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An Empirical Appraisal of Consumer Preferences toward Internet Adoption

- A Discrete Choice Approach -

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Abstract

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Understanding the preferences of Internet users is useful for ICT (information and communication technology) policy and planning. The aim of this research is to reach a greater understanding of rural consumers' preference structures toward Internet usage in relation to both household and public Internet access. Since the number of previous studies conducted in this field is very limited particularly in the experimental area of this type of research, this work gives valuable insights, for both academics and professionals, into consumer research and ICT diffusion, and adoption in rural parts of developing countries. This study has adopted the stated preference method in order to elicit preferences of rural consumers toward the Internet use. A discrete choice model based on random utility theory with rank-ordered choice tasks, totaling 16 alternatives, is implemented for samples representing far western, western, eastern and central regions of Nepal. The analysis of the gathered data is based on the mixed logit model to elicit consumers' taste variations via random coefficient settings. In addition, heterogeneity is sought through interaction among Internet attributes with demographics and actual respondents' Internet access and usage pattern. The tested attributes are Internet service providers (ISPs), mode of connection, bandwidth, price, probability of disconnection as a proxy of reliability and distance as the reasons for the choice of access at home or in public places.

The analysis from the final study reveals a negative marginal utility upon the distance consumers need to travel to access the Internet. However, 43% of consumers are indifferent to the distance they need to walk/travel, which implies the need for public Internet access in rural and remote regions. The service fee for the Internet clearly exerts the greatest impact on preference formation, followed by the connection mode: wireless access or a wired connection. Consumers prefer wireless access with adequate bandwidth and an uninterrupted service. The survey data show that a considerable number of respondents use the Internet at college, or work, where they hardly ever need to pay for the service. This is also evidence for the price sensitivity that consumers experience in these regions. The government of Nepal should address this issue through universal service obligation policies for household penetration of the Internet.

The findings are imperative to devising policies for improved Internet penetration in rural Nepal, which should include the strengthening of community wireless networks to pool demand in community centers, generating an enabling environment for household access, and expanding wireless Internet capabilities with a reliable and fast service.

On the whole, this study expects to justify the need for a demand based analysis of Internet adoption by rural consumers in developing countries as a means toward forging a context-oriented solution to the so-called digital abyss: what kind of Internet access and service rural consumers are willing to adopt, and how much they are willing to pay for the service they intend to subscribe to, given their locational, economic, social, and other circumstances contributing to forming their preference structures.

Keywords: Internet service, stated preference, mixed logit, willingness-to-pay, heterogeneity, conjoint survey, discrete choice method, rural Nepal

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Contents

List of Figures

List of Tables

Chapter 1. Introduction

1.1 Overview

The Internet plays an indispensable role in the modern information technology revolution. It is the fastest diffusing ICT to date. Ever since the release of Mosaic[1] in 1993, Internet use has achieved remarkably high exponential growth. For instance, it took just 10 years for the Internet to reach 50% of American homes, compared to 52 and 71 years for electricity and the telephone respectively (Thierer, 2000). Another study showed that Internet access spread to 50 million users in the world in only 4 years compared to the radio and the television, which took 38 years and 13 years, respectively, to reach the same user access level (ITU, 1999). Moreover, recent data from World Internet Stat[2] state that the worldwide penetration rate is 30.2%, with an astounding users' growth rate of 480.4% in 11 years from 2000 to 2011. Another more striking phenomenon is the number of countries connected to the global network. From just over 20 in 1990, there were more than 200 nations connected to the Internet by July 1999 (ITU, 1999). Despite rapid worldwide diffusion of the

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[1] The first graphical web browser popularizing the World Wide Web (WWW)
[2] http://www.internetworldstats.com/ (as of March 31, 2011)

Internet, there has been a great disparity between developed, and developing countries – rich and poor regions – in terms of the number of Internet hosts, and Internet users.

Given the impact of the Internet on education, communication, business, science, government, and humanity, it is one of the most important and powerful creations in all of human history (Evans, 2011). It has become an incredibly valuable informational-resource infrastructure and its diffusion has become a worldwide phenomenon, which is why, the global technological and economic transformation requires urgent attention and action in order to turn the current digital divide into digital opportunities for all. The use of ICTs persistently expands, covering not only urban but also rural regions in the post-modern knowledge society. In this connection, the new social paradigm has changed the concept of "rurality" from a traditional understanding of space and location, to a new kind of social interaction, via virtual social networks, and that of empowerment through new opportunities (Butkevičienė, 2005).

However, developing countries are still faced with severe challenges related to the provisions for their inhabitants of good health, quality education, adequate housing, employment, and sufficient income to meet material needs. Given the poor infrastructure and inadequate access to computing in both homes and public institutions, Internet diffusion particularly in rural areas has remained a huge challenge in these countries although the Internet facilitates in the delivery of basic services, such as health and education, which are unevenly distributed in such areas.

1.2 Research motivation and objectives

The Internet has been widely adopted in developed countries; however, it is still regarded as a new service for the people who reside in rural areas of developing countries. The estimates of the ITU (2011) reveal that the two-thirds of the world population are still a long way from being able to use the Internet. Therefore, considering the Internet as a new service for rural people in developing countries, this study aims at examining what kinds of demand phenomena are going to take place; that is, what kind of interactive relationships the Internet will have with respects to consumers, service providers, regulators, and other related firms and agencies as a part of demand analysis and adoption of the Internet in rural areas.

Hence, the objective of this study, with the methodological framework of conjoint and discrete choice analysis, is to identify and analyze the preference structures of the rural Nepali consumers by conducting a comprehensive investigation of the taste and taste variance of rural Nepali Internet consumers in terms of ISPs, mode of connection, bandwidth, service fee, probability of disconnection as a proxy of reliability, and distance to walk to access the Internet. Thus, it tends to reveal the importance of the various components an Internet service is composed of. Secondly, the study will scrutinize the willingness-to-pay (WTP) that each component poses to the consumers. Thirdly, the study aims at deriving some policy implications through the empirical estimation results and simulation of the effects of the Internet in households and in public places. Moreover, the impact of socio-demographic variables on the choice made by consumers is also assessed to identify which rural population (in terms of gender, age, education, income and Internet usage behavior) should be given priority from the policy perspective. The impact of the availability of other ICT facilities such as personal computers (PCs) for Internet adoption is considered as well.

As far as the motivation for this study is concerned, there are a few pertinent observations that have led the author to further the research. There have been several studies undertaken with regard to universal Internet access in rural areas, and the digital divide between urban, and rural areas (James, 2003; 2004; Goldfarb & Prince, 2008; Savage & Waldman, 2005; 2009; Chaudhuri *et al.*, 2005). However, most of those studies have been undertaken from a developed-country perspective. Moreover, they tended to focus on Internet access either at home or in public places. Despite some of the studies having examined tariffs, bandwidth, and reliability, their implications were intended for areas in which adequate telecommunication infrastructure was already in place, or where the government, or the concerned agencies could afford the relevant infrastructure to be installed for broadband deployment. Some other studies concentrated only on such socio-demographic characteristics as gender, age, education and income as the influencing variables to examine the adoption behavior of households.

It is important to mention here that the low Internet penetration rate in developing countries impedes obtaining historical and/or revealed preference data.

This research, thus, aims at addressing the following questions, providing room for the limitations that have been uncovered in the previous literatures.

As this research aims at revealing the preference structure of rural Nepali Internet consumers, the research is designed to address two main questions:

What are the preferences of rural Nepali consumers with respect to the attributes of Internet access and service toward Internet adoption and how do these preferences influence their choice of the Internet service?

Given this knowledge, what policy implications can be drawn based on consumer preferences regarding Internet adoption in rural Nepal?

To provide deeper insights and to make the findings of this work relevant to policy implications as mentioned in the second research question, the first research question is further divided into the following sub-questions:

What are the parameter values of the attributes given in the choice sets?

By analyzing the choice patterns of respondents, the utility that every attribute level poses to the average consumers is derived. With this knowledge, it is possible, for instance, to rank levels and attributes according to importance.

What impact does each component have on the usage decision of the average consumer?

By incorporating the stated preference data into a choice estimation, this work will reveal the influence that every component exerts on the preference formation of the average consumers. This allows us to draw conclusions on the impact of every change in choice sets on the usage likelihood.

What is a consumer's relative WTP for the various package components?

By calculating the implicit value of the attributes, it is possible to estimate the relative WTP of one attribute compared to another. This allows us to express the consumer's preference in Nepalese Rupee terms.

Similarly, decision-making about the subsidization for enhancing rural Internet penetration depends on the access mode. The Internet may be considered an essential service relating to the overall socio-economic development of the nation, enhancing long-term human resources, and avoiding inequalities between information haves, and have-nots. However, any policy regarding subsidizing the service fee would still need to have a reasonably clear assessment of the possible efficacy of such a policy. This study, therefore, prescribes potential efficient subsidization policies on the ground of shared or individual household Internet access in rural parts of developing countries.

There are some studies on Internet adoption and diffusion, particularly in developed countries. They have mostly identified variables such as income as the explanatory variables. In this respect, this study contributes in identifying consumer preferences in terms of Internet use from relatively a new dimension: decomposing the Internet and its access into several mutually exclusive characteristics, using the stated preference data, and finding consumers' WTP in terms of the trade-offs between the variables, thereby eliciting measures to foster Internet penetration in rural Nepal. The findings of the study are expected to be generalized for the underserved consumers in the developing world, where the Internet penetration rate is quite low because of such barriers as price, infrastructure, and awareness. Thus, what motivates this study is the use of the discrete choice analysis to examine the WTP values to improve Internet penetration in rural Nepal, because there is a dearth of ICT literature on valuation work based on developing countries' experience.

One major contribution of this dissertation is in drawing attention to the possible usefulness of public access points in bridging the digital divide. Policies of subsidizing, facilitating and incentivizing public Internet access has proven to be more effectual than home access in the short run because of the problem of identifying households, which not only need financial support for purchasing Internet services, but which are interested in it in the first place.

The research conducted in this study is technology independent. Anyone who knows about the Internet and its use, with or without the knowledge of its technical specifications, is taken as a subject for the study. As a result, findings of the study will be applicable to the Internet adoption behavior of the general public.

This study is organized as follows. The second chapter covers the background and problem discussion for the study as to how important the Internet is for rural, socio-economic development in order to reduce the gap of the so-called digital divide. It also explains the need for demand-based analysis of Internet adoption. It also comprises the Nepalese ICT sector scenario. Literature that deals with consumer preferences toward Internet services and adoption of Internet services is the subject of Chapter 3. This chapter includes a review of the literatures that has used stated preferences, conjoint analysis, and discrete choice models in eliciting consumer preferences. The fourth chapter deals with the theoretical framework of the methodology setting for the study on consumer preferences and welfare with regard to Internet services in rural areas. The consumers' behavioral model for rural Internet services is defined. It also includes the estimation procedure for the model setting and framework. Insights into random utility theory are provided and enriched with an overview of the random coefficient model. In addition to that, the subject of WTP is briefly outlined. Chapter 5 reveals how the research has been carried out together with estimation results. The consistency of the model framework is also discussed based on the comparison, and combination of estimates among rank-ordered logit, interacting socio-demographics and the random coefficient models. It also contains simulation results for the efficient policy measures for improved Internet penetration in terms of households and shared public access. Chapter 6 draws conclusions and gives policy implications. The results are put in a context and potential actions are derived. The dissertation ends with the bibliography and appendices. Figure 1-1 elucidates the analytical framework of the dissertation.

