Opportunities for Universal Telecommunication Access in Rural Communities: A Case Study of 15 Rural Villages in Nigeria's Kwara State

Olayiwola Wasiu Bello
Department of Information and Communication Science, University of Ilorin, Ilorin, Nigeria

Jayeola Femi Opadiji
Department of Computer Engineering, University of Ilorin, Ilorin, Nigeria

Nasir Faruk
Department of Telecommunication Science, University of Ilorin, Ilorin, Nigeria

Yinusa Ademola Adediran
Department of Electrical and Electronics Engineering, University of Ilorin, Ilorin, Nigeria

Abstract

The goal of universal telecommunication access is to make telecommunication infrastructure available to everyone irrespective of their geographical location, income level, age, gender or other discriminatory parameters. Despite substantial efforts to close the digital divide, developing countries still encounter daunting challenges in making access truly universal. In this article, the authors report on an exploratory field survey of 15 rural communities in Nigeria's Kwara State to document their perception of the effects of rural telecoms access on their livelihoods. Results revealed mostly positive effects in respect of economic growth, poverty alleviation, health education, primary healthcare delivery, and reporting of epidemic outbreaks such as the recent Ebola crisis. However, little impact on quality of government service was recorded, as awareness of participation in governance and socio-political issues was found to be very low. The article discusses some areas in which universal telecommunications access can be expected, going forward, to address the needs of communities in rural and remote communities.

Keywords

universal access, rural telecommunications, Kwara State, Nigeria

1. Introduction

Universal telecommunication access refers to the provision of telecommunication infrastructure in a geographical location such that people living in that area can communicate with people in other parts of the world (NTIA, 2014; Schorr, 2004). The goal of universal access is to bring telecommunication infrastructure close to everyone irrespective of their geographical location, income level, age, gender or other discriminatory parameters. Despite the potential benefits the rural areas could experience through telecommunication access, the research conducted in this study shows a continuing "digital divide" in 2015. This term is used for information inequality, for gaps in information, or knowledge, or computer and media literacy (Van Dijk, 2006). Generally, digital divide refers to the gap between those who have and those who do not have access to new forms of information technology (Gunkel, 2003). However, in this article we refer to digital divide as telecommunication access inequality within developing countries. Kilpeläinen and Seppänen (2014) argue that ICT offers an important opportunity to create and maintain communality in remote areas, and it would help to ease the hardships of everyday life, while Erdiaw-Kwasie and Alam (2016), Park (2016), and Salemink, Strijker and Bosworth (2015) discuss digital inequalities and social exclusion. The concept of closeness is defined by availability, affordability and reliability (Xavier, 2006). While rural access has proven to be a daunting challenge in most developing countries, substantial progress has been made globally over the last decade in achieving universal telecommunication access.

In this article, survey data is reported for 15 rural communities in Kwara State, Nigeria. A few areas in which universal telecommunication access can be expected to impact such rural and remote communities, is then discussed. The sectors (education, health, poverty alleviation and gender equality) considered here are selected based on the specific goals itemised in the United Nations sustainable development goals (SDGs) (United Nations, 2016) and are considered key to national development. While it may be relatively easy to appreciate the impact of ICTs on these sectors in urban centres, the challenges of poverty, illiteracy, rural-urban migration and geographical remoteness make it difficult to understand the effect of telecommunication access in rural areas. This is because ICT impact is negligible in the daily lives of most rural dwellers. However, an assessment of rural telecoms access can provide objective information on the feasibility and importance of universal telecommunication access for rural communities in Nigeria.

2. Telecommunications development in Nigeria

Telecommunications development in Nigeria can be divided into two main eras: colonial and post-colonial eras. Nigeria had a slow start during the colonial era, with the 1955-1962 Development Plan being the first serious attempt to plan public telecommunication services. Although progress slowed during the Civil War of 1967-1970, a giant leap was taken in 2001 with the introduction of the Global System for Mobile Communications (GSM) services.

Telecommunications development in the 1990s

In 1992, the Nigerian government initiated partial liberalisation and market reform of the telecoms sector. However, Nigerian Telecommunications Limited (NITEL) held a monopoly over basic telecoms services until the mid-1990s. Decree 75 of 1992 established the Nigerian Communications Commission (NCC) as the regulator for the telecoms sector and NCC became operational in 1993. As the independent regulatory authority for the telecoms sector, NCC's objectives were to create an enabling regulatory environment for the sector, facilitate the market entry of telecoms operators, promote fair competition and efficient market conduct and establish the Universal Service Fund (USF) to promote "the widespread availability and usage of network services and applications services" throughout Nigeria (NCC, 2016a).

By 1995, 42 licences had been issued for various services, including consumer premises equipment (CPE), payphones, DOMSAT links, cellular telephony, local community telephones, value-added services and cabling (Ajayi, Salawu & Raji, 1996). By 1997, 28 companies were licensed by NCC to provide various forms of telecoms services, though NITEL still remained the only national carrier (Sadiq, Oyelade & Ukachukwu, 2011). However, the then military government's intervention with NCC regulation, coupled with policy inconsistencies, meant that growth was slow.

The new civilian government of 1999 opted for full reform of the telecoms industry in order to eliminate misuse of monopoly power by NITEL, improve services, increase sector efficiency via competition, encourage innovation and extend services to underserved and unserved areas of the country. The reform started with the cancellation of all operating licences issued by NCC, as most of the 34 licences had been issued to friends and colleagues who did not need them, thus leading to more licences than available spectrum. In December 1999, a new National Telecommunications Policy was unveiled, which formed the blueprint for full liberalisation of the telecoms market (Sadiq et al., 2011).

Telecommunications development in the new millennium

Based on the new National Telecoms Policy published in September 2000, which included *universal telecoms access and services*, the Nigerian government encouraged foreign investment and inflow of capital and equipment through elimination of restrictions on the levels of foreign equity participation and reduction in the levels of import duties on telecoms equipment from 25% to 5% in August 2001, for two years (Sadiq et al., 2011). This facilitated the introduction of several telecoms services and licences, which included fixed telephony, cellular mobile telephony, long distance transmission, global mobile personal communication services (GMPCS), international data access, high speed data transmission, value added services, Internet service, and unified access service licences (UASL). The UASL technology takes advantage of technology convergence, thus enabling licence holders to offer a variety of services, such as voice, data and ISP, among others.

In 2001, licences were granted to three digital GSM operators: MTN, EWL and MTEL. Some fixed wireless operators (e.g., Intercellular) were also licensed. The incumbent operator, NITEL, was licensed as the only national carrier. An attempt to privatise NITEL failed and in 2002, Nigeria's telecommunications industry enthusiastically welcomed the licensing of Globacom Ltd as the second national operator to compete with NITEL (Adediran, Usman & Onyedike, 2005). The licence was awarded by NCC at a cost of USD200 million, thus yielding huge revenue to the Federal Government. Globacom launched its mobile service in August 2003. Also in 2003, the Nigerian Communications Act (NCA) repealed the NCC Act of 1992 and re-established the independence of NCC with increased regulatory power (Oniyedibe, 2004). The Act also sought to advance a new spectrum plan for Nigeria (Adediran et al., 2005).

