RAPID DESK BASED STUDY:

Summary of the main constraints to increased Digital Connectivity in sub-Saharan Africa

Michael Minges

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Report Summary

Sub-Saharan Africa has made impressive progress in expanding digital infrastructure over the last few years. This report examines the status of mobile networks and coverage, national backbones and international connectivity in the region. Much of this infrastructure has been constructed by the private sector under varying degrees of competition. Despite the steady gains, the region continues to lag all others in access to information and communication technologies.

This is partly due to the inevitable link between per capita income and telecommunication access. However in many cases the market is not functioning as well as it could. This is due to factors exogenous to the telecommunication sector such as poor governance, lack of electricity, the high cost of doing business in the region and a low level of digital skills. Other factors are internal to the sector and include imperfect competition, a lack of open access to fibre optic backbone networks and constrained spectrum allocation. Government strategies to narrow the digital gap through universal service funds have also been largely ineffective throughout the region.

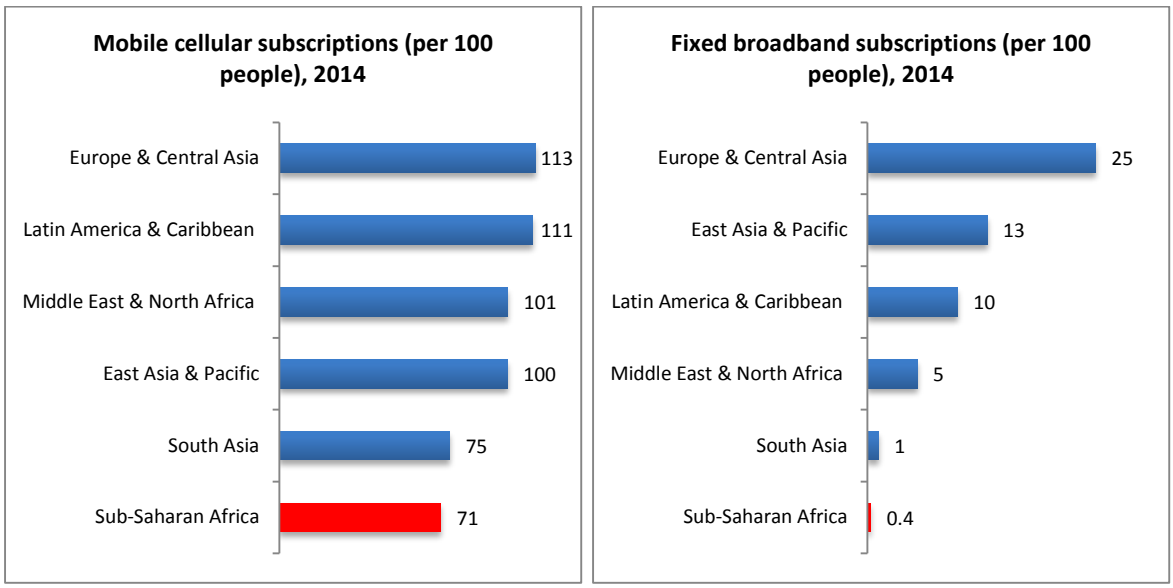
Solutions to these challenges require a top-level multi-sector approach. They can be alleviated through a more competitive market environment including embedding open access principles, in sector regulations, support for training regulators, more efficient and speedier spectrum allocation, improved universal service programs and initiatives for promoting mass digital literacy.

Overview

This report draws on a variety primary and secondary data sources to present evidence-based analysis regarding the status of digital connectivity in Sub-Saharan Africa (SSA). Reports from mobile industry associations, telecom equipment manufacturers and national telecommunication policy and regulatory authorities are referenced to provide different perspectives on the causes of constrained digital connectivity and possible solutions.

Sub-Saharan Africa (SSA) has made impressive progress in increasing access to mobile networks with the highest regional growth rate over the last few years (13%); the region's growth rate is projected to remain the highest through 2020 (GSMA Intelligence 2015). Nevertheless, SSA lags all other regions in mobile penetration (Figure 1, left). Wired broadband infrastructure is extremely limited with less than one subscription per 100 people (Figure 1, right). Scarcity of fixed infrastructure in the region and the high cost of deploying it compared to wireless, suggests that digital connectivity—the transmission of voice, text and data over electronic networks—in the context of SSA will remain overwhelmingly mobile-based for the foreseeable future.

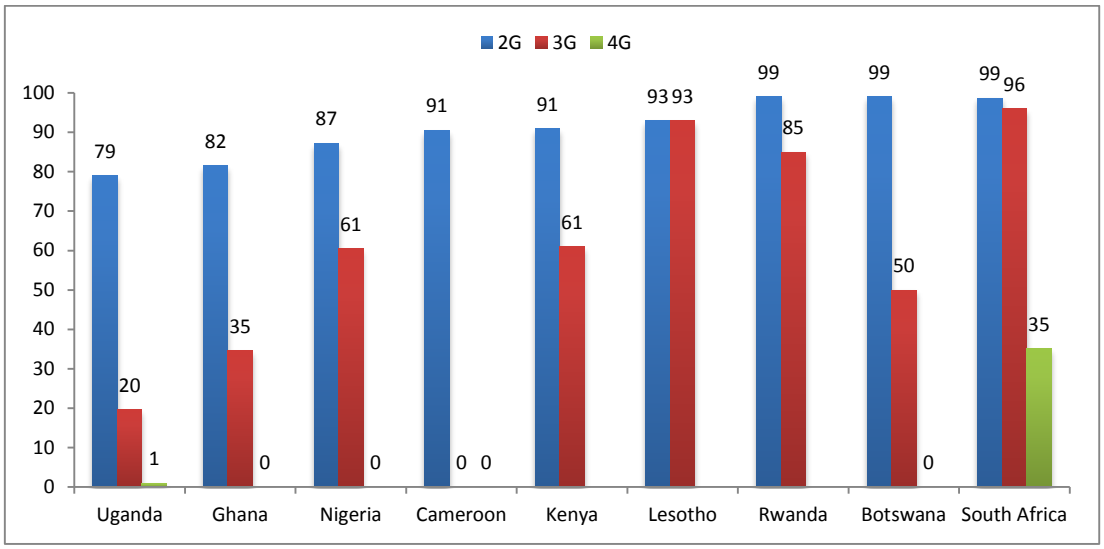
Figure 1 Mobile cellular and fixed broadband subscriptions per 100 people, 2014



Source: Adapted from the World Bank.

