January 2026

Full Connectivity

Bridging the Digital Divide with Shared Infrastructure

Citi Institute

Global Perspectives & Solutions

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Contents

Key Takeaways

1

Significant Progress, Remaining Gaps
The percentage of people living in areas not connected has dropped significantly, yet a major "usage gap" persists where people have coverage but do not use the internet.

2

Affordability as a Primary Barrier
Affordability is the main obstacle to universal internet access in low- and middle-income countries. Handset costs can be as high as 16% of monthly income, and data prices vary widely, making internet use inaccessible for many.[1]

3

Infrastructure Sharing as a Solution
Sharing telecommunications infrastructure, especially through models like TowerCos, can significantly reduce costs for operators, improve network quality and lower prices for consumers.

4%

Percentage of people living in areas that are not connected to the internet. In 2015 it was 20%.[2]

25%

Only 300 million people out of a population of 1.2 billion have their own mobile internet subscription in Sub-Saharan Africa.[3]

4x

Internet speeds in low to middle-income countries lag speeds in high-income countries by up to four times. [4]

Shared Digital Infrastructure for Universal Connectivity

About a third of the global population still does not use the internet, with surveys suggesting that even awareness of the internet is not universal.

Yet, the internet now gives access to vital services around the world, including healthcare and education, from which a substantial portion of the world is excluded.

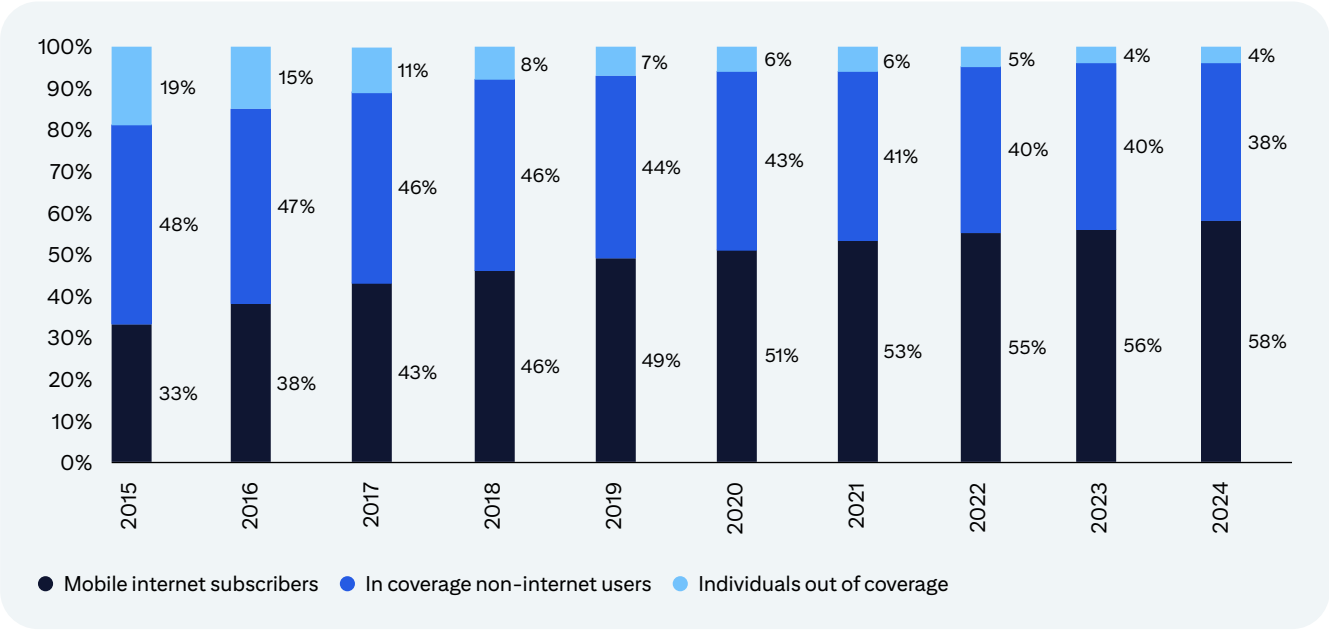
Citi Institute reports such as Stablecoins 2030 – Web3 to Wall Street and Real Time – 24x7 Finance in an Always-on World outline the digitalization of financial services for both businesses and individuals. This digitalization has given many more people access to facilities such as bank accounts and payment services.

Bringing the last third of the population online is therefore a major opportunity to catalyze global development, unlocking opportunities for the most underserved to access basic services.

