Chapter 3
Let Them Eat Movies: (How) Will Next-Generation Broadband Diffuse Through Africa?

Indra de Lanerolle, Alison Gillwald, Christoph Stork, and Enrico Calandro

"Wireless mobile services for the delivery of broadband provides false hope for the future and promotes inefficient use of resources in the present", Eli Noam argued in Lusaka,[1] one of the least connected capitals in the world. Applying his 2011 paper, *Let Them Eat Cellphones: why mobile wireless is no solution for broadband,* in which he rejects proposals in the United States for the deployment of mobile wireless services to meet rural broadband needs to Africa, he argued that the cost of mobile wireless deployment was only cheaper in the short term. The high costs associated with matching constantly growing demand with limited supply of spectrum, he argued, meant that mobile did not enjoy the longer term economies of scale that fixed-line investments did. Noam also cautioned against underestimating the power of video, to which he attributed broadband take up in the United States. He challenged the notion that communities forced to access video on mobile wireless networks would simply accept poorer quality services than their urban or wealthier counterparts, who were able to receive the array of high-quality digital services on offer.

There are compelling aspects to Noam's arguments. "Speed" or bandwidth is an important aspect of Internet functionality. The Internet is a global, general-purpose technology network that enables delivery of a range of communication, information and entertainment services. The designers and providers of these services—rarely African—must make decisions based on their assumptions about the bandwidth that their users have access to. As access speeds increase globally, the bandwidth demands for services increases. Voice over IP and video streaming services, for example, do not work well, or at all over slow connections. Facebook, originally largely a text-based service, now prioritises photos in its news feeds.

[1] Noam gave a keynote address at a conference in 2012 held in Lusaka, Zambia entitled: Next Generation Broadband as a Video Platform—Strategies for Africa. Two of the authors presented papers at this conference on which this chapter is based in part.

I. de Lanerolle (✉)
University of Witwatersrand, Johannesburg, South Africa
e-mail: indra@delanerolle.net

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Can and will such infrastructure get built on the African continent? If not will Africa simply fall further and further behind the rest of the world? Or will it, as it has in the past, modify, adapt to and occasionally even innovate with what is available?

Over the last century only two kinds of network infrastructure, both communication and both wireless, have succeeded over most of the continent of sub-Saharan Africa. The first is the group of national terrestrial broadcasting networks—radio and television. The second is the group of cellular wireless mobile phone networks. Many other network infrastructure exists—from road and rail to fixed-line telephones and even electricity grids—but almost invariably they have failed to reach scale and widespread use. As Yepes et al. (2008) have shown (Table 3.1), in such cases, African countries have achieved far lower levels of penetration than other parts of the world with similar levels of income.

Noam (2008, 2011) has made four important and related points about next-generation broadband[2] (NGB) and its relevance to Africa. First of these is a technical argument that NGB is required for only certain applications—those that require real-time or fast delivery of new forms of very rich video content—richer than current broadcast television standards including high definition (HD) (Noam 2008). Second he makes a related social and economic argument (Noam 2008) that this video content will be primarily entertainment content—as he put it in Lusaka: "entertainment will be the killer app" for NGB. Thirdly, he has made a further technical argument that NGB can only be delivered by fixed connections since wireless technologies are—and will be—incapable of delivering the required throughput efficiently (Noam 2011). Lastly, he has proposed that these arguments do not apply only to developed countries, such as the United States, but will also apply in Africa.

This chapter explores Noam's contention, based on these claims, that fast broadband or NGB must be the next important network infrastructure to come to Africa. It examines Noam's argument that demand for video entertainment which has driven the demand for faster broadband in the United States and other rich countries will drive the demand in Africa. It further considers the implications of his argument that fibre is the best and possibly the only means of delivering the very high bandwidths envisaged as NGB.[3] In considering the application of his arguments in an African context, we address two questions.

[2] There is some variation in the use of the term NGB. Noam (2008) defines it as bandwidth of 1 Gbps. The UK Government on the other hand recently defined it as 250 Mbps. As the term implies, what is "next" depends on where you start. This issue is discussed in the conclusion.

[3] We note Noam's arguments concerning the technical limitations of wireless transmission. However, "forever" is a long time, and while Noam (2008) does allow for future improvements in compression technologies for example, it seems to be possible at least that his estimates of these improvements could in principle be outperformed through technological innovations not yet foreseen. Samsung recently announced that they had successfully transmitted data at over 1 Gbps over a 2 km distance (Samsung 2013). Further, currently 3G and LTE networks can offer better throughput than the poor-quality ADSL available in South Africa.

Table 3.1 Network infrastructure in Africa

	Low income			Lower mid income			Upper mid income		
Sector	Africa	Other	Ratio	Africa	Other	Ratio	Africa	Other	Ratio
Density of paved road in km/1,000 km sq (2001)	31	134	4.3	94	141	1.5	238	781	3.3
Fixed-line density: subscriptions per 1,000 people (2004)	10	78	7.7	106	131	1.2	120	274	2.3
% of households with access to electricity (2004)	16	41	2.6	35	80	2.3	28	95	3.4
Density of mobile phone subscriptions per 1,000 people (2004)	55	86	1.6	201	298	1.5	422	554	1.3

Adapted from Yepes et al. (2008) p. 7

- On the supply side: In what ways is Africa different from the United States or the rest of the world in the capacity of firms or governments to deliver the infrastructure required (e.g. fibre or cable) to African homes?
- On the demand side: In what ways is Africa[4] different from the United States in particular or the rest of the world in general in its demand for entertainment, specifically video entertainment (and are those differences significant in how they might affect the demand for NGB)?

Forecasting the adoption of new technologies in Africa is notoriously inaccurate. Mobile services were introduced as a limited elite service to provide complementary mobile services for those with fixed lines at work and at home. Early business models forecast subscriber numbers at little of a quarter of what they achieved in the first 5 years in South Africa for example.[5] On the other hand nothing is inevitable. The skeletons of perfectly feasible services litter the continent.

Rather than presenting an alternative scenario on what the broadband landscape will or should look like in the future, the first section of this chapter examines some of the assumptions that underpin Noam's argument in the African context. Having considered some of the supply-side issues relating to existing networks and services, the institutional capacity required to create efficient markets or state delivery of broadband and the impacts of this on the cost of communication, it examines

[4] "Africa" is a broad term. Here we are concerned with sub-Saharan Africa, which in terms of ICT infrastructure differs substantially from North Africa. However even within sub-Saharan Africa, as Table 3.2 indicates, the development of ICT infrastructure varies greatly and the conditions (economic, political, geographic and social) in which such infrastructures develop vary greatly. So the generalisations offered are exactly that.

