ICED
Infrastructure & Cities
for Economic Development

Development in a Digital World - Frontier Digital Technologies

Country Benchmarking Tool

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Country Benchmarking Tool

Tool: Overview

Overview

Development in a Digital World - Frontier Digital Technologies

Country Benchmarking Tool

At a time when the transition commonly refered to as the fourth industrial revolution is gaining pace, it is important for donors to understand developing economies' capacities to build and leverage digit created this benchmarking tool to support DFID program managers better understand the different topics that are critical towards building a digital economy:

1. Wireless digital and broadband networks
2. Affordable devices and data
3. IT capacity and skils
4. Digital usage
5. Digital payments infrastructure
6. Availability of capital
7. Labour markets
8. Ecosystem policy and regulation
9. Reliable energy infrastructure
10. Reliable transporation and logistics infrastucture

In creating this tool ICeD analyzed different date sets from GSMA, the World Bank, Pew, etc. to measure the state of each of the above topic areas. The tool then provides an assesment of 3 countries in Ea benchmark and gauge the maturity of a country's digital economy. It should be noted that the metrics used offer only a rough outlook of the digital economy; for program managers that wish to investiga qualitative questions in this file, undertaking a broader landscape assesment using the ICED Digital Readiness Assesment Tool, and undertaking local stakeholder engagement to validate findings.

Development in a Digital World - Frontier Digital Technologies: Country Benchmarking Tool

Part 1 of 10

Wireless Digtal and Broadband Networks

Overview

Reliable wireless and fixed fiber broadband networks are the foundational elements for frontier digital technologies as they all require access to the Internet to work and be effective.

Components

We consider two areas to determine the state of wireless digital and broadband networks. The first is **Wireless Digital Networks**, the second is **Fiber Networks**. Wireless digital networks include mobile, satellite, and other alternative technologies. Fiber networks include fiber connections to businesses and fiber connections to the home. While there are a number of factors that could be considered, we hone in on wireless digital networks and fiber networks. Wireless digital are essential because this is how most people in developing world countries will connect to the Internet for most use cases. Fiber is important because of the network speeds and data capacity increases that it allows, which is particularly important for businesses or high fidelity communications (such as a radiographic medical image).

Wireless Digital Networks

Qualitative Questions

1. What is the state of wireless digital networks in Tanzania?
2. What percentage of the population connects to the Internet on Edge? 3G? 4G?
3. In addition to mobile operator connections, how else are people accessing the Internet?
4. What do we know about 'alternative' wireless digital access models operating in Tanzania?

Quantitative Indicator	Definition / Explanation	Unit of Measure	Tanzania	Kenya	Rwanda	Year and Source	Link
Market penetration, unique subscribers, mobile internet > 3G + 4G	Measures total subscribers at the end of the period, expressed as a percentage share of the total market population.	% of population	12.41%	9.37%	Not available. Total Market penetration, unique subscribers is 35.94%	GSMA Intelligence (Q1 2015)	https://www.gsmaintelligence.com
Growth rate, unique subscribers, annual, Mobile internet > 3G + 4G	Measures total subscribers at the end of the period, expressed as percentage growth from one year ago	Year on year growth rate	30.46%	23.60%	Not available. Total Growth Rate, unique subscribers is 20.21%	GSMA Intelligence (Q1 2015)	https://www.gsmaintelligence.com
Network coverage, by population, 3G	Measures how much of the geography is connected to a network speed where one can interact with the Internet effectively and efficently	% of population	27.67%	70%	75%	GSMA Intelligence (Q1 2015)	https://www.gsmaintelligence.com

Fiber Networks

Qualitative Questions

1. Who provides fibre internet services in Tanzania?
2. How many connections to premises have been established? a) FFTB and b) FFTH and penetration %.
3. What is the annual growth rate for new fiber account activations?