In this report, we highlight Oxford Martin School research, funded by Citi, which shows that when telecoms infrastructure is shared between mobile network operators rather than operated by individual telecommunication companies, network quality improves and costs for consumers fall. At the same time, costs for operators fall and return on investment tends to increase.

We therefore highlight the potential for this sharing of infrastructure to reduce the investment required to close the remaining digital divide and achieve the International Telecommunication Union (ITU) target of universal digital connectivity – meaning access to the internet for all – by 2030.

Figure 1: Share of global population accessing the internet, 2015 to 2024[16]



Source: GSMA, 2024

Despite Progress, Gaps in Digital Connectivity Remain

About two-thirds of the global population now have access to the internet.[5]

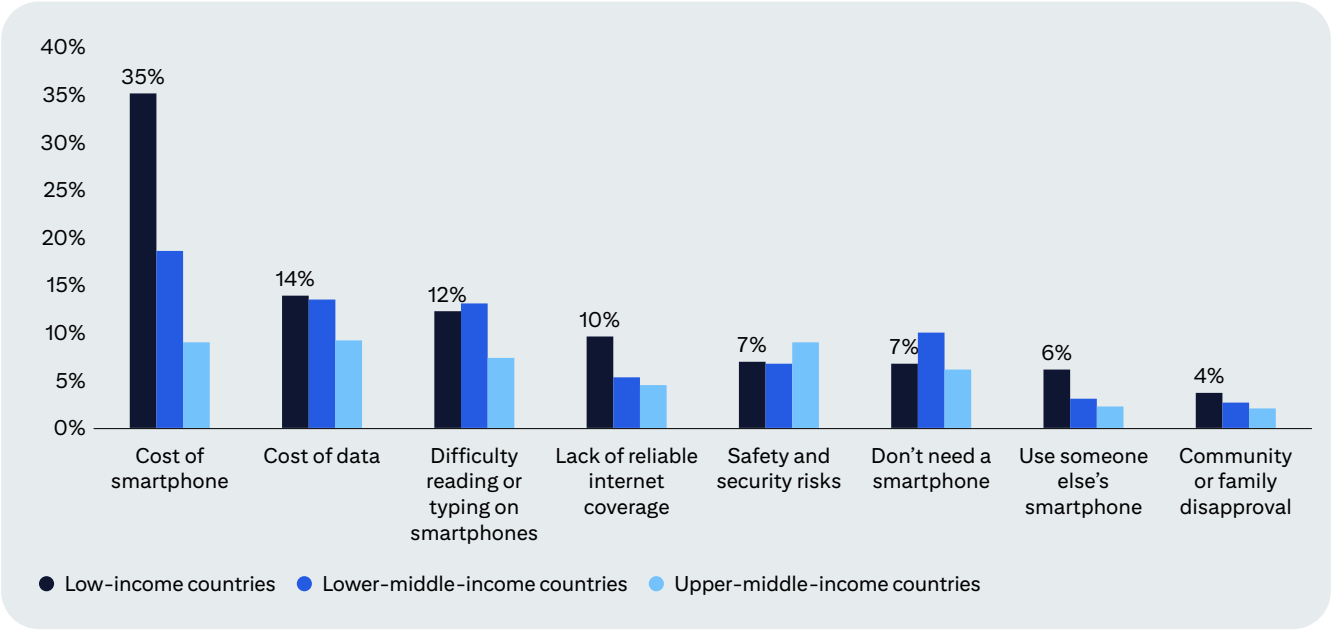
This progress has been driven by increases in both the share of the globe that the internet reaches (coverage) and the number of people choosing to use it (usage).

About a decade ago, almost 20% of people lived "out of range", in places that were not connected to the internet because mobile data had not yet reached them. By 2024 (the most recent data available) this had fallen to just 4%. (Figure 1)

Sub-Saharan Africa is the least digitally connected region with 10% of its population still out of range in the most recent data. But even here, scores of people continue to be brought online every year: just three years ago, 17% of people in the region were out of range. Yet, internet coverage is not strictly what counts. It is internet use that brings access to digital goods and services such as bank accounts, healthcare and education opportunities.

This usage gap – the share of people who do not use the internet even though their local area has internet coverage – is a bigger barrier to universal connectivity than the coverage gap. At a global level the usage gap (4%) is now 9x the size of the coverage gap (38%) (figure 1).