Currently, Nigeria has a relatively high rate of telecommunications development, with an estimated 153 million subscribers for all forms of telephony in October 2016, almost exclusively mobile telephony, with only 124,812 fixed wired lines (NCC, 2016b) relative to its population size of 182 million (NPC, 2016). Kwara State has an estimated population of 2,3 million (NPC, 2016). There are nine active, licensed telecommunication operators, with services provided via GSM, code division multiple access (CDMA) (NCC 2016c), fixed wireless, fixed wired and Voice over Internet Protocol (VoIP) technologies; and 37 active, licensed Internet service providers (NCC, 2016d). Internet penetration stands at 46% (Internet Live Stats, 2016). The contribution of telecommunication services to gross domestic product (GDP) was estimated at 8.5% in 2015 and 9.8% at June 2016 (NCC, 2016e).

3. Characteristics of rural communities in Nigeria

Nigeria's population was estimated at 182 million and its GDP at USD481 billion in 2015 (World Bank, 2015). Rural communities in Nigeria are mostly characterised as living in extreme poverty, with: up to 80% living below the poverty line; lack of, or limited, social services and infrastructure, such as potable water, primary healthcare and road network; the majority being resource poor with no land assets and very limited employment opportunities; even distribution across the country, rather than being concentrated in specific geographical areas; unequal capabilities due to education and health status; and high levels of inequality resulting from unequal access to income opportunities and basic infrastructures (Ogwumike & Ozughalu, 2016; Olaniyan & Bankole, 2005; Omonona, 2009; Rowe, 2003; Zhang et al., 2016). Nigeria's rural population was estimated at 53% of the total population in 2014 (World Bank, 2016a). Table 1 depicts a few of the areas of deprivation in the rural communities in Nigeria. Of particular interest is information deprivation whereby the rural community may not have access to sources of information such as newspapers, radio, television, or telephones.

Table 1: Measurement of deprivation

Deprivation	Mild deprivation	Moderate deprivation	Severe deprivation	Extreme deprivation
Food	Bland diet of poor nutritional value	Hungry on occasion	Malnutrition	Starvation
Safe drinking water	Lack of water on occasion due to shortage of money	No access to water in dwelling, but commercial piped water available within 200 metres of dwelling or less than 15 minutes' walk away	Long walk to water source = more than 200 metres away or more than 15 minutes' walk. Unsafe drinking water	No access to water
Health	Occasional lack of access to medical care due to insufficient money	Inadequate medical care	No immunisation against disease. Only limited non-professional medical care available when sick	No medical care
Shelter	Dwelling in poor repair. More than one person per room	Few facilities in dwelling. Structural problems. More than three people per room	No facilities in house. Non-permanent structure, no privacy, no flooring, more than five people per room	Roofless i.e., no shelter
Education	Inadequate teaching due to lack of resources	Unable to attend secondary but able attend primary education	Child is seven or older and has received no primary or secondary education	Prevented from learning due to persecution and prejudice
Information	Cannot afford newspapers or books	No television but can afford radio	No access to radio, television, books or newspapers	Prevented from gaining access to information
Basic social services	Health and education facilities available but occasionally of low standard	Inadequate health and education facilities e.g., less than one hour's travel	Limited health and education facilities e.g., a day's travel away	No access to health or education services

Source: Adapted from Olaniyan and Bankole (2005)

Figures 1 and 2 below show images of surveyed villages 2, 4 and 5, in photographs taken during the field survey of 2015.

Figure 1: Villages 2 and 5

Figure 2: Village 4, and access road to the village

Criteria for def inition of rural areas in Nigeria
Criteria that various authors have used to differentiate between "rural" and "urban" areas include size, population density, population composition, closeness to nature, occupation, culture, social interaction, social stratification, social mobility, social control, levels and standard of living. In Nigeria, a rural area is classified on the basis of population criteria, as defined by the National Bureau of Statistics and the 2006 census put the ceiling population at 20,000 (NPC & ORC Macro, 2004, p. 211). The International Fund for Agricultural Development (IFAD) considers rural people to constitute about 72% of the people living in extreme poverty, that is, on less than USD1.25 per day (IFAD, 2014), most of whom reside in low income and low-middle income countries (Adisa, 2012). Since the 1980s, the poverty levels in Nigeria have risen, increasing from 17.7 million poor in 1980 to 69 million in 2004 (Omonona, 2009), while the poverty profiles show that Nigerian poverty is predominantly a rural phenomenon. The national poverty headcount ratio in 2009 was 46% (World Bank, 2015).

4. Universal telecommunications access
In defining universal telecommunication access, the main consideration is access to service, but the term "service" remains a bone of contention in the telecommunication industry. Universal telecommunication access is characterised by service level,

which describes the level of adoption and penetration of telecommunication services in different countries (Noll & Wallsten, 2006). At a basic level, the objective of universal telecommunications access is to bring telephony (as a minimum service) within the reach of every individual. This includes the provision of public telephone booths to provide access to individuals who cannot afford private telephone lines (fixed or wireless) in their homes. The provision of telephone lines in every home is defined as universal service (Xavier, 2006).

The adoption of mobile telephone technologies in most developing countries has helped in improving the level of penetration in these regions. However, due to technological advancements in information and communication technologies (ICTs), it is important to define universal access based on the degree of technological advancement of the services provided. While telecommunications infrastructure provides a basic platform for the provision of most ICTs, some services require broadband access, which is not readily available. The scope of universal access goes beyond the provision of telephone access and can only be properly defined in terms of access to ICTs and online multimedia content (ECOWAS, 2007). In addition to availability, affordability and reliability, access is further expanded to mean acquisition of relevant skills to make use of ICT.

In Nigeria, as in most sub-Saharan countries, the greatest challenge for universal telecommunications access has been in the provision of access to low-income households in urban centres and rural settlements (Malecki, 2003; Noll & Wallsten, 2000). While the major challenge in urban centres is affordability and accessibility, challenges in rural communities are as much about availability as affordability (Adediran, Opadiji, Faruk & Bello, 2014). Lack of availability is caused by the geographical remoteness of many communities, the scattered nature of the settlements and the terrain and vegetation of these areas (IFAD, 2014; Omonona, 2009; Opata, 2013; Rowe, 2003). Despite these challenges, the level of telecommunication penetration has increased in the past two decades, due largely to the deregulation of the telecommunication sector, the adoption of mobile communications technology and the increasing affordability of smartphones and other devices for Internet access. Growth in mobile telephony has extended to rural communities, with a substantial population of rural dwellers now integrated with the rest of the nation through mobile communications.