Mobile cellular subscriptions stood at 71 per 100 people in 2014 in SSA. Subscriptions do not reflect the spread of mobile network infrastructure. A key indicator for measuring wireless infrastructure deployment is network coverage. In terms of 2G networks, which provide voice, text and low speed Internet access, a number of SSA countries have reached over 90% coverage of the population. The deployment of 3G networks, featuring high-speed mobile broadband, is lagging. The gap between coverage of 2G and 3G networks is illustrated in the figure below. While coverage of 2G networks averages 91% for the countries shown, those able to receive a 3G signal is only 56%. 4G (i.e., Long Term Evolution (LTE)) networks are nascent and outside South Africa, coverage is extremely limited.

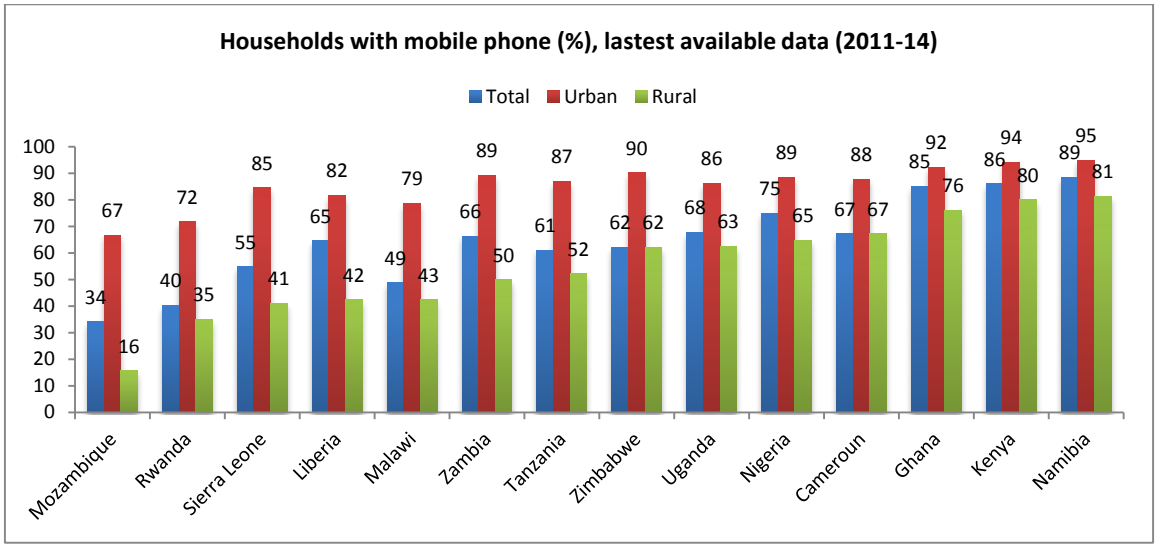
Figure 2 Proportion of population covered by mobile network, 2014



Note: 4G networks were launched in late 2014 in Kenya, Lesotho and Rwanda with coverage limited to parts of largest city.
Source: Adapted from mobile operators.

Coverage is widely available in urban areas in SSA where it is easier to deploy networks and there is strong demand. However, most of the region is not urban; according to the World Bank, 63% of the population in SSA lived in rural areas in 2014.[1] The lack of rural coverage is reflected in demand side data on the percentage of households with a telephone (Minges 2012). An analysis of survey data for 14 SSA countries finds that while on average 85% of urban households have a cell phone the corresponding figure for rural areas is only 55% (Figure 3).

Figure 3 Proportion of households with a mobile phone, latest available data



Source: Adapted from the Demographic and Health Service (DHS) Program.

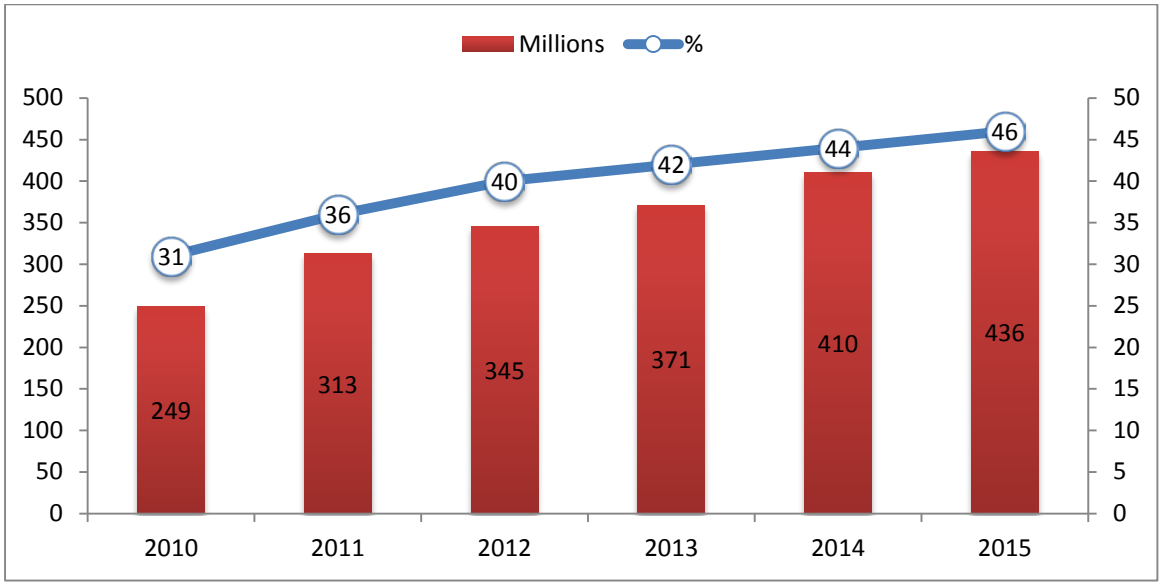
National backbone networks that transfer voice, text and data from one location to another are another important telecommunications infrastructure component. These include wireless microwave and satellite links and fibre optic transmission systems. While microwave links are less expensive to deploy than fibre optic, capacity and transmission speeds are lower.

[1] http://data.worldbank.org/indicator/SP.URB.TOTL.IN.ZS

Satellite is expensive and typically used for remote locations. The future proof option is fibre optic since it provides the fastest speeds with the lowest latency. Once the cable is laid, simply changing the transmission equipment can increase speeds. However, due to the high upfront costs of fibre deployment, many operators install microwave, at least initially, resulting in duplicate infrastructure in lower capacity equipment.

Another reason is that operators that own fibre backbones sometimes charge wholesale prices significantly above cost to other operators. Nevertheless, fibre is slowly expanding beyond urban areas as requirements for higher capacity transmission grow. According to one source, the length of operational terrestrial fibre networks in Africa stood at 622,930 kilometres by June 2015, an increase of almost 90% since 2010.[2] Some 436 million Africans or 46% of the population lived within 25 kilometres of a fibre optic network node in June 2015, up from 31% in 2010 (Figure 4).