Figure 2. Share of population reporting each reason for not owning a smartphone



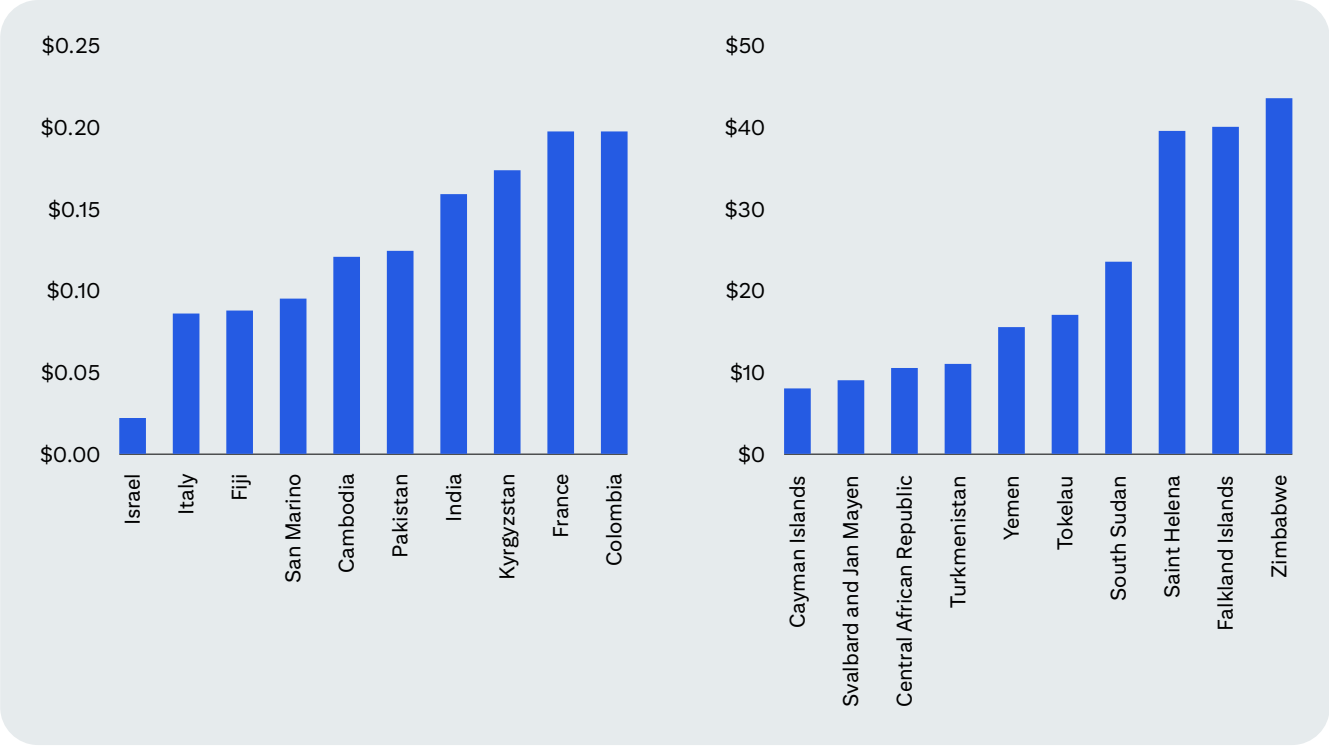
Source: World Bank, The Global Findex Database 2025. The Global Findex Database presents the findings of surveys conducted across more than 140,000 people spanning 141 countries in 2024.

The usage gap reduces if we include users who access the internet through a shared device, for instance children who use a parent's phone. But this only adds an extra 9% of the global population, so a third of the global population still does not have meaningful access to the internet.[6]

In some regions, non-internet users outstrip internet users substantially. Sub-Saharan Africa is one example: even though only 10% of the population lives in areas without internet access, only 25% (about 300 million people) have their own mobile internet subscription. A further 5% of the total population, or 60 million people, use someone else's subscription. Even among adults – accounting for the fact that Sub-Saharan Africa is one of the youngest places on earth – only 42% have their own device.[7]

While there is work to be done in extending internet coverage, especially to rural, poor and thinly populated areas[8], uptake rather than provision is the biggest hurdle to bringing more people online. The next step is to move internet access from theory to practice.

Figure 3. Top 10 least (left) and most (right) expensive data economies, 2023



Source: Best Broadband Deals, 2023.

Affordability is the Main Barrier to Closing the Internet Usage Gap

Universal digital connectivity will be achieved when everyone, everywhere has meaningful access to the internet. But there are many remaining barriers.

Affordability of smartphones and mobile data is a common theme across low- and middle-income countries (LMICs) (figure 3).