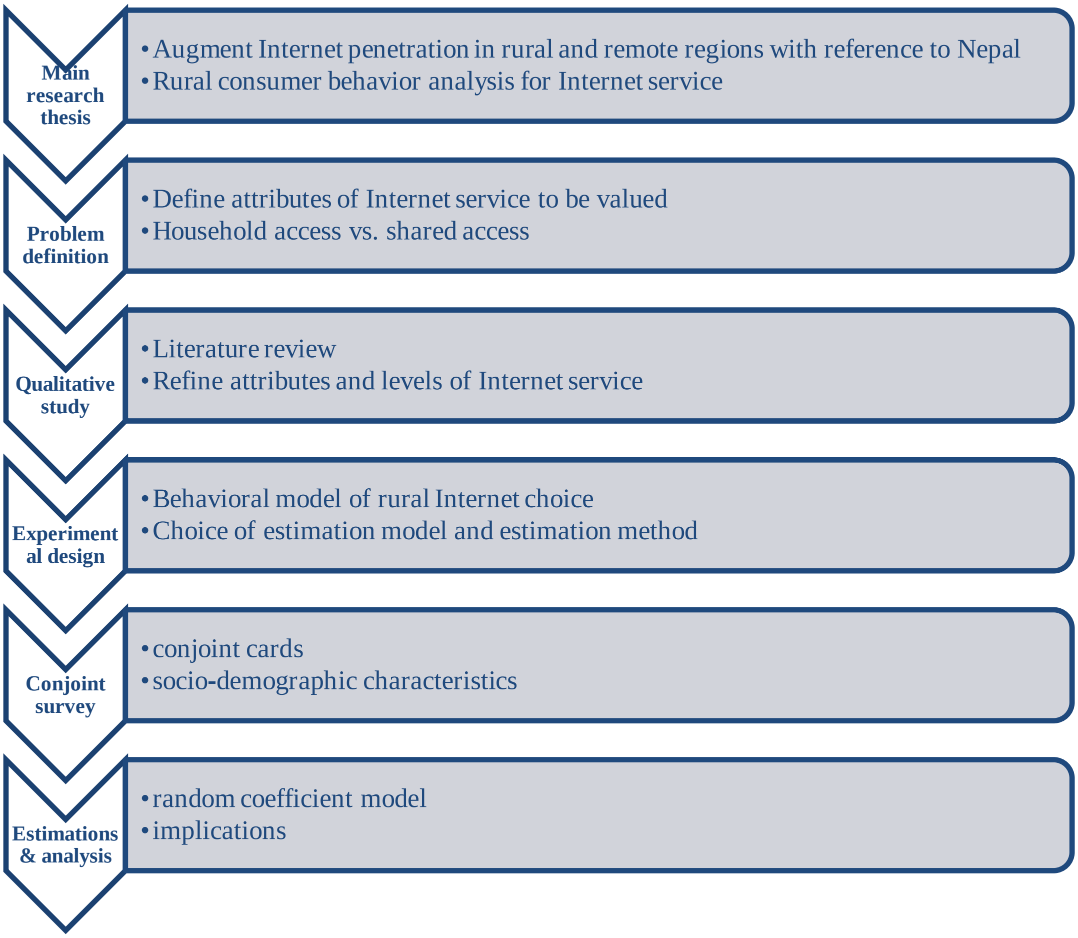

Figure 1-1: Analytical framework of the research

Chapter 2. Research background and problem discussion

2.1 Internet adoption

2.1.1 Internet and socio-economic development in rural areas

Let us imagine rural and remote region scenarios, where a farmer sells agricultural products in the market without any market information, where he is dependent upon traditional knowledge of the weather in his agricultural practices, where a patient gets no proper diagnosis and medication without a specialist doctor in a village health post, where a rural youth has no opportunity for work and goes to the city for job opportunities, or goes abroad to sell his cheap labor to foreign companies, where a student depends on inadequate learning materials, limited textbooks, and a limited number of available teachers for her studies, and where wives, and family members spend a lot of money making long-distance calls to their nearest and dearest who have gone overseas to work. Now let us see the flip side of the scenario – farmers selling agricultural products, knowing the market price before selling, getting up-to-date information on the weather, patients getting a proper diagnosis and medication upon the referral of a physician, youths getting educational information in their own village, taking computer classes, and exploring the world from their PCs, and other devices, finding lucrative business and employment opportunities in their own vicinity, and family members making cheap voice, and video calls. Such a world of information could have saved their time, money, and improved their livelihoods. Unfortunately, things are happening contrary to what is described in the second scenario. Very little information tends to reach the needy because of the infrastructure gap, content gap, ignorance and the economic gap, which is commonly termed as the digital divide (the gap between people who have access to digital technology – such as computers, the Internet, mobile phones etc., and those who have very limited access or no access at all).

Considering the second scenario mentioned above, the Internet has become inevitable for receiving and disseminating information and knowledge so as to be able to participate in the information society, a new social and economic paradigm restructuring the traditional dimensions of time and space within which we live, work, and interact (Loader, 1998). We use the Internet for information, communication, entertainment, and such specific applications as e-commerce, e-health, e-education, and e-government. It has become the universal source of information for millions of people at home, at school, and at work. However, there is a digital divide that affects a big percentage of the global population, as they have no access to the Internet, which aggravates social inequality, and widens the information gap. In order to lessen such a gap, an enabling environment should be built such that the use of the Internet becomes pervasive among rural communities that seek prosperity and welfare, that is no different from the access achievable by urban dwellers, who often tend to enjoy innovations right after their launch, as studies have identified that wealth, and education are major factors driving Internet diffusion, particularly with the wealthy, educated, young, male, and urban population as innovators (ITU, 1999).

It is in this context that it is worth mentioning that the World Economic Forum[3] 2010 formed a Telecom Industry Global Agenda Council with the goal of providing everyone with Internet access by 2015. However, such a goal for countries such as Nepal will not easily be achieved, owing to challenges derived from a huge urban–rural divide. Lack of sustainable infrastructure, lack of affordability, and lack of scalable applications have triggered severe challenges in rural areas, particularly in regions that are far-flung and sparsely populated.

According to an estimate by the ITU, as mentioned in Figure 2-1 below, one-third of the total population of the world is using the Internet. Compared to the year 2006, Internet users in developing countries have increased by 18% in 2011 (ITU, 2011).

Affordable Internet access has become essential for improving people's livelihoods. However, 35% of the world’s population has no access to the Internet, particularly those in the rural and underserved areas, and they are lagging behind as they are deprived of taking advantage of the social and economic opportunities of the Internet.

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[3] A Swiss non-profit foundation, which describes itself as an independent international organization committed to improving the state of the world: http://www.weforum.org/

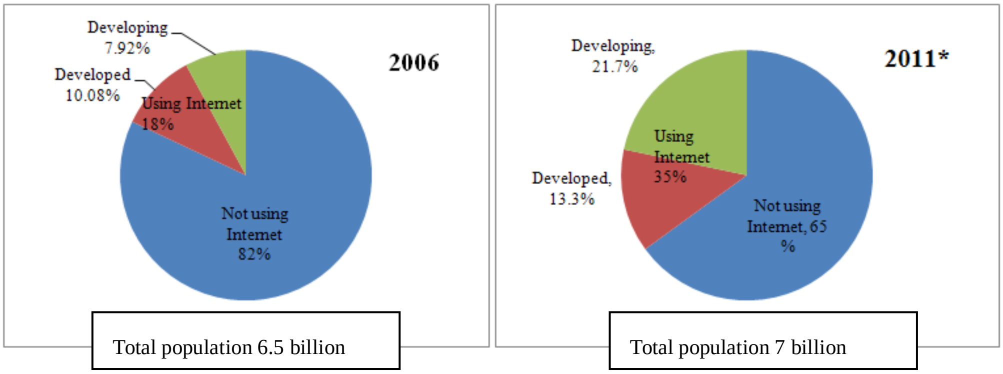

Figure 2-1: Share of the Internet users in total world population

Note: * Estimate

Source: ITU World Telecommunication/ICT Indicators database

It seems that conventional commercial solutions have failed to provide affordable Internet access to society at large, at least in developing countries. According to the Internet Usage Statistics, 78% of the world's population, particularly in rural and underserved communities in developing countries, does not have reliable and affordable Internet access. Such communities usually lack the viable commercial incentives necessary to attract telecommunication companies. This is mainly because of their remote location, characterized by relatively long distances from cities and district headquarters, and a high degree of locational isolation with low population density, and meager socio-economic infrastructure, harsh terrain, the high costs involved in deploying and maintaining infrastructure, residents with low-income and low levels of education with limited WTP for technology use. Therefore, they do not necessarily benefit from the wide range of digital resources and opportunities on the web.

Considering the above realities, many initiatives seek to bring affordable Internet access to rural and remote regions around the world. The World Summit on the Information Society (WSIS) 2003 emphasized establishing "sustainable multipurpose community public access points" that provide affordable or free-of-charge access for the citizens to various communication resources, particularly the Internet. This is backed up by the fact that the ownership of technologies such as the Internet is not feasible for single households in rural areas of developing countries. Along the same lines, James (2002, 2004) urges that the access to the Internet in such areas should be based on the communal rather than the individual level. Similarly, Molinari (2011) stresses how community access centers should be developed to enable more connections, better communication, and a way for more people to share their ideas[4]. On the other hand, offering wireless Internet is considered as one of the most successful ways to rapidly expand access. From this perspective, shared use can be a complement to a strategy that involves giving each person their own wireless device. Eventually, the price of such devices will be affordable so that everyone can own their own device. There are some examples that have proved that inexpensive wireless signals can now reach further into remote and rural regions for a small

[4] Excerpt from http://www.youtube.com/watch?v=kaxCRnZ_CLg, in which Aleph Molinari, founder of the Fundación Proacceso ECO and Learning and Innovation Network (RIA), illustrates a more cost effective model than the One Laptop per Child model to bring the digital revolution to more people in underdeveloped and underserved areas.

investment. The Nepal Wireless Project[5] is one such example of such an entrepreneurial initiative, which has been successfully adopted in a few, remote, Nepali rural villages.

Together with the views above, and with advances in ICT, especially with the growth of the Internet, and the introduction of wireless Internet with broadband technology, distance has become much less a barrier for economic development in rural communities, simply because the Internet can lead to an improved standard of living through job creation, higher income, better education, healthcare, and additional social services irrespective of how far away from an urban center, or how remotely people live. Good ICT services in the community enhance the competitiveness of local enterprises, enable them to cooperate with similar enterprises in different locations, and attract more businesses to the community (Min *et al.*, 2001). The Internet has made it possible to swap digitized information with more speed, ease, and convenience. Messages sent via the Internet Protocol (IP), primarily e-mail, have increasingly replaced traditional telephone and fax communication. High-speed Internet or broadband technology has continued to drive the Internet to substitute for older forms of communication. Even with wireless broadband technology, many activities that require exchanges of a large amount of data, such as telemedicine and e-commerce, are now feasible for rural communities.

[5] http://www.nepalwireless.com.np/

Reiterating the scenarios elucidated at the beginning of this chapter, some of the changes in the way businesses operate with the Internet in rural areas can be outlined as follows:

a) Local e-commerce: Electronic commerce includes every type of business transaction in which the participants (i.e., suppliers, end users, etc.) prepare for or transact business, or conduct their trade in goods or services electronically. Although e-commerce is a relatively recent phenomenon for rural people in developing countries, it will have a profound impact on life in rural areas. Rural people, for instance, are enabled to buy and sell their products in the local market through the local intranet.

b) Government and education service delivery: Distance education is a way of providing students in rural areas an opportunity to participate in classes far away from their homes. This also provides the students in rural areas with opportunities to interact with the outside world, and opportunities to develop and maintain technological competence. Tele-teaching and tele-training programs and e-learning materials help students, teachers, and rural communities through e-libraries.

c) Telemedicine: The disparity in the level of medical services available between urban and rural areas can be overcome, largely, by providing doctors and nurses in rural areas with the capability to interact virtually with physicians and resources in urban areas. In addition, distance education using wireless technology can enhance education, training, and support for patients, doctors, and nurses. Telemedicine breaks down geographic barriers and can be cost effective through treating patients on numerous remote sites who may not have good access to a comprehensive hospital.

d) Job creation: The promotion of ICT, particularly the Internet, among rural communities helps generate jobs for the younger generation through ICT-related services such as communication centers, VoIP phone services, remittance services, and virtual ATM machines. A low-cost Internet café, for instance, is able to offer telephones, the Internet, multimedia, a PC with a web camera, a printer, and power back-up to serve people at the bottom of the pyramid.

e) Accumulation of social capital: As mentioned above, social and geographical separation is a key challenge of life in rural and remote regions. Residents of such localities rarely see friends and family who live at great distances. The Internet creates more opportunities to increase communication and contact with the friends and family members of those residents, to develop social capital by exploiting social networks and to promote inclusion in a broader society for a positive social environment (Katz & Rice, 2002; Stern & Adams, 2010; Collins & Wellman, 2010).

