EXPECTATIONS VERSUS REALITY: A CASE OF INTERNET IN NEPAL

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ABSTRACT
The relation between Internet and development rests on the preconditions of minimum access, quality, affordability and many more. Presenting the picture of access, quality, and affordability, we raise doubts that Nepali internet infrastructure in its present form has any contribution to economic development. The Nepali policy circle also has felt the necessity of proliferating Internet access and use. But we argue major targets of the Nepali ICT policies are detached from the reality and hence failure prone. The formulation of a robust ICT policy cannot bypass the analyses of actualities of the demand side. There is a dearth of detailed statistics of ICT access, use, and affordability in Nepal. We thus recommend the government should conduct a census of ICT access, use, and affordability that would help the formulation of more grounded policies.

KEYWORDS
ICT, Economic Growth, Quality, Affordability

1. INTRODUCTION

Information and Communication Technology (ICT) is widely considered as an enabler of development. A series of researches in the ICT and development (ICTD) paradigm has put forward the evidence of association between Internet adoption and development, especially, economic growth (e.g. Qiang et al., 2009). Motivated by such findings, both the developing countries (DCs) and the least developed countries (LDCs) have put ICT infrastructure in the core of their developmental agenda. The Nepali policy circle has been reiterating the mantra of 'ICT for development' since the last decade without a careful assessment of the premises of ubiquitous access, quality and affordability.

It is apparent that the Nepali policy makers are in a great hurry to build ICT infrastructure of capacity equivalent to that in the developed countries. The Broadband Policy (2015), for instance, aims to connect all 75 Nepali districts by an optical fiber network within the acute deadline of 2020. The regulator, Nepal Telecommunications Authority (NTA), has initiated the primary phase of this massive project, utilizing the rural telecommunications development fund that had remained virtually idle in the past 15 years (NTA, 2016). The haste is also reflected in the claim of ICT Policy (2015) to promote Nepal in the top second quintile of the nations according to the ICT development index by 2020. Such hasty plans are results of incautious interpretation of international research on ICTD.

The research community has pointed towards several premises like minimum access, quality and affordability to observe the favorable role of Internet in development. In this paper, we examine the landscape of access, quality and affordability for Nepali Internet infrastructure. The evidences cast several doubts that the prevailing Internet infrastructure is conducive for development, economic or whatsoever. First, the access to Internet is low and entirely city centric. Second, the quality of available Internet connection is substandard at the users' end. Third, for the majority of the population, the use of Internet based services is constrained by their low income The policy makers also have felt the necessity of proliferating Internet access and

use, nonetheless they are treading the straightforward way of installing infrastructure based on latest technologies. Although there is no alternative to a backbone Internet infrastructure connecting all the districts, it is very unlikely that the proposed infrastructure will have its fullest utility; a mere installation of a sophisticated infrastructure will not change the demographic factors that describe its usage.

We argue that policy formulation should be based on a proper understanding of the factors that are shaping Internet access, quality and affordability. In Nepal, there is a dearth of thorough statistics of Internet access, use and affordability which has compelled the policymakers to rely solely on the finding of the global ICTD studies. Our recommendation is that the government should conduct a census of ICT access, use, and affordability that would help the formulation of more grounded policies. We will not address the complexities of policy regime, stakeholder dynamics, and energy shortage which have been analyzed elsewhere (Martin Chautari, 2014, 2015; Pandey & Raj, 2016; Regmi & Pandey, 2015).

This paper is based on the analysis of available statistics and field study at three sites. The field study comprises of preliminary tests of Internet connectivity and speed, and a small survey of mobile subscribers regarding the quality of services. The objective of field study is to provide a glimpse of ICT quality at the level of the users. We do not attempt to provide accurate datasets that could be used in further quantitative researches. The field study for this research was done at Panauti, Changu Narayan, Tangting, and Kathmandu, the capital city of Nepal. Panauti is a municipality in the Kavrepalanchowk district, about 32 km south-east from Kathmandu. Changu Narayan, a hilly area, is a newly declared municipality inside the Kathmandu valley. Changu Narayan has still a rural lifestyle as its majority of population is still dependent on agriculture. Tangting is a small village with 170 households, situated in the mountainous terrain of Annapurna conservation area. It is assumed that Panauti is a representative of urban Nepal, Changu Narayan of the sub-urban hilly territories, and Tangting of rural Nepal. These sites have huge differences in ICT and general infrastructure development, and we thus performed slightly different set of observations; this will be clear by the context in the subsequent sections. The field work of this paper was done in November 2015.

This paper is organized as follows. In section 2, we review the ICTD literature to clarify the role of access, quality, and affordability in the Internet and development relation as pointed by the ICTD research. In section 3, we present the picture of Internet access in Nepal based on available national statistics and our field observations. In section 4, based on available reports and our field study, we portray a picture of Internet quality as experienced by the end users. In section 5, we present the scenario of affordability in Nepal. We describe how low income and slow economic growth has been constraining ICT adoption. Finally, we conclude that the policies need to be reformulated addressing the realities of low income. In addition, we recommend that there is an immense necessity of ICT census that could guide the policy makers and researchers to identify appropriate strategies for proliferating ICT adoption and reducing the digital divide.

2. INTERNET, DEVELOPMENT, AND THE PREREQUISITES

The discourse on ICT and development has various dimensions. Even the notion of development as well as the mechanism through which ICT enables development has variations (Avgerou, 2010). To narrow the scope of discussion, we focus on the relation of Internet and economic development. It should be noted, however, that there is no consensus about the prerequisites necessary for Internet to have noticeable role in economic growth. In this section, we review the

literature to summarize the roles of access, quality, and affordability for extracting the full benefits of the Internet infrastructure.