Quantitative Indicator	Definition / Explanation	Unit of Measure	Tanzania	Kenya	Rwanda	Year and Source	Link
Households with Internet access at home	Measures the reach of fiber to individual households	% of households	4.50%	19.60%	6.70%	ITU (2015)	https://www.itu.int/net4/itu-d/icteye/CountryProfile.aspx
Fixed (wired) broadband subscriptions per 100 inhabitants	Evaluates the interest towards wired Internet access	Number per 100 inhabitants	3.2	0.2	0	ITU (2015)	https://www.itu.int/net4/itu-d/icteye/CountryProfile.aspx

Alignment to Inclusion Categories

	(of citizens, industry & gov't)
Connectivity (supply)	
Affordability (supply & demand)	
Relevance (supply & demand)	
Readiness (demand)	
Ecosystem	

Development in a Digital World - Frontier Digital Technologies: Country Benchmarking Tool

Part 2 of 10

Affordable Devices and Data

Overview

Affordable Devices and Data, like a reliable broadband network, are the foundational elements in which people connect to frontier technologies and their applications.

Components

We explore smartphones, both handset prices and data costs, to determine if the foundational elements are in place.

Smartphones	**Qualitative Questions**	1. What are the popular smartphone make / models currently sold in urban areas, and range of prices for smartphones? How does this cost compare to disposable income? 2. What is the average cost for data? Is it increasing or decreasing?						
	Quantitative Indicator	**Definition / Explanation**	**Unit of Measure**	**Tanzania**	**Kenya**	**Rwanda**	**Year and Source**	**Link**
	Smartphone ownership	A proxy for what % of users can have a robust mobile Internet experience	% of adults	11.00%	26.00%	NA	Pew Research center (2015)	http://www.pewglobal.org/2016/02/22/smartphone-ownership-and-internet-usage-continues-to-climb-in-emerging-economies/
	Average cost per GB, excluding connection	Evaluates how financially accesible mobile data is for users and businesses	US Dollars	$2.86	$9.04	$4.92	ITU (2016)	http://www.itu.int/en/ITU-D/Statistics/Pages/facts/default.aspx

Alignment to Inclusion Categories

Connectivity (supply)	
Affordability (supply & demand)	(for citizens & industry)
Relevance (supply & demand)	
Readiness (demand)	
Ecosystem	

IT Capacity and Skills

Overview
IT Capacity and Skills are critical for implementing frontier technologies within businesses and government organizations.

Components
We consider three in-demand tech skillsets, the absense of which could hinder implementations using frontier technolgies, to determine the state of IT capacity and skills. The first is **Data Scientist**, the second is **Programming**, and the third is **Solutions / Enterprise Architecture** skills. For each, we are concerned with the availability of workers who have these skillsets as well as how these skills are being used within organizations.