[5] "Vodacom's initial growth projections catered for 250,000 subscribers within 10 years. We have now exceeded three million during the year 2000." Vodacom quoted in African Wireless. http://www.africanwireless.com/vodacom_history.htm accessed 17th June, 2013.

some of the demand-side issues in the second section. This second section examines current demand for entertainment and information services and the drivers of broadband Internet from a nationally representative 12-country African household and individual user survey conducted during 2011–2012 (RIA Survey 2011/2012; see Appendix for details).

The final section considers the implications of Noam's contention for Africa in the context of existing infrastructure and institutional constraints and explores the likelihood of this coming to pass in the short to medium term.

Communications Infrastructure

While a number of the assumptions that underpin Noam's arguments may be true for the United States they are not necessarily correct for Africa. Making his case for fixed high-speed broadband deployment rather than wireless technologies, Noam points out that in the United States most rural households already are not dependent on wireless for broadband. The majority of rural homes are passed by cable TV or phone connection which enables much faster speeds and are likely to be upgraded given past trends. The relatively few homes that are not connected to any communications network "can be served by fixed wireless, provided by entrepreneurial wireless Internet service providers (WISPs) and their high-speed directional microwave service, without such a tiny tail wagging the rest of the country" (2011:481).

Infrastructure to Homes

The situation in African households is starkly different. The availability of electricity continues to be a major determinant of which communication modes are available and present at the household level, especially television, and at a more basic level, in seven countries surveyed, water is piped into less than one in ten households (Table 3.2).

Aligned to conventional wisdom on media access use in Africa, the 2011/2012 RIA Survey confirmed that in almost all the 11 African countries under investigation, the radio is the most widely owned electronic appliance for information at a household level compared to TV and the Internet, with the exceptions of Cameroon and South Africa, where TV is now the main electronic information means at a household level. Radio penetration at a household level across these 11 countries reached 40 %, and in countries such as Ghana, Kenya, Namibia, Rwanda and Uganda it is above 70 %. Rwanda and Uganda have a very low level of electrification at a household level and almost no Internet connectivity at the household level. In these two poor countries, radio still represents the only affordable electronic appliance for information.

Table 3.2 Households with working ICT appliances

	Main electricity grid (%)	Water piped into the house (%)	Fridge (%)	Radio (%)	TV (%)	Satellite decoder or cable (%)	Computer (%)	Pay TV (%)
Uganda	13.4	1.5	5.5	76.6	12.9	1.5	2.2	2.3
Rwanda	15.6	1.1	3.0	72.4	9.0	1.7	2.0	2.0
Ethiopia	18.1	0.3	3.1	40.7	10.0	3.0	0.7	0.0
Tanzania	19.4	0.6	8.5	63.1	18.3	3.2	1.6	2.5
Namibia	41.8	32.4	40.6	72.0	40.6	17.7	14.7	20.9
Nigeria	58.4	2.2	24.3	69.5	53.0	12.9	6.6	10.2
Kenya	60.1	14.6	14.1	80.6	54.4	6.2	12.7	3.2
Botswana	60.1	22.7	53.6	66.4	59.4	43.5	15.8	12.6
Cameroon	64.5	6.2	14.8	33.9	44.3	21.1	8.6	13.1
Ghana	73.0	7.8	36.7	71.8	54.1	8.0	8.5	4.4
South Africa	89.2	36.3	74.2	62.3	78.2	34.9	24.5	29.7

Source: RIA 2011/12 Survey

In a few countries such as Ghana, South Africa and Nigeria, radio ownership at a household level is decreasing compared to 2007/2008 penetration levels. These countries have a higher GDP per capita than the other countries under investigation, and therefore households can afford alternative information means such as TV.

Ownership of a working TV at a household level has grown in almost all the 11 countries in 2011/2012. It is still equal or below 40 % in Namibia, Rwanda, Tanzania, Uganda and Ethiopia. The main reason given for a low level of TV penetration in these countries is the lack of electricity at home which reflects the lower levels of electrification at a household level in these countries.

Internet connectivity at a household level is negligible in the majority of these countries, at below 4 %, except in Botswana, Kenya, South Africa and Namibia. However, the RIA 2011/2012 survey shows that penetration levels of Internet at home are growing at a fast pace, though off a very low base, with changes between 2007/2008 and 2011/2012 higher than 8 % in Botswana, Kenya, Namibia and South Africa. This low level of Internet connections to the home follows the failure of fixed-line networks to diffuse widely in Africa. Of the countries included in the RIA Survey only South Africa and Cameroon have achieved household penetration rates of over 10 % (Table 3.3).

Most Internet research in Africa therefore is still concerned with questions of diffusion of the current networks, broadband or not, rather than imagining if, or under what conditions, new generations of technology may be rolled out.

Mobile Networks and Devices

Noam also challenges us to look beyond mobile. This is difficult to do in the African context. In contrast to this rather dismal picture of infrastructure to the home, the

Table 3.3 Internet access via mobile phones

	Per 100 adult population (15+)					
			Among mobile phone owners			
	Internet users	Mobile phone owners	Internet-capable mobile phone owners	Using mobile to browse the Internet	Computer (desktop or laptop) owners	Fixed-line penetration per 100 households
Ethiopia	2.7	18.3	6.5	5.1	0.5	4
Tanzania	3.5	35.8	19.2	5.2	0.9	0.4
Rwanda	6.0	24.4	19.1	14.9	1.8	0.2
Uganda	7.9	46.7	14.9	7.7	2.0	1.5
Ghana	12.7	59.5	28.5	13.4	7.4	1.8
Cameroon	14.1	44.5	14.9	8.1	5.7	2.2
Namibia	16.2	56.1	30.7	23.8	9.3	11.5
Nigeria	18.4	46.7	22.7	16	5.0	0.3
Kenya	26.3	74	32.3	25.3	11.0	0.6
Botswana	29	80	29.5	22.8	NA	15
South Africa	33.7	84.2	51.0	27.6	17.6	18

Source: RIA household and individual survey 2011/2012

success story of the Internet in Africa is mobile, both mobile devices and mobile wireless networks, as many others have pointed out (see for example, Stork et al. 2013; Williams et al. 2011). According to the RIA Survey mobile phone adoption rates in the countries surveyed vary from 18 to 84 per 100 (Table 3.3).