2.1. Internet Access and Economic Development

The conceptual link between Internet and development comes from the argument that Internet is a General Purpose Technology (GPT). For a technology to be a GPT, it should be pervasive, it should get better over time, and it should be innovation spawning (Jovanovic & Rousseau, 2005). The definition of a GPT by itself indicates the prerequisites for Internet to have positive impacts in development. A GPT should be pervasive, but it can be well questioned if Internet in the low economies like Nepal has reached the threshold to be called pervasive. Similarly, for Internet to be innovation spawning, we can suspect if the low economies have sufficient human capital to exploit the fullest benefits.

The empirical literature also has pointed towards the prerequisites of minimum access to have significant effects of Internet diffusion. For example, Qiang et al. (2009) estimate a 10% increase in broadband penetration leads to GDP growth by 1.38 percentage points. But Qiang et al. (2009) also state a usually unnoticed disclaimer that the positive role of ICT on development is statistically less significant in low income countries. The reason for the low statistical signifance, according to Qiang et al. (2009), can suggest that broadband penetration in low income countries is well below the critical mass; i.e. the minimum threshold of penetration to have significant societal effects. Koutroumpis (2009), using broadband penetration and other statistics for the OECD countries, estimates a broadband would be conducive to economic growth after crossing the threshold level of 20% household penetration. The broadband penetration in the LDCs is way below this threshold. Nepal has household Internet penetration of about 7% (NTA, 2017).

There has been a series of researches on the economic opportunities created by the rapid proliferation of mobile telecommunications in the LDCs and DCs. Waverman et al. (2005) mention mobile telecommunications is playing the similar role as fixed line telephones in the development countries the decades of 1970s and 1980s. They further argue that mobile phones are significantly playing favorable role on economic growth in the developed countries. Micro-level studies also have shown association of telecommunications access with economic development (e.g. Abraham, 2007; Jensen, 2007). Up to our knowledge, there is no published work that explicitly deals with the relation between mobile Internet access and economic growth. Regarding critical mass, Röller and Waverman (2001) have estimated 40% penetration as threshold for telephone networks to have positive effect on economy. The question of critical mass for mobile Internet usage has not been addressed in the literature.

2.2. The Quality Dimension

The literature has also pointed the importance of the ‘quality’ dimension for the proper utilization of the Internet infrastructure. We first clarify our use of the term `quality' in this paper. We loosely ascribe the term ‘quality’ as synonymous to the basic quality of service (QoS) parameters for computer hardware and data networks. Our focus is in the hardware aspects of the infrastructure. We have centered our discussion on the QoS parameters such as processor’s speed, data download/upload speeds, network latency and jitter.

The quality parameters definitely shape the socio-economic impacts of Internet. Van Dijk (2006) mentions access to narrowband versus broadband connection has a strong effect on the usage time and the type of application used. People with faster connections could thus have more

benefits from the Internet compared to those having slower connections. The impacts of Internet quality at the national level have also been quantitatively analyzed. In the context of OECD countries, Rohman and Bohlin (2012) estimate that a doubling of broadband speed could add 0.3% to GDP growth relative to the year 2008. Lüdering (2016), taking the average network latency for a country as an alias for quality, concludes that improvements in Internet quality has significant effect in economic growth. These studies reinforce the argument that policies in the low income countries need to focus on quality assurance in addition to their conventional focus on proliferating Internet access.

As it is a general practice, the private ISPs in Nepal adopt familiar policies of data capping, bandwidth throttling, and bandwidth sharing between multiple users to control network congestion. Although some works suggest data capping and similar schemes of network congestion control is beneficial for the end user in terms of costs (e.g. Bauer & Wildman (2012)), there is an ongoing academic controversy in this subject. But surely such volume based schemes of broadband subscriptions are repellent to the subscribers and severely affect their use patterns (Chetty et al., 2012). The issues of congestion control policies adopted by ISPs, however, is less relevant to Nepal where broadband penetration is low.

Nepali ICT policies are ambitious of developing e-education, e-health, e-government, and land administration systems. The quality of Internet and related digital devices has obvious links with the performance of such systems. Whilst the Broadband Policy (2015) has set 512 kbps Internet as the target for rural areas, speed requirements of modern Internet applications have raised much higher (see Federal Communications Commission (n.d.)). Even the asynchronous interaction between students and teacher in an online education system require teleconference or video conference (Ngwenya et al., 2004) which is an intensively bandwidth demanding application. McAuley et al. (2010) mentions the popular higher education platform of Massive Open Online Courses has been bottlenecked by low bandwidth in developing countries. Incidentally, the entire document of ICT in Education Master Plan (Ministry of Education, 2013) does not contain the terms 'bandwidth' or 'Internet speed'. This exemplifies how remote the Nepali policies are from the foundational realities.

2.3. Affordability and Other Prerequisites

There is no widely accepted criterion for Internet affordability. The Broadband Commission (2016) considers a fixed broadband connection as affordable if its tariff does not exceed 5% of monthly per capita income. For mobile broadband, the Alliance for Affordable Internet (A4AI, 2017) defines a connection affordable if 1GB of data costs no more than 2% of monthly per capita income. These thresholds could be academically contested. Nonetheless it is almost unanimous that income is a significant factor in household Internet adoption (e.g. Chinn & Farlie, 2007). Income is one of the significant factors also in the adoption of mobile phones by the low income groups (de Silva et al., 2011). The globally reported significance of income in Internet adoption also holds the particular case of Nepal. Pandey and Raj (2016) report low income and low education as two factors characterizing households without Internet connection in their survey areas. We shall refer to the affordability criterion of the Broadband Commission (2016) in few instances, because the Nepali ICT policies have explicitly considered the 5% threshold (see, Broadband Policy, 2015, article 8.9).

