governments. In other words, regulatory harmonization is not clearly defined in terms of whether there are local permits that operators are responsible for obtaining.

Regarding the payment of license fees, the Licensing Guide establishes an annex where the initial and annual payments for this type of authorization are specified. For a national permit, 55,556 tariff units are determined and an annual payment of 1.5% of the annual income. Also, a permit is established for a period of 10 years.

Furthermore, the regulator has also issued the Infrastructure Installation Guidelines. Its main guidelines are related to: (i) the reduction of visual impact or mimicry, (ii) the promotion of co-location and definition of distances to prevent tower over- deployment and (iii) safety standards and risks related to the construction of structures. In order to comply with these principles, reference is made to the observance of international standards that operators and suppliers must consider. In addition, this document covers two important aspects: (i) standards for the deployment of networks and ducts for fiber deployment and (ii) requirements for the deployment of new technologies within a sandbox or testing scheme, both of which could encourage the development of infrastructure mainly for 5G.

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145 https://www.ucc.co.ug/standards-regulations-guidelines-and-frameworks/.

6.4. Summary of current African tower regulatory situation

Among the specific regulatory initiatives that were surveyed in the legal and regulatory framework regarding infrastructure development in Africa, it can be noted that:

- All countries except Ethiopia and Mozambique include the passive infrastructure provider as a figure for the operation of independent towers, and many have a specific standard on the subject.
- Independent tower companies currently operate in all countries except Ethiopia, Morocco, Mozambique and South Africa, however, in all of them, they are required to apply for some form of registration in order to obtain a passive operator license. In those three countries, authorization is a discretionary regulatory decision because they do not have a well-defined licensing framework.
- Only Kenya and Ghana can be considered to have national standards harmonized with local ordinances. In most countries there are general standards that do not precisely establish the technical mechanisms of deployment (e.g., distance, height, co-location, mimicry) coexisting with ordinances that regulate exclusively the civil construction of the building (e.g., building permit, land fees, landscape environment). In other words, the national regulators leave the local authorities free to determine the processes for civil permits or the establishment of fees.
- Aspects related specifically to tower over-deployment should include clear guidelines regarding distances and co-location as a way to avoid over-deployment. In this regard, Ghana, Kenya, Morocco, Rwanda, Uganda and Zambia contain guidelines for the construction and sharing of towers considering these requirements that encourage efficiency in the deployment and occupation of structures.
- Only South Africa, Tanzania, Uganda and Zambia have implemented "light" regulatory processes for the deployment and operation of passive infrastructure; the other countries have permitting procedures in place, although, in practice, they delay the construction of a site.
- Egypt, Ghana, Kenya, Kenya, Nigeria, Rwanda, South Africa, Tanzania, Uganda and Zambia have established procedures and reference tables that determine the use of space or land for tower deployment and licensing fees, respectively.
- In all countries, it is preferred that infrastructure lease prices be negotiated between the parties; however, in the event of disputes between operators or suppliers, the regulatory authorities may intervene to resolve the conflict by setting maximum ceilings for these fees.
- Only Egypt, Kenya and Zambia have related plans in the development of passive infrastructure for the adoption of new technologies such as 5G.

A summary of these characteristics is presented in table 6-5. Each of the 12 regulatory components is ranked according to documentary reviews and interview data. A score is assigned to each country and an overall score calculated to determine the level of advancement of the regulatory framework.

Table 6-5: Africa: Regulatory characteristics for passive infrastructure deployment