First, handsets are unaffordable for many. Analysis from the GSMA, a non-profit industry body representing global mobile network operators, found that it cost about $54 to buy an entry-level internet-enabled device in LMICs in 2024 or about 16% of monthly income.[9]

That's the equivalent of an American spending $1,300 on an entry-level handset today, a Brit spending £600 or a German €715[10] – between 5 and 8 times the costs of entry-level handsets in those countries.

Unaffordability of data is another cost barrier.

The cost of data varies widely between countries. A 2023 study of data prices in almost every country found that Zimbabwe had the highest cost of more than $40 for 1GB of data for use in a 30-day period. Israel had the lowest cost, at $0.02 for 1GB.[11]

There is great variation within regions and income levels: six regions are represented among the cheapest ten data economies and seven among the most expensive (figure 3). Costs in neighboring countries can also differ markedly: Zimbabwe's lower-income neighbor Malawi was in the 30 cheapest data economies with a 1GB entitlement costing less than 10% of Zimbabwe's prices,at $0.38.

In Sub-Saharan Africa, data costs are both the highest and the fastest falling. The region is home to four of the 10 most expensive economies for 1GB of data (figure 3, right-hand side).

Data affordability has increased fastest in Sub-Saharan Africa in recent years. In 2019, 5GB of data had an average cost of more than 10% of monthly income. That figure had fallen to 5% of median income for 5GB of data by 2024, according to GSMA, the industry body representing mobile network operators, highlighting significant improvements in data affordability across Sub-Saharan Africa.[12]

Yet the affordability challenge persists. The International Telecommunications Union, a UN agency responsible for digital technology, has two targets: first, for an entry-level data subscription to cost less than 2% of monthly income, and then to cost less than 2% of monthly income for the two lowest earning quintiles. 2024 was the first time that more than half of countries across all regions met the first of these targets.[13]

The reasons that these country and regional price differences persist, even between neighbors, are complex, encompassing the regulatory landscape and market maturity among other factors. A project with British International Investments (BII) on tower companies (TowerCos) for developing countries showed that telecommunications markets can differ vastly. Pantelis Koutroumpis, the lead economist and director of the programme on Technological and Economic Change at the Oxford Martin School, distinguishes three broad categories that define their performance:

- Efficient markets: Efficient telecommunications markets lead to a competitive landscape in services, spectrum allocation and a high level of regulation that builds on evidence-based governance.
- Average markets: These markets are characterized by delays in spectrum allocation, suboptimal competition among operators, telecommunications regulation that includes a thorough legal landscape but rarely enforced sanctions and a limited impact of government involvement in setting the agenda.
- Inefficient markets: These markets have significant parts of the electromagnetic spectrum left unutilized due to improper allocation mechanisms, including inadequate auction designs and licensing processes, lack of sanctions for unutilized spectrum and delays in mobile access. In these markets regional segmentation and monopolies often lead to high usage prices or lack of competition. These markets also have adequate regulatory provisions and minimal enforcement in cases of anticompetitive behaviors.

These findings also align with the International Finance Corporation (IFC) report[14] on TowerCos in emerging economies.

Poor Connection Quality Also Hinders Smartphone Adoption

The quality of internet access varies across the world and remains a barrier to adoption.

10% of those who do not use the internet in low-income countries cite the lack of reliable coverage as the reason that they do not have a smartphone (figure 2).

ITU data shows that almost three times as many calls are interrupted in LMICs as in high-income countries (figure 4). Internet speeds also lag by up to four times compared to high-income countries.

There are, of course, other challenges. Security and safety concerns – including the risk of fraud or scams, unwanted contact and harmful or unreliable information online – are other major barriers to owning a smartphone. Some also cite a lack of digital skills and literacy.[15]

Figure 4: Digital connectivity gaps between countries of different income levels.

	High-income countries	Upper-middle-income countries	Lower-middle and low-income countries
Share of population reporting internet use in the last 3 months (%)	93%	86%	39%
Average internet speed (Mbps)	140	65	30
Share of calls interrupted (%)	0.4%	0.6%	1.1%
Average latency (milliseconds)	12	16	27

Note: (1) Share reporting internet use in the last 3 months is updated vs. ITU publication, using the Global Findex 2025 data. (2) This is the average of low- and lower-middle-income countries' reported figures.
Source: Adapted from International Telecoms Union, 2025.

Low Earth Orbit satellites offer connectivity in hard-to-reach areas

Arthur Pineda and Michael Rollins, Telecommunications, Citi Research

Infrastructure sharing is not the only way to boost connectivity. A recent note from Citi Research argues that Low Earth Orbit (LEO) satellites could help close the coverage gap and bring more people online, especially in harder-to-reach areas and potentially in partnership with telcos. But the affordability challenge which accounts for the usage gap persists.