Universal telecommunications access models
A key issue to be considered for universal telecommunications access, particularly in rural communities, is the choice of an appropriate approach to achieve efficient and effective access. The approaches, referred to here as universal access models, depend on many factors that involve cooperation of all stakeholders i.e., service providers, governments at all levels, and benefitting communities. Universal access requires attention to the appropriate choice of access model and to the appropriate choice of

technology. Among the factors to be considered with respect to each stakeholder group when choosing a universal access model are the following (Stern, Townsend & Monedero, 2006):

- Service provider: Level of competition; commercial profitability; tariff packages to increase ownership by local people; marketing strategy e.g., Internet, road show, radio jingles, e-mail;
- Government: Capacity to organise and run a fair and open competition; funding options; identification of actual needs and socio-economic goals of the community; recognition of ICT as a poverty reduction mechanism; level of demand for access; monitoring of performance and quality of service (QoS); unavailability and unreliability of power supply from utility companies;
- Community benefit: Knowledge of business and technical skills with respect to the technology to be adopted; end-use preferences for mode of access e.g., teleshop versus operator's booth, mobile or fixed, etc.

The following international approaches have been identified: administrative universal service obligation (USO) designation; village phone programmes; public and community Internet access model, including telecentres and cybercafés; rural cooperatives model; regional or rural operator licensing model; and community and municipal broadband model (Stern et al., 2006). Many of these models were found to be effective in developing countries, though the success of the models is dependent on context. The administrative universal service obligation (USO) designation model was experimented with in Australia between 2001 and 2004, where the incumbent operator, Telstra, retained the obligation, but allowed other companies to offer or compete to undertake USOs and receive subsidies in specific areas. This model was not successfully implemented in developing countries, as the procedure has to be objective, transparent and non-discriminatory, all of which are difficult to achieve in such an environment.

An initiative that recorded success due to business model viability was the village phone concept, begun in rural Bangladesh in 1997, in which village women were empowered financially to develop sustainable income-generating activities (Richardson, Ramirez & Haq, 2000). This has been replicated in countries including Nigeria, Uganda and Rwanda. Telecentre models have been run successfully in many developed and developing countries, for example Uganda. However, some of the challenges of telecentre growth in developing countries arise from difficulty in gaining sufficient high speed, quality and timely access to a communication circuit, and lack of quality business management and technical skills among the locals to identify and understand user demand and run a centre successfully. The rural cooperatives model can provide communication services in some rural and remote areas, particularly where a nation's carriers are not interested because of lack of profitability.

A regional or rural operator licensing model emerged in Latin America in the mid-

1990s as an offspring of the first generation universal access service funds, which used very small aperture terminal (VSAT) satellite or fixed wireless technology, whereby operators are part of the VSAT subsidiary or rural telecommunications equipment vendors (Stern et al., 2006). Outside Latin America, the model was adopted in South Africa for rural areas with less than 5% teledensity, while each licensed operator was given ZAR5 million on licensing. The regional or rural operator-licensing model was designed with a fixed-line market in mind and later faced the challenge of encroachment of cellular operators. In addition, the operating and maintenance costs of VSAT outweighed revenues, thus making the rural operator model commercially unviable. Venezuela later introduced the concept without a minimum subsidy auction and offered a wider range of services, including fixed access, long distance and international, mobile and multimedia services. The lesson to be learnt from the Venezuelan experience is that there is a market for rural and regional operators if the appropriate business model can be found. The community and municipal broadband network model involves technologies that are not too technically demanding (e.g., Wi-Fi, VoIP) with free and open-access software. It is used in developed countries to bring broadband connectivity to rural and remote communities.

It is noteworthy that all these models require enabling policy frameworks and bridging the persistent gaps of infrastructure (connectivity), local ICT service, regulations, funding, industry, technical skills to adapt and maintain information infrastructure and system, thereby empowering change and innovation and setting policy frameworks (Hanna, 2016).

5. State of telecommunication access in rural communities: Exploratory survey in Kwara State

The results of an exploratory survey on the state of telecommunication access in rural communities in Nigeria are discussed below. The section includes the perceptions of rural villagers of the effects of mobile communications access on their welfare. Kwara State (longitude 4° 36' 25"E, latitude 8° 25' 55"N) is located in the North Central part of Nigeria with ethnic groups comprising Yoruba (majority), Nupe, Bariba and Hausa (minority) (NgEX, 2015). The state has 16 LGAs with a total coverage area of 36,825 km² and a population of 2,591,555 (2005 census) (Wikipedia, n.d.). Agriculture (farming) is the main economic activity. Figure 3 shows a map of Nigeria, with Kwara State in the West.

The study area comprises 15 villages across four local government areas (LGAs) of Kwara State, namely Asa, Ilorin-East, Ilorin-West and Mooro. Figure 4 shows the locations of the villages. These villages were chosen because they fell within the categories of the definition of rural areas provided by the National Population Commission (NPC & ORC Macro, 2004, p. 211). The villages surveyed have numbers of houses ranging from 10 to 40, with an average of 5 persons per home, and the

survey included persons 16 years and above. Figure 5 shows an abandoned NITEL office photographed during the field survey.
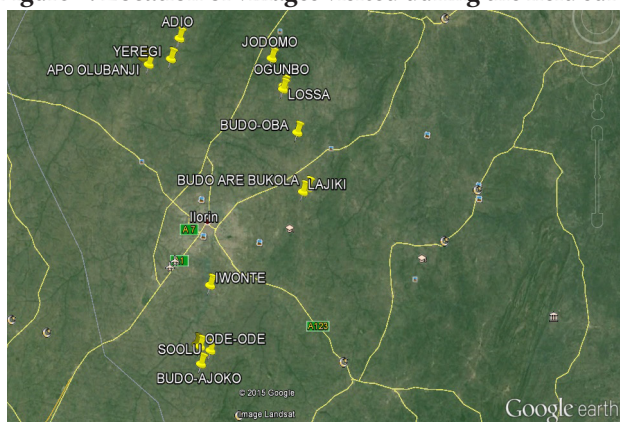
Figure 3: Location of Kwara State in Nigeria

Source: Jaymz Height-Field, Wikimedia Commons
Licence: Creative Commons Attribution-Share Alike 3.0 Unported, https://creativecommons.org/licenses/by-sa/3.0/deed.en

Figure 4: Location of villages visited during the field survey

Source: Adapted from Google Earth

Figure 5: Abandoned NITEL office

Source: Authors' field survey, 2015

Methods of data collection

Data collection methods involved a community and an individual survey question-naire. Interviews were conducted with each village head, for each of the 15 villages visited. The questionnaire sought to derive data about the level of telephone service coverage, access to electricity, availability of schools and other basic ICT services, such as a computer centre, Internet café, call centre and viewing centre. An individual survey questionnaire was administered to a sample of persons above the age of 16 years in the targeted villages. The subjects were selected based on convenience sampling. The visits were scheduled for Saturdays, for the convenience of both researchers and respondents. Researchers arrived at the village early, before the respondents would leave for their farms, as a large number of these rural dwellers engage in farming. The rural communities and the sample populations were selected using convenience sampling. Valid data were elicited from a total of 465 male and female respondents. The questionnaire was administered by researchers with the help of research assistants who had been well tutored on the subject of the survey. A break-down of the number of respondents per village and the corresponding local govern-ment area is presented in Table 2.