Data Scientist	**Qualitative Questions**	Questions for SMEs, large enterprise, or government: 1. Does the organization keep digital records? What data is stored? 2. How does the organization use data? 3. Which roles work with data? What are their qualifications? 4. How challenging is it to find skilled data scientists? Questions for learning institutions: 5. How does your institution develop data scientist skills (e.g. data mining, profiling, business intelligence machine learning, visual analytics)? 6. Is there a specific certification course for data scientists? When was this course started and how many students have graduated?						
	Quantitative Indicator	**Definition / Explanation**	**Unit of Measure**	**Tanzania**	**Kenya**	**Rwanda**	**Year and Source**	**Link**
	Linked In Key Term Results	Rough proxy for: a)state of data science b)professional interest in data science	Number of individuals with "data scientist" on LinkedIn Profile	1	54	21	LinkedIn (2017)	https://www.linkedin.com/search/results/people/?facetGeoRegion=%5B%22ke%3A0%22%5D&keywords=%22data%20scientist%22&origin=GLOBA
Programming	**Qualitative Questions**	Questions for SMEs, large enterprise, or government: 1. Does the organization have a need for programmers - does it anticipate having a need? 2. What applications or processes require programming resources? 3. What qualifications are needed to fill programming roles? How do these align to the skills needed for the role? 4. How challenging is it to find appropriately skilled programmers? Questions for learning institutions: 5. How does your institution develop programming skills (R, SQL, Arduino, Swift, Python, JavaScript, Ruby, Go, etc.)? 6. Is there a specific certification course for programming? When was this course started and how many students have graduated?						
	Quantitative Indicator	**Definition / Explanation**	**Unit of Measure**	**Tanzania**	**Kenya**	**Rwanda**	**Year and Source**	**Link**
	Linked In Key Term Results	Rough proxy for: a)opportunities in digital technology b)professional interest in computer programming Note: Due to the lack of industry accepted metrics, we had to manufacture our approach through linked-in	Number of individuals with "programmer" on LinkedIn Profile	550	1898	109	LinkedIn (2017)	https://www.linkedin.com/search/results/people/?facetGeoRegion=%5B%22tz%3A0%22%5D&keywords=%22programmer%22&origin=GLOBAL_SEARCH_HEADER
	Quality of developers - % of Stack Overflow users with rating >500	Evaluates the caliber of digital programmers	% of Stack Overflow users	2.8%	4.0%	1.5%	Stack Overflow (2017)	http://data.stackexchange.com/stackoverflow/query/352995/top-users-by-country
	Availability of developers - number of Stack Overflow users per 100,000 people	Evaluates the number of digital programmers	Number	0.72	4.96	1.14	Stack Overflow (2017)	http://data.stackexchange.com/stackoverflow/query/352995/top-users-by-country
	Activity of developers - number of GitHub commits per 100,000 people	Evaluates how active the developer community is	Number	0.37	7.46	8.42	GitHub (2017)	http://geeksta.net/visualizations/github-commit-map/
Solutions / Enterprise Architecture	**Qualitative Questions**	Questions for SMEs, large enterprise, or government: 1. Does the organization have a solution or enterprise architect role? 2. What qualifications are needed to fill this role? 3. How challenging is it to find appropriately skilled solutions architects? Questions for learning institutions: 4. How does your institution develop solutions architect skills (software platforms, business process knowledge, standards and best practices)? 5. Is there a specific certification course? When was the course strated and how many students have graduated?						
	Quantitative Indicator	**Definition / Explanation**	**Unit of Measure**	**Tanzania**	**Kenya**	**Rwanda**	**Year and Source**	**Link**
	Linked In Key Term Results	Evaluates how sophisticated the digital market is	Number of individuals with "solutions architect" or "enterprise architect" on LinkedIn Profile	Solutions Architect: 33 Enterprise Architect: 2	Solutions Architect: 261 Enterprise Architect: 15	Solution(s) Architect: 7 Enterprise Architect: 1	LinkedIn (2017)	https://www.linkedin.com/search/results/people/?facetGeoRegion=%5B%22ke%3A0%22%5D&keywords=%22enterprise%20architect%22&origin=GLOBAL_SEARCH_HEADER

Alignment to Inclusion Categories

Connectivity (supply)	
Affordability (supply & demand)	
Relevance (supply & demand)	(of industry & gov't)
Readiness (demand)	(of industry & gov't)
Ecosystem	

Digital Usage

Overview
Digital usage is an important measure of citizen readiness to interact with digital technology.

Components
We consider three areas to determine the state of digital literacy and use. The first is **Education Levels**, which are a proxy for digital literacy levles. Second is **Engagement in Internet use cases**, and the third is **Diffusion of Digital Technologies within SME Businesses**. These areas of inquiry are meant to cover citizen engagement as well as SME business engagement in Internet use cases.

Education Levels

Qualitative Questions
1. What is the gross enrollment ratio in tertiary education?
2. What is the completion rate for secondary education?

Quantitative Indicator	Definition / Explanation	Unit of Measure	Tanzania	Kenya	Rwanda	Year and Source	Link
Gross enrollment ratio, secondary, both sexes (%)	Educational level is used as a proxy for digital literacy	Percentage	34.24%	67.64%	38.39%	World Bank (2012)	http://data.worldbank.org/indicator/SE.SEC.ENRR?end=2012&locations=KE-TZ-RW&start=2012&view=bar

Engagement in Internet Use Cases

Qualitative Questions
How frequently are individuals using digital devices to:
1. Communicate using mobile internet
2. Access entertainment content
3.. Social networking
4. Navigate
5. Financial services
6. Access market intermediaries, such as Uber, e-learning content portals, etc.
7. Digital commerce
8. Access lifestyle services (health, job searching, government services)