This user base has in turn allowed significant growth in Internet adoption (Table 3.4). South Africa has the highest Internet penetration rate among all the countries under investigation, with 33.7 % of the population aged 15 years or older using the Internet. Kenya, a low-income country, almost doubled its level of adoption from 15.0 to 26.3 % over 4 years as did Namibia where Internet users increased from 8.8 to 16.2 %. Botswana had the highest growth of Internet users compared to 2007/2008. The number of Internet users also grew significantly in Uganda, Rwanda and Tanzania compared to 2007/2008, when a very low percentage of the population was connected to the Internet. Ethiopia has the lowest level of Internet penetration with less than 3 % of the population using the Internet. This is likely the outcome of policies that have prevented the kind of competition that drives take up in other jurisdictions. The Ethiopian market remains structured around a monopoly operator, where a single operator provides fixed, mobile, and Internet services and maintains the international voice and data gateway (Adam 2010).

While the first wave of Internet adoption rode on the back of desktop computers for the elite at home and for others at the work place, schools and universities or public access facilities such as Internet cafes, the second wave sweeping across Africa is through the use of mobile phones. Although Internet penetration in most countries is still very low, more than 70 % of Ugandan and 67 % of Ethiopian

Table 3.4 Individual Internet use

	15+ that use the Internet			Where the Internet was first used		Where did you use the Internet in the last 12 months?				
	2007/2008 (%)	2011/2012 (%)	Diff. (%)	Computer (%)	Mobile phone (%)	Mobile phone (%)	Work (%)	Place of education (%)	Another person's home (%)	Internet cafe (%)
South Africa	15.0	33.7	18.7	65.1	34.9	70.6	35.8	20.9	14.3	32.4
Botswana	5.8	29.0	23.2	70.6	29.4	64.1	51.1	32.2	43.7	58.3
Kenya	15.0	26.3	11.3	68.9	31.1	77.8	31.4	38.8	38.9	72.4
Nigeria		18.4		45.2	54.8	74.9	29.3	19.6	30.3	45.1
Namibia	8.8	16.2	7.4	50.1	49.9	87.3	48.4	36.0	32.6	22.5
Cameroon	13.0	14.1	1.1	82.1	17.9	29.7	9.8	20.1	18.7	80.0
Ghana	5.6	12.7	7.1	70.5	29.5	61.2	34.6	50.9	34.5	84.7
Uganda	2.4	7.9	5.5	28.2	71.8	81.3	55.0	51.2	54.0	74.0
Rwanda	2.0	6.0	4	70.8	29.2	70.9	52.1	30.7	24.9	50.2
Tanzania	2.2	3.5	1.3	45.8	54.2	74.7	44.6	24.4	23.9	62.8
Ethiopia	0.7	2.7	2	33.3	66.7	80.9	17.4	20.9	3.5	42.2

Source: RIA 2011/2012 Surveys

Internet users first used the Internet on a mobile phone. In Tanzania, Namibia and Nigeria about half of the population first used the Internet on a mobile phone (Stork et al. 2013).

The growing importance of the mobile phone to access the Internet is also demonstrated by the responses to the question "Where did you use the Internet in the last 12 months?" Either complementarily to computer access or exclusively, above 80 % of Internet users in Namibia, Uganda and Ethiopia access the Internet via a mobile phone. In South Africa, Kenya, Nigeria, Tanzania and Rwanda the Internet is accessed through a mobile phone by 70 % of Internet users. In most countries, besides Cameroon and Ghana, the mobile phone has overtaken the Internet cafe, historically the most common way to access the Internet.

The increase in usage intensity is also a positive development. Daily usage rose over the past 4 years compared to once-a-week and once-a-month usage, particularly in Rwanda and Ethiopia (Fig. 3.1).

Linked to the increase in the frequency of use, the figure above depicts the magnitude of the new wave of Internet users. In Ethiopia, almost half of the Internet users started browsing the Web during the last year. By contrast, the share of early Internet adopters (share of Internet users that started using the Internet 4 years ago or earlier) is larger in Botswana, Rwanda, South Africa and Ghana.

While Namibia reflects early adopters already forming a wider base, Rwanda's continued low rate of adoption of mobile Internet may have something to do with the state-sponsored programme to promote low-cost computer uptake, together with limited 3G or better mobile data access, at a time that the market was meeting pent-up demand to access the Internet through mobile access.

This evidence shows that the infrastructure situation on the ground in Africa is exactly the inverse of the situation Noam describes above in the United States. Almost all rural (and indeed many urban) homes are not connected to any fixed-line communications network (cable or phone, copper or fibre). The primary means by which people communicate and the primary means by which Internet users connect are via mobile phones and mobile wireless networks.

So if Noam is correct that NGB can only be efficiently delivered by fixed fibre networks then this would require that the limited reach of fixed infrastructure identified above, beyond the main backbone, would be overcome.

Demand for Entertainment and Video Services

In the United States and elsewhere, the most important applications driving demand and supply of fast broadband appear to be those that compete with or substitute for broadcast (free or pay) television and the entertainment video market. A recent study by IDC for example shows that download video content in the United States exceeds uploading by more than ten to one (IDC 2012). Another study by CISCO systems estimates that video now accounts for most data transferred over the Internet (CISCO 2011). The online video download service Netflix is now the market leader in the

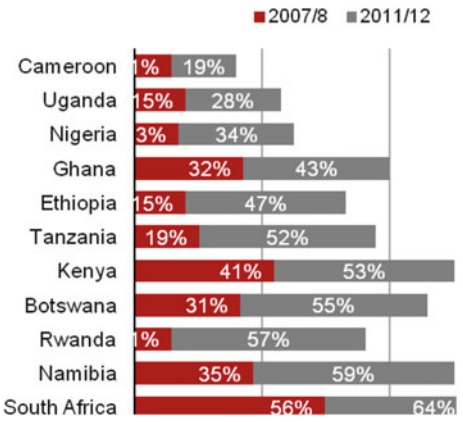

Fig. 3.1 Frequency of Internet daily usage in the last 3 months (*source:* RIA 2011/RIA 2007)

video market ahead of bricks-and-mortar businesses like Blockbuster and cable pay-per-view services like Comcast (Noam 2011). While there are many other uses of the Internet, given innovation in traditional television services (ultra HD, increasing television screen sizes, and 3D television for example) the bandwidth required to provide these services via broadband means that in the United States, these broadcast-like services may be the key driver of demand for increased bandwidth. In South Korea, the global leader in terms of broadband speeds to the home, video gaming was an important driver of early broadband adoption (Yun et al. 2002). The World Internet Project reports seven countries where gaming is more popular than video and seven countries where the reverse is the case (World Internet Project 2012). But in both cases, it is the requirement for high-quality real-time moving images that drives the demand for fast broadband. This evidence supports Noam's technical arguments concerning both the specific range of applications for which fast speeds are required and the prime place of entertainment in driving demand. But what evidence is there that this claim is true for Africa? Our research suggests that demand for Internet video in Africa differs from many other countries due to differences in the broader communications landscape.