2.1.2 The need for demand-based analysis of Internet adoption

Given its huge potential for socio-economic development, ICT adoption, particularly the Internet, has been a focus of public policy issues in developing countries. It seems that both industry and government have concentrated on supply-driven measures to increase the deployment of ICT infrastructure. These include subsidies for the universal provision of Internet services, providing tax, and non-tax incentives to access providers to build networks, and the funding of appropriate infrastructure initiatives (ITU, 1999; Rosston *et al.*, 2010). Before giving such direct or indirect support to the supply providers to address the supposed digital divide, it would be wise to take a closer look at the current market for Internet access, and stimulate the consumers prior to adoption. This requires a consumer-level study to understand how the forces and mechanisms identified at the global and national/regional levels, and other emergent factors influence the perception, preferences, motivation, evaluation and experience of individual Internet users. For instance, in order for service providers to take a lead in Internet subscription, it is inevitable for them to put the users first when it comes to service and fee design. In order to drive service adoption and user satisfaction, it is important not only listen to the users' stated needs and wants, but also to their latent desires (Flores, 1993), which can be realized by getting insights into the user's preference structures. The insights can be used to create packages that exactly meet the users' needs.

2.2 Nepal and ICT development

Nepal, located between two of the world's most populated BRICS countries – India and China – is a small country of approximately 30 million people and consists of 73% of hilly and mountainous lands, with the altitude varying between 1,000 and 4,000 meters. Over half (51.57%) of the population[6] live in this region, which is geographically very challenging, and adequate road and telecommunication infrastructure is yet to put in place.

As far as the Internet in Nepal is concerned, unlike in India and many other Asian countries, the private sector first connected Nepal to the Internet in 1995, although the incumbent public telecommunications company, Nepal Telecom, had a monopoly on international data connectivity, for which private ISPs were compelled to rely on. When Nepal joined the world of the Internet, it was used for e-mail only. At that time, the cost of e-mail was NRs. 20 (US$ 0.25) per KB, which was too high by Nepalese standards. Initially, there were about 150 e-mail users[7].

According to the ICT Development Index (IDI)[8], 2011, by ITU, Nepal ranks 134th with an IDI score of 1.56 (with a slight improvement from 1.28 in 2008) out of 152 economies; thus, Nepal is not making encouraging progress in the ICT sector, with weaknesses in access, use, and skills (Table 2-1).

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[6] http://www.cbs.gov.np

[7] Byoma Tamrakar, http://www.helsinki.fi/lehdet/uh/499h.html

[8] The Index, developed by the ITU, combines 11 indicators into a single measure to be used as a benchmarking tool globally, regionally and at the country level. These are related to ICT access, use and skills, such as households with a computer, the number of Internet users, and literacy levels.

Table 2-1: Global IDI ranking of Nepal

Economy	Rank 2010	IDI 2010	Rank 2008	IDI 2008
Korea (Rep.)	1	8.4	1	7.8
Sweden	2	8.23	2	7.53
Iceland	3	8.06	7	7.12
United Kingdom	10	7.6	10	7.03
Japan	13	7.42	11	7.01
United States	17	7.09	17	6.55
China	80	3.55	75	3.17
India	116	2.01	117	1.72
Nepal	**134**	**1.56**	**137**	**1.28**
Bangladesh	137	1.52	135	1.31

Excerpt from ITU, ICT Development Index 2011

However, we can find, as in Figure 2-2, that Nepal has recently experienced significant improvements in its telecommunication infrastructure and high growth in the number of Internet users during the past few years, albeit through a very limited traditional, copper-line telephone network. Lee and Lee (2009), and Howard and Mazaheri (2009)'s argument about the positive role of fixed telephones and mobile telephones in the diffusion of the Internet is noteworthy in the Nepalese context as well. The responsible agents in such a drive are social networking sites, the need for instant information retrieval, so-called micro-blogging, constant updates of status notes and other web features. Another driver of Internet growth certainly is the ongoing enhancement of Internet network technologies. The evolution from dialup connections to ADSL, cable TV, wireless hotspots, and optical fibers has several effects. Wireless or cellular phone networks have leapfrogged the fixed-line system, making a digital jump, which is a very strong contender for countries such as Nepal when considering diffusing ICTs. As Howard and Mazaheri (2009) argue, connectivity through mobile phones is relatively cheap and ownership of PCs is relatively expensive. A further driver concerns the pricing strategies of service providers, which has a significant impact on usage and growth of the Internet, particularly for the mobile Internet and wireless Internet. Falling prices are fuelling growth in adopting Internet services. Particularly with rural consumers, it is due to the increasing awareness about the advantages of the Internet in the quest for a better livelihood.

Nevertheless, a striking point is that the Internet penetration rate, as shown by the Nepal Telecommunications Authority, is 14% (as of December 2011)[9], from which it can be seen, if we take out the share from the mobile data service, that the rate comes to a mere figure of 1.2%[10] (Figure 2-3). Despite privatization efforts and market competition, which are lowering telecommunications costs, Figure 2-3 reveals that Internet access, largely, is still limited to those who are at the top income level, and those who live in the cities.

There is, so far, no country level data available as such to show what the actual

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[9] http://www.nta.gov.np/articleimages/file/NTA_MIS_58.pdf

[10] The mobile data service covers the service of two telecommunications companies, Nepal Telecom and Ncell, with their GPRS/GSM service and United Telecom Limited's CDMA 1X. Other Internet services referred to are dialup (PSTN+ISDN), wireless modem, optical fiber Ethernet, cable modem, and ADSL.

rural Internet penetration rate is; however, it is plausible to affirm that Internet usage is basically an urban phenomenon that excludes the majority of those living in rural and remote

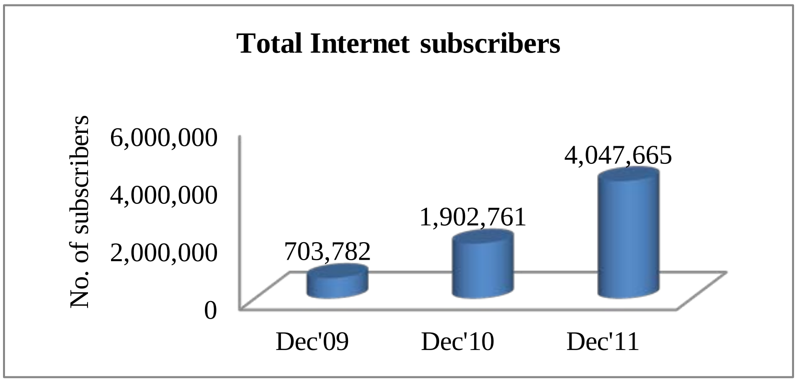

Figure 2-2: Internet subscribers in Nepal (2009-2012)

Source: Nepal Telecommunications Authority

regions. The poor communication infrastructures, low levels of knowledge, and limited incomes have put the rural people in a disadvantaged position, resulting in a huge digital divide between the urban and the rural, and between the more developed cities, and the vast rural areas.

However, with the continued improvement in the technological paradigm, the average cost for using the Internet has dropped dramatically over the last few years. The rapidly improving innovations (such as the access platform and bandwidth) have made the quality-adjusted price even less. Given such a scenario, despite its low penetration rate in rural areas, the Internet is perceived as a new engine for rural empowerment, and quite a number of wireless networking projects have been launched in recent years to test the assumption of rural empowerment.

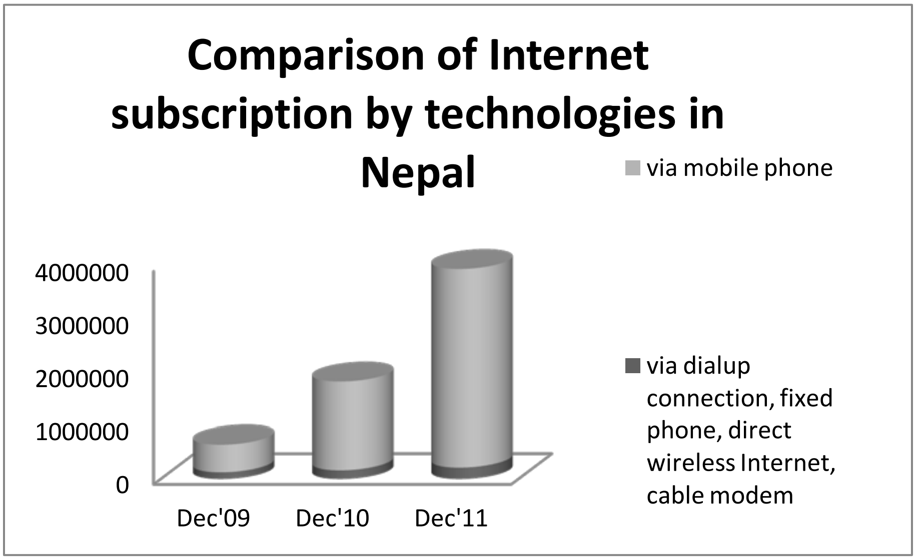

Figure 2-3: Comparison of Internet subscription by technologies in Nepal

Source: Nepal Telecommunications Authority

2.2.1 Market overview

The Nepali Internet market has four substantial players: Nepal Telecom (the Nepali incumbent telecommunications company), Ncell (a Teliasonera[11] shareholder), United Telecom Limited (an Indian IT shareholder), and other local ISPs. Among the local ISPs, Worldlink has the biggest network both in urban and rural parts of Nepal. It owns an international private-leased, circuit network (IPLC) via undersea fibers to Singapore, and peers directly with Singtel[12]. Mercantile Communications, the first ISP to introduce the Internet to the Nepali market, is currently focusing on providing the services to big business houses and international organizations. It is also a leading

[11] TeliaSonera is the dominant telephone company and mobile network operator in Sweden and Finland.
[12] http://www.worldlink.com.np/company/

bandwidth provider for other ISPs in Nepal. In addition, Nepal Wireless has come to the forefront as a rural wireless ISP. Initiated in 2001 as a pilot project in *Nangi*, a small and remote village of Nepal, with the help of foreign supporters and volunteers with the objective of the socio-economic transformation of rural villages in Nepal by optimum use of ICTs, it is promoting wireless technologies connecting rural parts of the country to urban areas so that the transfer of technologies from urban to rural areas can be made possible through the Internet and Intranet.

As far as telecommunication companies are concerned, Nepal Telecom was the only state-owned telecommunication company in Nepal until 2003. United Telecom Limited started providing services in 2003 as the involvement of the private sector in the development of the telecommunication services was sought under a liberalization policy. Nepal Telecom was converted into a Public Limited Company in 2004. Ncell (formerly known as Spice Nepal), established in 2004, is the first private GSM mobile operator in Nepal. Ncell claims that it is committed to continuing to create value for its subscribers by offering the best quality of network and service, innovative solutions, and attractive campaigns that will make communication easier, and more fun. The Internet subscribers' data reveal that the mobile services of Nepal Telecom and Ncell have contributed toward bringing the Internet over mobile phones to 3.7 million subscribers, which is a 94.6% share of the total Internet penetration rate in the country, as shown in Figure 2-3. This clearly reflects that the mobile telephone has not only contributed significantly to voice services but also to data services.