Quantitative Indicator	Definition / Explanation	Unit of Measure	Tanzania	Kenya	Rwanda	Year and Source	Link
Global Mobile Engagement Index	Measures the level of engagement of smartphone and non-smartphone users across different use cases and services. The higher the score the more likely consumers are to frequently engage in services	Overall score, 1=low 5=high	1.4	1.5	NA	GSMA Intelligence (2017)	https://www.gsmaintelligence.com
% of consumers engaging in mobile Internet use cases	Mobile internet use cases include: Mobile Internet communcation; entertainment content; social networking; navigation; financial services; market intermediaries; digital commerce and lifestyle	% of consumers	35-40%	30-35%	NA	GSMA Intelligence (2017)	https://www.gsmaintelligence.com
Minutes of use, per connection	Self explanatory	Average minutes used monthly	114	NA	NA	GSMA Intelligence (2014, 2015)	https://www.gsmaintelligence.com
SMS messages, per connection	Self explanatory	Number of message sent monthly	46 - 247	36251	NA	GSMA Intelligence (2014, 2015)	https://www.gsmaintelligence.com
ARPU / Month, by subscriber	Self explanatory	$ US	$6.44	$9.86	NA	GSMA Intelligence (2014, 2015)	https://www.gsmaintelligence.com

Diffusion of Digital Technologies within SME Businesses

Qualitative Questions
Important to ask about use of technology; not just whether its present.
1. Use of broadband
2. Company website
3. Electronic purchase orders
4. Use of social media for marketing
5. Enterprise resource planning (e.g. digital accounting, inventory, etc.)
6. Cloud computing
7. Electronic sales
8. Supply chain management using data
9. RFID

Quantitative Indicator	Definition / Explanation	Unit of Measure	Tanzania	Kenya	Rwanda	Year and Source	Link
Country Code Top-Level Domains (ccTLD)	Proxy for web activity by public, private and non-profit organizations	Number of registered 2-letter country code domains	12,133	50,957	2,582	Domain Tools (2017)	http://research.domaintools.com/statistics/tld-counts/
M2M Connections	Active unique SIM cards (or phone numbers, where SIM cards are not used), excluding M2M, that have been used for voice, messaging or data activity on the mobile network over the operator's activity period, which can range from one to 13 months. Connections differ from subscribers such that a unique subscriber can have multiple connections.	Number of connections, including cellular M2M - Number of connections, excluding cellular M2M	172,597	145,602	82,804	GSMA Intelligence (2014, 2015)	https://www.gsmaintelligence.com
Facebook custom audience	An assessment of how prevalent social media is in marketing and product promotion	% of Advertising Mix	7.95%	10.28%	3.70%	Built With (April 2017)	https://trends.builtwith.com/ads/country/Tanzania
Secure servers per 1 million people	Proxy for interest in digital security	Number of secure servers	109	421	48	World Bank (2015)	http://data.worldbank.org/indicator/IT.NET.SECR

Alignment to Inclusion Categories

Connectivity (supply)	
Affordability (supply & demand)	
Relevance (supply & demand)	(of citizens and SMEs)
Readiness (demand)	(of citizens and SMEs)
Ecosystem	

Digital Payments Infrastructure

Overview
Digital payments infrastructure is critical for all monetary transacations and the growth of e-Commerce. There are three critical components to digital payments infrastructure: First, there is core primary infrastructure, which includes the creation of digital money (e-money) and the ability to have digital "stores of value" of e-money, e.g. digital wallets. Second, there is infrastructure that enables e-money to be move between digital wallets, as well as core banking systems. And third, there is 3rd party infrastructure that enables more complex intertemporal transactions involving risk, such as savings and wealth management, insurance, loans and credit, etc. This 3rd party infrastructure involves matching demand and supply of capital, credit ratings, risk assessment, etc.

Components
While there are a number of components to consider, we focus on **Digital Wallet Interoperability or Integration** because e-money needs to be liquid and apply to many different everyday use cases in order for it to be relevant. A critical mass adoption is essential for e-money to take off, and this is hampered when use cases are limited within the four walls of a single e-money ecosystem.