Table 2: Surveyed rural communities and numbers of valid responses

Village ID	Community name	Local government area	No. of valid responses
VL1	Adejimi	Mooro	24
VL2	Adio	Mooro	36
VL3	Apo Olubaji	Mooro	34
VL4	Budo-Are Bukola	Ilorin-East	31
VL5	Budo Ijako	Asa	29
VL6	Budo-Oba	Mooro	30
VL7	Iwonte	Ilorin-West	13
VL8	Jodomo	Mooro	14
VL9	Lajiki	Ilorin-East	45
VL10	Lossa	Mooro	21
VL11	Odo-Ode	Asa	38
VL12	Ogunbo	Mooro	58
VL13	Sakamo	Asa	22
VL14	Sholu	Asa	30
VL15	Yeregi	Mooro	40
			Total: 465

The survey yielded 489 responses, of which 465 were valid, representing about 94% valid responses. Of the valid responses, almost 65% (300 responses) were male respondents, while 35.48% (165 responses) were female respondents. About 62% (N=287) of the respondents had no formal education or had primary school level education only. For those that pursued education beyond primary level, only 31% of achieved some secondary level schooling.

Rural communities and universal access

Table 3 provides a summary of field survey locations based on access to telephone service, electricity, road network, education and basic ICT. Out of the 15 villages visited, 11 villages have limited access to a cellular mobile telephone service and such service is of poor quality. It was noted by respondents that they would have to climb trees or onto the roofs of their houses to make a voice call, due to poor signal reception. The remaining four villages, with total population of about 350 people, do not have access to any telephone services. Nine of the villages are connected to electricity, but electricity supply is occasional; five villages are not connected to the electricity grid; and one village, although connected to the national grid, has no electricity supply. None of the roads to the villages is easily accessible, despite the closeness (< 3 km) of some villages to the LGA headquarters. Twelve villages have at least a primary school, while three villages do not have access to schools. In terms of basic ICT access, no ICT facilities such as a computer centre, Internet café, call centre or TV viewing centre could be found in any of the villages.

Table 3: Summary of field survey conditions and access to ICT

Vil-lage ID	Houses/ Population	Tele-phony operator	Electricity supply	Road condition/ Distance to LG head-quarters	Year of telecom-muni-cation service inception	School types/ Number	Access to ICT			
							A	B	C	D
VL1	10/40	1	+Not con-nected	Not acces-sible/ 48 km	2000	NIL	N	N	N	N
VL2	17/120	1	+Not con-nected	Not acces-sible/ >24 km	2002	Prima-ry/1	N	N	N	N
VL3	14/60	1	+Not con-nected	Not acces-sible/ >80 km	2002	Prima-ry/1	N	N	N	N
VL4	16/48	1	Connected/ Occasional	Not acces-sible/ <6 km	2002	Prima-ry & Second-ary/1	N	N	N	N
VL5	21/60	>3	Connected/ Occasional	Not acces-sible/ 3 km	2010	Primary /1	N	N	N	N
VL6	25/150	0	Connected/ Occasional	Not acces-sible/ >40 km	NIL	Prima-ry/1	N	N	N	N
VL7	10/50	1	Not connected	Not acces-sible/ 15 km	2005	Primary /1	N	N	N	N
VL8	10/24	0*	Not con-nected	Not acces-sible/ 15 km	NIL	NIL	N	N	N	N
VL9	22/70	1	Connected/ No supply	Not acces-sible/ <5 km	>5 years	Prima-ry & Second-ary/1	N	N	N	N
VL10	15/50	0*	Connected/ Occasional	Not acces-sible/ 10 km	NIL	NIL	N	N	N	N
VL11	18/50	>2	Connected/ Occasional	Not acces-sible/ <3 km	2002	Public School/1	N	N	N	N
VL12	25/150	0	Connected/ Occasional	Not acces-sible/ >40 km	NIL	Prima-ry & Second-ary/1	N	N	N	N
VL13	16/48	>2	Connected/ Occasional	Not acces-sible/ 6 km	2002	Primary /1	N	N	N	N

| VL14 | 40/190 | 2 | Connected/ Occasional | Not accessible/ 6 km | 2004 | Primary /1 | N | N | N | N |
| VL15 | 30/100 | >2 | Connected/ Occasional | Not accessible/ 48 km | 2002 | Primary/1 | N | N | N | N |

Notes:
A=Computer Centre; B=Internet Café; C=Call Centre; D=TV Viewing Centre; N=No; Y=YES
*Received signal from neighboring BTS from other towns
+Pay–Per–Charge Electricity Supply (₦ 50 to charge mobile phone)
The mean sample per community is 31 with a standard deviation of 11.8 from minimum and maximum values of 13 and 58 respectively.

Perceptions of respondents of the effects of rural telecoms access

Responses were elicited on the extent of mobile phone ownership. About 77% of respondents (N=360), said they had at least one mobile handset. Of those with mobile phones, about 65% (N=236) possess a regular phone, while the remaining 35% have some form of smart phone. A brief discussion with some of the respondents, however, showed that the phones were acquired more for status conferral than for functional purposes.

The team collected data on the respondents' perceptions of the effect of rural telecoms access as it relates to, among other issues, health, education, security, business opportunity, and quality of government services. The researchers sought to record the perception of respondents on how the introduction of telecommunication services has affected them individually, or at the household level. The survey was interested not only in the use of the service in the rural location, but also the use of telecommunication in general. The data indicated that respondents perceived eight of the nine dimensions examined as improving. Support from family members, relationships with friends and neighbourhood security are the dimensions with the highest percentage of improvement (77% to 90%). Education, health and economic advancement are also included in the dimensions perceived as improving. This data provides some limited insight into the effects of life advancement through telecommunications services in rural communities. Only one dimension, quality of government service, is reported as declining. This may be connected with lack of awareness, as well as the low literacy status of rural dwellers. The responses are presented in Table 4 below.

Table 4: Perceptions of telecoms access effects

Dimensions	Perceptions of the services					
	Worse		Better		Same	
	N	%	N	%	N	%
Family members' health	9	1.90	283	60.87	173	37.20
Health/medical communication	54	11.40	257	55.15	156	33.55
Children's education opportunities	3	0.66	323	69.46	139	29.89
Personal level of education	6	1.29	326	70.10	132	28.39
Neighborhood security	18	3.87	359	77.20	83	17.85
Household income	53	11.40	256	55.05	156	33.55
Support from family members	3	0.66	370	79.56	92	19.78
Relationships with friends	12	1.86	420	90.32	33	7.10
Quality of government service	254	54.62	119	25.59	92	19.78
Business opportunity	64	13.76	250	53.76	151	32.47

6. Considerations for increasing the impact of universal telecommunication access in rural communities

The United Nations has initiated 17 aspirational global Sustainable Development Goals (SDGs), with 169 targets across the 17 SDGs (UN, 2016). The discussion that follows examines how improving rural telecommunication access can be expected to contribute to achievement of elements certain SDGs, e.g., SDG1 ("No poverty"), SDG3 ("Good health and well-being"), SDG4 ("Quality education"), SDG5 ("Gender equality"), and SDG10 ("Reduced inequalities").