Since voice and Internet can be provided through the same telecommunications infrastructure, the rapid proliferation of mobile phones in the low income countries implies the increase in access to the Internet. But access does not imply the use. The survey by Zainudeen and Ratnadiwakara (2011) suggests, for the mobile users, low income is not a barrier for the use

of more than voice services; but the authors do not provide indications about the extent of money that the low income users are willing to pay for more than voice services like the Internet. Several studies, on the other hand, suggest mobile Internet access is associated with income. For example, Srinuan et al. (2012) considers price as one of the strongest factors of mobile Internet adoption in Thailand. Even in the context of the OECD countries, Lee et al. (2011) suggest income as a factor of mobile broadband adoption. It can be said that low income is still a major obstacle to mobile Internet adoption and a drastic reduction in mobile services tariffs appear less probable in the developing countries. Based on a cross country analysis of non-OECD countries, Choudrie et al. (2015) argue the services providers of the developing countries are still recouping the expenditure of building the infrastructure necessary for providing mobile services. The results of Choudrie et al. (2015) nonetheless show an association between competition and reduction in mobile broadband costs, which could suggest a way out from the constraint of low income in mobile Internet adoption.

There are several other prerequisites to a proper functioning ICT infrastructure that will yield the fullest possible benefits. Being the core component of ICT, the same prerequisites apply to Internet as well. The World Bank (2016) emphasizes that a country needs the 'analog complements' of favorable business environment, strong human capital, and good governances to observe the positive impacts of ICT. From the physical perspective, the development of ICT has a strong dependence on energy infrastructure (see, Van Heddeghem et al., 2014). Regmi and Pandey (2015) mention the Nepali ICT policies have neglected the energy-infrastructure nexus and warn that the energy consumption of existing Nepali ICT infrastructure has already become comparable to the transportation sector. Without any long term visions, the underdeveloped energy infrastructure will soon emerge as the foremost barrier to ICT development in the country (Regmi & Pandey, 2015). Pandey and Raj (2016) mention that the reason for Internet non-use is the lack of local evidences which could convince the non-users about the benefits of the Internet. This would imply contents having local utility as important factors that determine the Internet use, and therefore its role in development.

3. INTERNET ACCESS IN NEPAL

We now present a picture of Internet access and quality at the Nepali households and public centers. Beginning with household level ICT related statistics in the census and other reports, we describe the scenario of public Internet access based on our field observation.

3.1. Household Access

Nepal's current penetration of household Internet can be estimated to be around 7% (NTA, 2017). The national census report (Central Bureau of Statistics, 2012) shows a slightly lower value for household Internet penetration (see Table 1).[1] Regarding the regional distribution of Internet and other ICT devices, the only dataset available is the national census report. Table 1 shows the distribution of household level penetrations of various facilities in the 3,973 Nepali VDCs[2]/municipalities. The distributions for most of the facilities are highly skewed with majority of VDCs/municipalities having extremely low level of penetrations. Radio, television

[1] Apart from the fact that the census was held five years earlier, this difference might have resulted because the census questionnaire does not precisely specify the meaning of household Internet. The questionnaire asks, `do you have following facilities in your household?' Internet is listed as one of the multiple choice options.

[2] Village Development Committees (VDCs) are groups of small villages. We have described the distribution of facilities jointly for VDCs and municipalities because a separate presentation of statistics will offer no new insight for this paper.

and mobile phones are the exceptions having comparatively uniform distribution. Note that electricity connection referred in Table 1, as evident from the census questionnaire, refers to electrical power sufficient for lighting the household, i.e. one or few electric bulbs. It may or may not refer to electrical supply sufficient for power intensive applications like refrigerators.

Internet diffusion, as indicated by the census data, is mostly Kathmandu centric. The Kathmandu metropolitan[3] has household Internet penetration of 23.7%, and there are only eight VDCs/municipalities in Nepal having Internet penetration larger or equal to 20%, all inside the Kathmandu valley.[4] The number of households in the Kathmandu metropolitan is 4.7% of total households in Nepal, but the number of households having Internet in the metropolitan is 33.4% of total Nepali households having Internet connection. Similarly, the number of households having internet connection in the three districts of Kathmandu valley jointly have is 67.7% of total Nepali households having Internet.

Table 1: Quintiles and Averages for Household Penetration of Various Facilities at 3973 Nepali Villages/Municipalities*

	Quintile Group					National Average
Facility	**0%**	**25%**	**50%**	**75%**	**100%**	
Internet	0	0	0.07	0.36	26.76	3.33
Telephone	0	0.35	0.96	2.47	41.75	7.37
Mobile	0	39.85	56.66	70.01	96.51	64.63
Radio Set	2.66	39.83	53.93	65.23	97.67	50.82
Television Set	0	4.67	18.92	36.12	93.42	36.45
Cable TV	0	0.13	1.08	7.74	75.5	19.33
Motor	0	0	0.13	0.72	27.29	1.57
Motorcycle	0	0.09	1.41	6.74	40.34	9.58
Cycle	0	0	0.48	58.94	93.69	32.38
Refrigerator	0	0	0.12	0.77	46.6	7.16
Computer	0	0.18	0.6	1.43	45.67	7.28
Electricity as Main Lighting Source	0	16.23	60.34	87.01	100	67.26

*Source: Author's presentation of national census data (Central Bureau of Statistics, 2012)

It is less probable that the skewed distribution of household Internet access has changed noticeably after the census in 2011. Internews (2014), based on a survey of 4,011 respondents in 44 districts, estimates the household penetration of Internet in rural and urban Nepal are 3.1% and 16.1%, respectively. Pandey and Raj (2016) estimates household Internet penetration at Panauti, a municipality, is 28.8%, and at Pragatinagar, a settlement sharing boundary with the Kathmandu metropolitan, is 7.1%. The estimated Internet penetrations at other three sites which happen to be rural, Changu Narayan, Dapcha Chatrebanjh, and Tangting, are 2.8%, 0%, and 0.8%, respectively. The Nepali ISPs have a fairly long history of more than two decades, but as

[3] Kathmandu metropolitan should not be confused with Kathmandu district, the former being a part of the latter. Similarly, 'Kathmandu Valley' refers to the valley containing the three most populous districts of Nepal, Kathmandu, Bhaktapur, and Lalitpur.