Digital Wallet Interoperability or Integration	**Qualitative Questions**	1. Who can offer digital money services? 2. Can P2P payments be sent to any other digital wallet or bank account? 3. Which businesses or government services can be paid for using digital wallets? 4. Are payments gateways available for businesses?						
	Quantitative Indicator	**Definition / Explanation**	**Unit of Measure**	**Tanzania**	**Kenya**	**Rwanda**	**Year and Source**	**Link**
	Mobile money accounts	Self explanatory	# active per 100,000 adults	648.62	1,182.85	368.53	IMF (2015)	http://data.imf.org/?sk=E5DCAB7E-A5CA-4892-A6EA-598B5463A34C&ss=1460043522778
	Mobile money transactions	Self explanatory	# per 100,000 adults	47,363.03	41,649.83	24,637.75	IMF (2015)	http://data.imf.org/?sk=E5DCAB7E-A5CA-4892-A6EA-598B5463A34C&ss=1460043522778
	Number of interoperable mobile money services	Self explanatory	Number per country	Completely Interoperable Market, with 5 live services	Not interoperable; 6 live services	Completely Interoperable Market, with 6 live services	GSMA (2015) and GSMA (2016)	http://www.gsma.com/mobilefordevelopment/tracker http://www.gsma.com/mobilefordevelopment/wp-content/uploads/2016/11/SOTIR_2015.pdf

Alignment to Inclusion Categories

Connectivity (supply)	(to payments systems)
Affordability (supply & demand)	
Relevance (supply & demand)	
Readiness (demand)	
Ecosystem	

Availability of Capital

Overview
Availability of Capital is an important indicator for whether businesses and government can finance implementations using frontier technolgy.

Components
We consider 2 areas to provide a perspective. The first is **Unsecured Small Business Lending** as these projects are unlikely to be collateralized; the second is **Government Ability to Raise Capital**.

Unsecured Small Business Lending	**Qualitative Questions**	1. What is the rate of interest for unsecured business or personal loans? 2. What facilities are available for unsecured small business lending? 3. What are the requirements to obtain an unsecured loan?						
	Quantitative Indicator	**Definition / Explanation**	**Unit of Measure**	**Tanzania**	**Kenya**	**Rwanda**	**Year and Source**	**Link**
	Average bank lending rates for prime customers	Measure of growth for small/medium sized enterprises	Monthly %	13.33%	13.69%	NA	Trading Economics (2017)	http://www.tradingeconomics.com/tanzania/bank-lending-rate
Government Ability to Raise Capital	**Qualitative Questions**		1. Does local or national government have a facility or an existing program under which they can draw on to invest in frontier technologies or implement frontier technologies? 2. What other funding mechanisms exist that local or national government can tap into?					
	Quantitative Indicator	**Definition / Explanation**	**Unit of Measure**	**Tanzania**	**Kenya**	**Rwanda**	**Year and Source**	**Link**
	Government Credit Rating	An evaluation to the strength of an economy - measures the ability of a government to pay back debt and raise capital	Grade by Ratings Agency	NA Moody's: NA S&P: NA Fitch: NA	All Non-Investment Grade Moody's: NA S&P: B+ (Highly Speculative) Fitch: B+ (Highly Speculative)	All Non-Investment Grade Moody's: NA S&P: B (Highly Speculative) Fitch: B+ (Highly Speculative)	Country Economy (2017)	http://countryeconomy.com/ratings

Alignment to Inclusion Categories

Connectivity (supply)	
Affordability (supply & demand)	(for industry & city/national gov't)
Relevance (supply & demand)	
Readiness (demand)	
Ecosystem	

Labour Market

Overview
Labour markets are increasingly susceptible to both computerization and globalization - which may have positive and negative effects for developing world countries.

Components
We consider 2 areas to explore the current state of the labour market in Tanzania, particularly the potential for the labour market to be transformed by automation. The first area is **Jobs that can be automated**, leaning on the World Bank's 2016 Development Report; the second is **Labour market composition**.

Jobs that can be automated

Qualitative Questions
1. How has the labor market been changing?
2. What percentage of jobs are "high-skilled occupations" (intensive in nonroutine congnitive and interpersonal skills) comparad with "middle-skilled occupations" (intensive in routine cognitive and manual skills), compared with low-skilled occupations (intesive in nonroutine manual skills)?
3. How quickly are businesses and industry adopting computers and robotics?