Figure 4 SSA population within 25 kilometres of fibre optic network



Source: Adapted from Africa Bandwidth Maps.

One positive trend has been the emergence of wholesale backbone providers. When these companies are not involved in, or have limited activity in downstream retail markets, then they normally offer competitive pricing to all operators. Founded in 2004, Mauritius-headquartered Liquid Telecom has the largest independent fibre network in the region. It has deployed over 20,000 kilometres of fibre optic cable in central, east and southern Africa stretching from South Africa to Uganda with some 50 clients.[3] Utilities and transportation networks are also starting to lease the fibre in their networks. Kenya Power earned Shs. 1 billion between 2010-2014 from leasing fibre on its 1,800-kilometer network to the country's telecommunication operators.[4] In Tanzania, mobile operators are laying fibre backbones along railway lines.[5] A World Bank road construction project from South Sudan to Kenya included the installation of fibre optic cable, as it would cost far less than deploying the cable network as a standalone project.[6] The Southern Africa Power Pool, a grouping of electrical utilities from a dozen African countries has started to require any new power lines include

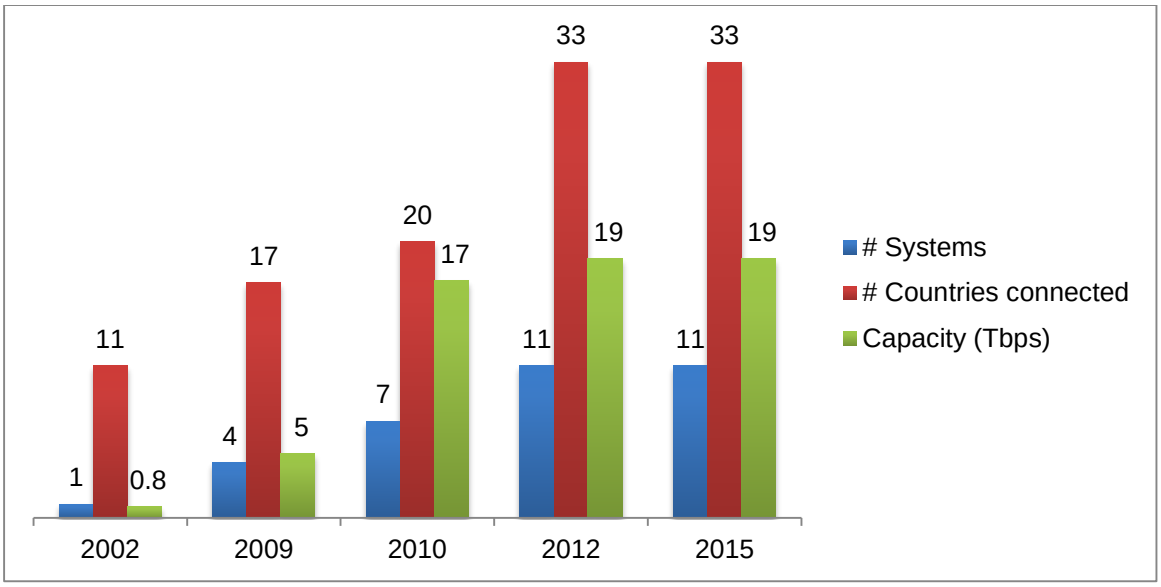
2 http://www.africabandwidthmaps.com/?p=4856
3 https://liquidtelecom.com/about-us/network-map
4 http://www.kplc.co.ke/content/item/246/kenya-power-earns-shs.1-billion-from-fibre-optic-business
5 https://wiocc.wordpress.com/tag/fiber-optic/
6 http://www-wds.worldbank.org/external/default/WDSContentServer/WDSP/IB/2014/04/22/000442464_20140422134859/Rendered/PDF/PAD6460P131426010Box385188B00OUO090.pdf

fibre optic cable.[7] China has been active throughout the region with Chinese firms reportedly building over 20 national fibre optic backbone networks.[8]

International connectivity is critical since considerable internet content desired by users in SSA is located abroad. The region is gradually migrating from high latency, expensive satellite links to undersea fibre optic cable systems. Connectivity to undersea cables has mushroomed since 2009 (Figure 5) and today virtually every sea-based nation in the region has at least one submarine cable landing point (Eritrea and Guinea Bissau are the exceptions).

Although this rise in international connectivity has reduced the price of Internet access to some extent, there are still challenges. Landlocked nations must work out transit arrangements with neighbours in order to access the undersea cable. In some cases, transit costs can exceed the price for use of the undersea cable. Another bottleneck is control over access to submarine cables by a few operators who charge competing operators significantly above wholesale cost prices. Efforts to ameliorate these challenges include a trend towards multiple cross-border links for landlocked countries to increase resilience and routing choices,[9] as well as open access options that result in a more competitive environment.

Figure 5 Submarine cables in Sub-Saharan Africa



Source: Adapted from https://manypossibilities.net and http://www.submarinecablemap.com

Internet exchange points (IXPs) can help to reduce reliance on expensive international connections and improve quality by keeping locally destined data traffic within the country. As the name implies, an IXP is a facility where Internet Service Providers (ISPs) can exchange traffic from one user to another or to locally hosted content. ISPs can pass on these cost savings to users and/or use the savings to reinvest in improving and growing their networks. As the IXP grows, international backbones and content providers are encouraged to participate, making a country's Internet system more innovative and sustainable. Studies for Kenya and Nigeria found that they saved over US$1 million each by using IXPs.[10]

7 http://www.ictafrica.info/FullNews.php?id=9592

8 http://www.newsecuritylearning.com/index.php/archive/75-chinas-mighty-telecom-footprint-in-africa