DIMENSION	ANG	DRC	EGY	ETH	GHN	KEN	MAR	MOZ	NIG	RWA	SUD	TAN	UGA	ZAM
Passive Infrastructure Regulation	Yes	Yes	Yes	No	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes
Specific Regulation for Tower Industry	Yes	Yes	Yes	No	Yes	Yes	No	Partially	Yes	Yes	Yes	Yes	Yes	Yes
No Need for Concession of Tower Operators	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Nationally Harmonized Deployment	Partially	Partially	Partially	No	Yes	Yes	Partially	Partially	Partially	Partially	Partially	Partially	Partially	No data
Need for Fast Permit Approvals	Partially	No	No	No	Partially	Partially	Partially	Partially	Partially	Partially	Yes	Yes	Yes	Yes
Establishment of Caps on Fees & Taxes	Partially	No data	Partially	No data	Yes	Partially	Partially	Partially	Partially	Partially	Partially	Partially	Yes	Yes
No Need for Contract Price Regulation	Partially	Yes	Yes	No	Yes	Yes	Yes	No data	Yes	Partially	Yes	Yes	Yes	Yes
Policies to Promote Development of 5G	No	No	Yes	Partially	Partially	Yes	No	No	No	No	Partially	No	No	Yes
Future Infrastructure Sharing Plans	No	No	Partially	No	Partially	Yes	No	Partially	Partially	Yes	Partially	Partially	Partially	Yes
Rules to Prevent Duplicity (Distance, Co-Location)	Partially	Partially	Partially	No data	Yes	Yes	Yes	Partially	Partially	Yes	Partially	Partially	Yes	Yes
Long-Term Guarantees in Regulations	Yes	No data	Yes	No data	Yes	Yes	No data	No data	Yes	Yes	Yes	Yes	Yes	Partially
Sharing Best Practice Manuals	No	No	No	No	No	Yes	No	No	No	No	No	No	No	No
OVERALL REGULATORY LEVEL	Partially	Partially	Partially	No	Yes	Yes	Partially	Partially	Partially	Partially	Yes	Yes	Yes	Yes

YES NO PARTIALLY NO DATA

Source: Telecom Advisory Services

Countries depicting a regulatory score higher than 0.70 were assigned a high level of development (Ghana, Kenya, South Africa, Tanzania, Uganda and Zambia). Countries with a score between 0.40 and 0.70 were determined to be in intermediate development (Angola, Democratic Republic of the Congo, Egypt, Morocco, Mozambique, Nigeria and Rwanda). Only Ethiopia scores under 0.40.

7. A LOOK AHEAD AT THE AFRICAN TOWER INDUSTRY

Beyond the ongoing support of deployment of wireless infrastructure, the future business of tower companies entails migrating from a pure passive infrastructure "specialist" to a vertically integrated value-added supplier, provided institutions and regulation allow and incentivize them to go through a profound transformation. Now that carriers' expansion in Africa is established, a significant share of market opportunities from their tower divestures lies in the independent tower companies' balance sheets. Along these lines, there is an opportunity for towercos to become more agile, more data-driven and more focused on new revenue flows (Schicht et al.).[146] In other words, towercos will move away from the current view of them as "grass and steel" financial partners (Casahuga et al.)[147] and move decidedly toward more diversification, expanding in the digital ecosystem. The regulatory framework should accompany this process, even incentivizing this digital and corporate transformation of towercos to enrich the digital ecosystem. Business opportunities are evident both in the traditional tower company space — going smarter — and in the addition of new telecommunication services and new lines of digital businesses.

7.1. Smarter traditional tower company business

First, funded on the economics and financials built in this report, towercos' opportunities imply going deeper into optimizing some services by sharing them with the different tenants, in particular telecommunication operators sharing the same infrastructures. Should this be allowed and fostered by regulation, cost savings could be directed toward improving and modernizing infrastructure, making it more eco-friendly beyond the sustainable approaches of power-as-a-service towerco or investing in digital transformation inside and outside the companies. This diversification will have an additional contribution to telecommunication wireless services as additional resources can be focused on improving quality, affordability and sustainability.

Second, there are significant gains from digitizing the core, implementing real-time smart data systems in installed infrastructure and moving away from just passive infrastructure provision. This would allow gathering real-time precise state evaluation of the infrastructures (e.g., degree of corrosion, energy consumption, tenants' ratio, financials per site) and their environments, from climate conditions to identifying competitors (Cane; Schicht et al.).[148] The starting point is challenging, as a 2020 survey by TowerXchange and Analysys Mason showed: it found that 28% of towercos are still using Microsoft Excel as their

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[146] Schicht, R., S. Banerjee, J. Arias, and A. Voytenko. *The New Digital Landscape for Tower Companies.* Boston Consulting Group (2020).

[147] Casahuga G., P. Ugarte and F. Merry del Val. *Attention Towercos: It's time to listen to your customer*. Arthur D. Little (2022).

[148] Cane, R. (2022), *TowerXchange Meetup Americas 2022*, July.

unique data management tool, and less than half had embarked on a data strategy of any form.

7.2. New opportunities in the IoT and smart cities market spaces

Beyond improving the core business, tower companies will expand into other diversification spaces, such as enhanced support of 5G and IoT, combined with a more sustainable "green" profile.