2.2.2 Market drivers

The widespread use of the Internet, both on a global and national scale, registers steep growth rates in the use of ICT and the Internet, in particular. Certain factors have been identified in several studies as the main drivers for those growth rates.

The social networking phenomenon can be taken as the main driver. The phenomenon has a huge number of Nepali users sharing their photos, favorite songs and details about their family, friends and colleagues on social media and other Web 2.0 features such as social networking (for example, Facebook, LinkedIn, Hi5), micro blogging (Twitter), photo-sharing (Flickr, Picasa Web), video-sharing (YouTube), and weblogs with constant updates via status notes. What has prompted the many Nepalese – as has occurred in other countries – to the phenomenon, is the core technology with higher interactiveness[13] among the services of the World Wide Web[14].

Another driver of Internet growth certainly is the ongoing enhancement of Internet network technologies. Nepali ISPs have offered services ranging from dialup to a WCDMA-based 3G system offering High-Speed Downlink Packet Access (HSDPA)

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[13] refers to an individual's power to comment on, share, like or dislike any content, thus forcing producers to set their priorities according to audience choice

[14] In "Saga of social media" by Ujjwal Acharya in the English Daily *My Republica* of June 30, 2011

high-speed Internet up to 14.4 Mbps, albeit with most of the service plans concentrated in urban areas such as the Kathmandu valley, in particular. With the high growth in cellular mobile phones by two Telco giants, Ncell and Nepal Telecom, the General Packet Radio Service (GPRS) – which enables services such as Internet browsing, e-mail on the move, multimedia messages, and so on – has become popular among the mobile phone users in order for them to stay online and connect with family and friends. The Nepal Telecommunication Authority (NTA) MIS report as of February 2012 reveals that 14% of people use the GPRS service for Internet use out of the total Internet penetration rate of 15.2%[15]. In the rural parts, community-based wireless services are on the rise.

The other driver concerns the pricing strategies of service providers. With competitive pricing of their services, for instance, by offering attractive packages, service providers might have a significant impact in terms of acceptance and growth of Internet use. Particularly in Nepal, where Internet tariffs are above average compared to other developing countries Internet markets, appealing packages could further spur growth.

2.2.3 Accessibility and service fee structures

Tariff structures for Internet subscription in Nepal are competitive owing to the competition among the service providers. Tariffs can roughly be classified into two

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[15] http://www.nta.gov.np/articleimages/file/NTA_MIS_58.pdf

categories: unlimited single-user and fixed-hour packages. Fixed-hour packages per month for a PSTN terminal costs roughly NRs. 300 and an unlimited single user package for PSTN costs NRs. 500, while an ISDN unlimited, single-user package with 64 kbps data speed roughly costs NRs. 1500 and with 128 kbps data speed costs about NRs. 3000. Different tariff rates are applicable for ADSL broadband services, GSM mobile Internet and CDMA wireless Internet in terms of the subscription plan such as volume-based and unlimited monthly plans. Regarding the mobile Internet, the price for the data option cannot be estimated precisely, as this part of the bundle is not available separately. Roughly, the additional charge should be between NRs. 1000 and NRs. 2000 a month, coming with 128 kbps of included traffic. These price structures are largely applicable in cities. Internet service in rural areas provided by rural ISPs and telecommunications companies also follow the above price structures with limited offers. On the other hand, the Internet brought through VSAT (very small aperture terminals) technology in remote rural areas costs NRs. 12,000 to 13,000 per month for 64 kbps data service, which is too costly for rural residents[16].

[16] Excerpt from the *Nagarik* News daily of January 30, 2012

Chapter 3. Literature review

There are many econometric studies on the adoption of the Internet in rural areas, and on the determinants for lessening the digital divide, typically using a variety of socio-economic, demographic and policy variables, both at the individual and aggregate levels (Rosston, Savage & Waldman, 2010). Some other studies have used revealed and/or stated preference data from household surveys to explain how fee and non-fee characteristics affect consumer utility. This chapter, thus, reviews the existing literature on Internet adoption and the digital divide, together with the literature on the state-of-the-art methodologies for deriving utility maximizing behavior for Internet adoption in general, thereby, providing the rationale for the need for this study.

3.1 Studies on Internet adoption and the digital divide

Several pieces of research have been undertaken concerning the digital divide and universal Internet access in rural areas (James, 2002; 2003; 2004; Savage & Waldman, 2009; Heeks, 2008), focusing on Internet access either in households or public places.

Torero and Braun (2006) explain Internet services as an increasingly important tool for the delivery of pro-poor public goods and community services – such as the use of VSATs for wireless Internet access in remote areas and voice-recognition systems for illiterate users – especially at cost drops, and as technologies advance to overcome difficulties in service provision. Nonetheless, Internet service penetration is still low, and the majority of Internet users are in developed countries and the more affluent segments of developing country populations. The use of the Internet is considered as an effective means to integrate socially excluded people more fully into society, because living in rural regions should not be the key issue for being excluded.

They further assert that ICT's role in development is unclear, especially without convincing evidence for its impact. The authors provide several case studies, although they show significant variation in terms of impact. Sciadas (2003) focused on the macro level in developing a framework to quantify and monitor the divide in order to compare data across countries and within countries over time. The authors found that the same kinds of ICT that create the digital divide (Internet use, cellular phones, and Internet networks) are also the ones that have the potential to overcome that divide.

Whitacre (2010) sees rural communities as having supply- and demand-side deficiencies when dealing with Internet access. Telecommunication companies are reluctant to provide the necessary infrastructure to rural areas because of lower population densities and these areas also tend to have lower levels of factors such as education and income to persuade the providers over the access decision. Although market liberalization has augmented expanding the basic communications infrastructure and lowering the costs, market forces alone are inadequate to induce companies to invest in those areas. Competitive forces also tend to encourage providers to focus on high-margin groups, the disadvantaged and low-income populations.

Based on the complete data for broadband supply and demand from the state of Oklahoma, Whitacre (2010) applies econometric techniques to estimate rural broadband access rates when supply diffusion occurs at the same rates as in urban areas, leading to policy suggestions for helping to bridge the rural–urban divide.

Under such circumstances, Choi (2004) prescribes that governments should make investments in such underserved and disadvantaged areas so as to achieve a level of universal service. Although community access centers have become more prevalent, they are limited in number and reach.

Shields (2009) argues that Nepalese government policies and the regulatory environment have failed to create the competition necessary for rapid expansion of information access through ICTs, particularly in rural areas. Although Nepal nominally privatized its national telecommunication operator and created an independent regulator, this seems superficial as it pays lip service to the privatization philosophy rather than creating true competition. Elaborating further, Shields (2009) finds restrictive approaches to licensing and excessive fees to be a barrier to civil society organizations, non-governmental organizations (NGOs) and small and medium enterprises (SMEs) being able to access information at the local level, resulting in very limited access to information outside a few urban centers, with one of the highest access costs in any of the developing countries. Nevertheless, government planning and policy documents have continued to stress the need for ICT as the cornerstone for the ultimate development of the country. Policy changes such as the removal of licensing requirements for the industrial, scientific, and medical (ISM) frequency bands can be taken as a hint at a loosening of the restrictions and the removal of prohibitive licensing fees.

Ruth and Giri (2007) present a wireless Internet project in Nangi village in Nepal as one of the successful projects that “fits in the rare 15% of success stories” and suggest five lessons from the case that can be useful to the e-government community: a comprehensive, agreed-upon plan; enthusiastic participants and favorable publicity; appropriate IT interventions; sustained follow-on projects; and skilled leadership by home-grown talent. The five characteristics of the *Nangi* experience have made the project a regional success and a model for other implementations. The study will be instrumental in prescribing policy implications for this study.

Vaidya and Shrestha (2002) prescribe wireless networks as the economically viable means of Internet connection for the sparsely distributed population in the remote areas of Nepal. Locally available and appropriate renewable energy sources can be used for electricity in the unconnected remote areas. The study is relevant to the current study in defining one of the attribute – mode of connection: wireless access or a wired connection.

In the context in which the Internet has been seen as an indispensable tool for the socio-economic development of a country, Chaudhuri, Horrigan, and Flamm (2005) assert that the demand for the Internet might be inelastic with respect to price and that other factors might have a larger contribution to make to the diffusion of the Internet in rural areas. A spatial explanation is sought to account for the substantial variation observed in access price. Subsidizing access price for the rural Internet users would be of little marginal value in that case. Such a policy might also distract resources away from more productive measures to kindle Internet demand. Similarly, they issue a caveat that the adoption of the expansion of the supply of Internet infrastructure without the study of consumer behavior in the area is unlikely to succeed, as it will not cater for the preferences of the money-conscious consumer. The study also finds the influences of income and education to be particularly strong.

Heeks (2008) forwards the reasons for the priority that should be given to ICT applications for the poor in developing countries. They include the "potential benefits of applying new technology to address mega-problems arising from climate change to conflict and terror, from disease to resource depletion”, which are phenomenal issues for the poor people in developing countries. Ironically, in the globalized context, the problems of the developing countries may become those of the developed ones. On the contrary, the poor, when they improve their standard of living, can afford more of the goods and services from industrialized countries, leaving behind the so-called thread of the developing and developed. Furthermore, the digital era of the 21st century has engrossed people in rural parts to a greater extent. They may not be technically well informed or rich enough to afford digital gadgets but they are gradually awakening to the understanding of their need for a better life.

Heeks (2008) further asserts that a supply-driven focus marginalizes the poor, who are largely seen as passive consumers, while a demand-driven focus centralizes them, seeing them as active producers, and innovators. The Heeks (2008) study is instrumental in forming the research motivation for demand analysis through preference structure analysis in this study.

Goldfarb and Prince (2008), using an 18,439 American-household sample in 2001, assume two stages in household Internet adoption in their empirical study. In the first stage, households decide whether or not to adopt the Internet service. If they adopt the service, in the second stage, they choose how much time to spend online, in which the households face utility maximization, conditioned by the leisure time spent on the Internet, other leisure time, money and total leisure time. In this setting, type-

II Tobit regression is used to estimate adoption and usage with revealed preference data. They find that income and education correlate positively with Internet adoption but they are negatively related with hours spent online. In the condition of post-adoption with a fixed connection and near-zero usage fees, low-income/less-educated people spend more time online due to their lower opportunity costs relating to time.

In conclusion, it can be inferred that the above-mentioned studies have typically used aggregated data and reduced-form model specifications to estimate the effects of income, education and location on Internet penetration rates. They do not measure the direct impact of prices and other quality characteristics on Internet demand and, as such, provide little information on the value households place on different Internet services, and on individual service characteristics.

3.2 Studies on utility maximizing behavior – based on RUM

Some studies mentioned above have employed a discrete choice model describing the relationship between explanatory variables and the outcome of the choice of Internet adoption. Other literature under this sub-heading has modeled the analysis using the assumption of utility maximizing behavior. This study follows the latter trend of using a discrete choice model.

Using survey data obtained from revealed and stated preferences, Savage and Waldman (2005) estimate a random utility model for Internet service choice, seeking respondents' preferences in terms of attributes such as always-on functionality, price, speed, installation, and reliability of the Internet. They find that the reliability of service, speed, and always-on connectivity are important access attributes; thereby, consumers are willing to pay up to $16.54 for a more reliable service, $11.37 for a substantive improvement in speed and $5.07 for “always-on” functionality. Similar to Goldfarb and Prince’s (2008) finding, they also reveal that a preference for high-speed access comes from households with a higher income, higher education, and multiple PCs.

Savage and Waldman (2009) extend their analysis by focusing on the preference heterogeneity between urban and rural households. This study attempts to answer two questions: what value does a household place on higher bandwidth Internet access and how does that valuation of a household vary in terms of its members’ technical ability and its location? The study employs stated and revealed preferences, and examines the heterogeneity in the preferences of consumers by the variation in demographics and by random parameter settings. The study reveals that high-ability, urban customers are willing to pay a substantive monthly premium for an improvement in speed relative to rural customers. Savage and Waldman (2009) reiterate that reliability and speed are the most important Internet access attributes for both rural and urban households at a cost of approximately $8 to $25 per month for low- and high-ability households, respectively. However, an increase in ability translates into a $3.07 increase in WTP for bandwidth per month for urban households compared to $1.15 for rural consumers.