[4] These VDCs/municipalities are Lalitpur sub metropolitan, Sainbu, Balkot, Dhapasi, Kathmndu metropolitan, Khadka Bhadrakali, Kirtipur municipality, and Mahankal.

listed in the website of NTA, there are only six ISPs registered as 'rural ISPs' compared to 65 non-rural ISPs. Paradoxically, three of the rural ISPs have official address in the major cities, viz. Kathmandu and Pokhara. It is appears that market competition is insufficient to proliferate Internet access and quality in the low income pockets.

3.2. Public Access

We do not find official statistics for the number and distribution of public Internet access centers in Nepal. Most of such centers are commercial public Internet centers (aka 'cyber cafe') located at the cities. Centers providing free Internet access to the public are very rare, and are funded by NGOs as pilot projects. We examined some of the public Internet access centers at Panauti.[5] The quality of Internet offered to the end users in public Internet access centers, including the commercial cyber cafes, was of substandard. The cyber cafes at Panauti had Internet bandwidth subscriptions of at most 512 kbps and share it to the customers whose number can be up to 8 to 12, simultaneously. They lacked power backup and thus are closed at the hours of power cut. As told by the entrepreneurs, the main reason for not installing power backups like inverter was lack of business return. People prefer mobile based Internet than paying extra charge for the power backup in the Cyber cafes. Note that Nepal is facing a chronic shortage of electricity,[6] which could be a major factor describing the ubiquitous use of mobile phones for browsing the Internet.

Panauti lacks an effective framework for providing public Internet access, despites it is a municipality and a tourist destination. As per the National Planning Commission's aims of establishing telecenters at all District Post Offices and major area Post Offices (National Planning Commission, 2007), there is a telecenter at Panauti which is now completely non-functioning. The web page of the Postal Service Department still lists telecenters in Nepal, but there is no mention about the current working condition of those kiosks. There were private and community initiated places of public Internet access at Panauti (Table 2), but they offered a low speed Internet to the end users. Note that the library mentioned in Table 2 free Internet access to the public and is NGO funded. In the listed centers, Internet QoS accessible to a single person deteriorates badly because of bandwidth sharing between several users.

We could not find places of public Internet access except one cyber cafe at Changu Narayan. The cyber cafe is located at the market in the periphery of the historic temple which happens to be a famous tourist destination in Nepal. There was no public Internet access center at Tangting. Being a small village, Tangting has only a single school, which had some desktop computers gathered from donations of local dwellers and visitors, but the computing machines were idle because of electricity shortage.[7] The case of Panauti, Changu Narayan, and Tangting indicates that public Internet access centers established by GoN are non-functioning, whereas entrepreneurs have no interest in providing such services due to financial risks.

[5] The selection was done with a consultation of the local residents to ensure that influential educational institutions and public centers have been covered.

[6] A technical discussion on electricity shortage in Nepal and the reasons behind it can be found in Sharma and Awal (2013).

[7] As told by a local teacher in a recent telephone conversation with the author, the school has now gathered some laptops and set-up solar power panels from the financial support of the local community

Table 2: ICT Equipments at Sampled Public Internet Access Places and Educational Institutions at Panauti*

Spot	Details of Computers	Total Number of Computers for Customers/Users	Power Backup	Subscribed Internet Bandwidth
Panauti Cyber Cafe	2GB RAM, Intel Dual core processor, Windows 7 and Windows 8, LCD monitor	10	None	512 kbps
Cyber Cafe (unnamed)	1GB RAM, Pentium processor, Windows XP, CRT monitor	5	None	256kbps
Gyan Bikash Library	Dell Laptops, 2GB RAM, Windows 7	9	Solar Battery	328kbps
Shree Panauti Lower Secondary School	2GB RAM, Intel Dual Core CPU, Windows 7 Ultimate, LCD monitor	8	None	None
Shree Indreswhar Higher Secondary School	Variation: from Pentium CPU and CRT monitors to Intel Dual core CPU and LCD monitors	22	few UPS	512kbps
Kavre English Higher Secondary School	Pentium 4 CPU	14	None	256kbps
Indreshwar Campus		No computers	None	512kbps

*Source: Author's Survey

3.3. Mobile Internet Access

The access of mobile phones is less skewed as shown in Table 1. The regulator NTA (2016) claims a 50% penetration of mobile Internet. But the statistics for mobile Internet use is unavailable. Pandey and Raj (2016) report 72.36% of the responded owned mobile phone, and among the mobile owners, a large proportion are non-users of mobile Internet. In their survey, the respondents that own mobile but do not use were 34.05%, 63.2%, 40.34%, 34.26%, and 53.76% at Changu Narayan, Dapcha, Pragatinagar, Panauti, and Tangting, respectively (Pandey & Raj, 2016). At the moment, we do not have sufficient data to give the details of mobile Internet access and use.