Geospatial Earth Orbit (GEO) satellites have provided broadband connectivity for decades. But the increasing proliferation of Low Earth Orbit (LEO) satellites now stands to provide far more pervasive data connectivity with superior user experience and capacities. Beyond broadband data, the recent development of direct to device capabilities allow these LEO satellites to deliver data, voice, and SMS services direct to end-users' devices using traditional smartphones phones utilizing telecom spectrum.

LEOs operate between 150 and 2000km from the ground, vs. more than 36,000km for GEOs. They therefore offer a far lower latency which makes them more practical for services like video conferencing or real-time gaming.

LEOs could help close the telecom infrastructure coverage gap by providing higher quality services in places where traditional telecommunications companies cannot profitably sustain operations – like rural areas with a low density of potential subscribers. We estimate that LEOs, capacity considerations aside, could cover these areas for 20% of the cost of traditional telecommunications infrastructure. Already, we are seeing some telecom companies strike partnership agreements with LEO operators for backhaul and direct to device services.

LEO services are still priced at a premium to both fixed line fiber and 5G fixed wireless access – especially in emerging markets.

While coverage cost is indeed cheaper, capacity constraints do remain a key consideration as cost per GB throughput (the cost of storing or transmitting one gigabyte of data) remains expensive. Equipment and connection costs further add to this price difference.

These pricing gaps may narrow substantially as new LEO competitors enter the market, and the technology scales further across the global footprint. However, the premium persists, for now, despite lower unit economics on account of the lower density of populations that LEOs would cater for.

Beyond pricing, service quality may be a second barrier: antenna/device location (including being indoors) and inclement weather can both affect service quality, especially for direct to device usage. Capacity limitations also hindered the rollout of LEO in Nigeria for a few months in late 2024.

On a global view, we think that partnerships between telcos and LEO providers could profitably deliver connectivity to low-density and harder-to-reach rural areas. These partnerships could be a win-win for both parties, allowing telcos to service new customers without major capex, and LEO providers to increase the utilization of their assets.

In Africa, many telco operators have partnered with LEO operators for “backhaul”, i.e., to link cell sites with the main network. Partnerships might be the best approach in the medium term until or unless terrestrial options become viable. Beyond broadband, some telecom companies in US/Asia and Europe have engaged partnerships with LEOs for direct to device services which could potentially allow them a more extensive reach and a more viable cost model for under-served areas or back-up services.

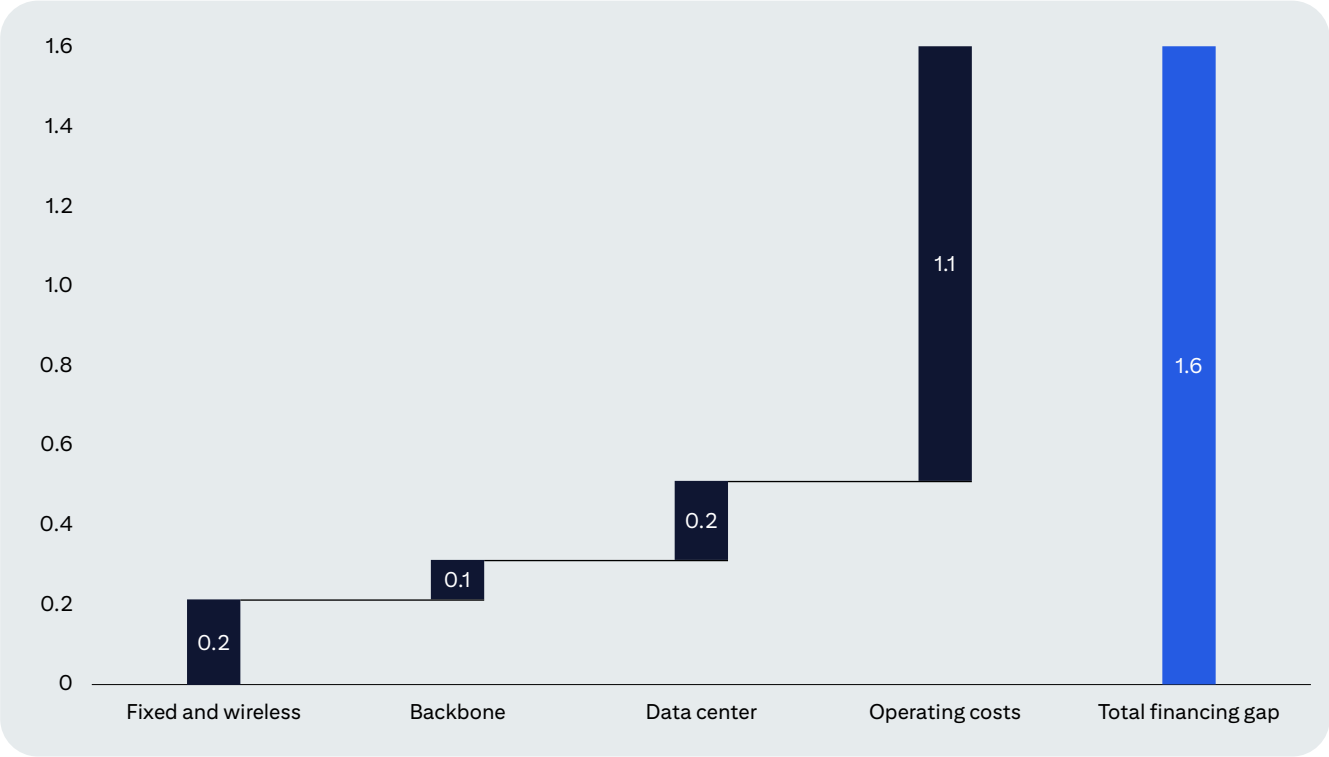
Infrastructure Sharing Could Address Barriers to Internet Use