Quantitative Indicator	Definition / Explanation	Unit of Measure	Tanzania	Kenya	Rwanda	Year and Source	Link
Employment by Occupation - Type of task (%)	Self explanatory	Sub-saharan Africa Non-routine manual occupations: 70% Routine occupations: 25% Non-routine cognitive occupations: 5%				UN (2015)	https://sustainabledevelopment.un.org/content/documents/1831World%20Employment%20Social%20Outlook%20Trends.pdf
Employment distribution by occupation (ILO modeled estimates)	Assess the technical capacity of the existing work force	Percentage	Skill levels 3 & 4 (high): 4% Skill level 2 (medium): 88.1% Skill level 1 (low): 7.9%	Skill levels 3 & 4 (high): 5.6% Skill level 2 (medium): 88.7% Skill level 1 (low): 5.7%	Skill levels 3 & 4 (high): 3.9% Skill level 2 (medium): 91% Skill level 1 (low): 5.1%	ILO (2016)	http://www.ilo.org/ilostat/faces/oracle/webcenter/portalapp/pagehierarchy/Page27.jspx?subject=ILOEST&indicator=EMP_2EMP_SEX_OCU_DT&datasetCode=A&collectionCode=ILOEST&_afrLoop=8

Labour market composition

Qualitative Questions
1. What are the economic and demographic trends in the labour market (including, formal/informal sector in rural/urban, male/female)?
2. What policies are impacting formal / informal workers?

Quantitative Indicator	Definition / Explanation	Unit of Measure	Tanzania	Kenya	Rwanda	Year and Source	Link
Informal economy rate	Measures how large the unoffical economy is	Total %, Agriculture %, Non-agriculture %	Total: 74.4% Agriculture: 83.2% Non-agriculture: 55.6%	NA	NA		http://www.ilo.org/ilostat/faces/oracle/webcenter/portalapp/pagehierarchy/Page27.jspx?subject=EMP&indicator=IFL_IECN_SEX_ECO_RT&datasetC
Percentage of persons employed in informal sector as main or secondary actvity by area and sex	Guidance on urban informal sector	Percentage of persons, exlcluding agricultural activities. Informal sector includes enterprises that are non-separate legal entities with 5 or fewer employees	Dar es Salaam Main Activity: Male 13.6%, Female 13.6% Secondary Activity: Male 0.7%, Female 0.5% Other Urban Main Activity: Male 21.2%, Female 25.6% Secondary Activity: Male 9.4%, Female 10.4%	NA	NA	Tanzania Integrated Labour Force Study (2014)	NA
Share of temporary employees	Self explanatory	Total %	58%	22%	NA	ILO (2014 Kenya, 2006 Tanzania)	http://www.ilo.org/ilostat/faces/oracle/webcenter/

Alignment to Inclusion Categories

Connectivity (supply)	
Affordability (supply & demand)	
Relevance (supply & demand)	(of industry & gov't)
Readiness (demand)	(of industry & gov't)
Ecosystem	

Ecosystem Policy & Regulation

Overview
Ecosystem Policy & Regulation is necessary to harmonize activities, as well as ensure certainty and fairness in governance of areas impacted by frontier technologies.

Components
We consider 5 ecosystem areas for investigating foundational elements. The first is having a **Strategic framework** that brings together necessary stakeholders and outlines a vision that private and public sector can align around. The second is **Legal infrastructure addressing liability**, which is important for addressing the legal and ethical concerns that arise as digital and in particular robotics and AI become part of everyday life. The third is **Internet security** as an environment that is vulnerable to cyber attacks can jeapardize trust, particularly in early adoption days. The fourth is **Relative control / openness of data**, which factors in the way people engage with applications or use social media. The fifth is **Corruption & transparency**, because an environment that tolerates high levels of corruption or low transparency can thwart efforts to increase visibility via technology.

Strategic framework

Qualitative Questions
1. Is there an ICT Strategy and roadmap at country level? What are the core pillars in the strategy?
2. How is private sector, and in particular technology firms, involved in the execution of the strategy?

Quantitative Indicator	Definition / Explanation	Unit of Measure	Tanzania	Kenya	Rwanda	Year and Source	Link
ICT Strategy	Indicates the governments views and how they position digital technology within the economy	Document link	https://tanzict.files.wordpress.com/2016/05/national-ict-policy-proofed-final-nic-review-2.pdf	http://icta.go.ke/national-ict-policy/	http://www.myict.gov.rw/fileadmin/Documents/Strategy/SMART_RWANDA_MASTER_PLAN_FINAL.pdf	Local Government Websites (various years)	See country for link

Legal infrastructure addressing liability

Qualitative Questions
1. Is there laws that address civil liability for damage caused by AI, such as driverless cars?
2. Is there laws that address ethics and liability for defective robotic products that cause personal damage?