The authors of the paper precisely define the benefits of bandwidth and time online from the “labor-leisure choice” perspective. By incorporating the “essential time” into the maximization of consumer utility in terms of consumption, leisure-time bandwidth use, and online time, Savage and Waldman (2009) argue that an increase in technical ability leads to a growth in demand for bandwidth, and due to the longer distances involved for rural areas, the marginal time saved from an increase in Internet bandwidth is probably larger than in urban areas, causing a higher bandwidth demand.

Combining household data obtained from choices in a real market and an experimental setting, Rosston, Savage, and Waldman (2010) further estimate the marginal WTP for improvements in eight Internet service attributes. Again, reliability and speed are identified as the most important characteristics of Internet service. Willingness-to-pay increases with better education, more income, and more online experience, while it decreases with age. This study confirms the higher WTP in rural households for speed, as in earlier findings.

It is contextual to briefly review some more studies that deal with preference and demand for broadband Internet services, mobile services and digital television in Japan and Korea. Ida and Sato (2006) use conjoint analysis and a nested logit discrete choice model to examine consumer preferences for broadband Internet in Japan.

Analyzing the heterogeneous and rapidly changing consumer demand for high-speed Internet access services, they reveal that different access technologies lead to differences in WTP. People who do not possess FTTH, for instance, have a higher WTP for such a service. With this finding, the authors confirm the discussion by Louviere, Hensher, and Swait (2000) that the "stated preference method primarily takes into account the innovative qualitative changes of goods or services"; hence, "stated preference is thought to indicate not a temporary preference but a long term preference".

Kasuga, Zeng, and Shishikura (2008) examine Japanese consumers' preferences toward the basic attributes of digital television using the stated preference method and analyze how consumers with strong preferences for new information devices (hardware) and content (software) behave when choosing a digital television. Using a mixed logit model for the analysis, the study reveals that consumers are affected not only by hardware attributes but also by software factors in choosing a digital television (network externality). Similarly, consumers with strong preferences for broadcast and telecommunication services in terms of both hardware and software show significant preferences when choosing a digital television.

Lee and Koh (2005) estimate consumer preferences regarding the future multiuse-converged mobile terminal to predict the future direction of device convergence for mobile phones. Their research questions include how large the display should be, how portable the future mobile device should be, what kind of input equipment would be most likely to be adopted, what level of Internet service quality should be provided, and whether the terminal should be compatible with a PC or go with diverse applications. Employing conjoint analysis and a mixed logit model using a Bayesian approach with Gibbs sampling, they find that consumers generally prefer a keyboard and a medium-sized display, although most consumers are indifferent to whether the terminal provides high-quality Internet service and to whether it operates many kinds of application programs or programs originally designed for PCs.

Lee *et al*. (2006), adopting a random coefficient discrete choice model, estimate the switching costs and consumers' valuation of the number-portability services in the Korean mobile communications market in order to provide some implications for competition strategy in the mobile communications market. They find that a significant level of switching costs still remain despite number portability, the introduction of which was supposed to lower switching costs. To further lower the existing switching costs, two striking policy implications are drawn. First, a fair evaluation of the quality and price of service providers should be made. Second, service providers should be compelled to establish an easy and simple brand-switching system using the Internet. This study is applicable for the current research as a methodological insight.

Zubey, Wagner and Otto (2002) measure the preference structure between IP telephony and PSTN services using conjoint analysis to suggest the attributes that best meet consumer needs, and found that call quality, followed by reliability, is an important attribute for consumers.

Long (2010) attempts to design a methodological framework to capture rural Vietnamese consumer preferences in terms of Internet use both at home and in public Internet access places. The study incorporates heterogeneity through a random coefficient setting and interaction of Internet attributes with socio-demographic characteristics including a conventional rank-ordered logit model to elicit preferences toward selected attributes of the Internet. He finds that the majority of people have negative marginal utility in terms of accessing the Internet away from the home setting. Similarly, the majority of rural dwellers are indifferent to Internet speed, prefer ADSL and cellular technologies to access the Internet, are sensitive to ISP brand names, and use Internet applications for entertainment, news and communication matters rather than education, agricultural, and healthcare information.

Several pieces of research have been undertaken concerning the digital divide and universal Internet access in rural areas (James, 2002; 2003; 2004; Savage & Waldman, 2009; Heeks, 2008). Nevertheless, the focus of the studies concerned Internet access in either households or public places. Previous studies have also indicated that there is limited historical data on rural Internet service owing to rather low Internet penetration rates in developing countries.

3.3 Summary

The overview of previous studies has revealed that little consumer research has been carried out in the field of rural Internet adoption. In addition, consumers observed for preference research are mainly from developed countries. As was specific with Savage and Waldman (2005; 2009), and Rosston *et al.*'s (2010) findings from American data, this study tends to examine what role speed and reliability play in the case of the rural areas of developing countries. Moreover, the setting used in the study is not be applicable for that of developing countries simply because of the lack of measurable revealed preference data owing to a low penetration rate of the Internet in rural areas of developing countries. Similarly, the confirmation by Ida and Sato (2006) on the use of the stated preference method for long-term preference implications is taken as the base for this study, for the Internet in rural areas of developing countries can be considered as an innovative change for rural Internet consumers.

This study employs a discrete choice mixed logit model to elicit consumer preferences on Internet subscription and usage, following Lee *et al.* (2006), Kim (2005), and Kim *et al.* (2005), who have devised conjoint analysis and a mixed logit model using a Bayesian approach with Gibbs sampling for estimation.

Following studies such as Chaudhuri *et al.* (2005), this study adopts income, education, gender and age as socio-demographic variables. The findings of Chaudhuri *et al.* (2005) are motivational insights for this study, as it seeks a further spatial explanation for the substantial variation observed in the access price for Internet usage.

Chapter 4. Models and methodology

The selection of an Internet service subscription by a consumer can be regarded as a choice from among a limited set of alternatives. In econometrics and marketing research, such choices are usually modeled by discrete choice approaches. This chapter provides details of the theoretical foundations of the approach. Underlying assumptions and models are presented and a brief outline of WTP is provided.

4.1 Foundations of discrete choice analysis

The discrete choice experiment has its foundations in probabilistic choice theory and random utility theory and is consistent with Lancaster's economic theory of value (Lancaster, 1966), which assumes that consumers derive utility from the underlying attributes of the goods under valuation, rather than the goods *per se*. Probabilistic choice theory assumes that one cannot perfectly predict an individual's choices, due to unobservable parameters. Thus, models based on the theory, which try to explain consumer choice, do not identify alternatives as the chosen option, instead assign probabilities to them.

4.1.1 Random utility model

Random utility model (McFadden, 1973) is used as a theoretical basis for analyzing consumer preferences using discrete choice models. The maintained assumption of the model is that respondents choose their preferred alternative on the basis that it maximizes their utility. The model further implies that there is a function containing attributes of alternatives and characteristics of individuals that describes an individual's utility valuation for each alternative. Thus, we assume that each consumer perceives the utility associated with each attribute of the Internet usage and chooses the one with the greatest possible perceived utility. In random utility model, this utility is decomposed into two parts: deterministic and stochastic (unobservable by the researcher) as follows:

$$U_{nj} = V_{nj} + \varepsilon_{nj} \tag{4.1}$$

Where, subscript n stands for the nth consumer, and j for the jth alternative of choice situation. U_{nj} is the utility obtained from alternative j by nth consumer. V represents the deterministic part while ε represents the stochastic part of utility, which accounts for factors affecting the utility of an alternative not included in V_{nj}, as well as other factors, which are fundamentally unobservable (Ben-Akiva and Lerman, 1985). The deterministic part comprises the utility obtained from attributes of goods/service and characteristics of consumers as follow:

$$U_{nj} = V_{nj} + \varepsilon_{nj} = V(x_{nj}, s_n) + \varepsilon_{nj} \tag{4.2}$$

Where, x_{nj} is the vector composed of attributes of alternative j to nth consumer and s_n is the vector composed of characteristics of nth consumer.

Assuming linear relationship in the deterministic part in Eq. (4.2), we can obtain

$$U_{nj} = \beta_{nj}'x_{nj} + \alpha_{nj}'s_{nt} + \varepsilon_{nj} \tag{4.3}$$

Where, β (consumer preference) and α represent the degree of influence on the deterministic part of utility by attributes of the Internet access and characteristics of individuals respectively.

In the case of the stochastic part, $\varepsilon = \{\varepsilon_{n1}, \varepsilon_{n2}, \dots \dots \varepsilon_{nJ}\}$ follows joint distribution, which helps in making probabilistic decisions about the individual consumer's choice. Hence, the probability that nth consumer chooses alternative i from the set of available alternatives J_n is equal to:

$$P_{ni} = P(U_{ni} \geq U_{nj}, \forall j \neq i) = P(V_{ni} + \varepsilon_{ni} \geq V_{nj} + \varepsilon_{nj}, \forall j \neq i) \tag{4.4}$$

Rearranging the terms:

$$P_{ni} = P(\varepsilon_{nj} - \varepsilon_{ni} \leq V_{ni} - V_{nj}, \forall j \neq i) \tag{4.5}$$

Thus, the probability that an alternative is chosen depends on the joint distribution of the differences between the error terms, i.e., the probability P_{ni} is the function from integration over the distribution $f(\varepsilon_n)$. Several different models have been developed from different specifications of this density, according to the distribution assumed for the stochastic part of the utility (Train, 2003).

4.1.2 Multinomial and rank-ordered logit model

The multinomial logit model (MNL), also known as conditional logit model, is the most utilized random utility model (Verma & Plaschka, 2003) in which the degrees of influence of attributes of product/service and individual characteristics are assumed to be homogeneous (Koh, 2007). Hence, the stochastic part follows independent and identically distributed (IID) type I extreme value distribution. Following the probability in MNL that a consumer n chooses one of the m alternatives, c_i from choice set *C* is (Ben-Akiva & Lerman, 1985):

$$p(c_i|C) = \frac{e^{U_{c_i}}}{\sum_{j=1}^{m} e^{c_j}} = \frac{e^{x_i\beta}}{\sum_{j=1}^{m} e^{x_j\beta}} \qquad (4.6)$$

Where, x_i denotes a vector of alternative attributes and β a vector of parameters that are estimated. $U(c_i) = x_i\beta$ is alternative c_i's utility, and for the above stated situation, the probability is the exponential of the utility of the alternative divided by the sum of all the exponentiated utilities.

Using this choice probability, likelihood function is established and parameters are estimated by maximum likelihood estimation (MLE). The model assumes a Gumbel or extreme-value distributed error, which closely approximates the normal distribution and produces a closed-form probabilistic choice model (Hensher *et al.*, 2005). It further assumes that error components are identically and independently distributed across alternatives as well as across individuals. The model has another restrictive assumption, independence of irrelevant alternatives (IIA), which states that if g is the preferred alternative out of the given choice set *{g,h}*, the preference should not change towards *h* if a third alternative *i* is added, supplementing the choice set to *{g,h,i}*, which means *i* is to be considered as an irrelevant alternative and should not change the choice between g and h. This assumption makes the MNL very simple to estimate, however, it leads to the restriction in reflecting the realistic substitution pattern caused by change in attributes of other alternatives. Moreover, assuming the same coefficients over all consumers in case of heterogeneity in consumer preferences may mislead the implication (Koh, 2007).

Rank-ordered logit model is an extension to multinomial logit model in the sense that the former uses ranked choices and the latter most preferred choice. Unlike conventional choice model, if consumers are asked to rank their choice of alternatives rather than making just one choice, this captures more information about their preferences, resulting to more robust parameter estimation. Beggs, Cardell, and Hausman (1981) urge to use ranked data to estimate the characteristics of consumer choices from stated preference data as it provides a better view on the preferences of a consumer than data from a choice experiment.