4. INTERNET QUALITY IN NEPAL

4.1. Household Internet Quality

Majority of household Internet connections in Nepal are still the ADSL service provided by the state owned telecommunication company Nepal Doorsanchar Corporation Limited, also known as Nepal Telecom (NTC) (Table 3). Nepal has a very low International bandwidth usage, which was 2.9 kbps per Internet user in 2013, lower than the average value for low income countries, 3.5 kbps (The World Bank, n.d.). The quality of landline Internet even in the urban areas is also not up to the standards. Observations on a total of ten randomly chosen households at Panauti,

Changu Narayan and Kathmandu indicated landline Internet subscribers get about 70% of acclaimed bandwidth in an overall. [8]

The subscribers made similar complains of not getting fully subscribed bandwidth suggesting the quality of land-line Internet subscribed by householders at the sites did not have significant difference with that at Kathmandu. However, Kathmandu dwellers have an option of selecting Internet subscription from a pool of ISPs whereas the dwellers at the sites have limited choice. The dominant ISPs in the localities of Changu Narayan and Panauti provide wireless connections, most probably due to the ease of expanding wireless networks in the rural areas. These areas have low landline telephone penetration which naturally reduces the option of using relatively low-cost NTC's ADSL service, and have low land-line Internet subscription.[9]

Table 3: Types of Household Broadband Subscriptions in Nepal*

Connection Type	Total Subscribers	Percentage
Dial up	5150	1.34
Wireless Modem Optical fibre	56539	14.72
Cable Modem	141211	36.76
ADSL	181159	47.17

*Source: NTA (2017)

The scenario of users getting Internet quality inferior to that advertised or paid for is a worldwide problem, for example, European landline Internet users get about 75.6% of the speed advertised by the ISPs (SamKnows Ltd., 2013). But it should be noted that average download speed at peak hours in the Europe is 30.37Mbps, whereas that in the project sites is no more than 300kbps. Getting only 70% of the subscribed bandwidth is therefore a big loss in Nepal. Landline ISPs are certainly not providing 100% of their claimed quality; this finding is reinforced by interviews with the subscribers. However, the performance of Internet at private households is not a crucial issue because of extremely low landline Internet penetration. The critical issue is low quality Internet at schools, colleges, and public access places that constraint educational and recreational uses of ICT, as shown in Table 3.

4.2. Mobile Internet Quality

We surveyed a total of 120 mobile phone users at Panauti, Changu Narayan, and Kathmandu. Our survey was limited to the users of NTC and Ncell; latter is a private telecommunication giant in Nepal. The respondents were asked about their perception of quality for various aspects of mobile telecommunications. We used Likert scale where 1 represents the best and 4 the worst perception. An important finding of the survey is both NTC and Ncell users are more satisfied with voice call services. Most of the responded have good perception of voice services (Table 4) in comparison to data (Table 5). Users find Ncell's Internet better than NTC in terms quality. There was a recurring complain during the interviews from mobile users that Inter quality was poor despite good BTS signal strength, these complaints are reflected in the survey data as well

[8] We performed Internet speed tests at five households in Panauti, two in Changu Narayan, and three in Kathmandu. No household in Tangting had Internet access except one user subscribing wifi service from the telecom operator Ncell.

[9] The national census 2011 shows telephone penetration at Panuati and Changu Narayan are 15.86% and 14.41%, respectively.

(Table 5). The responses regarding mobile voice call quality does not show noticeable site specific patterns to draw any significant conclusions.

An earlier study presented in NTA (2012) reports technical examination of several QoS parameters for voice services in four major cities of Nepal. The report shows most of the QoS parameters are inferior to the benchmarks for services provided by NTC, Ncell and other smaller telecommunication companies. This result slightly contrasts our findings because the respondents in our survey appear mostly satisfied with voice services. NTA (2012) presents a picture that even the voice communication quality is substandard.

Table 4: Responses for Mobile Phone Connection Qualities from NTC and Ncell Users.*

Parameter	Network	Most frequent Likert scale response (Frequency in the parenthesis)	Interpretation of the most frequent response
Dial attempts for successful call	NTC	2 (73.1%)	Sometimes 2-3 attempts
	Ncell	2 (70.4%)	Sometimes 2-3 attempts
Connection loss during conversation	NTC	2 (56.5%)	Sometimes
	Ncell	2 (69.4%)	Sometimes
Sound quality	NTC	2 (57.0%)	Rarely deteriorates
	Ncell	2 (62.6%)	Rarely deteriorates

*The Likert scale for the responses is calibrated into four values where 1 represents the best and 4 the worst. Source: Author's Survey.

Table 5: Area Wise Comparison of User Response for Mobile Internet Speed.*

Operator	Area	Most Frequent Likert Scale Response for Internet Speed (Frequency in the Parenthesis)	Interpretation of the Most Frequent Response	Percentage of Users Complaining Good BTS Signal but Bad Internet Quality
NTC	Changu Narayan	4 (50%)	Slow, can't open Facebook	50
	Panauti	3 (42.1%)	Can browse Facebook, but no YouTube	73.7
	Kathmandu	4 (58.9%)	Slow, can't open Facebook	88.2
Ncell	Changu Narayan	1 (63.6%)	Fast, no complain	24.2
	Panauti	3 (43.2%)	Can browse Facebook, but no YouTube	54
	Kathmandu	1 (32.2%)	Fast, no complain	45.4

*The Likert scale for the responses is calibrated into four values where 1 represents the best and 4 the worst. Source: Author's Survey

We also examined mobile Internet QoS at Panauti and Changunarayan. The observations were made at a total of ten test points, with five test points at each the sites. The test points were selected to represent localities with high and low household density, market place, fields, and roads. We made three tests at different day hours in each of the test points using Android mobile phones. The overall quality of mobile Internet service was found to be extremely low at the test points. Even basic upload and download tests required several attempts. Although user perception for Ncell's service was satisfactory (Table 5), there were areas where even Ncell's Internet could not be connected. In many instances, despite of Internet connection, speed tests showed absolutely no response implying worst quality of service (see Table 6). There were test points in the sites where even the ping tests required multiple attempts or failed, which indicates extremely poor connectivity.[10] The download/upload speeds are shown in Table 7. Signal strengths of BTS in the test sites were within a tolerable range but with two notable exceptions. There were two test points at Changu Narayan with extremely poor signal strength for both NTC and Ncell BTS. Incidentally, these test points are located at areas with low household density.