Quantitative Indicator	Definition / Explanation	Unit of Measure	Tanzania	Kenya	Rwanda	Year and Source	Link
Strength of legal rights index	Gauges strength of and respect towards civil liberties with digital technology by the government	score, 0=weak to 12=strong	5.00	7.00	11.00	World Bank, Doing Business (2016)	http://data.worldbank.org/indicator/IC.LGL.CRED.XQ

Internet security

Qualitative Questions
1. Is there a policy to increase internet security / decrease vulnerabilities?
2. Are businesses aware of internet security protocols?

Quantitative Indicator	Definition / Explanation	Unit of Measure	Tanzania	Kenya	Rwanda	Year and Source	Link
Susceptibility to unsafe or potentially vulnerable internet services	Guages presence of insecure networks and internet channels, such as unencrypted, plain text services	Exposure Rank, 1=High, 50=Low	Most Exposed (p. 14) based on Percentage of encrypted & non-encrypted web-oriented systems (ports 80 & 443)	11	NA	Rapid 7 (2016)	https://information.rapid7.com/national-exposure-index.html

Relative control / openness of data

Qualitative Questions
1. Are there government efforts to block specific applications or technologies?
2. Who has legal and ownership control over internet and mobile phone access providers?
3. Is content filtered or blocked?
4. Can digital media be used for social and political activism?

Quantitative Indicator	Definition / Explanation	Unit of Measure	Tanzania	Kenya	Rwanda	Year and Source	Link
Freedom on the Net	Indicates the degree to which the government controls access to data and openness of data	Score, 0 = Most Free, 100 = Least Free F=Free, PF=Partially Free, NF=Not Free	NA	29, F	50, PF	Freedom House (2015)	https://freedomhouse.org/sites/default/files/FH_FOTN_2015Report.pdf
Internet censorship and surveillance by country	Indicates the degree to which the government controls access to data and openness of data	Pervasive, Substantial, Selective, Changing Situation, Little or none	Little or None	Little or None	Selective	Wikipedia (2017)	https://en.wikipedia.org/wiki/Internet_censorship_and_surveillance_by_country
Internet censorship and surveillance by country, detail	Text accompanying rating	N/A	There are no government restrictions on access to the Internet; however, the government monitors Web sites that criticize the government. Police also monitor the Internet to combat illegal activities.[667] The constitution provides for freedom of speech, but does not explicitly provide for freedom of the press. The law generally prohibits arbitrary interference with privacy, family, home, or correspondence without a search warrant, but the government does not consistently respect these prohibitions. It is widely believed that security forces monitor telephones and correspondence of some citizens and foreign residents. The actual nature and extent of this practice is unknown.[667]	The government does not employ technical filtering or any administrative censorship system to restrict access to political or other content.[559] There are no government restrictions on access to the Internet, but Internet services are limited in rural areas due to lack of infrastructure. In 2008, approximately 8.6 percent of Kenyans used the Internet.[560] By 2012 this figure had grown to 32.1%.[421][561] The constitution protects freedom of expression and the "freedom to communicate ideas and information." However, it also grants the government the authority to punish defamation, protect privileged information, and restrict state employees' "freedom of expression in the interest of defense, public safety, public order, public morality or public health." In January 2009, the government passed a	NA	Wikipedia (2017)	https://en.wikipedia.org/wiki/Internet_censorship_and_surveillance_by_country

Corruption & transparency

Qualitative Questions
1. What do stakeholders perceive to be the state of corruption and corruption control (at various levels)?
2. What do stakeholders perceive to be the willingness of companies to pay bribes? In what sectors are bribes most prevalent?
3. Have anti-corruption measures been put in place?