Impact on rural education

While education is important for national development, rural communities in Nigeria have been greatly disadvantaged in this respect with an adult literacy level of just 49% compared with the 74% in urban Nigeria (National Bureau of Statistics, 2010). The digital divide between rural and urban dwellers has aggravated an already bad situation. While it could be said that an increase in the digital divide is widening the literacy gap between rural and urban communities, it is important to note that an increase in the level of literacy in rural communities (promoted by telecommunications access) can lead to a reduction in the digital divide (Calvo, 2012). There-

fore, implementing universal telecommunication access in Nigeria can be expected to impact rural education positively, not only by increasing the literacy level in rural communities, but also by helping to bridge the digital divide by giving rural dwellers the opportunity to access skills necessary for them to take advantage of ICTs. Ultimately, it would be advantageous to introduce e-libraries, where students can gain access to free online resources and where highly motivated rural dwellers can take the opportunity to enrol for various online certificate programmes offered by Nigerian universities (Nkanu & Okon, 2010).

Universal telecommunication access also has an impact on the current drive of government to provide education for nomadic communities (Ajidagba, Yusuf, & Olumorin, 2014; Na'Allah, 2014), who are located mostly in rural and remote areas. The deployment of mobile access points could enable access to information by nomadic teachers. Furthermore, informal education in rural communities could be enhanced through the use of mobile devices. Although education challenges cannot be totally overcome by simply providing more and better ICT devices and access or connectivity (World Bank, 2016b), educational policymakers and planners have faced persistent challenges related to the adoption of many of the products, services and usage models in remote, low-income communities around the world. In summary, implementation of universal telecommunication access in rural communities in Nigeria can impact on rural education development by providing ICT-enabled libraries and information centres and access to content for basic and post-basic education, enhancing the delivery of nomadic education and facilitating skills development among artisans.

Impact on rural community healthcare service delivery

Issues relating to the provision of community healthcare services in rural Nigeria with respect to the sustainable development goals (SDGs) include reduction of infant and maternal mortality, eradication of tropical diseases and epidemics such as malaria, cholera and polio, and combating of the spread of HIV/AIDS and other sexually transmitted infections (STIs) (United Nations, 2016). Achievement of these goals will be dependent on factors such as availability and competence of health workers, availability and reliability of health infrastructure, health education in rural communities, affordability of health services. Implementation of universal telecommunication access schemes in rural communities in Nigeria will go a long way to impact healthcare service delivery by providing access to information for healthcare workers and communities. Furthermore, universal telecommunication access will reduce information latency in healthcare delivery that often leads to unwanted outcomes like delayed response to emergencies and, in extreme cases, fatalities (Hoffman et al., 2010; Grameen Foundation, 2011; Faruk, Oloyode, Bello, & Popoola, forthcoming;).

Through the provision of rural telecommunication infrastructure, a hierarchical database for rural healthcare information management could be developed and integrated into the national health insurance system, thereby reducing the cost of ware-

housing information in all the rural communities. Another way in which universal telecommunication access could impact the provision of healthcare infrastructure is in the management of a flexible patient transportation scheme using ICT-enabled health emergency vehicles that are on call among sparsely populated rural communities situated in relative proximity to each other, while rural communities that are closer to urban areas would be able to make use of emergency vehicles in cases where patients are to be transported to secondary or tertiary healthcare facilities.

One of the greatest challenges facing rural healthcare delivery, in Nigeria and developing countries alike, is the lack of credible real-time data on the health challenges in various rural settlements. Part of the problem is the remoteness of some of these communities, a number of which are not accessible by road and, in some extreme cases, have no waterways, as they are located deep in the rain forests, such as villages in South Eastern and Southern Nigeria. As a result, only estimates of healthcare planning parameters are derived for such areas. One way to plan for rural healthcare needs would be to implement a mobile health initiative for data transfer from rural healthcare centres to central healthcare planning offices in urban centres. Mobile health (m-health) initiatives have been gaining momentum and could be deployed for disease outbreak alerts, health education and remote access to patient registration documents (WHO, 2011). These mobile-driven initiatives were unveiled in some developing countries: mobile phone SMS in antiretroviral treatment in Kenya (Lester et al., 2010); AIDS patient care using mobile phones in Uganda (Chang et al., 2008); health workers text-message reminders to malaria treatment in Kenya (Zurovac et al., 2011); rural health centres, communities and malaria case detection mobile systems in Zambia (Kamanga, Moono, Stresman, Mharakurwa, & Shiff, 2010); remote clinics for laboratory results via SMS in Swaziland (Jian et al., 2012) and many other projects reported. These types of initiatives can only be deployed if universal telecommunication access is in place in rural communities.

Management of epidemic outbreaks is another area in which universal telecommunication access can impact rural healthcare delivery. During epidemic outbreaks, movement of people across borders of villages and towns is discouraged and, as a result, information on the situation in areas affected by the epidemic is greatly hampered where there is no means of electronic communication. Rural communities with telecommunication access have the advantage of providing information on the state of health of their populations during an epidemic outbreak are able to get information on how to manage the health crisis with minimal risk to neighbouring communities. Recently, various communication tools were used to fight the Ebola outbreak in West Africa. Ebola-related messages were disseminated on social media (COSMIC, 2016). The government of Nigeria and UNICEF used the SMS-based community dialogue platform "U report" (USAID, 2014) to reach out to people as a means to curtail the spread of the disease. In Uganda, UNICEF supported Uganda's National Task Force on Ebola to operationalise an mhealth platform, "mTrac", which enables

real time alerts and surveillance via SMS from communities and health workers. Similarly, Senegal partnered with major mobile phone operators to send four million SMSs to the general public warning of the dangers of Ebola and how to prevent it (USAID, 2014). However, difficulties still arose due to lack of access to mobile communications and Internet across rural Africa. As the disease spread to remote locations across countries in West Africa, those people most at risk became the ones most difficult to reach, though in Nigeria the conventional communication methods such as radio and television were used to reach out to people in rural locations.

Impact on economic development and poverty alleviation: Agriculture and finance

Rural communities in Nigeria are largely agrarian societies who live mainly on the proceeds from farm produce. Other forms of economic activities, like trading and services, are localised and are small compared with the agricultural sector. One of the greatest challenges to the development of agriculture in rural communities is the limited access to agricultural extension services, including planning, education, service delivery and market control policies. In the area of planning, the deployment of Internet services in rural communities could provide agriculture extension workers with access to geological and climatic information for a particular rural community that will aid them in determining efficient distribution of farm inputs such as fertilisers, pesticides and herbicides.