New telecommunication services, 5G and beyond

Towercos could take an active role in network densification for 5G and not just adapt to its deployment. As reviewed in chapter 2, 5G connectivity requires macro towers as well as small cells, with massive site numbers and backhaul provisioning. This will have a notable impact on passive infrastructures.

In this context, towercos should secure fast and flexible permits from local authorities for the small-cell rollout that will characterize most of 5G infrastructure expansion. Investing in small-cell backhaul could be riskier, but initial results in the U.S. and Europe appear promising (Wilson).[149] Operators that do not already have dense fiber infrastructure need to build stronger and frequent relationships with towercos as 5G rollouts begin.

Towercos could also develop business lines directly as business partners to industries in 5G private networks in support of business cases, which will start deployment earlier than the massive retail 5G service. These autonomous networks can address various needs of industry verticals or even local governments supported by 4G and 5G capabilities and integrated to national networks from manufacturing (e.g., automobile), energy and mining, and ports and transportation. This will enable more reliable and high-performance industry 4.0 solutions for different sectors.

New digital services

New open standards and cloud-based developments are making it easier to disaggregate network hardware and software components. These open the way to increase the "active" components of towercos' infrastructure business lines, such as antennas and radio transmission equipment. In this model of multiple digital services, towercos play the role of neutral host model (Carvalho et al.).[150]

While the revenue opportunity for towercos in the Internet of Things and smart-city segments could be lower than for the small-cells segment, the CAPEX involved is also low.

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[149] S., Wilson, S. *Revenue Opportunities for Towercos and MNOs now and in the 5G era. Small cell densification and IoT*. Analysys Mason (2016).
[150] J., Carvalho, J., G.CR Budden and P.M. Vaz. *The Rise of the Netcos*. Deloitte (2021).

On the other hand, the upside of these services could be higher than expected, given the variety of new services that could be supported, from imaging and logistics to asset-heavy sectors (energy) complementing drones, data intelligence and smart cities (weather, traffic, energy as a service). More generally, towercos' perimeter could be enlarged by entering into edge computing businesses, due to the right regional and local footprint of installed infrastructure and services offered today (Cane, 2022; Wilson 2016).

A forward-looking regulation to favor a diversified value-added tower sector

Some relevant conditions need to be fulfilled in this transformation. The required capabilities, technology, processes and labor organization inside towercos cannot be taken for granted.

In addition, the envisioned diversification faces regulatory and strategic challenges. First, the new business opportunities both in the telecommunication sector and in other digital services should be pursued to protect towercos' relationships with their current main clients, the carriers. Second, as their core business does not require licenses or all the associated regulatory burden, policymakers and regulators should accompany this process by allowing and proactively supporting towerco transformation, while properly regulating deployments based on quality and sustainability standards.

First and foremost, regulators in Africa should allow and foster infrastructure and services sharing as a key element for further investment in capital and innovative services. The observed over-deployment in some countries of the continent and in many urban areas is a waste of resources and has a negative impact on the environment. Second, regulators should accelerate the issuance of permits from local municipalities for small-cell rollouts, especially for 5G services. Despite the slow start for retail 5G services, private networks are starting to be developed across the region; once started, 5G take off will be fast. Therefore, planning it in advance will have significant benefits.

Also, regulators could foster light-touch regulation, even experimenting before regulating in controlled environments using regulatory sandboxes, for example, regarding the entry of new players to these innovative services around smart cities. Digital technologies and data availability can enable new real-time ways to regulate the digital ecosystem. In the absence of significant regulatory reforms to deal with new business models and technologies in the increasingly converging audiovisual sector, sandboxes are seen as a way for regulators to promote competition by fostering and unleashing disruptive innovation. Additionally, regulatory sandboxes allow authorities and industry players to gather information on new markets and services (as the ones towercos could enter), where the behavior of agents, such as firms and consumers, might still be unknown and unpredictable (Enríquez and Melguizo, 2021). This framework could serve to test light authorization regimes, replacing burdensome and slow processes, minimum and reasonable reporting obligations, or tax incentives to foster infrastructure expansions in rural and remote areas.

Finally, business transformation is not easy, but public authorities and development banks could support the digital transformation inside towercos. Digitizing and training will take time and resources for investing in equipment, implementing new digital processes and training the workforce, easing not core regulatory burdens and offering training resources.