Table 6: Unsuccessful Tests for Mobile Internet Speed*

	Changu Narayan		Panauti	
	NTC	**Ncell**	**NTC**	**Ncell**
Absolutely no response	75%	37.5%	66.7%	0%
Could not perform download tests	100%	37.5%	66.7%	0%
Could not perform upload tests	100%	50%	100%	0%

*Source: Author's survey.

Table 7: Download/Upload Speeds (mbps) and Related Parameters at the Sites*

	NTC	**Ncell**	**NTC**	**Ncell**
Maximum Download Speed	na	0.684	0.107	3.722
Average Download Speed	na	0.434	0.06	2.94
Maximum Upload Speed	na	1.715	na	1.894
Average Upload Speed	na	1.2	na	1.587
Average Jitter from ping tests (ms)	318.75	424.31	500.63	46.33
Average BTS Signal Strength (dBm)	-89	-97.4	-90.6	-87.4

*The label `na' (not available) indicates test could not be completed because of extremely poor Internet connection. Source: Author's Survey.

Ping test statistics further show that NTC mobile Internet does not offer the minimum QoS requirements for multimedia related applications whereas Ncell's overall service is far more superior. We performed ping tests at the sites as well as in Kathmandu for a comparison. Analysis of jitter for mobile Internet reiterates the supremacy of Ncell over NTC in terms of quality. The average jitter for NTC mobile Internet at Panauti and Changu Narayan were 500.6 ms and 318.3 ms , respectively. The average jitter for Ncell at Panauti and Changu Narayan were 46.3 ms and 424.4 ms, respectively. The jitter value for Ncell Internet at Panauti much less than the prescribed tolerable threshold of 100ms (see Chen et al., 2004), while the jitter for NTC was worse at the both sites. However, Ncell's Internet has poor performance at Changu Narayan create doubt on the obligations of private corporations to serve the rural areas. The QoS

[10] A ping test is the simplest test for Internet connection and speed. Ping tests use very small data packets of size 32 kilobytes, thus ping test failures reveal the Internet connection is extremely poor.

examinations also justify complaints of good signal strength but bad Internet, specifically for the NTC subscribers (Table 5). The average signal strength at the test point is within the tolerable range but average jitter is higher than the 100ms threshold (Table 7).

5. THE AFFORDABILITY PERSPECTIVE

In the preceding sections, we presented the picture of Internet access and quality. Now we analyze the complications created by the reality of low income in Nepal in the proliferation of Internet access and use. We begin by analyzing some major targets of Nepali ICT policies and argue they are failure prone as they are detached from the reality of low per capita income. Then we discuss how the same constraint of income applies to the usage of widespread mobile Internet.

5.1. Broadband Affordability and Policy Targets

We now describe how low income has hindered household Internet adoption and set obstacles to some important policy targets. The Broadband Policy (Ministry of Information and Communication, 2015a) and the National ICT Policy (Ministry of Information and Communication, 2015b) are the two policies guiding ICT development in Nepal. These documents have several imprecise targets, such as converting villages into e-villages, whose success or failure cannot be ascertained. We mention four precise policy related targets and discuss the possibility of realizing them.[11]

Target 1: Make a 512 kbps speed broadband connection accessible in all areas, and a 10 mbps speed broadband connection in the urban areas (Ministry of Information and Communication, 2015a; article 8.1).

Target 2: Assure broadband access to at least 45% households by 2018 (Ministry of Information and Communication, 2015a; article 8.2).

Target 3: Link all the headquarters of 75 Nepali districts with optical fiber network by 2018 (Ministry of Information and Communication, 2015a; article 8.4).

Target 4: Promote Nepal to the top second quartile of nations ranked according to 'network readiness' by 2020 (Ministry of Information and Communication, 2015b; article 11.17.1)

The first target is somewhat fuzzy as an area could refer to a ward, a VDC, or even an 'ilaka' (a collection of VDCs/ municipalities). Nonetheless, this declaration indicates that the policy regards a 512 kbps Internet connection as an entry level broadband.

We can see the sheer difficulty in achieving Target 2. The household budget survey report (Nepal Rastra Bank, 2015) describes incomes and expenditures of each economic quintile (see Table 8). The first rows of table 2 mention the monthly household expenses of each income quartile. The second row is the broadband affordability calculated as 5% of the income. The monthly subscription NTC's 192 kbps ADSL is NRs. 1017 which requires an extra of NRs. 200 for the minimum monthly tariff for PSTN connection. It is clear that the 5% rule will tells even the richest quintile cannot afford the basic ADSL service. The third row of table 2 shows the monthly household expenses on recreation, communication, and miscellaneous activities. If the householders completely check their expenses in these three categories, NTC's 192 kbps ADSL will become affordable to all income quintiles. Now consider the monthly depreciation for

[11] These are author's translations. The policy documents are in Nepali.

computer, which is near about NRs. 1000 for Nepal (Central Bureau of Statistics, 2012). Incorporating this depreciation, even under the very unrealistic assumption that people will stop expending on recreation, communication, and miscellaneous activities, and allocate the surplus to pay the broadband tariff; the 192 kbps connection will remain unaffordable to the poorest 40% of the population.