Television in Africa

Globally, television is by far the most successful entertainment distribution system yet devised. Even amongst Internet users, in all 16 countries surveyed in the World Internet Project in 2009 and 2010, most people regarded television as important or very important as an entertainment source and in all but two cases, more so than the Internet (WIP 2012). Despite the so-called 'mobile miracle', in a number of African countries, significantly more people have access to television than to mobile phones and even those with mobile phones depend on traditional communication services—radio and television—for their informational and entertainment needs.

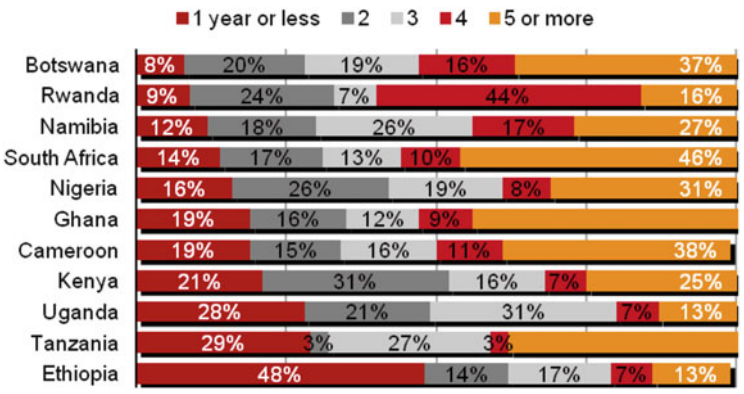

Fig. 3.2 Share of Internet users by years since they first used the Internet

There is, however, a shift to acquiring their information needs from the Internet through their mobile phones as we see below. While the RIA Survey shows that television use remains below 40 % in many countries in Africa (Fig. 3.3), this does not necessarily reflect demand. Rather, this lack of usage is often due to the absence of electrification or availability of broadcast services, which seems to be the case in Namibia, Tanzania, Uganda and Rwanda. Other than Namibia, these are also countries which have lower GDPs per capita. In fact all evidence suggests a pent-up demand for information and entertainment services.

In support of Noam's contention on entertainment driving uptake, the RIA Survey demonstrates that those with access to television rated entertainment highly. When asked what channels or programmes they like to see more in the context of digital migration, entertainment is the one that the majority of TV watchers want to see much more of (Figs. 3.4, 3.5, and 3.6).

As importantly, this research shows that television audience consume large quantities of broadcasting. Most TV viewers watch for more than 1 h a day. Only in Ethiopia and Namibia did respondents seem to watch TV irregularly and infrequently, while in the countries with bigger TV audience such as Kenya, Nigeria, South Africa and Botswana most TV viewers watch TV for 2 h and more a day (Table 3.5).

Where affordable and accessible, the preference is to watch TV at home. Only in Tanzania, Uganda and Ethiopia which are the least electrified does public TV viewing play an important role.

The main reasons for not watching TV are lack of electricity at home and the high cost of acquiring a TV set (Table 3.6). Lack of electricity was the main reason for 85 % of Ugandans and 89 % of Tanzanians that do not watch TV (Table 3.7).

This evidence supports Noam's contention that entertainment is the key to understanding demand. This echoes a study which found that despite the focus by donor and multilateral institutions on educational, health and other developmental applications in Africa (see for example, Qiang et al. 2009), that were believed to be what people at the base of the pyramid needed, what all people actually want is very

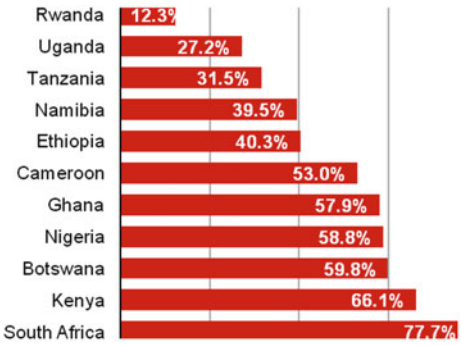

Fig. 3.3 Share of individuals watching TV (*Source:* RIA 2011/2012)

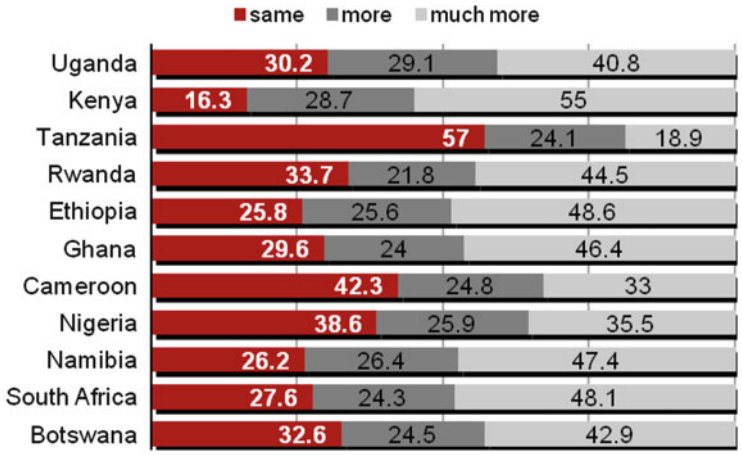

Fig. 3.4 Entertainment: If more channels were made available, which programmes would you like to see more?

similar to the things people at the top of the pyramid want, just more affordably. This includes games, social networking, music and video shorts (see also Calandro et al. 2012).

Can African Consumers Pay for Video Entertainment?

These patterns of television consumption put mobile phone use into some perspective. In South Africa for example, the median average amount spent on mobile airtime per month is around R70—less than $8[6] which at 2012 average call rates in

[6] The exchange rate in January 2013 was approximately 9 South African rands to the US dollar.

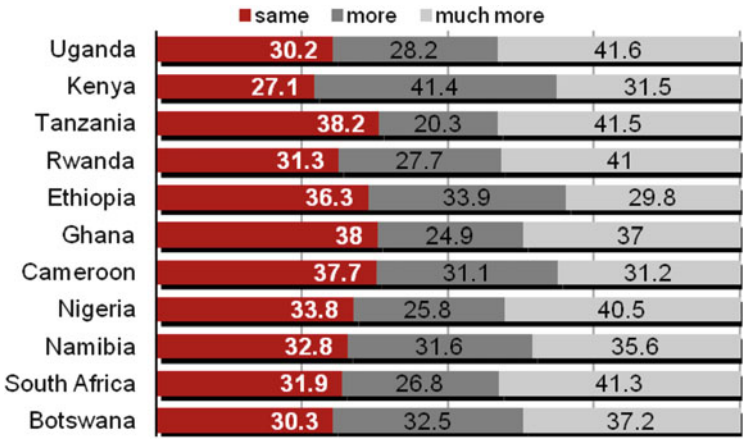

Fig. 3.5 News: If more channels were made available, which programmes would you like to see more?