8. CONCLUSION: STUDY RESULTS AND IMPLICATIONS

A vibrant independent tower industry is a pillar for an African 4.0 to be more productive, more inclusive and more sustainable (socially and environmentally).

This report has shown that the tower industry sector is going through profound changes in Africa, opening opportunities for strategic partnerships. In particular, due to its dynamism and also to the divestments from some traditional telecommunication operators, on average 44% of the tower stock is run by independent companies. Still, there is a close interdependence between wireless industry players and passive infrastructure providers, not only as tenants of the latter, but as potential partners as additional services arise from digital transformation. A particular area for mutual win-wins comes from infrastructure sharing, as tower companies secure a relatively stable monetization of its substantial investments and operators can cumulate savings to reinvest in better quality services of future ones (via R&D).

Beyond this positive trend, this report has quantitively shown that the increasing position of independent towercos is an asset for the digital economy and, in particular, for the wireless industry. Following the methodology developed by World Bank's IFC, we showed that from 2016 to 2023, countries in Africa with a more dynamic independent towerco sector exhibit better wireless connectivity in terms of coverage, use, affordability and quality (download speed). At the same time, the wireless industry in these countries shows more competition and more investment, demonstrating once again the potential win-wins. More precisely, with higher 4G coverage in these countries compared to the rest of countries (90% of the population vs. 82%), wireless broadband is 35% faster than the rest (44 Mbps vs. 33 Mbps), capital spending is 130% higher in country leaders (US$8.82 per capita vs. US$3.83 per capita) and wireless broadband services represent less than half of costs in terms of per capita income in country leaders relative to the rest of countries. Furthermore, country leaders exhibit higher broadband adoption than in the rest of the region (35% vs. 27%) and wireless competition is more intense in countries with higher share of independent tower deployment (30% less concentration).

These correlational results have been confirmed in our original econometric modeling, as independent towers show a significantly higher impact on wireless broadband use, coverage, speed and affordability, favoring a more competitive telecommunication industry. A 10% increase in the number of independent towers leads to:

- An increase in 4G coverage levels of at least 5.95%.
- An increase in wireless broadband adoption of 3.29%.
- An increase in service quality levels (measured as mobile broadband download speed) of 5.07%.
- An increase in mobile market competition levels (measured as a decrease in the Herfindahl–Hirschman Index that measures industry concentration — a lower index depicts more intense competition) of 1.38%.

- An improvement in the level of mobile affordability (measured as a decrease in service price relative to the monthly GNI per capita) of 7.82%.

Now is the time to make public policies right. This involves implementing a smart and flexible regulation of the independent towerco sector — covering its quality and security standards, but also its environmental impact and sustainability — securing the predictability and stability that a capital-intensive sector requires for its financial viability and long-term sustainability and favoring infrastructure sharing all along the telecommunication sector. A review of the research literature and interviews with regulators and policymakers have led to the identification of 12 types of initiatives that can contribute to the development and sustainability of an independent tower sector: (i) regulation of passive infrastructure sharing, (ii) specific regulation for tower industry, (iii) no need for service concession, (iv) nationally harmonized deployment, (v) need for fast permit deployment approvals, (vi) establishment of caps on fees, taxes and rights of construction, (vii) no need for contract price regulation, (viii) policies to promote infrastructure sharing for deployment of 5G, (ix) regulations to prevent duplicity, (x) absence of price regulation of tower company contracts with service providers, (xi) long-term guarantees in regulations and permits, and (xii) sharing of best practices adopted in key countries.

The good news is that these policy and regulatory prescriptions have been undertaken by some countries and should be considered as benchmarks when it comes to development of the telecommunications and passive infrastructure sharing industries from which to learn from their design and implementation: South Korea, the United Kingdom and the United States. In a nutshell, these countries have specific laws to regulate the deployment of passive infrastructure:

- They do not require independent tower companies to register with the regulatory authorities to begin operations.
- They have enacted laws that are in harmony with local ordinances, light procedures for construction permits and references to construction fees that are known to infrastructure operators.
- They do not have pricing regulations for shared infrastructure.
- They present information that promotes the deployment of networks for new technologies such as 5G and small cells.
- They have plans or manuals of good practices that make it possible to supplement or complement the regulatory frameworks that promote the orderly construction of shared telecommunication infrastructure.