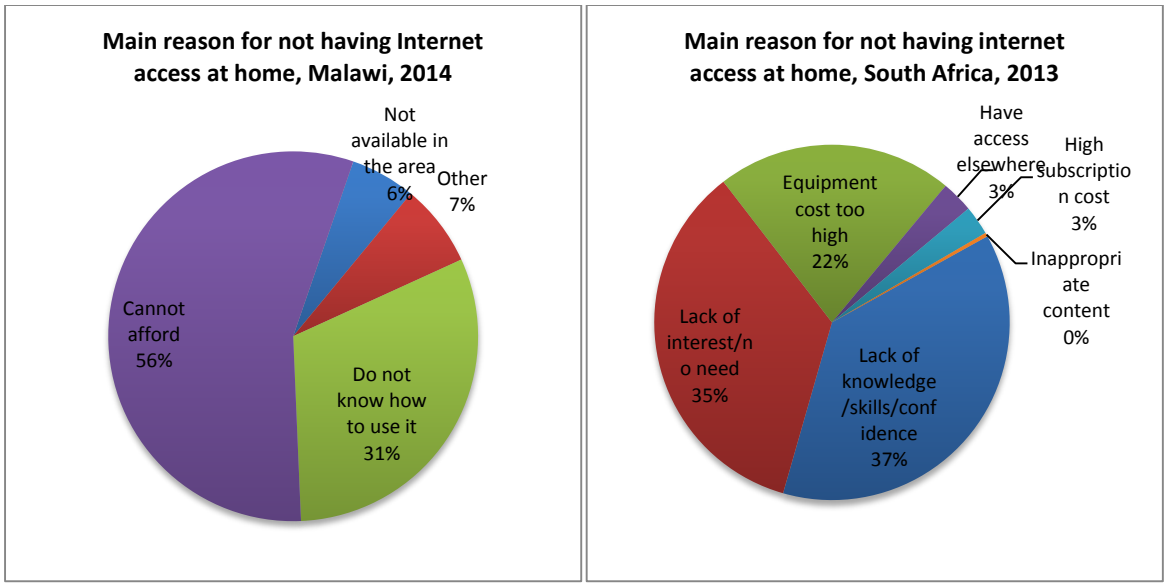
9 For example, Rwanda, which previously only had a cross-border link via Uganda to submarine cables in Kenya, signed an agreement to purchase international bandwidth from Tanzania after cross-border connectivity links were established between the two countries. See: http://independent.co.ug/rwanda-ed/rwanda/5562-rwanda-tanzanias-telecoms-firm-sign-us67-million-internet-capacity-deal-

10 http://www.internetsociety.org/ixpimpact

Despite the potential to lower costs and enhance quality, less than half of SSA countries have an operational IXP.[11]

The level of demand also has a bearing on infrastructure development. Operators will be reluctant to make investments particularly for wireless broadband infrastructure if demand is weak. While Internet, penetration has grown in the region, it is still low at less than one fifth of the population in 2014.[12] It is useful to contrast the reasons for not having Internet access. In South Africa, which has near ubiquity coverage for 2G, high 3G coverage and growing 4G coverage, barriers are related to digital literacy rather than lack of access or costs. In 2013 almost three quarters (72%) of South African households reported they did not have Internet access because they lacked the knowledge to use it or did not see a need—both of which are symptomatic of a lack of digital skills (Figure 6, left). Affordability ranks far lower as a barrier with over a fifth of households (22%) reporting that the cost of equipment (e.g., computers, tablets, smartphones) was too high and just 3% reporting that service charges are too high. In contrast, affordability is the biggest challenge in Malawi with 56% of households reporting they did not have Internet access in 2014 because they could not afford it (Figure 6, right). Only six per cent reported it was not available while almost a third (31%) said they did not know how to use it, again illustrating the digital literacy barrier.

Figure 6 Reasons for not having home Internet access



Source: Adapted from MACRA 2015 and Statistics South Africa 2015.

11 https://prefix.pch.net/applications/ixpdir/?new=1&show_inactive=1&sort=Region&order=asc

12 http://data.worldbank.org/indicator/IT.NET.USER.P2

SECTION 1

Constraints

Reasons for constrained telecommunications infrastructure deployment in SSA can be classified as exogenous or internal to the sector. Some factors such as governance, income and literacy are external to the sector and require top-level solutions to remedy. Others such as spectrum and open access to key facilities are specific to the sector.

- **Weak governance**. The fragility of many SSA nations and opaqueness in others contributes to an environment of poor governance. This has grave consequences with a recent World Bank noting that "analog complements" such as strong institutions and competition among businesses are essential to nurture ICT infrastructure development (World Bank 2016). Almost a dozen countries from the region have a very high or high alert fragility status.[13] This affects the telecommunication sector through reduced investment and poor enforcement of regulations and laws. Progress in governance has stalled[14] with implications for sustaining the growth the region has made in telecommunications infrastructure deployment.

- **Electricity and cost of doing business in Africa**. Firms operating in SSA face a number of obstacles (Figure 7). The two main ones directly affecting the supply of and demand for telecommunications services are electricity and taxes. According to the World Bank, just over a third of SSA's population has access to electricity.[15] Limited grid-based electricity in many SSA countries adds to mobile cellular network deployment costs. If operators choose to deploy in areas with no grid electricity, then they usually do so using expensive diesel generators. The lack of grid electricity also makes it difficult and costly for mobile customers to recharge their handsets.

- In Malawi, it is estimated that off-grid phone charging costs users around US$12 million a year.[16] Various initiatives aim to improve electrification for the region.[17] M-Kopa in Kenya is distinctive in that it is leveraging the money platform running over mobile networks for rural dwellers to purchase solar panels.[18] In respect of taxes, sector-specific levies raise the price of the service, affecting affordability and are particularly onerous for the poorest. Sector specific taxes include customs duties on smartphones and other types of handsets, communications service tax on mobile data, customs duties on network equipment and surtaxes on international incoming telephone traffic. A study on Ghana found that mobile specific taxes added nearly

13 http://fsi.fundforpeace.org/rankings-2015

14 http://www.moibrahimfoundation.org/news/2015/the-2015-ibrahim-index-of-african-governance-key-findings/

15 http://data.worldbank.org/indicator/EG.ELC.ACCS.ZS?order=wbapi_data_value_2012+wbapi_data_value+wbapi_data_value-first&sort=asc

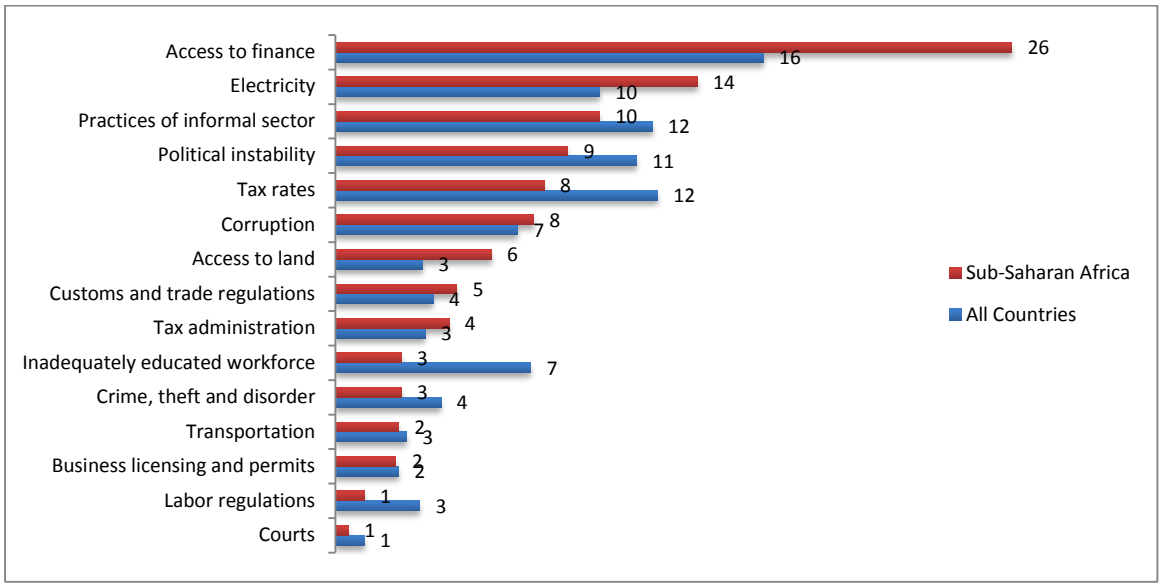
16 http://www.gsma.com/mobilefordevelopment/wp-content/uploads/2013/02/TNM-Feasibility-Study.pdf