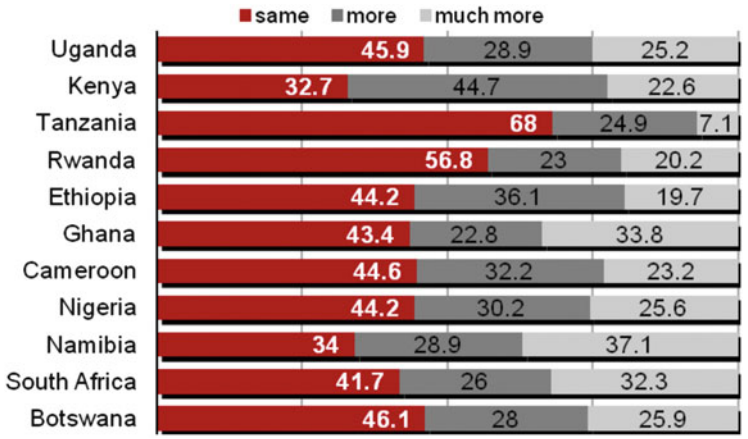

Fig. 3.6 Educational programmes: If more channels were made available, which programmes would you like to see more?

South Africa (Research ICT Africa 2012) could represent less than one 3 minute call per day.[7]

However, while African consumers may want such entertainment, the question remains as to whether economic demand is sufficient to support investment that would be required to service it via NGB fibre networks.

[7] This does not include time spent receiving calls. Based on the analysis of the RIA Household Survey, mobile phone users most commonly report receiving as many calls as they make.

Table 3.5 How many hours a day do you watch TV?

	Very irregularly (%)	Less than 1 h (%)	Between 1 and 2 h (%)	Between 2 and 4 h (%)	More than 4 h (%)
Uganda	26.2	9.0	31.2	18.5	15.1
Kenya	5.9	5.1	25.9	37.8	25.2
Tanzania	5.9	24.0	43.0	18.5	8.5
Rwanda	23.1	11.1	40.5	18.5	6.8
Ethiopia	68.2	6.9	14.4	8.3	2.1
Ghana	11.9	10.2	27.0	26.8	24.2
Cameroon	17.4	6.8	36.7	18.2	20.9
Nigeria	16.0	14.7	26.0	29.6	13.7
Namibia	31.5	6.7	16.7	17.5	27.6
South Africa	4.3	4.0	20.6	27.6	43.6
Botswana	13.0	8.1	19.0	25.3	34.7

Source: RIA 2011/2012

Table 3.6 Where do you watch TV mostly?

	At home (%)	At friends', relatives' or neighbours' home (%)	Public places (bars, community halls, TV clubs) (%)	Other (%)
Uganda	39.7	13.2	41.1	6.0
Kenya	82.5	6.5	7.6	3.5
Tanzania	53.2	22.2	17.4	7.2
Rwanda	65.0	22.8	9.8	2.4
Ethiopia	21.9	13.1	59.8	5.2
Ghana	90.1	8.0	1.5	0.4
Cameroon	85.9	9.9	3.5	0.7
Nigeria	84.7	12.1	3.1	0.2
Namibia	86.9	5.6	6.5	1.1
South Africa	97.0	2.4	0.4	0.2
Botswana	87.0	11.0	1.5	0.6

Source: RIA 2011/2012

Pay television provides some sense of who can pay for what. It has grown significantly in the last few years, especially in South Africa. However, most broadcast audiences across the continent, where they have access to television, are consuming "free-to-air" services—in other words they are not paying directly for the services they consume (Fig. 3.7). Advertising rates—the amount that marketers pay to reach this audience—provide an indicator of the economic value that each thousand viewers create for the television service. The most popular programme in South Africa for example, a soap opera called "Generations", screened in prime time on the most popular channel, had an undiscounted advertising rate of R130,000 per 30 s in January 2013 (SABC 2013). Its viewership is in the region of 6.5 million viewers. This is equivalent to a value of SA rands R0.40c or less than US $0.05c

Table 3.7 Reasons for not watching TV

	Not interested (%)	House has no electricity (%)	Cannot afford a TV set (%)	Don't have time to watch TV (%)	Cannot afford TV license (%)
Uganda	32.9	85.0	69.4	31.6	60.6
Kenya	13.5	72.5	70.6	19.7	50.8
Tanzania	8.0	89.3	87.9	34.2	83.6
Rwanda	16.5	73.8	78.6	11.3	57.6
Ethiopia	18.2	75.1	80.1	21.9	31.5
Ghana	22.7	51.1	55.0	31.0	27.8
Cameroon	25.8	60.8	73.5	33.5	62.3
Nigeria	22.9	69.6	54.6	23.1	42.8
Namibia	10.2	87.2	75.2	20.9	70.6
South Africa	17.1	35.4	59.0	12.5	44.3
Botswana	12.2	71.4	55.8	18.4	32.4

Source: RIA 2011/2012

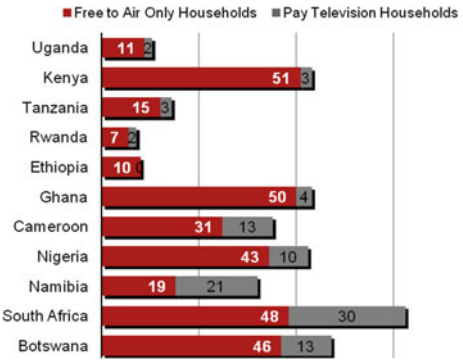

Fig. 3.7 Share of households with pay and free-to-air television

per viewer per hour for the most popular programme on television. Average prime-time television rates per hour per viewer in South Africa—the richest country with the richest broadcasting system in sub-Saharan Africa—are lower than this. We estimate, across the three most popular channels, that they are less than 25 % of this amount—around 2c (US) per hour.[8]

When considering the economic demand available to fund investment in further services we also need to take account of the fact that the current television market on the continent is highly concentrated with a relatively small number of channels available to most audience. Further services—via fibre to the home (FTTH) for example—would increase competition on the supply side and thus would be likely to put downward pressure on rates per viewer.

[8] This does not take account of discounting of published rates—a common practice in South Africa and elsewhere.

Individual Internet Use

The RIA Survey also offers evidence that Internet use in the African countries surveyed is predominantly meeting users' communication needs rather than their desire for entertainment, though entertainment dominated informational activities on a daily basis (see Table 3.8).