Most rural communities in Nigeria have specific market days. Universal telecommunication access would facilitate an efficient flow of information between producers and consumers. This would have the effect of reducing transportation overheads, thereby making the price of goods more competitive in these rural communities. Traders would be able to estimate the quantity of their products that would sell in the markets by establishing contact with their customers via telephone and SMS, including daily updates on the price of commodities. There are over 770 million farmers in Africa and over 119 million in Nigeria (VC4A, 2014). The Agric Mobile Phone Xchange (AMPX) provides a platform that connects farmers with buyers through SMS (VC4A, 2014). This project aims to reduce rural poverty by 50% by increasing rural farmers' output by 65%, connecting 50 million Nigerian farmers and 400 million farmers across Africa by 2025. In rural Nigeria, 95.7% perceived ICT could enable them to take decisions for the sale of their products (Usman, Adeboye, Oluyole, & Ajijola, 2012). More advanced applications for food and agriculture include applications referred to as the Internet of Agricultural Things (AIoT) (Liu et al., 2016). Universal rural telecommunications access is a necessary foundation for these applications.

With respect to the financial sector, the provision of universal rural telecommunication access could promote business activities by giving the rural population access to bank accounts. In addition to this, transfer of funds could be made easier between rural farmers and customers in the urban areas.

Impact on gender equality and development of women

Gender equality and the development of women are major thrusts of socio-political policies. Women in rural communities are worst hit by centuries of neglect due to socio-cultural practices that put them at a disadvantage in terms of economic empowerment and social justice. In order to stem the tide of further degradation suffered by women, a number of policies have been put in place by governments, assisted by non-profit organisations. These policies aim to increase of women's access to information, improvement in the rate of girl-child education, and provision for women to seek redress when discriminated against. However, the policies have limited effect. Universal telecommunication access would provide rural women with access to counselling hotlines and the opportunity to link up with legal aid groups that can fight for them in cases of domestic abuse and gender-based violence.

Sensitisation of rural communities in Nigeria about the need to improve on the current level of enrolment of girl children in schools can be facilitated by universal telecommunication access. Provision of telecommunication devices to children in some rural communities in Nigeria has already given a boost to enrolment in basic schooling. The introduction of "opon imo", a learning tablet that contains electronic copies of books required by pupils in schools in the Osun State of Nigeria, has greatly reduced the financial burdens on parents. This has led to more parents being willing to release their children to go to school, which, in turn, affects the enrolment level of girls in basic schools. It is important to provide telecommunication connectivity that will give these pupils greater access to information about the world outside their communities.

Economic empowerment of women is another area in which rural communities could benefit from universal telecommunication access. Women would be able to advertise their goods easily by taking pictures and displaying them in online marketplaces, assisted by local women's cooperative societies, reducing the overhead cost of marketing their products and increasing the visibility of their goods. Rural women would be able to establish their own contacts with customers, using rural telephone access or simple text messages, as well as to secure raw materials needed for the manufacture of their products, without having to travel.

Impact on community participation in governance and socio-political issues

While democracy is a generally accepted system of governance in the world today, it has not yielded expected dividends in many developing nations. One of the major challenges is the level of participation of the general population in the political process. For countries like Nigeria, where a substantial percentage of the population lives in rural areas, the outcome of the democratic process is shaped largely by urban dwellers. Most rural communities have little or no access to information on governance. Their participation in the political process is largely engineered from urban centres and access to their representatives in government is not guaranteed. It has

therefore become increasingly difficult to put their agenda on the front burner of the nation's political process and their visibility to the outside world is virtually non-existent.

The aforementioned problems could be tackled using universal telecommunication access. Rural communities that are in geographical proximity to each other could mobilise their populations to bring their agenda to the fore. Individuals in these communities could have access to their representatives in government via universal telecommunication access. Furthermore, participation of the rural populace in the democratic process could be enhanced by ensuring that information on governance reaches rural communities. With universal telecommunication access, rural dwellers would be able to make their voices heard around the world, thereby gaining the attention of their own governments.

7. Conclusion

In this article, a review of the distribution of the telecommunications infrastructure in Nigeria shows their neglect in the rural communities studied, while the digital divide between urban and rural areas needs to be reduced. One way to do this is to improve the areas of application of ICT in rural areas by building on current levels of mobile communications access towards universal access to telecommunications services applied to education, healthcare, agriculture and finance, amongst other applications. The investigation of the effects of telecommunication access on rural communities in Nigeria revealed mostly positive effects in the area of economic growth, community infrastructure development, healthcare service delivery and increase in socio-political awareness and participation. However, telecoms access is not yet universal. Universal rural telecommunication access is needed to impact on community healthcare service delivery, primary healthcare delivery, reporting of epidemic outbreaks, rural economic development and poverty alleviation through adequate telecommunication infrastructure for agricultural and financial services sectors, and to impact on gender equality and women development, as well as rural participation in governance and socio-political issues.

Acknowledgements

References

Adediran, Y. A., Opadiji, J. F., Faruk, N., & Bello, O. (2014). *Rural telecommunications access in Nigeria.* First quarterly report of 2014/2015. University of Ilorin, Nigeria.

Adediran, Y. A., Usman. A. U., & Onyedike, B. N. (2005). Nigeria's telecommunication industry in the new millennium: Problems, challenges and prospects. In *6th Annual Engineering Conference Proceedings*, Federal University of Technology, Minna, Nigeria.

Adisa R. S. (2012). Rural development in the twenty-first century as a global necessity. In R. Adisa (Ed.) *Rural development: Contemporary issues and practices.* Rijeka, Croatia: Intech. doi: 10.5772/49098

Ajayi, G. O., Salawu R. I. & Raji T. I. (1996). *A century of telecommunications development in Nigeria: What next?* Retrieved from http://www.vii.org/papers/nigeria.htm

Ajidagba, U. A., Yusuf, A., & Olumorin, C. O. (2014). *Integrating mobile learning to achieve effective implementation of nomadic education programme in Nigeria.* Retrieved from https://www.musero.org.ng/publications/INTEGRATING-MOBILE-LEARN-ING-TO-ACHIEVE-EFFECTIVE-IMPLEMENTATION-OF-NOMAD-IC-EDUCATION-PROGRAMME-IN-NIGERIA.pdf

Calvo, A. G. (2012). *Universal service policies in the context of national broadband plans.* Paris: Organisation for Economic Co-operation and Development (OECD). doi: 10.1787/5k94gz19flq4-en

Chang, L. W., Kagaayi, J., Nakigozi, G., Packer, A. H., Serwadda, D., Quinn, T. C., Gray, R. H., Bollinger, R. C., & Reynolds, S. J. (2008). Responding to the human resource crisis: Peer health workers, mobile phones, and HIV care in Rakai, Uganda. *AIDS Patient Care STDS*, *22*(3), 173-174. doi: 10.1089/apc.2007.0234

Contribution of Social Media in Crisis Management (COSMIC). (2016). The role of social media in the Ebola virus outbreak. Retrieved from http://www.cosmic-project.eu/node/56