Closing the remaining digital connectivity gap is complex: those who still do not use the internet are often harder to reach than those who have been brought online in the last decade.

Connecting everyone to the internet is expensive. The ITU estimates that an additional $1.6 trillion needs to be spent on digital infrastructure over the next five years to achieve the goal of universal connectivity[17] (figure 5).

Oxford Martin School research led by Dr Pantelis Koutroumpis and funded by Citi, found that sharing telecommunications infrastructure between mobile network operators – including through tower companies and joint ventures – can reduce costs for telecoms companies and consumers, while improving network quality. Therefore, this sort of infrastructure sharing could help to deliver universal connectivity by reducing the infrastructure investment required and directly addressing the remaining barriers to internet use, like unaffordable data and poor-quality coverage.

Figure 5. Universal connectivity requires $1.6 trillion over five years



Source: Figures from ITU, 2025.

Infrastructure Sharing Improves Internet Quality and Reduces Costs

Pantelis Koutroumpis, Director of the Programme of Technological and Economic Change, Oxford Martin School

Avoiding duplication of infrastructure should normally reduce the costs of providing digital connectivity. In practice this would require mobile network operators to mutually decide to share some parts of their networks instead of covering every region or country with three or more equivalent networks. This process will then reduce capital expenditures by multiple operators.

There are many ways that networks can share infrastructure:

1. A simple "roaming" service: Only one operator covers a region, and the others re-sell the same service over the host network.
2. Passive sharing: Two or more operators enter an agreement where they share physical and non-electronic infrastructure components of a mobile network, like towers, masts and site locations.
3. Active mobile network sharing: Operators share not just physical infrastructure, but also the active electronic equipment within those sites, such as base stations and antennas. This is a more committed and complex level of sharing compared to passive infrastructure and offers potential cost savings but requires closer cooperation between operators.
4. Tower companies (TowerCos) combine the passive or active types of sharing under a separate legal entity that owns and manages the physical and electronic components used for mobile network services. The ownership structures for TowerCos can either be controlled by a single operator, multiple operators (joint venture) or be independent.

Each tower can be used by one or more operators. The number of operators per tower – the so-called tenancy ratio – when averaged across all towers in a portfolio, provides information about the utilization of existing infrastructure.

A report by EY showed that TowerCos average a tenancy ratio of 2.8 for ground towers and 1.5 for rooftop towers, with an overall ratio of 2.4. Operator-controlled towers reach tenancy ratios of 1.5 for ground towers and 1.1 for rooftop towers, with an overall ratio of 1.3.[18]

The higher tenancy ratio of TowerCo towers indicates that this sort of infrastructure sharing is more efficient as the infrastructure is closer to full utilization.

One of the first comprehensive reviews of network sharing effects investigated mobile network sharing in Europe during the 2000-2019 period including 140 mobile operators in 29 countries.[19]

In this paper, we found that network sharing generated significant benefits for operators and consumers, that led to lower prices for subscribers and improved network quality and coverage. The majority of these effects were driven by cost reductions, higher returns on investment and increased competition.