17 These include high-profile initiatives such as the U.S.-led Power Africa initiative and Electrify Africa Act to the African Development Bank's New Deal on Energy for Africa and the United Nations' Sustainable Energy for All partnership. See: http://afrobarometer.org/publications/ad75-unreliable-electricity-supply-still-plague-majority-of-africans

18 http://www.bloomberg.com/features/2015-mkopa-solar-in-africa/

25% to the total cost of mobile ownership.[19] Another for Tanzania finds that the reduction of sector specific taxes will lead to more employment and larger industry revenues allowing the government to gain higher tax revenues over time.[20]

Figure 7 Biggest obstacles faced by firms, latest year available



Source: Adapted from Enterprise Surveys (http://www.enterprisesurveys.org), The World Bank.

- **Affordability.** The relationship between a country's income and its level of ICT infrastructure was established over fifty years ago.[21] SSA's per capita income is one of the lowest of any region in the world so to some extent its level of digital connectivity matches its income. Nevertheless, there are exceptions especially where the market is not functioning properly. In economic terms, this is the situation where the supply and demand for a product does not intersect at the market equilibrium price. The main determinant influencing demand is the price of the product. A price proxy for digital communications is the Average Revenue Per User (ARPU) per month. SSA's ARPU is higher than other developing regions such as South Asia, inhibiting demand. This is illustrated by average ARPU for Airtel, an Indian mobile operator providing services in three South Asian nations as well as 17 SSA countries. In the fourth quarter of 2014, Airtel's SSA ARPU (US$4.6) was 70% higher than its South Asian ARPU (US$2.7).[22] Market imperfections as well as the high cost of business in SSA contribute to this disparity negatively affecting demand for digital communications in the region.

- **Skills**. As illustrated by the case of Malawi and South Africa above, many people in SSA lack the skills to benefit from Internet use. This in turn affects whether operators will invest in mobile broadband technology. Urgent attention is needed to improve connectivity and ICT training in schools as well as reaching out to older populations with limited education. Several countries in East Africa have launched initiatives in an effort to boost digital literacy. Rwanda signed an agreement with the International Computer Driving License (ICDL) program to teach computer skills to the general

19 http://www.gsma.com/publicpolicy/wp-content/uploads/2012/03/GSMA_Ghana_1_pager_WEB.pdf
20 http://www.gsma.com/publicpolicy/wp-content/uploads/2015/01/Digital-inclusion-mobile-sector-tax-Tanzania.pdf
21 See: http://www.ictdata.org/1970/03/jipps-curve.html
22 http://www.airtel.in/wps/wcm/connect/about-bharti/equity/results

population, particularly in areas where there are few English speakers.[23] The initiative also aims to improve the digital skills of 85,000 government employees. The Kenyan government launched the Digital Learning Programme in 2013 to spread digital literacy to all primary schools in the country.[24] In Uganda, the Rural Communications Development Fund has been used for providing ICTs to schools and training thousands of people (GSMA 2014).

- **Effective competition.** The lack of strong competition has resulted in insufficient investment and network coverage. While virtually all SSA countries have introduced some degree of competition in their mobile markets, the quality varies. The effectiveness of competition is strongly influenced by the number of operators with some markets having only two, while others have four or more.[25] The number of countries moving beyond a duopoly has been stagnant in the region and five countries still have just a single provider of mobile cellular services (Figure 8). Tools are undeveloped to guard against competitive abuses and promote markets to be more competitive.

- Enforcement of regulations guarding against operators with significant market power is often weak. Some countries lack pro-competition tools such as infrastructure sharing and number portability. Competing operators should have an incentive to rollout services to areas with limited coverage in order to gain market share. However, many are not doing so. One exception is Movitel who targeted un-served rural areas when it launched in Mozambique in May 2012. By the end of 2013, the joint venture between Vietnamese mobile operator Viettel and Mozambican companies had installed more fibre optic cable and mobile base stations than existed in the country before its entrance into the market. Rural population coverage increased from 35% to 70%[26] and Movitel had 2.4 million subscribers at the end of 2013.[27]

23 http://www.gov.rw/news_detail/?tx_ttnews%5Btt_news%5D=1046&cHash=060451e64b0f728ee0e106080b4fa094