Crankshaw, T., Corless, I. B., Giddy, J., Nicholas, P. K., Eichbaum, Q., & Butler, L. M. (2010). Exploring the patterns of use and the feasibility of using cellular phones for clinic appointment reminders and adherence messages in an antiretroviral treatment clinic, Durban, South Africa. *AIDS Patient Care STDS*, *24*(11), 729-734. http://dx.doi.org/10.1089/apc.2010.0146

Economic Community of West African States (ECOWAS). (2007). Supplementary Act A/SA.6/01/07 on Universal Access/Service. ECOWAS Thirty-first Session of the Authority of Heads of State and Government, Ouagadougou, Burkina Faso. Retrieved from http://www.lta.gov.lr/doc/Univeral_Access_ECOWAS_Engl[1].pdf

Erdiaw-Kwasie, M., & Alam, K. (2016). Towards understanding digital divide in rural partnerships and development: A framework and evidence from rural Australia. *Journal of Rural Studies, 43*, 214-224. http://dx.doi.org/10.1016/j.jrurstud.2015.12.002

Faruk, N., Oloyode, A. A., Bello, O. W., & Popoola, S. (forthcoming 2016). Framework for universal telecommunication access: Prospects for mhealth in developing economies. Paper for presentation to IEEE Conference on ICT for Communicable Diseases, New York.

Grameen Foundation. (2011). *Mobile technology for community health (MOTECH) project in Ghana: Early lessons learned.* Retrieved from https://courses.cs.washington.edu/courses/cse490d/12sp/docs/MOTECH.pdf

Gunkel, D. J. (2003). Second thoughts: Toward a critique of the digital divide. *New Media & Society, 5*(4), 499-522. Retrieved from http://ww.gunkelweb.com/articles/digital_di-

vide.pdf

Hanna, N. K. (2016). *Mastering digital transformation: Towards a smarter society, economy, city and nation*. Bingley, UK: Emerald Group.

Hoffman, J. A., Cunningham, J. R., Suleh, A. J., Sundsmo, A., Dekker, D., Vago, F., Munly, K., Igonya, E. K., & Hunt-Glassman, J. (2010). Mobile direct observation treatment for tuberculosis patients: A technical feasibility pilot using mobile phones in Nairobi, Kenya. *American Journal of Preventative Medicine*, *39*(1), 78-80. doi: 10.1016/j.amepre.2010.02.018

Internet Live Stats. (2016). Nigeria Internet subscriber base. Retrieved from http://www.internetlivestats.com/internet-users/nigeria/

International Fund for Agricultural Development (IFAD). (2014): *Rural poverty in Nigeria*. Rome. Retrieved from http://www.ruralpovertyportal.org/country/home/tags/nigeria

Jian, W. S., Hsu, M. H., Sukati, H., Syed-Abdul, S., Scholl, J., Dube, N., Hsu, C. K., Wu, T. J., Lin, V., & Chi, T. (2012). LabPush: A pilot study of providing remote clinics with laboratory results via short message service (SMS) in Swaziland, Africa. *PLoS One, 7*(9), e44462. http://dx.doi.org/10.1371/journal.pone.0044462

Kamanga, A., Moono, P., Stresman, G., Mharakurwa, S., & Shiff, C. (2010). Rural health centres, communities and malaria case detection in Zambia using mobile telephones: A means to detect potential reservoirs of infection in unstable transmission conditions. *Malaria Journal*, *9*. doi: 10.1186/1475-2875-9-96

Kilpeläinen, A., & Seppänen, M. (2014). Information technology and everyday life in ageing rural villages, *Journal of Rural Studies*, *33*, 1-8. http://dx.doi.org/10.1016/j.jrurstud.2013.10.005.

Lester, R., Ritvo, P., Mills, E. J., Kariri, A., Karanja, S., Chung, M. H., Jack, W., Habyarimana, J., Sadatsafavi, M., Najafzadeh, M., Marra, C. A., Estambale, B., Ngugi, E., Ball, T. B., Thabane, L., Gelmon, L. J., Kimani, J., Ackers, M., & Plummer, F. (2010). Effects of mobile phone short message service on antiretroviral treatment adherence in Kenya (WelTel Kenya1): A randomised trial. *Lancet*, *376*(9755), 1838-1845. http://dx.doi.org/10.1016/S0140-6736(10)61997-6

Liu, Y., Han, W., Zhang, Y., Li, L., Wang, J., & Zheng, L. (2016). An Internet-of-Things solution for food safety and quality control: A pilot project in China. *Journal of Industrial Information Integration*, *3*, 1-7. http://dx.doi.org/10.1016/j.jii.2016.06.001

Malecki, E. (2003). Digital development in rural areas: Potentials and pitfalls. *Journal of Rural Studies*, *19*(2), 201-214. http://dx.doi.org/10.1016/S0743-0167(02)00068-2

Na'Allah, A.R. (2014). *Thoughts on the Nomadic Education Programme with special reference to Kwara State*. Retrieved from https://www.researchgate.net/publication/242258885

National Population Commission (NPC) & ORC Macro. (2004). *Nigeria demographic and health survey 2003*. Retrieved from http://www.dhsprogram.com/pubs/pdf/FR148/FR148.pdf

NPC. (2016). State population. Abuja. Retrieved from http://www.population.gov.ng/index.php/state-population

National Bureau of Statistics (NBS). (2010). *Report of the National Literacy Survey*. Abuja. Retrieved from www.nigerianstat.gov.ng/download/43

Nigerian Communications Commission (NCC). (2016a). Functions of the NCC. Retrieved from http://www.ncc.gov.ng/about-ncc/mandate#functions-of-the-ncc

NCC. (2016b). *Subscriber/teledensity data (November 2015 – October 2016)*. Retrieved from

http://www.ncc.gov.ng/stakeholder/statistics-reports/industry-over-view#view-graphs-tables

NCC. (2016c). *Industry statistics*. Retrieved from http://www.ncc.gov.ng/statistics-reports/industry-overview

NCC. (2016d). *Internet service operator data*. Retrieved from http://www.ncc.gov.ng/stakeholder/statistics-reports/subscriber-data#internet-service-operator-data

NCC. (2016e). *Percentage contribution of telecoms industry to GDP*. Retrieved from http://www.ncc.gov.ng/stakeholder/statistics-reports/industry-over-view#view-graphs-tables-7

NgEX. (2015). About Kwara State. Available at http://www.ngex.com/nigeria/places/states/kwara.htm

Nkanu, W. O., & Okon, I. H. (2010). Digital divide: Bridging the gap through ICT in Nigerian libraries. *Library Philosophy and Practice*. Retrieved from www.webpages.uidaho.edu/~mbolin/nkanu-okon.htm

Noll, R. G., & Wallsten, S. J. (2000). *Telecommunications reform in developing countries*. SIEPR Policy Paper, Stanford, CA: Stanford Institute of Economic Policy Research.