The benefits of each type of agreement materialized in different ways across different types of sharing, technology cycles and the market position and size of the operators entering the agreement. This solidified the view that network sharing can play a vital role in the deployment of new 5G networks and that the technological and market specificity of each type of sharing agreement can significantly affect its outcomes.

Another typical approach to reduce the costs of providing digital connectivity is achieved when telecommunications companies merge to form a larger entity. Before sharing agreements, mergers were the only structural way network operators sought to reduce costs.

In a separate study[20], we found that mergers did help operators to improve their financial positions and EBITDA margin (by 8.6 percentage points on average) but consumers faced significantly more concentrated markets with fewer options. By contrast, tower companies reduced average revenues per user due to increased tenancy ratios that were passed through to consumers, helping operators reduce their capital expenditures.

In short, we find that sharing infrastructure between mobile network operators stands to be socially optimal compared to mergers between those operators in closing the internet usage gap. Such sharing could both reduce the investment required in digital infrastructure and address affordability concerns.

While there is still a lot to be understood about the future markets for digital infrastructures, it is clear that sharing infrastructure between mobile network operators has a prominent role to play in achieving universal digital connectivity.

TowerCos are an Under-Tapped Opportunity in Emerging Markets

Mobile network sharing emerged in the U.S. in the late 1990s and gradually expanded to the rest of the world.

Today more than seven out of ten towers globally are owned and maintained by tower companies rather than individual mobile network operators.[21]

However, some emerging markets – where coverage and usage gaps are at their widest – lag, suggesting that infrastructure sharing could accelerate progress toward universal connectivity.

Oxford Martin School research on Europe found that infrastructure sharing boosted access to 4G. In Portugal, sharing led to a 12.5% increase in 4G coverage and in Switzerland, a 13.3% increase.

A 2025 report from Tower XChange estimates that almost half of Sub-Saharan Africa's towers are managed by mobile network operators and not by TowerCos.[22] The coverage gap in the region is in double digits.

By contrast, more than three quarters of towers in South Asia are managed by TowerCos, even according to older data from 2020,[23] and 46% of the population are internet subscribers, with a coverage gap of only 4%.[24]

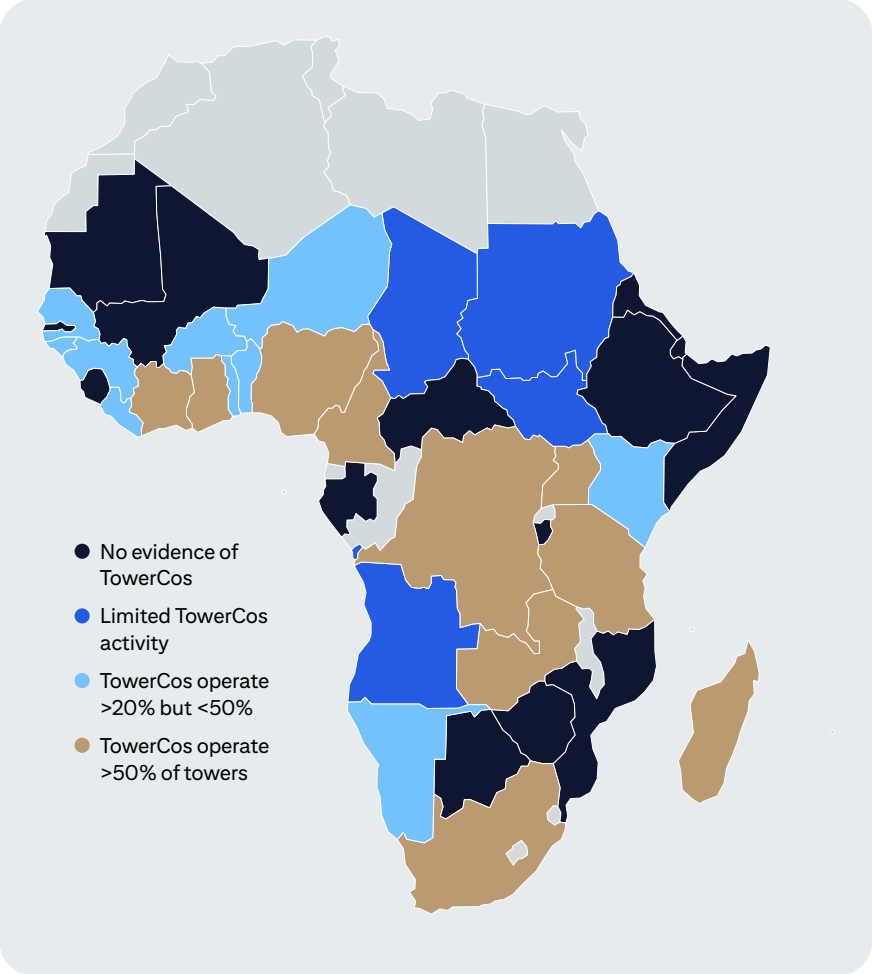
Analysis from the International Finance Corporation also finds a correlation between mobile network operators sharing infrastructure through tower companies and digital connectivity outcomes.[25]

Infrastructure sharing might therefore present an under-tapped opportunity to achieve universal connectivity in places that currently have the largest internet usage gaps.