Quantitative Indicator	Definition / Explanation	Unit of Measure	Tanzania	Kenya	Rwanda	Year and Source	Link
Control of Corruption	Evaluates how contained corruption is within a government	Percentile Rank, 0 = Low to 100 = High	25.48	13.46	75.00	World Bank, Worldwide Governance Indicators (2015)	http://info.worldbank.org/governance/wgi/index.aspx#reports
Corruptions perception index	Index aggregates data from a number of different sources that provide perceptions of business people and country experts of the level of corruption in the public sector	Score, 0=corrupt to 6=not corrupt	32.00	26.00	54.00	Transparency International (2016)	http://www.transparency.org/news/feature/corruption_perceptions_index_2016
CPIA transparency, accountability, and corruption in the public sector rating	Proxy for how open the public sector is	Score, 1=low to 6=high	3.00	3.00	3.50	World Bank (2015)	http://data.worldbank.org/indicator/IQ.CPA.TRAN.XQ

Alignment to Inclusion Categories

Connectivity (supply)	
Affordability (supply & demand)	
Relevance (supply & demand)	
Readiness (demand)	
Ecosystem	

Reliable Energy Infrastructure

Overview
Electricity is a critical backbone for technology both for busineses and customers; a low access rate may create important limitations for technology busienss models, especially those who aim to target rural populations.

Components
We consider **Access to and quality of electricity** as a good indicator of energy infrastructure, however the qualitative questions are more useful in terms of whether the electricity provided is reliable.

Access to and quality of electricity

Qualitative Questions

1. Does the country have a regulatory agency that is independent in decision making? Is it separate from the utility?
2. Are utilities state-owned or run by private companies? If equity is shared, who is majority stakeholder? Does the state interfere in the running of the utility? Is there a difference in terms of electricity generation and electricity distrbution?
3. Is generation and distribution handled by the same company or different companies?
4. Do power outages occur frequently? What is the cause of power outages, the last several ones that have occured?

Quantitative Indicator	Definition / Explanation	Unit of Measure	Tanzania	Kenya	Rwanda	Year and Source	Link
Access to electricity	Critical indicator as to what percentage of the population can power digital technologies	% of Population	15.30%	36.00%	19.80%	World Bank (2016)	http://data.worldbank.org/indicator/EG.ELC.ACCS.ZS?end=2012&locations=TZ-KE-RW&start=2012&view=bar
Access to electricity, urban	Critical indicator as to what percentage of population living in cities can power digital	% of urban population	41.16%	100.00%	47.53%	World Bank (2014)	http://data.worldbank.org/indicator/EG.ELC.ACCS.UR.ZS?end=2014&locations=KE-RW-TZ&page=3&start=2014&view=bar
Access to electricity, rural	Critical indicator as to what percentage of population living in rural areas can power digital technologies	% of rural population	4.03%	12.60%	9.10%	World Bank (2014)	http://data.worldbank.org/indicator/EG.ELC.ACCS.RU.ZS?end=2014&locations=KE-RW-TZ&page=3&start=2014&view=bar
Number of electrical outages in typical month, and duration	Indicator of the disrutpion of electricity	Number per month (duration in hours)	8.9 (5.1 hours)	6.3 (5 hours)	4 (2.7 hours)	World Bank, Enterprise Surveys (2011 Rwanda, 2013 Tanzania & Kenya)	http://www.enterprisesurveys.org/data/exploretopics/infrastructure#sub-saharan-africa--1
Losses due to electrical outages	Indicator of the cost of the burden due to the inadequate provision of electricity	% of annual sales	5.50%	5.60%	1.00%	World Bank, Enterprise Surveys (2011 Rwanda, 2013 Tanzania & Kenya)	http://www.enterprisesurveys.org/data/exploretopics/infrastructure#sub-saharan-africa--1
Proportion of electricity used from generator	Indicator of burden due to inadequate provision as well as availability of work-arounds during outages	Percentage	8.20%	7.80%	3.00%	World Bank, Enterprise Surveys (2011 Rwanda, 2013 Tanzania & Kenya)	http://www.enterprisesurveys.org/data/exploretopics/infrastructure#sub-saharan-africa--1
Percent of firms identifying electricity as a major constraint	Indicator of perception around provision of electricity	Percentage	45.80%	22.20%	15.40%	World Bank, Enterprise Surveys (2011 Rwanda, 2013 Tanzania & Kenya)	http://www.enterprisesurveys.org/data/exploretopics/infrastructure#sub-saharan-africa--1

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