In all of the countries surveyed, communication services such as email or social network services were used daily by more Internet users than entertainment or information services. In eight countries, there was more daily use of one or more information services than of an entertainment service. There could be a number of reasons for this including lack of content (in comparison to what is available on other media such as television), the cost of consuming data required for viewing video content (compared to free-to-air broadcasting) and the limitations of mobile phone devices for consuming entertainment content. Given the evidence that mobile phone users ration their calls because of costs, it appears that unmet demand for communication is what is currently driving Internet diffusion in many African countries. As one young man in a village in Kenya reported to one of the authors to explain his heavy use of Facebook on his mobile phone: "its much cheaper than calling my friends".[9]

So in examining consumption of television and Internet services, we again see an inversion of the situation between technologies in the United States and in many African countries. In the United States, television is usually paid for—offering an existing market that broadband video entertainment services can compete in. In Africa the vast majority of television viewers consume only free-to-air services. In the United States, local telephone calls (on fixed-line networks at least) are often free. In Africa, voice calls are relatively expensive and only available via mobile phones. In this context, especially for low-income users, using the Internet for entertainment in Africa is expensive (compared to free television services) and using it for communication is cheap (compared to the cost of using mobile voice services).

The significant growth in Internet use in Africa over the last 4 years has not been driven by demand for online entertainment but rather by the need to communicate cheaply, and while social demand for entertainment on "traditional media" in Africa may be similar to that in rich countries, economic demand is far weaker. This leads directly to the supply-side question: Will this weaker demand be sufficient to encourage supply of NGB services, or if such services are available would they stimulate demand for online entertainment?

[9] Interview with Mwangi Nahashom, Olekasasi village, Kenya, March 2013.

Table 3.8 Internet users that perform the following activities daily

	Communication		Entertainment		Information			
	Social networking (%)	Email (%)	Gaming (%)	Download or watch movies, music, TV, radio (%)	Information: health related (%)	Find or check a fact or look up a definition (%)	From government (%)	Online newspapers, magazines, electronic books (%)
Uganda	19.4	27.9	10.6	14.0	2.4	4.0	4.2	14.6
Kenya	45.8	24.6	4.1	10.6	2.4	16.7	1.4	8.8
Tanzania	27.1	38.1	9.0	11.9	3.2	20.6	12.0	21.2
Rwanda	43.8	23.6	0.1	1.0	1.0	5.0	1.0	0.0
Ethiopia	9.3	19.0	0.0	1.2	1.0	3.9	2.1	5.4
Ghana	35.1	35.3	6.9	11.2	7.9	24.3	15.1	9.5
Cameroon	24.2	16.1	3.5	5.2	5.8	7.4	1.0	5.8
Nigeria	35.5	22.4	15.2	8.3	13.1	11.6	10.1	11.9
Namibia	31.3	28.7	10.7	12.8	9.0	30.6	7.4	19.9
South Africa	51.7	35.6	12.7	12.7	4.2	12.0	4.9	10.7
Botswana	41.4	40.1	8.1	8.9	3.6	13.9	2.8	16.5

Source RIA 2012/2012 Survey

Current and Next-Generation Networks

Any investment in the supply of new broadband infrastructure in Africa will take place in a context of the current state of the Internet network infrastructure. We have highlighted the low levels of fixed-line connectivity. But it is the limited capacity of the network infrastructure in general that gives an indication of the further challenges any next-generation investment faces.

International Connectivity and National Backbones

Following the landing of international undersea cables (Fig. 3.8), the astronomical input costs of international bandwidth, which for example used to make up as much as 80 % of ISP charges in South Africa, have plummeted in the last 3 years in many countries, particularly those with coastal landing points.

However, the lack of International Exchange Points (IXPs) in many African countries and the lack of sufficient backhaul connections, together with high transit charges between countries, have limited the benefits of these cables, especially for landlocked countries. National backbone infrastructure is also weak and very unevenly distributed with the bulk of it in South Africa where almost the entire network is owned by one firm—Telkom SA (Fig. 3.9).

The Last Mile: ADSL, LTE and DTT

Despite the gains in mobile service, Noam is right that universal access to the full range of communication services and quality of service remain crucial policy issues. The slow deployment of fixed broadband service and the high cost of this service mean that mobile broadband services have rapidly become the primary form of broadband access over the last 5 years. In Africa, mobile broadband is not a complementary service to fixed broadband as it is in mature Northern economies. While significant, mobile broadband take up was still constrained by the requirement of a computer into which wireless dongles are plugged. The availability of more feature phones and smartphones means that Africans are accessing the Internet for the first time from their mobile phones in significant numbers. The immediate relief provided by wireless and mobile services to bandwidth-starved Africans, however, has been stymied by the lack of access to next-generation spectrum (LTE). This is the result of the delays in the migration of analogue terrestrial broadcasting to digital.

At present FTTx (fibre to the home, the curb or business) is almost non-existent across the continent with minor exceptions in a very small number of cities—for example in Nairobi in Kenya and Lagos in Nigeria. While a small number of

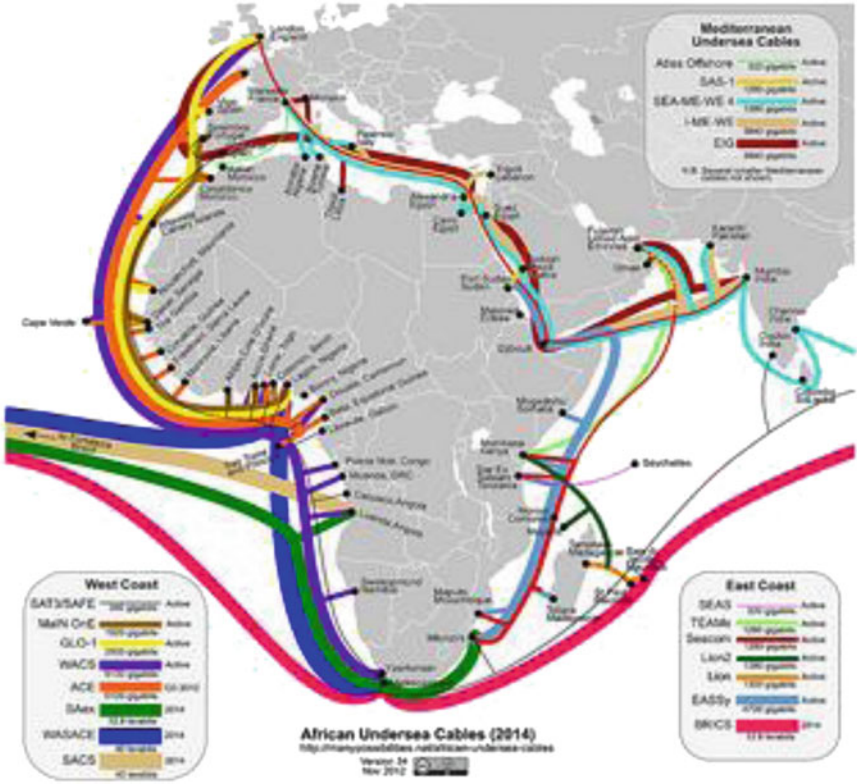

Fig. 3.8 International undersea cables in Africa. *Source:* Steve Song, http://manypossibilities.net/african-undersea-cables/

firms—largely in Southern Africa and east Africa—are investing in new infrastructure, levels of investment are still far from adequate and far from sufficiently spread to provide the basis of an NGB network or indeed of any broadband network to homes across the continent.