Following Calfee, Winston, and Stempski (2001), for consumer n, let there be a choice set C with J elements, with each element indexed $j = 1,2, \dots, J$. Let the vector of attributes for each element in the choice set available to be denoted x_{nj}, and let s_n denote the characteristics of each consumer. The utility of each element in the choice set for each individual is represented as in eq. (4.2).

Let consumer n generate a survey response $r_n = \{r_{n1},\ r_{n2}, \dots ,\ r_{nJ}\}$, a ranking of the choice set in descending order of preference. The probability of a given survey response may be expressed as

$$U(r_{n1}) > U(r_{n2}) > \cdots > U(r_{nJ}) \; or \; Pr(rn) = Pr\,[U_n(r_{n1}) > U_n(r_{n2}) > \cdots > U_n(r_{nJ})]$$

Then, this form can be decomposed as follows (Eq. 4.7):

$$\begin{aligned} Pr(rn) &= Pr\big[U_n(r_{n1}) > U_n(r_{n2}) > \cdots > U_n(r_{nj})\big] \\ &= Pr\big[U_n(r_{n1}) > U_n(r_{nj}) for\, j = 2, \ldots, J\big]\, Pr\big[U_n(r_{n2}) \\ &\qquad > U_n(r_{nj}) for\, j{=}3,\ldots,J\big] \ldots Pr\big[U_n(r_{n,J-1}) > U_n(r_{n,J})\big] \end{aligned}$$

Therefore, the *J*-dimensional survey experiment can be transformed into *J-1* binary statements of which the alternative is preferred one (Calfee *et al.*, 2001).

Rank-ordered logit also assumes type I extreme value distribution in parameter estimation. The model uses full ranking information by repeatedly applying the multinomial logit model to an exploded data set as in eq. (4.7), which can be transformed into a closed form solution (Calfee *et al.*, 2001) as follows:

$$Pr\big[U(r_1) > U(r_2) > \cdots > U(r_J)\big] = \prod_{k=1}^{J-1} \frac{e^{\beta x(r_k)}}{\sum_{m=k}^{J} e^{\beta x(r_m)}} \qquad (4.8)$$

where $x(r_k)$ is the vector of the alternative ranked k in the ordering. Given an independent sample of *N* individuals facing independent and identically distributed ε_{nj}, following the derivation by Calfee *et al.* (2001), the log-likelihood function to be maximized is (Eq. 4.9):

$$LL(\beta) = \sum_{n=1}^{I} ln\left[\prod_{k=1}^{J-1} \frac{e^{\beta x(r_{nk})}}{\sum_{m=k}^{J} e^{\beta x(r_{nm})}}\right] = \sum_{n=1}^{N}\sum_{k=1}^{J-1} \beta x\,(r_{nk}) - \sum_{n=1}^{N}\sum_{k=1}^{J-1}\left[ln \sum_{m=k}^{J} e^{\beta x(r_{nm})}\right]$$

In eq. (4.8), there is only one choice set. If assumed that there are *T* choice sets, the choice probability is formed as follows (Kim, 2005):

$$Pr[U_t(r_1) > U_t(r_2) > \cdots > U_t(r_J)] = \prod_{t=1}^{T} \prod_{k=1}^{J-1} \frac{e^{\beta x_t(r_k)}}{\sum_{m=k}^{J} e^{\beta x_t(r_m)}} \qquad (4.10)$$

Succintly speaking, the rank-ordered logit gives much more information than the model with the most preferred choice. As in eq. (4.8), a respondent generates multiple pseudo-observations (*J-1* pseudo-observations for *J* alternatives), which are again multi-folded if the choice is repeated *T* times as in eq. (4.10), leading to the likelihood of decreasing estimation biasness. However, as mentioned above, the rank-ordered logit is an extended version of the conditional logit model, hence, it carries the similar potential problems (Layton, 2000).

4.1.3 Mixed logit model

Train (1998) emphasizes the need of the explicit recognition of taste heterogeneity in choice estimation to avoid biased utility results, breaking many years' dominating assumption of homogeneity in preferences in the literatures of discrete choice analysis. Given the need of a more flexible logit model in order to give space for random variation in taste, relaxation from the IIA property, and correlation among unobserved factors in repeated choices, different flexible models such as multinomial probit, mixed logit (random parameters) and latent class models have been developed. Mixed logit, a state-of-the-art model in logit class, has been developed (McFadden & Train, 2000) as a highly flexible model to accommodate unobserved heterogeneity in estimation, approximating any random utility model and widely applied in ICT new product choice analysis using stated preference methods (Kim, 2005; Kim *et al*.; Lee *et al*., 2006; Savage & Waldman, 2005; 2009).

In mixed logit models, the unobserved factors can be decomposed into two additive parts ($\varepsilon_n = \eta_n + \sigma_n$), a stochastic part ($\eta_n$) that is correlated over alternatives and heteroskedastic over consumers and alternatives, and another stochastic part (σ_n) that is independently and identically distributed over alternatives and consumers (Brownstone & Train, 1999 as cited in Jeong, 2008). Accordingly, the utility of a consumer *n* from alternative *j* can be defined as follows:

$$U_{nj} = X_{nj}\beta_n + \varepsilon_{nj} \qquad (4.11)$$

Where, unknown parameter β_n which comprises a vector of coefficients of explanatory variables X_{nj} allows a variation in tastes with respect to consumers. In order to allow the coefficients to vary with respect to consumers in the population, β_n is assumed to have density $f(\beta)$. The choice probability with regard to the random coefficient framework is:

$$P_{nj} = \int L_{nj}(\beta)\, f(\beta) d\beta \qquad (4.12)$$

Where, $f(\beta)$ is a density function and $L_{nj}(\beta)$ is the logit choice probability at parameters β:

$$L_{nj}(\beta) = \frac{e^{V_{nj}(\beta)}}{\sum_{k=1}^{K} e^{V_{nk}(\beta)}}$$

$V_{nj}(\beta)$ is the observed part of the utility. If utility is linear in β, $V_{nj}(\beta)$ becomes $\beta' X_{nj}$ and the choice probability takes the form (Train, 2003):

$$P_{nj} = \int \left(\frac{e^{\beta' X_{nj}}}{\sum_K e^{\beta' X_{nk}}} \right) f(\beta) d\beta \tag{4.13}$$

As a multinomial probit model, the choice probability of a mixed logit model has no closed form expression; hence, it should be approximated numerically. In conclusion, a mixed logit model can overcome the IIA assumption of a multinomial logit model and accommodate any pattern of correlation and heteroskedasticity arising from an error term or coefficients with density.

Various kinds of distributions such as normal, log-normal, censored normal, triangular and uniform can be assumed in mixed logit (Banerjee & Ware, 2003; Train, 2003). This flexibility relaxes situations that may lead to an inappropriate assumption in reality (Train, 2003). For example, with normal distribution, the model is considered unbound, i.e., there is the existence of some extreme values, both negatively and positively in terms of various attributes. In such a case with price, the positive value infers higher prices of certain goods or services. Moreover, if the marginal rate of substitution with price coefficient is calculated as the denominator in such an “expected” sign situation, the result of WTP gets unusable and similarly if it overlaps with zero, the marginal rate of substitution becomes unboundedly large for some consumers (Train & Sonnier, 2003).

Log-normal distribution is applied in such cases where the response parameter requires a specific sign and different from zero, for instance, price (Kim *et al.*, 2005). A censored normal is useful when indifferent response is expected (Train, 2003). The important aspect with regard to different distributions is arbitrariness in real behavioral profiles. Which distribution to follow for estimation should be led by the sense that the "empirical truth is somewhere in their domain" (Hensher & Green, 2001). This study applies three kinds of distributions, viz. normal, log-normal and censored normal, for the random parameters of Internet usage attributes.

The procedures for estimating a mixed logit model have been developed within both the classical and Bayesian approach. This study uses Bayesian approach because of some advantages in estimation over the classical approach.

4.1.4 Bayesian Estimation

Bayesian approach begins with the specification of the distribution of the data y, given the unobservable parameters θ and $p(y|\theta)$ as a likelihood function. Also needed is $p(\theta)$ which denotes prior beliefs about parameters of interest θ. The following Bayes' rule provides the updating mechanism for how prior beliefs are converted into posterior beliefs (Rossi, Allenby, & McCulloch, 2005).

$$p(\theta|y) = p(y|\theta)p(\theta)/p(y) \propto p(y|\theta)p(\theta) \tag{4.14}$$

Where, $p(\theta|y)$ is posterior distribution and reflects both prior beliefs as well as sample information.

Applying *Eq. 4.13* for the research setting of ranking data, the equation becomes:

$$p(b, W|r_i(r_1, r_2, \dots, r_n)) \propto \prod_{i=1}^{n} L(r_i|b, W)p(b, W) \tag{4.15}$$

Where, the researcher has prior distribution of $p(b, W)$.

Bayesian approach requires various kinds of multi-dimensional integration over the posterior distribution in many cases. One of them is Markov Chain Monte Carlo (MCMC), which is a simulation method, suitable for building models from a sequence of conditional distributions (Koh, 2007). In addition, Metropolis-Hastings (MH) algorithms and Gibbs sampler (one of the members of MH algorithms) provide a set of methods for constructing Markov chains. Some significant advantages of Bayesian approach over the classical approach are presented below:

First, Bayesian approach requires no direct evaluation of nontrivial likelihood function and the associated problems of approximating choice probabilities. Second, Bayesian procedures provide more relaxed conditions for desirable estimation properties; namely, consistency and efficiency. Maximum simulated likelihood (MSL) is consistent only if the number of draws used in a simulation is considered to rise with sample size. Efficiency is obtained only if the number of draws rises more quickly than the square root of the sample size. In contrast, Bayesian estimators are consistent for a fixed number of draws in a simulation and are efficient if the number of draws rises, at any rate, with the sample size (Train, 2003).

Moreover, the estimation results from Bayesian procedures can be interpreted from both Bayesian and classical perspectives. Bernstein von Mises theorem maintains that the mean of the Bayesian posterior is a classical estimator that is asymptotically equivalent to the maximum likelihood estimator. Similarly, the covariance of the posterior is the asymptotic covariance of this estimator (Train & Sonnier, 2003).

4.2 Willingness-to-pay (WTP)

Consumer research is conducted not only to find out about the likes and dislikes of potential consumers, but also to optimize prices. For doing so, it would be helpful to know what the consumer is prepared to spend on that certain good or service. Unlike ‘hedonic concept’, willingness-to-pay for Internet service, in this study, is related to a set of underlying service characteristics that combine to produce a single, separable index of service utility to consumers (Chaudhuri *et al*., 2005). There are a multitude of factors affecting willingness-to-pay, the marginal valuations, for the Internet services. Willingness-to-pay for Internet services is affected by existing Internet service accessibility, quality, affordability and ability to pay, together with consumers’ level of awareness of Internet usage. The status quo can also have a significant effect on willingness-to-pay amounts, with consumers generally preferring the status quo over changes in service levels and costs structures (Hensher *et al*., 2005), indicating a welfare change in attributes.

Willingness-to-pay can be elicited in various ways, for example, surveys and observations. Survey methods are often referred to as stated preference methods, as consumers are asked – directly or indirectly – what their willingness-to-pay is. Breidert (2006) subdivides survey methods into direct surveys and indirect surveys. While in direct surveys experts or actual consumers are explicitly asked about their willingness-to-pay, indirect surveys such as conjoint analysis apply a more subtle method, which help in estimating willingness-to-pay for single respondents, segments, or aggregated to whole samples or markets. Direct surveys may bring deflated results as asking consumers directly about what they are willing to pay might unnaturally increase the respondent's price perception. In addition, respondents could feel that they have direct influence on a product's pricing, which might incentivize them to understate their true willingness-to-pay (Breidert, 2006). Therefore, conjoint analysis can be considered the most prominent methods in measuring willingness-to-pay. In the context of discrete choice models, the willingness-to-pay principle is used to convert part-worth into dollar terms (Nepali rupees in this study) and to make the results more communicable. Willingness-to-pay is estimated calculating the implicit value of the attribute levels included in the design that is by dividing a level by the linear price parameter.