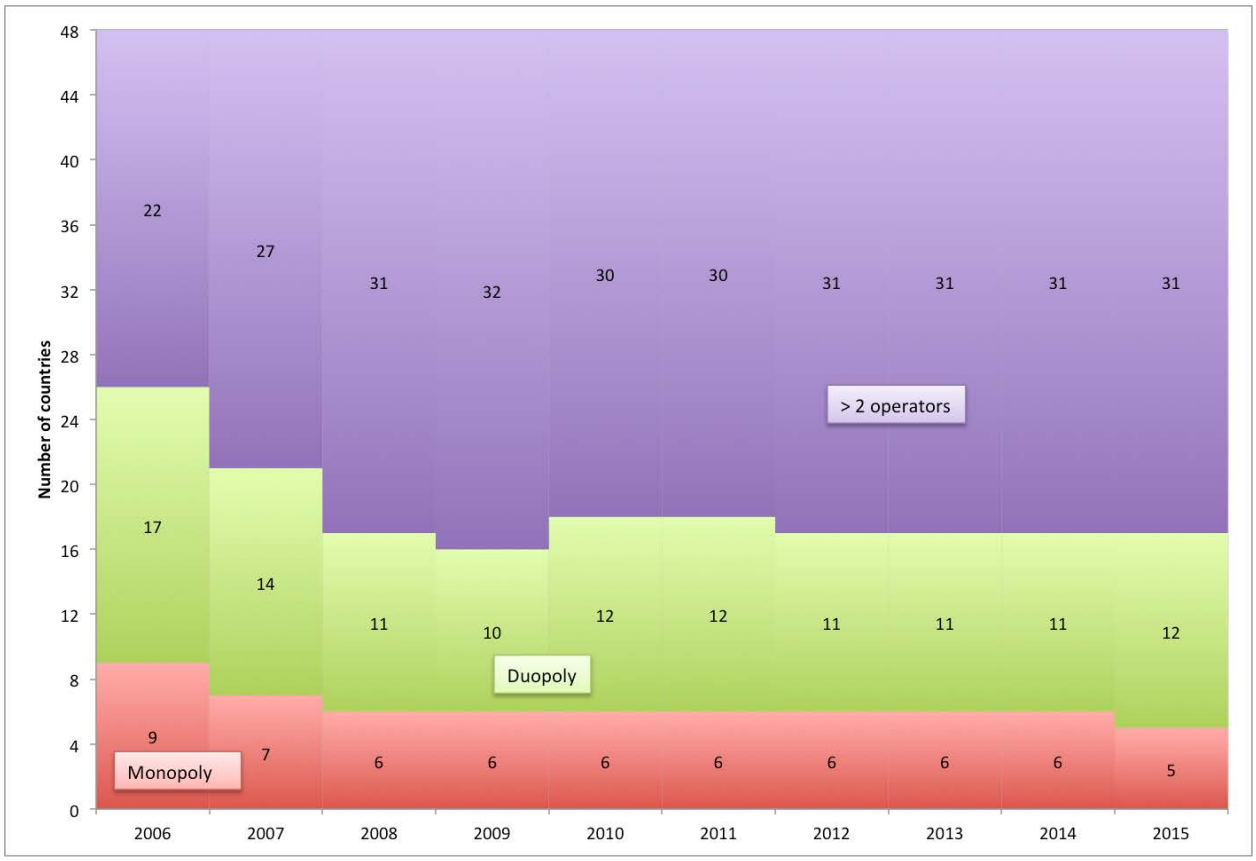
24 http://digischool.icta.go.ke/about/vision/

25 A recent 25-country study by the communications regulator in the United Kingdom found that "...greater competition - delivered by a greater number of players - has a positive effect on pricing" and also found that "...disruptive firms reduce prices..." OFCOM (2016) *A cross-country econometric analysis of the effect of disruptive firms on mobile pricing*. Available at: http://stakeholders.ofcom.org.uk/market-data-research/other/cross-media/disruptive-firms-econometrics/?utm_source=updates&utm_medium=email&utm_campaign=disruptive-firms [Accessed 18 March 2016]

26 http://stevieawards.com/iba/movitel-sa-maputo-mozambique

27 Eaglestone Securities (2014) *The Telecoms Sector in Mozambique*. Available at: http://www.eaglestone.eu/xms/files/Telecoms_Research_Mozambique_Eaglestone_Securities_November_2014.pdf [Accessed 18 March 2016]

Figure 8 Number of mobile operators, Sub-Saharan Africa, 2006-2015



Source: Author research.

- **Open access**. High wholesale costs for use of key facilities such as landing stations and fibre optic backbones can be a bottleneck, raising retail prices and stifling competition. These critical infrastructure facilities are essential for service providers in order to interconnect their dispersed network sites and they require significant investment. It often does not make economic sense to build duplicate backbone facilities particularly in low-income countries. The problem arises when the company that owns the facilities operates in both wholesale and retail markets and charges prices to other operators that are significantly above cost. This raises prices for end users and stifles competition.

- There has been a move towards opening up these facilities. One of the first instances was The East African Marine System (TEAMS) a marine cable financed by the Kenyan government and the incumbent telecommunication operator of the United Arab Emirates. The Kenyan government allowed any licensed telecommunication operator to take a stake in the cable with 11 doing so.[28] The recent emergence of independent backbone providers and utilities leasing fibre has made national wholesale markets in some countries more transparent. An initiative by the Communication Regulatory Authorities of Southern Africa (CRASA) aims for landlocked countries in its region to pay the same price for access to undersea

28 http://broadbandtoolkit.org/Case/ke/6

cables as sea-based nations.[29] Infrastructure sharing and open access must be implemented in such a way that it does not discourage investment and innovation.[30]

- **Spectrum**. Spectrum is a key ingredient for mobile networks with the type (i.e., frequency) and amount strongly influencing investment. The greater the amount of spectrum released by authorities, the lower the cost of network investment. For rural areas, capital expenditure can be cut using low-frequency spectrum since it covers a wider area. One study comparing the use of 700 MHz to 1800 MHz spectrum found the former to cost four times less in addition to reaching breakeven far quicker.[31] Less spectrum has been released by SSA than other region even though the region is more reliant on wireless networks (GSMA 2015). Further, many SSA nations have missed the so-called Digital Dividend deadline for migrating broadcasting from analogue to digital, which would release significant amount of lower frequency spectrum in the 700 and 800 MHz bands for mobile use.

- Experts suggest that greater effort is needed to generate the political will to carry out the transition and that limitations to the use of spectrum are negatively impacting development of the region's mobile broadband networks.[32] There is also a need for cross-border coordination. Lesotho had to delay use of the 800 MHz for 4G networks due to South African television stations still broadcasting in that frequency.[33] As of March 2016, seven SSA countries have allocated low-frequency spectrum in the 800 MHz band. Of note is Smile Communications, a pure-play 4G operator that has deployed networks using 800 MHz in Nigeria, Tanzania and Uganda.[34] Rwanda has chosen a wholesale/retail model for its 800 MHz 4G network with Olleh Rwanda Network (ORN) the wholesale spectrum provider for three retail mobile service providers, as well as ISPs offering fixed wireless services.[35]

- **Profitability.** The ability to earn a profit in many rural and remote areas is problematic since the network investment is unlikely to be covered by revenues. One solution is a public private approach where the government subsidizes the investment and private operators deploy infrastructure. A number of countries in SSA have universal service funds that are meant to accomplish this. However, many are not effectively managed and some have yet to disburse funds. According to one study, "In general, there are significant deficiencies in fund structure, management and operation throughout the SSA region" (GSMA 2014). Out of 23 funds it studied, seven were inactive, only four had a high activity level and at the end of 2011, more than US$400 million was waiting to be disbursed.