While the regional figures show there is an opportunity to scale up infrastructure sharing in Sub-Saharan Africa, there is also significant variation between countries. 15 countries have no active TowerCos, including many of the region's poorest countries (for example, Sierra Leone and Chad) along with conflict zones[26] (like Mali and Somalia) (figure 6).

But other countries in the region have a much more active TowerCo market – including both the lowest income states and those affected by conflict. For example, Madagascar is one of the world's poorest countries. More than 80% of its towers are managed by TowerCos. Likewise, war persists in the DRC, which faces other challenges to doing business like a lack of transport infrastructure, but the majority of its towers are already operated by TowerCos.

Figure 6. Share of towers managed by TowerCos varies across Sub-Saharan Africa



Source: Tower XChange, 2025.

Recommendations from the IFC on how to encourage infrastructure sharing to expand digital access are also instructive.[27] A supportive regulatory environment that supports competition and reduces legal barriers to entry can be the difference between a developed, diverse TowerCo market and its absence.

Reaching the stage where everyone everywhere has meaningful access to the internet will be challenging, but it could also supercharge financial inclusion and access to other basic services like healthcare and education.

We have argued in this report that infrastructure sharing presents an opportunity to reduce the investment required to reach universal connectivity, not least by addressing some of the main barriers to internet usage like improving quality and reducing costs for consumers.

Endnotes

1 GSMA, 2025. The State of Mobile Internet Connectivity Report 2024. p. 29

2 GSMA, 2024

3 GSMA, 2024. p.13.

4 International Telecommunication Union, 2025, Digital Infrastructure Investment Initiative: Closing the digital infrastructure investment gap by 2030, p5

5 The GSMA found that 66% of the global population had access to the internet in 2024 either as a subscriber or through someone else's subscription. GSMA, 2025. The State of Mobile Internet Connectivity Report 2024. p. 22. The World Bank Global Findex also found that 71% of those aged 15+ globally had accessed the internet in the last three months. World Bank, 2025. Global Findex Database 2025: Connectivity and Financial Inclusion in the Digital Economy, p.62.

6 The Figure shows that 58% of the global population are mobile internet subscribers. A further 9% have (some) access to the internet through someone else's subscription. GSMA, 2025. p. 8.

7 GSMA, 2024. p.13.

8 These are the primary characteristics of the remaining 4% of communities that do not have access to the internet. GSMA, 2025. p. 13-14

9 GSMA, 2025. p.29

10 Based on IMF estimates. Their World Economic Outlook 2025 put (annual) GDP per capita in the US at $89,110, in the UK at $54,950 and in Germany at $55,910 in April 2025. Dollar figures were converted to local currency at published exchange rates on 18th August 2025.

11 Best Broadband Deals, The Cost of 1 GB of Mobile Data in 237 Countries. Sample data collected July to September 2023. Accessed 19th August 2025.

12 GSMA, 2024. p. 65. And GSMA, 2025. p.30.

13 GSMA, 2025. p. 30.

14 IFC, 'Enabling a Competitive Mobile Sector in Emerging Markets through the Development of Tower Companies,' EM Compass 104 (2021)

15 GSMA, 2025. p. 26.

16 "Non-subscriber internet users" describes those who access the internet, but without their own device or subscription. This is common among under 18s.

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22 Tower XChange's Sub-Saharan Africa Guide: A country-by-country guide to the Sub-Saharan Africa tower market. (21st August 2025)

23 IFC, 'Enabling a Competitive Mobile Sector in Emerging Markets through the Development of Tower Companies,' EM Compass 104 (2021)

24 GSMA, 2025. p.13

25 IFC, 'Enabling a Competitive Mobile Sector in Emerging Markets through the Development of Tower Companies,' EM Compass 104 (2021), p.3

26 As defined by the World Bank list of states experiencing conflict in 2025.

27 IFC, 'Enabling a Competitive Mobile Sector in Emerging Markets Through the Development of Tower Companies' (June 2021)

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IMPORTANT DISCLOSURES

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