ADSL is still to be widely deployed, even in countries with higher levels of fixed-line networks. And where it has been deployed, it is often expensive. LTE, the fastest commercially available mobile wireless broadband technology, has not been rolled out widely, in part because of delays in "digital migration" in Africa—the replacement of analogue broadcast services with digital terrestrial services (DTT), which would make valuable spectrum available.

There are many issues facing digital broadcasting in a continent with limited access to "big" entertainment, a wide free television following, uneven levels of literacy and low household incomes. While the development of a sufficient amount of relevant content to drive the uptake of multiple channel broadcasting services is arguably a big challenge, even a limited number of alternative channels, particularly with premier sports and film rights, may present an attractive source of

Fig. 3.9 Fibre backbone networks in Africa. *Source:* http://afterfibre.net

information and communication to consumers. In some countries, the opportunity to have their first non-state-owned services might also be a spur to adoption. A multichannel environment supported by the state, would also be able to deliver formal education support services and informational services such as health, small business development, general citizen or parliamentary programming. Although people will not purchase new services in order to get e-government services, focus group research done on the Base of the Pyramid in South Africa in 2011, in a mobile phone environment, indicates that when health or e-government applications were preloaded on their devices people used them (Calandro et al. 2012). Likewise in several of the countries in the RIA Survey in 2012 education was still prioritised as a reason for watching television.

In this way freeing up high-demand spectrum for 4th Generation mobile services and the migration of analogue to digital broadcasting may meet the information and entertainment needs of African consumers who are becoming dependent on mobile

communications and increasingly on high-speed mobile services, at least in the near term.

Quality of Service

Both for ADSL and LTE, service providers claim that the high, uneven costs for broadband services on the continent reflect the higher quality of services available. However, these claims do not seem to be true. According to the latest report of Ookla, an international broadband testing company, South Africans, for example, are on average only getting 74 % of the speeds they sign up for, which is lower than the global average of 85 %. Ookla's household promise index ranks South Africa number 55 out of 64 countries, way below Ghana, Libya, Rwanda and Kenya.

A quality of service pilot study undertaken by RIA in South Africa suggests that consumers in South Africa are not getting advertised speeds. It demonstrates that mobile outperforms fixed broadband, but that speed is not the only limiting factor on performance. Moreover, although the mobile broadband service throughput is better at all points throughout the country, it is unlikely to become a substitute for fixed-line connectivity where that is already available. Although the throughput is poor, the reliability of ADSL over time is better for those requiring consistent quality levels (Chetty et al. 2013).

Fixed Versus Wireless

So will NGB happen in Africa? We have identified some of the constraints and some of the differences between the environments in African countries and those in northern developed economies such as the United States. Why have wireless networks been so much more successful in Africa than fixed-line networks? A number of explanations have been advanced which are not necessarily mutually exclusive. The development of prepaid pricing for mobile services, greater competition in mobile than in fixed-line markets and inefficiency amongst fixed-line operators have been suggested (Wallsten 2002; Melody 2003; Gillwald 2005a, b). These reasons are not intrinsic to the technical properties of mobile technologies compared to fixed-line technologies. However, the cost structures of supplying these technologies are different. The marginal cost of adding a new user to a mobile network is in general lower than the cost of adding a new user to a fixed-line network. When considered as an investment decision—projected fixed cost investment versus projected income—this difference becomes especially marked in the case of low-consumption users. This difference applies similarly to fibre or cable networks when compared to terrestrial or even to satellite broadcast television. It is beyond the scope of this chapter to analyse this difference in detail, but it is worth noting that the most successful networks in many African countries, mobile telephony and broadcasting, including satellite

broadcasting, have a low marginal cost of adding a user and that those that have not succeeded as well, electricity, fixed-line telephony and fibre to the home, do not.

This may have a direct connection with not just the relative poverty of the continent but also its physical and human geography. Development economists have pointed to the importance of geographic factors such as population density and coastal population distributions in Africa's development (Gallup et al. 1999). Telecommunication networks may be particularly sensitive to these factors. At the conference that preceded this book, Nick Rudnick, CEO of Liquid Telecom, a leading fibre network company in Southern and East Africa, estimated that while costs of rolling out infrastructure vary greatly across the continent, they are probably in the range of one-third of those in Europe, on a per-kilometre basis. But the relative cost of passing a household, a critical measure of viability for fibre networks, may be far higher in many African countries. Many African cities have much lower densities of residential households, particularly in higher income areas, than those in many European or South Korean cities. At a recent meeting of FTTH businesses in Cape Town, one industry leader stated that his costs (on a per-home-passed basis) in East Africa were similar to those in Sweden. Wananchi, the largest fibre and hybrid cable operator in Kenya, has been developing lower cost methods, importing skills and technology from the Philippines. But so far few other operators have extended these methods to other countries.

The Next Generation for Africa?

In contrast to our wireless-connected present, Noam challenges us to imagine a fixed-line (fibre-based) NGB future for Africa driven by consumer demand for rich video entertainment content. Our evidence supports his contention that demand for entertainment content may be as strong in Africa as elsewhere when measured by interest or behaviour. However it also points to two significant constraints in that demand being translated into a market capable of sustaining NGB fibre networks. First, most consumption of entertainment in the African countries reported here is free at the point of consumption, and low incomes in Africa support relatively low advertising revenues. This is a very different competitive environment for video entertainment in the United States, for example, where more than eight out of ten households subscribe to pay television services (Hollywood Reporter 2013). We have suggested that this may explain in part the relatively limited consumption of entertainment video and games online in Africa when compared to developed nations. Second, the very poor fixed-line infrastructure, both backbone and last mile, makes the investment case particularly challenging. We start from a very low base: less than one million fixed broadband connections in the whole of sub-Saharan Africa, of which more than half were in South Africa (Williams et al. 2011, pp. 262–263).