- Uganda is notable as having the only fund (Rural Communications Development Fund) in the region that regularly disburses money. It has supported over 5,000 projects since its inception. There is an urgent need to restructure funds, improve their management and introduce relevant projects for funding. There are also solutions that may be more appropriate given the SSA regulatory environment. This includes imposing coverage obligations when licenses are awarded or renewed or

29 http://www.pcworld.com/article/2874972/regulators-push-for-open-access-to-africas-undersea-cables.html

30 http://pubdocs.worldbank.org/pubdocs/publicdoc/2016/1/533261452529900341/WDR16-BP-Infrastructure-Mutualisation-Garcia.pdf

31 http://www.ucc.co.ug/files/downloads/ucc_reform%20of%20spectrum%20management%20in%20Uganda.pdf

32 http://www.dynamicspectrumalliance.org/wp-content/uploads/2015/10/South-Africa-Wireless-Communications_Aug_2015.pdf

33 http://www.lca.org.ls/images/documents/LCA%20Annual%20Report%202013_14.pdf

34 https://smilecoms.com/operations/#drc

35 http://orn.rw/company-profile/

additional spectrum is allocated to operators. For example in Rwanda, ORN has an obligation to cover 95% of the population with its 4G signal within four years.

SECTION 2

Conclusions

SSA countries have different levels of income and demand that affect their digital connectivity. This makes it difficult to offer generic recommendations on how connectivity can be improved. In situations where supply roughly matches demand, then the level of digital connectivity is likely to be where it should be, given a country's level of economic development. Therefore it is useful to analyse which countries are where they should be, given their per capita income, and which ones seem to be suffering from market failure, a lack of demand or both.

The relationship between per capita income and mobile subscriptions, (a supply side indicator), highlights where the market might not be functioning as well as it should be. Countries that have a mobile penetration level below where they should be, in relation to their per capita income, would appear to be suffering from market failure. Likewise, the relationship between per capita income and internet use, (a demand side indicator), reveals whether the level of demand is strong enough to encourage operators to invest in mobile broadband networks.

These relationships are illustrated in the figure below which shows where SSA countries are in relation to supply and demand in mobile subscription penetration and Internet usage, according to their per capita income. There are four quadrants: i) low demand and constrained supply, ii) high demand and constrained supply, iii) low demand and high supply, and iv) high demand and high supply. A handful of countries are in the best quadrant--high demand and high supply. This includes South Africa where there are four mobile operators contributing to a high level of competition and supply. The country has the highest household mobile penetration in Africa and more homes have a cell phone in South Africa than Canada or the United States.[36] As noted earlier, barriers to Internet access in South Africa are not availability or affordability but instead related to digital literacy.

An example of the low demand and high supply category is Botswana. There are three competitive mobile operators for a market of just 2.2 million people. Voice coverage extends to over 99 per cent of the population, 3G coverage to over half and 4G networks were recently launched. However, Internet demand remains relatively low, a matter addressed in the country's broadband strategy.[37] The third situation is where there is high demand but insufficient supply epitomized by Nigeria, which has the fourth highest Internet penetration rate in SSA. Yet, despite four mobile firms, investment has been insufficient with the country's leading mobile operator by subscriptions reporting that in 2014 just 87% of the population was covered by voice services and 61% by a mobile broadband signal.[38] The most challenging category is where both demand and supply are low, considering the country's level of economic development. This is reflected by Tanzania whose mobile

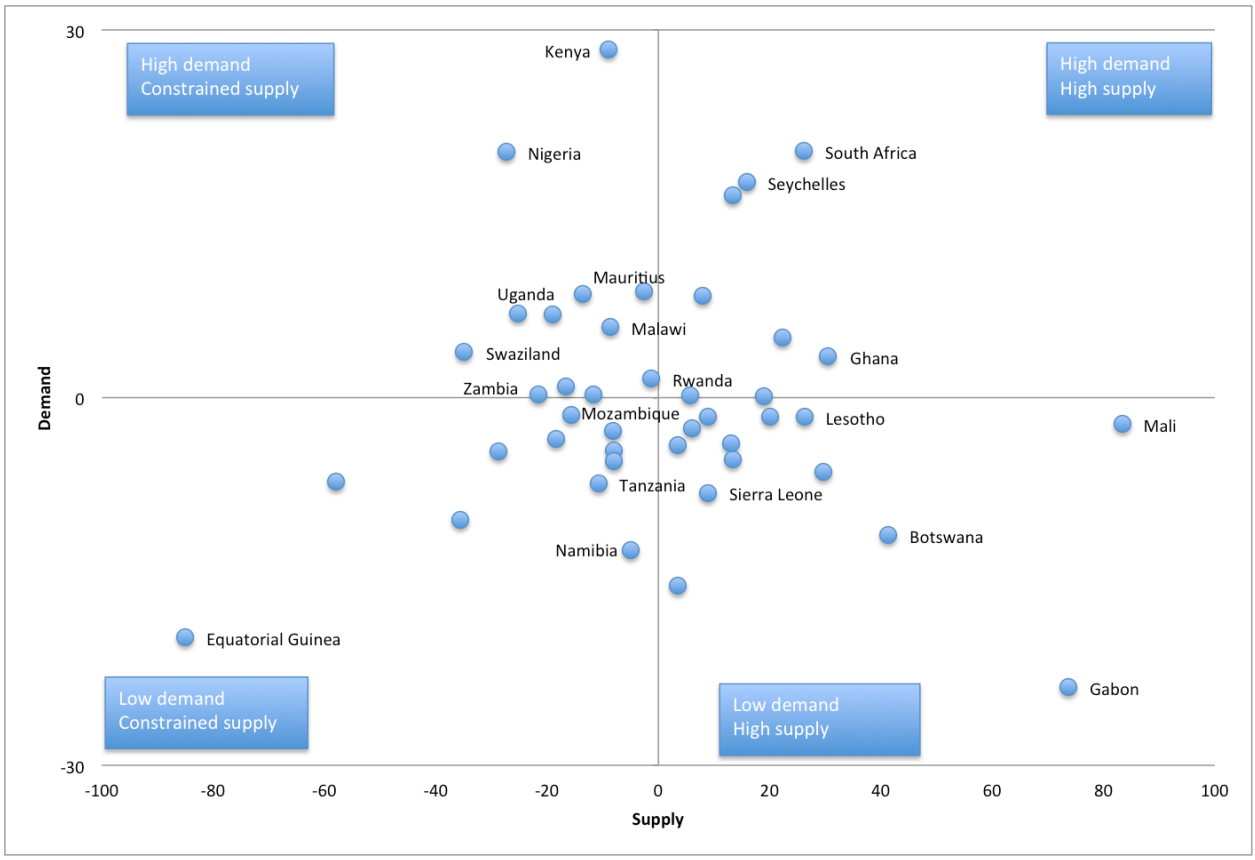
36 http://www.ictdata.org/2015/11/cellphones-rapidly-shrinking-digital.html

37 The country's draft National Broadband Strategy notes that "Building a state of the art broadband infrastructure while the majority of the people in the country lacks the basic skills to access broadband services is of no benefit to the country" (p.28) with the government recommending a mass digital literacy program. Available at: http://www.bocra.org.bw/sites/default/files/documents/Phase%203%20Report%20V3%201%20%282%29.pdf

38 MTN (2015) Annual Integrated Report 2014.

penetration is 11 percentage points less than predicted and Internet access 7 percentage points less.