Most commonly, welfare analysis refers to the estimation of WTP for policy changes. When consumers are utility-maximisers and improvements to one attribute can be expressed as an equivalent deterioration in another along an indifference curve (i.e. a compensatory decision process is assumed), a consumer's WTP is measured by the Hicksian consumers' surplus attached to the equivalent price change (Hicks, 1939; Diamond & McFadden, 1974; Varian, 1984; McFadden, 1997). As argued above, generally a linear and additive indirect utility is assumed, so that Hicksian and

Marshallian measures of consumer surplus coincide and preferences can be aggregated into representative "community" preferences (Chipman & Moore, 1990; McFadden, 1999).

To sum up, the WTP for a one unit improvement in that attribute is the ratio of its marginal utility to the marginal utility of price$\left(\beta_i/\beta_{price}\right)$. This study calculates the median willingness to pay (MWTP) of consumers as follows (Kim, 2005):

$$MWTP_z = Median\left(-\frac{\partial U_n/\partial_{zn}}{\partial U_n/\partial p_n}\right) = Median\left[-\frac{C(\beta_{zn})}{C(\beta_{service\ fee,n})}\right] \qquad (4.16)$$

4.3 Model estimation

Random utility model provides the framework for understanding household choices among the proposed alternatives. Under the assumptions of the RUM, consumer utility for Internet usage is expressed as a function of Internet service attributes and socio-demographic characteristics. As discussed in chapter 5 in details, households are asked to consider six-attribute scenarios using conjoint methods: (a) service provider, (b) mode of connection, (c) speed/bandwidth, (d) service fee, (e) probability of disconnection, and (f) distance.

This study employs a rank-ordered conjoint choice experiment to measure the importance of the features of the Internet service in making a subscription and/or usage decision, for which each respondent is asked to choose his/her preferred alternative from four alternatives in four choice sets. As the starting point for empirical investigation, data from the rank-ordered experiment is analyzed by the rank-ordered multinomial logit model as prescribed by Beggs *et al.* (1981); Hensher *et al.* (2005). The setting of choice probability for maximum likelihood estimation is made as outlined in *Eqs. 4.8, 4.9,* and *4.10* with fixed coefficients and socio-demographic characteristics interaction.

Subsequently, this study estimates econometric models based on mixed logit in order to incorporate heterogeneity in preferences towards the Internet service adoption among rural consumers in Nepal since the evaluation of preferences for Internet usage can vary between individuals with respect to their tastes, abilities, affordability and so on.

To minimize sampling costs and elicit more information from each respondent, each individual *n* in the survey is asked to rank the alternatives in order of preference among *J* alternatives in each of *T* choice sets as prescribed by Layton (2000). Thus, assuming a mixed logit model – that is, as stated above, a kind of random coefficient discrete choice model that captures preference variation among individuals by introducing stochastic terms into the coefficients and allowing those terms to be correlated with each other, the utility of individual *n* from alternatives *j* in a choice set *t*, U_{njt}, can be denoted as follows:

$$U_{njt} = \beta_n' x_{njt} + \varepsilon_{njt} \tag{4.17}$$

Where x_{njt} is the vector of the attributes associated with alternatives j; β_n is the vector of the coefficients of partworths distributed multivariate normal with *b* mean and variance covariance matrix W, and ε_{njt} is a random term assumed to have an independent and identical extreme value distribution.

As described above, in a mixed logit model, the coefficient vector β_n is assumed to have a normal distribution with mean vector b and variance-covariance matrix W in general. However, as discussed above, an unbounded normal distribution is inappropriate for the coefficient of an attribute that all respondents dislike as normal distribution allows some share of the population actually to prefer undesirable attributes (Jeong, 2008). As an example, it is unlikely to claim that there are consumers who would prefer paying more to use the Internet, *ceteris paribus*. In the same way, a normal distribution may not work for the coefficient of an attribute that all respondents like. Therefore, this study assumes a log-normal and censored normal distribution for the coefficients of desirable and undesirable attributes such as service fee and distance. The log-normal distribution can be obtained from a transformation of normal β using $C = exp\,(\beta)$ and then changing the utility specification as follows (Kim, 2005; Choi, Koh, & Lee, 2008):

$$U_{njt} = C(\beta_n)' x_{njt} + \varepsilon_{njt} \qquad (4.18)$$

Where, C is a transformation. A caution by Hensher & Green (2001) points out that the model may not converge or, even if converged, may converge with unacceptable large estimates when an attribute specified with a random parameter in log-normal distribution with a positive sign. As a remedy, the negative of the attribute should be defined instead of imposing a sign change on the estimated parameter.

Concerning the censored normal, all the values below zero are massed at zero: $C = Max(0, \beta)$ (Train & Sonnier, 2003). This helps in identifying consumers' indifference of the particular attribute.

Now, the likelihood function of individual n's observed sequence of ranking can be represented as follows (Choi *et al*., 2008):

$$L(r_n|\beta_n) = \prod_{t=1}^{T} \prod_{j=1}^{J-1} \frac{e^{c(\beta_n)' X_{jt}}}{\sum_{k=j}^{k=J} e^{(\beta_n)' X_{kt}}} \tag{4.19}$$

Where $r_n = (r_{n1t}, \ldots, r_{nJt})$ denotes the vector of consumer n's ranking responses in choice set t in descending order of preference, with T being the total number of choice sets.

Using the β_n samples taken from the retained draws of *b*s and *W*s in the Bayesian process, we can calculate the relative importance of each attribute as follows (Choi *et al*., 2008):

$$Average\ relative\ importance\ \% = \frac{1}{N} \sum_{n=1}^{N} \left(\frac{part\ worth_{nm}}{\sum_m part\ worth_{nm}} \times 100 \right) \tag{4.20}$$

$$part\ worth_{nm} = interval\ of\ attribute\ m's\ level \times C(\beta_n)$$

Where $part\ worth_{nm}$ is the difference between each attribute $m's$ highest and lowest part worth. The term denotes the impact of changing the attribute level within a particular attribute.

To sum up, Figure 4-1 captures an overall methodological framework of the study.

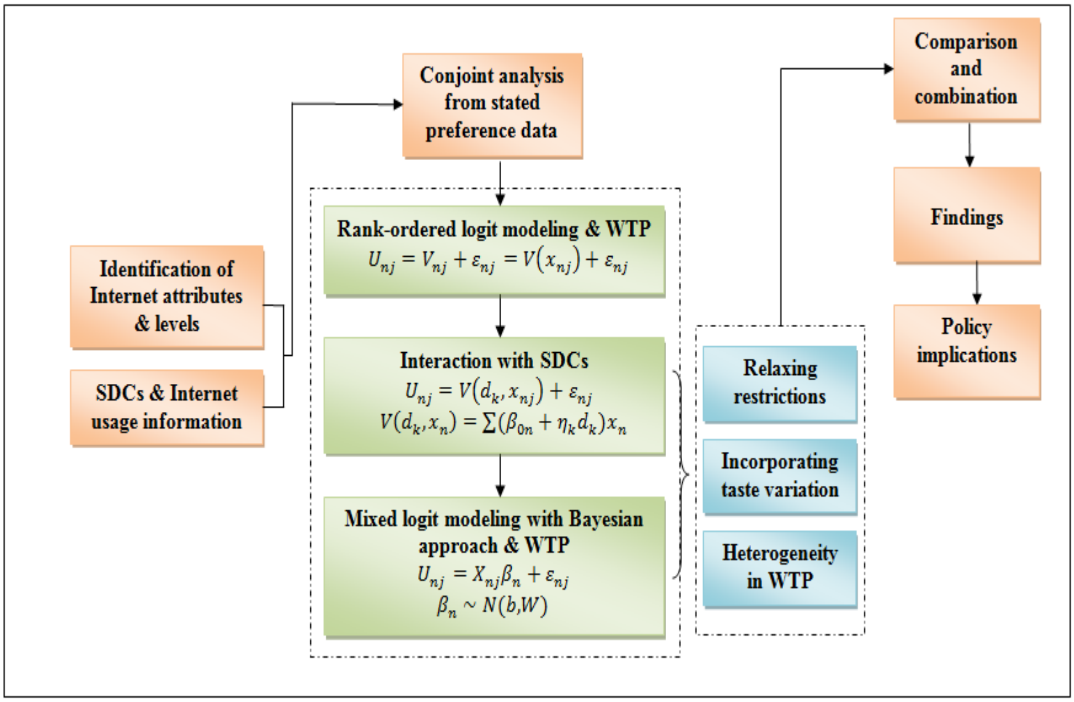

Figure 4-1: Overall methodological framework

Chapter 5. Experimental design and estimation results

A crucial part of the discrete choice procedure involves the experimental design stage since the design of an experiment has a significant impact on the accuracy of the estimated parameters of the fitted model. Choosing the appropriate alternatives and grouping them in choice sets in the best possible way according to an optimality criterion yields an optimal design (Vermeulen *et al.*, 2011). The first part describes how this stage is treated throughout this research and the second part deals with the estimation results plus a simulation of an efficient policy design for enhancing Internet penetration in the rural regions of Nepal.

5.1 Survey and data

5.1.1 Conjoint survey

Conjoint analysis has long been applied in market research to assist in the design of new products (Cattin & Wittink, 1982). It judges the utility of a product/service by combining the separate utilities attached to each attribute, and deals with the measurement of such psychological judgments as consumer preferences, perceived similarities, or differences between choice alternatives (Green & Srinivasan, 1990). Conjoint methodology is based on rigorous utility-theoretic principles (Louviere *et al.*, 2000) and has been adopted as an alternative to contingent valuation with validity concerns (Ryan *et al.*, 2001). DeShazo and Fermo (2002) argue that conjoint methods can obtain more information at higher quality and lower cost than contingent valuation methods for service-delivery programs. It is also considered as a popular method for examining the relative importance of attributes; thereby, estimating WTP for them. As DeShazo and Fermo (2002) suggest, when conjoint analysis is applied, several design issues and options such as attribute definitions need to be considered at the outset to prepare a conjoint survey so as to ask decision makers to choose between hypothetical scenarios in an experiment to uncover the value they place on different criteria.

For this study, the conjoint survey offers a compromise between a controlled experiment in which Internet services are randomly varied across the population and consumer data, which has too little variation for analysis. For example, if everybody in the sample pays exactly the same price, it will be impossible to trace out a demand curve using consumer data (Yang *et al.*, 2006).

In short, conjoint analysis enables us to use the stated choices of survey respondents to measure their preferences in hypothetical situations (Louviere *et al.*, 2000; Green & Srinivasan,1990). Such stated preference data are usually much richer than revealed preference data and, hence, open up real opportunities to enhance the behavioral capability of the mixed logit model (Hensher *et al*., 2005) in such situations where market data is scarce, or where it is useful to know about consumer preferences for products/services that do not exist in the market (Kim *et al.*, 2005; Jeong, 2008).

Estimating demand for Internet services, particularly in rural areas of developing countries where the penetration rate is quite low, is an intricate task. Moreover, it is even harder to elicit consumer preferences relating to specific characteristics of Internet services with the available data. For instance, one can find information about the subscription rates of different ISPs for Internet access; however, the pricing and scheme choice seem to be obscure to general consumers in rural areas, most of whom have a very limited fundamental expertise about Internet subscription. As a result, it would be difficult to implement the discrete choice methods with revealed preference data. In addition, even if the data were available, there would be inadequate variation in product characteristics to identify the important marginal utility parameters of interest. Internet usage plans, for example, are typically structured in such a way that more reliability is bundled with more speed, which makes it unfeasible to separate the WTP for these two characteristics. Considering the above facts, this study follows Louviere *et al*. (2000) who consider stated preference data as being "particularly good at improving the behavioral value of the parameters representing the relative importance of attributes in influencing choice."