Table 8: Internet Affordability by Quintile Groups of Nepali Population*

	Poorest 20%	**Second Poorest 20%**	**Middle 20%**	**Second Richest 20%**	**Richest 20%**
Monthly Household Income (NRs)	18338	23739	24516	32042	53578
Broadband Affordability (NRs.)[12]	183	237	245	320	536
Household Expenses on recreation, communication, and miscellaneous activities (NRs.)	1218	1909	2312	3710	8315

*Source: Fifth Household Budget Survey (Nepal Rastra Bank, 2015) and author's calculations.

The second target is unachievable in the near future too. An examination of economic growth rate of Nepal clearly inhibits the possibility of meeting target 2. Recall that NTC's 192 kbps ADSL connection together with minimum PSTN tariff costs NRs. 1217 per month. Taking real GDP growth rate of Nepal as 5% per annum[13] and using the Broadband Commission's criteria of affordability, this connection would be affordable to an average Nepali only after 29 years. Even after considering growth rate for nominal GDP (as 15%) the 192 kbps connection would be affordable after 10 years. Not to mention, a 512 kpbs leased line by NTC costs NRs. 5,000 per month and will be remain virtually unaffordable by an average Nepali under the current trend of economic growth. Thus the second target is ambitious and will be missed even if the required network infrastructure could be built within the deadline.

The possibility of the third target is not directly challenged by the data presented in the earlier sections; however the chances of its realization are still doubtful. In 28 September 2016, NTA handed the responsibility of laying optical fiber from east to west span of the country along the mid-hills to NTC and half of this project is expected to be completed in the following year (The Himalayan Times, 2016).The task of connecting remaining districts to the mid-hill east-west optical fiber line is even more difficult because of the difficult mountainous terrains without roads.[14]

The fourth target is also dubious. There are several reasons that this fourth target will also be missed. The Networked Readiness Index devised by the World Economic Forum is a combination of 64 variables indicating multiple dimensions (Kirkman et al., 2002). The success

[12] Broadband affordability calculated taking average family size equal to 5.

[13] The average value of real GDP growth rate for Nepal over the past 7 years is 5%, see Nepal Rastra Bank (2015)

[14] Apart from technological and infrastructural challenges, regional politics has always been a barrier to development projects in Nepal. For instance, the Melamchi drinking water project that targets to provide safe water for Kathmandu city was signed on 2003 and was expected to finish by 2007 (see Thapa (2006)), but the project is still incomplete; see The Himalayan Times (2016)

of fourth target partially depends on the success of the third target. But besides network infrastructure, the NRI covers diverse dimensions like electricity, political rights, and quality of air transport. It would be wrong to hope the ICT policy could solely lead to improvements in the NRI. The statistics also do not support the possibility of Nepal jumping into the upper second quartile of nations according to this index in the short span of five years. Presently, Nepal ranks 118 out of 139 countries with a NRI value of 3.2 (World Economic Forum, 2016a). Nepal has lowest NRI value in the SAARC region; the indices for Afghanistan and Maldives are unavailable. The NRI indices and ranks for Nepal have remained almost constant in 2014, 2015, and 2016.

5.2. Mobile Broadband Affordability

The Nepali ICT policies have not explicitly addressed the issue of mobile access and affordability. Consequently, as with the case of household broadband, we have no detailed knowledge of mobile broadband affordability. The policy makers appear contended with prevailing telecommunications infrastructures as the major achievement of the past efforts. Though this is true up to some extent, penetrations statistics solely do not explicate the reality. The regulator NTA (2017) claims Internet penetration of above 50%, but has not yet addressed the question of usage directly.

There is a low usage of mobile broadband in Nepal; surprisingly, this is revealed from a report published by NTA itself. Basic calculations on the numbers given in NTA (2016) shows that average monthly data consumption expenses of the mobile Internet users of NTC and Ncell, the monthly expenses on data are NRs. 43 and NRs. 66, respectively.[15] In terms of data, the mobile Internet users of NTC and Ncell spend about 43Mb and 66 Mb per month, as 1Mb of data costs about NRs. 1 for both.

We have no evidence to conclude low income is the factor for this low usage of mobile broadband. As mentioned earlier, the literature considers income as a prominent factor in the adoption of mobile and mobile broadband. The mobile broadband affordability criteria by the Alliance for Affordable Internet indicate low income as a major probable cause of the non-use. According to A4AI (2017), mobile broadband is affordable if the cost for 1GB of data is within the 2% of monthly per capita income. From Table 8, we get 2% of monthly annual Income for each economic quintile as NRs. 73, NRs. 95, NRs. 98, NRs. 128, and NRs. 214, respectively. On the other hand, the tariff for 1 GB data for NTC prepaid mobile is Rs. 500, and expires in one month. For Ncell, a 1GB data pack costs about NRs. 250 and expires in one month. Mobile Internet is not affordable to any of the income quintiles as per A4AI's criteria. A4AI's criteria could be considered too restricted; a further study is required to extract the factors associated with low usage of Internet in Nepal.

6. DISCUSSIONS AND RECOMMENDATIONS

The evidences provided in this paper suggest, if not prove, Internet in Nepal has not been conducive to economic development. The penetration of household Internet in Nepal is 7% (NTA, 2017), which is well below the 20% threshold specified in the literature (Koutroumpis, 2009) to have any noticeable effect on the economy. In addition, the household Internet

[15] The report provides details of revenues generated by operators and ISPs from Internet data, the numbers of mobile Internet users for each operator, and the number of subscriber for each ISPs. Our estimates can be directly obtained from these statistics.

subscriptions are of low speed, largely ADSL connections, which cannot be called broadband according to the contemporary standards. The access of household Internet is city centric which naturally offers the more thoroughly distributed mobile telecommunications as the alternative platform for development planners. But the quality of mobile telecommunications deteriorates more in the rural areas and the usage of mobile Internet has been extremely low in Nepal, which restricts the fullest possible benefits of the infrastructure. The Nepali ICT policies need to be reworked.