Noll, R. G., & Wallsten, S. J. (2006). Universal telecommunications service in India. *India Policy Forum*, 255-288. Retrieved from https://works.bepress.com/scott_wallsten/37/

National Telecommunications and Information Administration (NTIA). (2014). *The new universal service: A user's guide*. Washington, DC. Retrieved from www.ntia.doc.gov/legacy/opadhome/uniserve/UNIVWEB.htm#definition

Ogwumike, F. O. , & Ozughalu, U. M. (2016). Analysis of energy poverty and its implications for sustainable development in Nigeria. *Environment and Development Economics*, *21*(3), 273-290. https://doi.org/10.1017/S1355770X15000236

Olaniyan, O., & Bankole, A. S. (2005). *Human capital, capabilities and poverty in rural Nigeria.* Interim report submitted to the African Economic Research Consortium (AERC), Nairobi for the Second Phase Collaborative Poverty Research Project. Retrieved from http://www.sarpn.org/documents/d0002272/Human_capital_Nigeria_Oct2005.pdf

Omonona, B. T. (2009, November). *Qualitative analysis of rural poverty in Nigeria*. Nigeria Strategy Support Program (NSSP) Background Paper 9. Abuja: IFPRI-Abuja, International Food Policy Research Institute (IFPRI). Retrieved from http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.440.5853&rep=rep1&type=pdf

Oniyedibe, B. N. (2004). *Development and regulatory system reform of the telecommunications industry in Nigeria*. Unpublished M.Eng. Thesis, Department of Electrical/Electronic Engineering, University of Port Harcourt, Nigeria.

Opata, C. B. (2013). Sustainable development and rural access to telecommunications in Nigeria. In C. Onwumechili, & I. S. Ndolo (Eds.), *Re-imagining development communication in Africa* (pp. 225-244). Lanham, MD: Lexington Books.

Park, S. (2016). Digital inequalities in rural Australia: A double jeopardy of remoteness and social exclusion [online first]. *Journal of Rural Studies*. doi:10.1016/j.jrurstud.2015.12.018

Richardson, D., Ramirez, R., & Haq, M. (2000). *Grameen Telecom's village phone programme in rural Bangladesh: A multi-media case study.* Guelph, ON, Canada: TeleCommons Development Group (TDG). Retrieved from https://www.microfinancegateway.org/sites/default/files/mfg-en-case-study-grameen-telecoms-village-phone-programme-in-rural-bangladesh-a-multi-media-case-study-mar-2000.pdf

Rowe, B. (2003). Rural technology development and access: Success upon which to build. *Government Information Quarterly*, *20,* 85-93. doi:10.1016/S0740-624X(03)00034-0

Sadiq, O. M., Oyelade. A. O., & Ukachukwu, C. A. S. (2011). 10 years of telecommunication infrastructure development in Nigeria. Paper presented to International Conference on Innovations in Engineering and Technology (IET 2011), 8-10 August, University of Lagos, Nigeria. Retrieved from http://www.unilag.edu.ng/opendoc.php?sno=18194&doctype=pdf&docname=10%20YEARS%20OF%20TELECOMMUNICATION%20INFRASTRUCTURE

Salemink, K., Strijker, D., & Bosworth, G. (2015). Rural development in the digital age: A systematic literature review on unequal ICT availability, adoption, and use in rural areas [online first]. *Journal of Rural Studies*. http://dx.doi.org/10.1016/j.jrurstud.2015.09.001

Schorr, S. (2004). Universal access policies. Presentation to ITU-WTO Workshop on Telecommunications & ICT Regulation Relating to WTO Obligations and Commitments, 1-7 December, Geneva. Retrieved from https://www.wto.org/english/tratop_e/serv_e/telecom_e/workshop_dec04_e/itu_universal_access.ppt

Stern, P. A., Townsend, D., & Monedero, J. (2006). *New models for universal access in Latin America.* Regulatel/World Bank (PPIAF and GPOBA)/ECLAC Project on Universal Access for Telecommunications in Latin America. Retrieved from www.ictregulationtoolkit.org/Documents/Document/Document/3511

United Nations (UN). (2016). *Sustainable development goals.* New York. Retrieved from http://www.un.org/sustainabledevelopment/sustainable-development-goals/

US Agency for International Development (USAID). (2014). *Use of technology in the Ebola response in West Africa.* Retrieved from https://www.msh.org/sites/msh.org/files/technology_and_ebola_response_in_west_africa_technical_brief_final.pdf

Usman, J. M., Adeboye, J. A., Oluyole, K. A., & Ajijola, S. (2012). Use of information and communication technologies by rural farmers in Oluyole local government area of Oyo State, Nigeria. *Journal of Stored Products and Postharvest Research*, *3*(11), 156-159. doi: 10.5897/JSPPR12.008

Van Dijk, J. (2006). Digital divide research, achievements and shortcomings. *Poetics*, *34*, 221-235. http://dx.doi.org/10.1016/j.poetic.2006.05.004.

Venture Capital for Africa (VC4A). (2014). The Agric Mobile Phone SMS Xchange. Retrieved from https://vc4a.com/ventures/oguz-integrated-services-limited/

Wikipedia. (n.d.). Kwara State. Available at en.wikipedia.org/wiki/Kwara_State

World Health Organisation (WHO). (2011). *mHealth: New horizons for health through mobile technologies.* Global Observatory for eHealth Series, Volume 3. Geneva. Retrieved from http://www.who.int/goe/publications/goe_mhealth_web.pdf

World Bank. (2015). Data: Nigeria. Washington, DC. Retrieved from http://data.worldbank.org/country/nigeria

World Bank. (2016a). *World development indicators: Rural environment and land use.* Washington, DC. Retrieved from http://wdi.worldbank.org/table/3.1#

World Bank. (2016b). *World development report 2016: Digital dividends.* Washington, DC. doi:10.1596/978-1-4648-0671-1

Xavier, P. (2006). *Universal access for telecommunications in a competitive environment.* Paper prepared for OECD-World Bank Fifth Services Experts Meeting, 3-4 February, OECD, Paris. Retrieved from https://pdfs.semanticscholar.org/9db8/4b2abe11def-59e31c5a6a5a0af330a00be2b.pdf

Zhang, W., Kato, E., Bhandary, P., Nkonya, P., Ibrahim, H. I., Agbonlahor, M., Ibrahim, H. Y., & Cox, C. (2016). Awareness and perceptions of ecosystem services in relation to

land use types: Evidence from rural communities in Nigeria. *Ecosystem Services, 22*, Part A, 150-160. http://dx.doi.org/10.1016/j.ecoser.2016.10.011

Zurovac, D., Sudoi, R. K., Akhwale, S., Ndiritu, M., Hamer, D. H., Rowe, A. K., & Snow, R. W. (2011). The effect of mobile phone text-message reminders on Kenyan health workers' adherence to malaria treatment guidelines: A cluster randomised trial. *Lancet, 378*, 795-803. doi: 10.1016/S0140-6736(11)60783-6