The tower industry in Africa and globally is going through a deep transformation to render its core business more agile, digital and environmentally sustainable, and at the same time diversify both in telecommunication services and other businesses in support of digital developments. Regulators should also accompany this process and favor the emergence of an additional digital sector with a forward-looking view.

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APPENDIX

A. African regulatory framework scores

	ANG	DRC	EGY	ETH	GHN	KEN	MAR	MOZ	NIG	RWA	SUD	TAN	UGA	ZAM
Passive infrastructure regulatory framework	1	1	1	0	1	1	1	0	1	1	1	1	1	1
Specific tower regulations	1	1	1	0	1	1	0	0.5	1	1	1	1	1	1
No need for concession of tower operators	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Regulatory harmonization	0.5	0.5	0.5	0	1	1	0.5	0.5	0.5	0.5	0.5	0.5	0.5	
Need for fast permit approvals	0.5	0	0	0	0.5	0.5	0.5	0.5	0.5	0.5	1	1	1	1
Establishment of caps on fees and taxes	0.5		0.5		1	0.5	0.5	0.5	0.5	0.5	0.5	0.5	1	1
No need of price regulations	0.5	1	1	0	1	1	1		1	0.5	1	1	1	1
Policies to promote new 5G technologies	0	0	1	0.5	0.5	1	0	0	0	0	0.5	0.5	0	1
Future infrastructure sharing plans	0	0	0.5	0	0.5	1	0	0.5	0.5	1	0.5	0.5	0.5	1
Regulations to prevent over-deployment	0.5	0.5	0.5		1	1	1	0.5	0.5	1	0.5	0.5	1	1
Long-term guarantees in regulations and permits	1		1		1	1			1	1	1	1	1	0.5
Sharing best practice manuals	0	0	0	0	0	1	0	0	0	0	0	0	0	0
	6.5	5	8	1.5	9.5	11	5.5	4	7.5	8	8.5	8.5	9	9.5

Normative	1.00	1.00	1.00	0.40	1.00	1.00	0.50	0.65	1.00	1.00	1.00	1.00	1.00	1.00
Harmonization	0.50	0.30	0.30	-	0.80	0.80	0.50	0.50	0.50	0.50	0.70	0.70	0.70	0.40
Tariff regime	0.50	0.60	0.80	-	1.00	0.80	0.80	0.20	0.80	0.50	0.80	0.80	1.00	1.00
Outlook regulatory framework	0.40	0.20	0.65	0.10	0.75	1.00	0.40	0.25	0.45	0.70	0.55	0.55	0.65	0.80
	2.40	2.10	2.75	0.50	3.55	3.60	2.20	1.60	2.75	2.70	3.05	3.05	3.35	3.20

	ANG	DRC	EGY	ETH	GHN	KEN	MAR	MOZ	NIG	RWA	SUD	TAN	UGA	ZAM
Normative	1.00	1.00	1.00	0.40	1.00	1.00	0.50	0.65	1.00	1.00	1.00	1.00	1.00	1.00
Harmonization	0.50	0.30	0.30	-	0.80	0.80	0.50	0.50	0.50	0.50	0.70	0.70	0.70	0.40
Tariff regime	0.50	0.60	0.80	-	1.00	0.80	0.80	0.20	0.80	0.50	0.80	0.80	1.00	1.00
Outlook regulatory framework	0.40	0.20	0.65	0.10	0.75	1.00	0.40	0.25	0.45	0.70	0.55	0.55	0.65	0.80
	2.40	2.10	2.75	0.50	3.55	3.60	2.20	1.60	2.75	2.70	3.05	3.05	3.35	3.20

NP. Normative	0.15	0.15	0.15	0.06	0.15	0.15	0.08	0.10	0.15	0.15	0.15	0.15	0.15	0.15
H. Harmonization	0.25	0.15	0.15	-	0.40	0.40	0.25	0.25	0.25	0.25	0.35	0.35	0.35	0.20
TR. Tariff regime	0.10	0.12	0.16	-	0.20	0.16	0.16	0.04	0.16	0.10	0.16	0.16	0.20	0.20
RF. Outlook regulatory framework	0.06	0.03	0.10	0.02	0.11	0.15	0.06	0.04	0.07	0.11	0.08	0.08	0.10	0.12
TOTAL	**0.560**	**0.450**	**0.558**	**0.075**	**0.863**	**0.860**	**0.545**	**0.425**	**0.628**	**0.605**	**0.743**	**0.743**	**0.798**	**0.670**