Figure 9 Relation between mobile supply and Internet demand, SSA



Note: The values are calculated by the difference between a country's actual value and predicted value in mobile subscriptions and Internet usage.
Source: Adapted from World Bank data.

Although SSA has made tremendous improvement in access to ICTs over the last decade, coverage of mobile networks still lags, particularly for mobile broadband services. Some reasons for this are external to the telecommunication sector. Incomes are low and electricity lacking, inhibiting network deployment and take-up. Solutions to these challenges require a top-level multi-sector approach. There are other factors endogenous to the telecommunication sector constraining digital connectivity. These include inadequate competition, limited regulatory expertise, lack of spectrum and low digital literacy. These ailments can be alleviated through a more competitive market environment including embedding open access principles in sector regulations, support for training regulators, efficient and speedier spectrum allocation, improved universal service programs and initiatives for promoting mass digital literacy.

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Analysys Mason (2012) *Assessment of the impact of Internet Exchange Points (IXPs) – empirical study of Kenya and Nigeria*. Internet Society. Retrieved from http://www.internetsociety.org/ixpimpact

The study commissioned by the Internet Society and conducted by independent strategy and research consultancy, Analysys Mason, examined the critical cost and performance benefits of IXPs in Kenya and Nigeria – two sub-Saharan countries that have been on the leading edge of Internet growth in Africa.

Ericsson (2015) *Mobility Report: Sub-Saharan Africa*. Retrieved from http://www.ericsson.com/mobility-report

The Ericsson Mobility Report provides insights into current mobile network data traffic and market trends, as well as forecasts about the future of mobile networks.

Evidence on Demand (2012) *Infrastructure: Rapid Evidence Reviews*. Retrieved from http://www.evidenceondemand.info/infrastructure-rapid-evidence-reviews

This document contains a collection of the 15 Rapid Evidence Reviews commissioned by DFID as background papers for its Infrastructure Position Paper. Each Rapid Review considers the evidence on different sectors under three key themes: climate change adaptation, mitigation and low carbon development; service delivery to the poor; and, infrastructure's role in growth and poverty reduction. Particular topics addressed include: Climate Finance; Energy Infrastructure; Water & Sanitation; and Corruption & Transparency.

GSMA (2014) *Sub-Saharan Africa – Universal Service Fund study*. Retrieved from http://www.gsma.com/publicpolicy/wp-content/uploads/2012/03/Sub-Saharan_Africa_USF-Executive_Summary-English.pdf

Examines the performance of Universal Service Funds in Africa including several case studies.

GSMA Intelligence (2015) *The Mobile Economy - Sub-Saharan Africa*. GSMA. Retrieved from http://www.gsmamobileeconomy.com/ssafrica/

This report provides an overview of the mobile industry in Sub-Saharan Africa and forecasts outlook and trends for 2015-2020. In addition to various metrics on the industry it also examines how regulatory policies can sustain growth.

Malawi Communications Regulatory Authority (MACRA) (2015) *National Survey on Access to and Usage of ICT Services in Malawi.* Retrieved from http://www.macra.org.mw/wp-content/uploads/2016/01/MACRA-Survey-Report-National-Household-and-Individual-access-to-and-usage-of-ICT.pdf

MACRA is mandated to provide reliable and accurate information and data to guide policy makers in developing evidence based policies and strategies. In this regard, MACRA commissioned a national survey on ICT services and engaged the services of the National Statistical Office (NSO) to independently carry out the national survey on access to and usage of ICT services in Malawi. The main objective of the survey was to establish reliable data on the access to and usage of ICT services at household and individual levels in the country as a baseline and comparable statistics with other countries.

Minges, M (2013) *Briefing paper: indicators for measuring ICT access*. Evidence on Demand. Retrieved from http://www.evidenceondemand.info/briefing-paper-indicators-for-measuring-ict-access

This report was prepared to consider the data availability and measurability of indicators for a proposed target to enable everybody to have access to telecommunications. The report considered existing indicators used by the United Nations, and whilst their value was recognised, revisions were proposed to reflect technological change and a shift towards demand-side statistics. With advances in technology and increasing competition and investment by the private sector, the report concludes that infrastructure is becoming less of a barrier to access and in the future the price of services and user devices and digital literacy are likely to be the main barriers to expanded ICT access.

Statistics South Africa (2015) *GHS Series, volume VI, ICT, 2002–2013*. Pretoria: Statistics South Africa. Retrieved from http://www.statssa.gov.za/publications/Report-03-18-05/Report-03-18-052013.pdf

This study confirms that even though access to mobile phones has increased significantly across all socio-economic and population groups, there is indeed a tangible divide in South Africa in terms of access to the knowledge economy elements of an information society. This relates very specifically to aspects such as connectivity to the Internet and ownership of computers and play themselves out starkly along socio-economic and settlement type lines. Households that are urbanised, living in formal dwellings and in the higher socio-economic classes are generally better equipped and connected than households in living in rural areas, in traditional or informal housing and that form part of the lower Living Standard Measure groups.

TI-UP (2010) *ICTD and the digital divide in Africa – focus on infrastructure*. Evidence on Demand. Retrieved from http://www.evidenceondemand.info/TI-UP-Briefing--Note-ICTD-and-the-digital-divide-in-Africa---focus-on-infrastructure.aspx

This report is written as a reference document for those seeking to gain an understanding of the 'digital divide' in Africa with a focus on ICT infrastructure. The report begins with an overview of the wider ICT development goals, provides examples of the problems facing the private ICT sector in Africa, and indicates the latest figures on infrastructure and finance. The final sections look at potential investment pathways in ICT infrastructure – highlighted with DFID-funded case studies – and ends with relevant declarations of the 2010 AU Summit.

World Bank (2016) *World Development Report 2016: Digital Dividends*, Washington DC: World Bank Available at: http://www.worldbank.org/en/publication/wdr2016.

Digital technologies have spread rapidly in much of the world. Digital dividends—that is, the broader development benefits from using these technologies—have lagged behind. In many instances, digital technologies have boosted growth, expanded opportunities, and improved service delivery. Yet their aggregate impact has fallen short and is unevenly distributed. For digital technologies to benefit everyone everywhere requires closing the remaining digital divide, especially in internet access. But greater digital adoption will not be enough. To get the most out of the digital revolution, countries also need to work on the "analog complements"—by strengthening regulations that ensure competition among businesses, by adapting workers' skills to the demands of the new economy, and by ensuring that institutions are accountable.