The history of network infrastructure in Africa—from the railways to mobile telephony—shows that while most if not all of these technologies have come to

Africa in some shape or form, only a few, broadcasting systems and mobile wireless networks, have become very widely available. In other cases, supply and demand have met, not at the scale of a mass consumer market but at the level of a much smaller market made up of urban elites and firms. Over a 100 years ago, the greatest network infrastructure project of the time—the Cape to Cairo Railway—did not connect many of the major urban populations of the continent, as railways did elsewhere, but rather connected the continent's major mineral resources to ports for export to European and other markets (Williams 1921). As with the railways, whether and how next-generation fibre networks get built in Africa, where and who they connect and when this happens will be determined by similarly complex interactions of economic, political and technological factors.

Our research shows that the rate at which Internet adoption in Africa is growing is dramatic, but these are off very low bases and within the constraints of the available network infrastructure and available devices. It suggests that an NGB network, that would require an entirely new last mile fibre infrastructure and new devices (including televisions), is unlikely to come to most Africans in the short to medium term. Meanwhile policymakers and market participants need to focus on what constitutes the next milestone or generation of Internet connectivity in Africa: accessible and affordable broadband. If capacity constraints to the delivery of current broadband are addressed, prices fall and investment is sufficient to address the quality of service issues, then it is possible to imagine a near future in which most Africans have access to broadband services. However, the price and quality of services that continue to inhibit the uptake of services, through whatever mode, remain highly dependent on effective regulation of the imperfect markets that characterise infrastructure industries, more so in Africa with the lack of competition in many markets. With one or two exceptions, policymakers have not yet created sufficiently competitive markets or enabled the type of open-access common carrier networks that could carry affordable (current generation) broadband services to the populace. The longer term policy implications of this are severe. The lack of development of always-on high-speed and -quality bandwidth in the access networks (last mile) required by business, public institutions and citizens has negatively impacted on Africa's informational development, a major determinant of global competitiveness.

However, even if policymakers, regulators and operators in Africa meet these current challenges, Noam's arguments remind us that what is, in global terms, "fast enough" has been and is likely to continue to be a moving target and the relationship between fixed and wireless technologies is not static. Some would argue from a policy point of view that having lower speeds widely available but with the focus on them being of sufficient quality to be used reliably for current needs may be more important than targeting speed or throughput alone. Whether and when (and over what parts of the planet) 1 Gbps speeds over fibre become "the new normal" is yet to be seen. But since its inception, Internet speeds have continued to get faster, and African Internet users have been and will be affected by these global changes. While NGB may not be "next" for most Africans, it may be for some, and on past evidence, even a couple of Internet generations may not be decades away.

Appendix: Household Survey

The RIA e-Access & Usage survey delivers nationally representative results for households and individuals using enumerator areas (EAs) of the national census sample frames as primary sampling units and sampling households from created listings for each EA. The random sampling was performed in four steps for households and five steps for individuals.

- Step 1: The national census sample frames were split into urban and rural EAs.
- Step 2: EAs were sampled for each stratum using probability proportional to size (PPS).
- Step 3: For each EA a listing was compiled, serving as sample frame for the simple random sections.
- Step 4: 24 Households were sampled using simple random samples for each selected EA.
- Step 5: From all household members 15 years or older or visitor staying the night at the house one was randomly selected based on simple random sampling.

The desired level of accuracy for the survey was set to a confidence level of 95 % and an absolute precision (relative margin of error) of 5 %. The population proportion P was set conservatively to 0.5 which yields the largest sample size (Lwanga and Lemeshow 1991). The minimum sample size was determined by the following equation (Rea and Parker 1997):

$$n = \left(\frac{Z_a\sqrt{p(1-p)}}{C_p}\right)^2 = \left(\frac{1.96\sqrt{0.5(1-0.5)}}{0.05}\right)^2 = 384$$

Inserting the parameters for the survey yields the minimum sample size for simple random sampling. Due to the sampling method chosen for the survey the minimum sample size has to be multiplied by the design effect variable (Lwanga and Lemeshow 1991). In the absence of empirical data from previous surveys that would have suggested a different value, the default value of two was chosen for the design effect (UNSD 2005). This yields then a minimum sample size of 768 for households and individuals. The actual sample size is slightly larger than the minimum requirement to compensate for clustering effects and to have a wide enough spread of EAs throughout a country (Table 3.9).

Weights were constructed for households and individuals. The weights are based on the inverse selection probabilities[10] and gross up the data to national level when applied.

Household weight: $\mathrm{HH_w} = \mathrm{DW}\frac{1}{P_{\mathrm{HH}} \times P_{\mathrm{EA}}}$.

Individual weight: $\mathrm{IND_w} = \mathrm{DW}\frac{1}{P_{\mathrm{HH}} \times P_{\mathrm{EA}} \times P_{\mathrm{I}}}$.

[10] See UNSD (2005) p. 119 for a detailed discussion on sampling weights.

Table 3.9 Survey summary

Target population	All households and all individuals 15 years or older
Domains	1 = national level
Tabulation groups	Urban, rural
Oversampling	Urban 60 %, rural 40 %
Clustering	Enumerator area (EA) national census
None response	Random substitution
Sample frame	Census sample from NSO
Confidence level	95 %
Design factor	2
Absolute precision	5 %
Population proportion	0.5, for maximum sample size
Minimum sample size	768
Household	Constitutes a person or a group of persons, irrespective of whether related or not, who normally live together in the same housing unit or group of housing units and have common cooking arrangements
Head of household	A head of a household is a person who economically supports or manages the household or, for reasons of age or respect, is considered as head by members of the household or declares himself as head of a household. The head of a household could be male or female
Member of a household	All persons who lived and ate with the household for at least 6 months including those who were not within the household at the time of the survey and were expected to be absent from the household for less than 6 months
	All guests and visitors who ate and stayed with the household for 6 months and more
	Housemaids, guards, babysitters, etc. who lived and ate with the household even for less than 6 months

Household selection probability: $P_{\mathrm{HH}} = \frac{n}{\mathrm{HH_{EA}}}$.

EA selection probability: $P_{\mathrm{EA}} = m\frac{\mathrm{HH_{EA}}}{\mathrm{HH_{STRATA}}}$.

Individual selection probability: $P_{\mathrm{I}} = \frac{1}{\mathrm{HH}_{m15+}}$.

DW = design weight compensation for oversampling of major urban and other urban EAs and under-sampling of rural EAs.

$\mathrm{HH_{EA}}$ = number of households in selected EA based on information of last census or updated listing by field team.

$\mathrm{HH_{STRATA}}$ = number of households in strata (major urban, other urban, rural).

HH_{m15+} = number of household members or visitors 15 years or older.

m = target number of EAs for each strata (major urban, other urban, rural).

n = target number of households in EA.

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