A question that arises now is what should be done to extract the fullest benefit of ICT in Nepal. A full exploration of this question would be a research topic of its own; however, the research literature has provided sets of guidelines for the ICT policy makers worldwide. We resort to the framework of the World Bank (2016) to specify some policy implications of this work. This framework certainly has some limitations which will not examine (see Hanna, 2016). Our view is that the framework of the World Bank (2016) is a generic template that has to be fine-tuned according to the local necessities of a country.

The framework of the World Bank (2016; p. 31) provides guidelines for setting different policy targets for countries with different level of developments. To have the fullest benefits of the ICT, the Bank argues that a country should have the three analog complements of regulations that promote competition, skills to leverage digital opportunities, and institutions that are capable and accountable. Our focus in this paper is on the barriers of low access, low quality, and low affordability for the adoption of Internet in Nepal. These barriers, in the framework of the World Bank (2016), are basic barriers to Internet adoption. An examination of the two remaining analog complements is beyond the scope of this work. However, there are reasons to think that Nepal lacks both of these complements, as statistics show a low human development (World Economic Forum, 2016b) and a high corruption (Transparency International, 2016).

We now focus on the first analog complement; an environment that eases the fundamental constraints on Internet adoption. The widely advocated idea of increasing competition to loosen the basic access barriers is also reiterated by the World Bank (2016). In Nepal, there is virtually no competition between the Internet vendors. There are a total of six telecom operators in Nepal with NTC and Ncell jointly accounting for a 95% of market share (NTA, 2016). The regulator NTA (2016) itself admits that there is a lack of competition in the mobile industry because being a state owned company; NTC has bureaucratic complexities for procurement and decision making. Approaches to increase competition, such as providing ISPs the license to offer communication services using the VOIP technologies, have not been tried yet. Our first recommendation is to ensure the competition between the telecom operators and the ISPs.

As argued in an earlier section, the cost constraint on Internet adoption is too strong in Nepal. This creates a doubt that a competition between the operators alone is sufficient to assure the service quality because higher quality implies higher tariffs. In the context of household broadband, the debate between the Indian operator Bharti Airtel and the Telecommunications Authority of India (TRAI) illustrates this point. In January 2016, TRAI floated a draft directive to set ensure minimum broadband speed as 512 kbps. Opposing the draft, Bharti Airtel argued that an ISPs should be allowed to throttle the speed to 64 kbps after the assigned data limit to the customer, because ensuring minimum broadband speed as 512 kbps would raise data tariff for each customer (Bharti Airtel, 2016). It would be difficult for the regulator to assess such claims without a thorough statistics of users' socio-economic profile. In addition, the observation that high quality standards will make infrastructure services inaccessible to the poor (Baker &

Tremolet, 2000) adds more complexities to the task of quality regulation. At present, the policy makers have been relying on macro-level indicators and findings of global ICTD research. In this paper itself, we could not claim a convincing link between access, quality and affordability chiefly because of data scarcity.

Our second recommendation is therefore to conduct a nationwide census of ICT access, quality, affordability and related demographics. If feasible, the census should be performed on a periodic basis. The available demographic statistics for Nepal are sporadic which are mostly based on sampling of a very small fraction of the population. A through demand side dataset could also aid the task of strengthening the remaining two analog complements of digital skills and accountability of institutions.

7. CONCLUSIONS

The Nepali policy circle has an implicit belief in the potency of Internet infrastructure to uplift national development. Such beliefs are often explicated in the policy documents themselves in the forms of claims like the proposed ICT infrastructure would contribute significantly to portion the economic growth. The policy makers need to acknowledge that the relationship between Internet and development is not pre-determined. The ICTD literature has emphasized the role of minimum access, quality and affordability to have the benefits of Internet; nevertheless there are others requirements like human capital and appropriate content. Nepal has low Internet access, quality, and affordability. Major policy targets of proliferating ICT access and use are unrealistic as they lack grounded analysis of affordability, lest the other preconditions of human capital, content, energy infrastructure, and accountability institutions.

There are two sets of problems for the Nepali policy makers. First is the problem of proliferating Internet diffusion. Second is the task of quality assurance. Any attempt to tackle these questions relying on the research findings in the foreign countries is risk prone. We discussed how the goals of proliferating Internet access in Nepal are faulty as they are detached from the reality of low income. We also pointed the straightforward forward approach of setting quality standards could be troublesome because quality is intricately related with income and other demographic factors. A proper ICT policy and quality regulatory mechanism can be built upon a thorough bottom level statistics of ICT access, quality, usage and affordability. Currently, there is a dearth of ICT statistics that could guide the policy makers and researchers.

We recommend two set of activities that would aid the Internet diffusion in Nepal. First, the concerned authorities should immediately apply measure to increase competition between the telecommunication companies and ISPs. Second, for the formulation of long term plan, the authorities should perform a national ICT census, if possible periodically. The national census report is insufficient for inferring the determinants of ICT adoption as several details are missing. Only an exhaustive dataset of ICT access, quality and usage would guide the policy makers and ICTD researchers towards the goals of reducing the digital divide.

Our study has several limitations. The sample areas taken for the field study is definitely small to make bold generalizations of the findings. The quality tests of mobile telecommunications are performed using android phones, which reduces the numerical accuracy of the findings. Our arguments related to Internet affordability are based on preliminary calculations; we have not resorted to formal economic models. In addition, we could not provide a picture of human capital and energy infrastructure, which also have important roles in the ICT and Development phenomena. We think these limitations are tolerable because our objective was

to justify the necessity of bottom level ICT statistics and invoke a series of researches that could guide the formulation of a proper ICT policy for Nepal.

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