This study employs a household survey, which is essential for the analysis of most policy issues, since accurate, up-to-date, and relevant data from household surveys are instrumental in making sound economic and social policy decisions (Grosh & Glewwe, 2000). The conjoint survey asks respondents to state their preferences for each alternative card on which a hypothetical bundle of Internet service attributes is presented.

5.1.2 Attributes and attribute levels

The first stage of a discrete choice experiment and a conjoint survey involves identifying the attributes relevant to the stated research question and then assigning levels for each of these attributes (Hensher *et al.*, 2005). This is a critical aspect of the design, as the attributes and their levels describe the hypothetical scenarios under consideration in the research.

As Hensher *et al.* (2005) suggest taking precautions when recognizing ambiguity inherent in establishing the meaning of what attributes influence an individual's choice – in our case, use of the Internet – this study has recognized this, and made substantial efforts to work through the ambiguity to try and recover as much clarity in the attribute content (in terms of meaning and measurement) as is possible.

Focus-group studies and questionnaire pre-tests play an important role in securing the success of choice experiment studies in developing countries (Do & Bennett, 2010), particularly in establishing plausible, and understandable scenarios to respondents who may never have experienced such choice tasks before. With this view in mind, a focus-group meeting was organized by the researcher, who acted as a moderator, in order to understand the nature of phenomenon in a holistic sense, and to overcome the challenges of choice modeling applications (Do & Bennett, 2010).

The focus group in this study suggested that an example of making choices when using the Internet would help respondents better comprehend the relevance of attributes in the choice tasks they faced. This was found to be effective in the survey. In addition, the pre-testing of the questionnaire helped identify the obstacles to respondents in understanding the questionnaire. For example, it was found that instead of using the term “bandwidth”, the questionnaire should explain how the speed would work. This is because the term “bandwidth” is not familiar to common Nepali respondents, who may not know such a technical term. The focus group also helped in structuring questions. For example, the focus group suggested placing choice cards at the beginning to be preceded by questions related to Internet access and usage information, and respondent characteristics so that respondents would focus on the choice cards more, and it would be interesting for them to answer questions in the second part.

Table 5-1: Service attributes and definitions of independent variables

Attributes	Levels	Definition	Previous research
Internet Service Providers (ISPs)	Nepal Telecom (NTC)	Worldlink = 0; Ncell = 1; NTC = base alternative	Long (2010)
	Ncell		
	World Link (WL)		
Mode of connection	0	Without telephone = 0	Ida and Sato (2006)
	1	With telephone = 1	
Bandwidth (speed) of connection	56	The Internet access speed in kbps (divided by 10 for normalization)	Savage and Waldman (2005, 2009)
	256		
	312		
Service fee (in Nepalese Rupee)	200	Monthly service fee (divided by NRs. 100 for normalization)	Lee *et al.* (2006); Savage and Waldman (2005; 2009); Kim *et al.* (2005)
	500		
	800		
Probability of disconnection	0.05	Percentage of the probability of disconnection as a proxy to reliability of the Internet service	Zubey *et al.* (2002); Savage and Waldman (2005)
	0.2		
Distance	0	Distance to walk in kilometer 0 = at home, otherwise '1' '2'	James (2003; 2004)
	1		
	2		

A pilot survey of 30 samples in *Nuwakot* district of central Nepal was conducted. From the survey, one important point was identified. Some respondents selected options from the choice sets randomly due to their inability to cope with the task's complexity and/or their intention to finish the task responses as quickly as possible. The final questionnaire used in the survey underwent a few revisions following on from focus groups and the pilot study.

In the final version of the questionnaire, six attributes as exhibited in Table 5-1 were decided upon to describe the Internet and its service characteristics based on the literature survey, qualitative interviews with experts and a focus-group discussion with rural people having access to the Internet. The first attribute is "Internet Service Provider", a dummy variable with three levels, which indicates the company that provides access to the Internet. Nepal Telecom is the incumbent landline, cellular mobile telephone provider and ISP. Ncell is a GSM-based cellular mobile provider and ISP. Similarly, World Link is the largest ISP, which is not a telecommunication company. This attribute is placed in order to recognize the consumers' level of awareness on the brand of the providers, as there are several candidate ISPs for the provision of Internet services in rural Nepal, and their brand reputation might affect consumer preferences for the adoption of Internet services in different ways. Information on consumer preferences for the ISPs can help the government to select a mutual partner for the initiatives.

The second attribute, “Mode of Connection”, is a dummy variable denoting wireless access or a wired connection. When the pilot survey was undertaken, this attribute was leveled with access technologies such as dialup, ADSL, cable TV and wireless, as mentioned in previous studies by Ida and Sato (2006), and Long (2010). However, the estimation result showed that the respondents were not quite familiar with the level, which was also justified by the focus group. Hence, in order for the respondents to easily understand the access mode, it was leveled to with or without a telephone line, followed by a proper explanation.

The third attribute, “Speed”, accounts for the bandwidth at three levels: 56, 256 and 312 kbps, representing low, medium and high speed, given the bandwidth available in the current market in rural Nepal. Savage and Waldman (2009) find that high-ability, urban consumers are willing to pay a substantial monthly premium for an improvement in bandwidth compared to rural areas. This study, however, concentrates on rural areas, considering much less developed Internet infrastructure in Nepal than in the United States.

The fourth attribute, “Service Fee”, with three levels, is the tariff that covers the price paid for Internet service per month. This is a most important factor in determining consumers’ WTP for each of the other attributes identified in the study. Savage and Waldman (2005; 2009), Kim *et al*. (2005), Lee *et al*. (2006) and Kasuga *et al*. (2008) include the price to investigate consumer demand for Internet bandwidth, mobile terminals, mobile communication services and digital televisions respectively. In this study, the first level of NRs. 200 represents a low-cost price, similarly the second, NRs. 500 a modest price, and the third, NRs. 800, is expensive, given the affordability and real market price scenario. The levels of the service fee are constructed hypothetically, but based on real service fees charged currently by major ISPs in rural Nepal.

The fifth attribute, “Probability of Disconnection”, the proxy to the reliability of the Internet service, indicates how often users face the disconnection problem, ranging from rare (5% probability of disconnection), to intermittently (20% probability of disconnection). This attribute resembles the attribute of reliability as studied in Savage and Waldman (2005; 2009) to some extent.

The final attribute, “Distance”, works as the proxy to Internet access, meaning whether consumers prefer the Internet at home or somewhere else in the case of unavailability. The levels range from zero, which means they prefer the Internet at home, and above zero (1 km and 2 km) means Internet access at cyber cafés, or community centers, or other public places, requiring 1 km or 2 km of walk/travel. Generally, the travel distance is not considered in developed areas, but it should be crucially considered in technologically lagging rural areas. Even these days, most people in Nepali rural areas are compelled to travel very far to get services such as the Internet.

To sum up, six attributes are defined to establish the choice experiment, giving consideration to the requirements of a good understanding of the target population's perspective and experience (Coast & Horrocks, 2007), based on an exploratory identification process: the results of earlier studies, a focus group and a pilot study (Lancsar & Louviere, 2008). To the best of the researcher’s knowledge, to fit the goal of the research, the identified attributes are relevant and the assigned levels are realistic. The characteristics of the attributes and their levels are presented in Table 5-1.

While generating hypothetical alternatives to create choice sets, this study considers the goal of ensuring maximum efficiency in designing the experiment as prescribed by Huber and Zwerina (1996), encompassing the principles of level balance, orthogonality, minimal overlap and utility balance. As the identified four attributes with three levels and the remaining two attributes with two levels make up total 324 choice sets, a fractional factorial design is used to develop an orthogonal array of hypothetical Internet service packages using six attributes along with their factor levels. The array contains four sets with four alternatives in each set that each consumer could rate in terms of likelihood to adopt, as presented in Table 5-2.

As consumers’ preferences differ with respect to their socio-demographic backgrounds (Okazaki, 2006; Wareham & Levy, 2002; Chaudhuri *et al.*, 2005), it is necessary to investigate consumer demands for the Internet in terms of these characteristics. Hence, demographic data such as sex, age, education, income, household size, and so on are included in the survey instrument to ensure a broad consumer base is covered.

Table 5-2: Generated choice cards

Card	ISP	Connection mode	Speed	Service fee	Disconnection probability	Distance
1	WorldLink	with phone line	56 kbps	NRs. 500	0.05	1 km
2	NCell	with phone line	56 kbps	NRs. 200	0.2	2 km
3	NTC	without phone line	256 kbps	NRs. 200	0.2	0 km
4	NTC	without phone line	312 kbps	NRs. 800	0.2	2 km
5	NCell	without phone line	256 kbps	NRs. 500	0.2	0 km
6	WorldLink	with phone line	312 kbps	NRs. 200	0.05	1 km
7	NTC	with phone line	256 kbps	NRs. 500	0.2	1 km
8	NCell	without phone line	56 kbps	NRs. 200	0.2	1 km
9	NTC	without phone line	56 kbps	NRs. 200	0.2	2 km
10	NTC	with phone line	256 kbps	NRs. 500	0.05	1 km
11	NCell	with phone line	256 kbps	NRs. 800	0.05	0 km
12	WorldLink	without phone line	256 kbps	NRs. 800	0.05	2 km
13	NTC	with phone line	56 kbps	NRs. 500	0.05	2 km
14	NCell	without phone line	312 kbps	NRs. 500	0.2	0 km
15	WorldLink	with phone line	56 kbps	NRs. 800	0.2	0 km
16	NTC	without phone line	56 kbps	NRs. 800	0.05	1 km

Such socio-demographic variables are interacted with partworths to examine how such factors impact on consumer preferences. In addition to demographics, the Internet access and usage information part is also incorporated to scrutinize other relevant factors that may help in adding heterogeneity in the estimation for robust results. The survey questionnaire is annexed.

To make the preference task more realistic and engaging, the survey-taker briefed the participants about the Internet: how it has been evolving technologically and how people are taking advantage of it. Many of the attributes are described to the respondents by giving them similar reference points; for example, what kind of service they can get at 128 kbps speed. For the attributes that are specific to the Internet, images of examples are given to the consumers to gain a reference point for the attribute. For example, logos of the ISPs are displayed on the questionnaire. If the respondents were still unsure of the characteristics of the attributes, the survey-taker elaborated more on the specific aspect without creating bias toward any level or attribute mentioned in the instrument.

For the sample selection, the selected rural areas are grouped into four strata in terms of the political division of the country: far western development region, western development region, central development region and eastern development region. These four strata are further regrouped into two strata in terms of the accessibility to telephone lines. These explicit strata are – mountains (where landline telephones are not available) and rural hills (landline telephones or fixed wireless telephones are accessible).

5.2 Descriptive statistics

To understand the market dynamics of the mountainous and hilly rural areas, the survey selects five different locations, representing four regions of Nepal (the locations are highlighted in the annexed map) and random sampling was implemented. To improve reliability, the survey was conducted through personal interview. The dataset is restricted to consumers who are literate. Table 5-3 shows the outline of the sample design.

Table 5-3: Sample design

	Description
Population	Ranging in age from 19 to 55 years and living in 4 different regions
Survey period	October 2011
Sample size	286 individuals
Method used in drawing the sample	Allocation by mountainous and hilly regions and age

The general statistics of the survey are presented in Table 5-4. Out of 301 received samples, 286 responses with valid answers in rank-ordered choices are utilized for the estimation. The invalid responses consisted of not duly filled out or only one number written response.

Table 5-4 shows that 31.8% of respondents are female and 68.2% are male. The incidence of Internet use frequency is highest among the 19-34 age group with a higher incidence of male users, followed by the 35-44 age group with the majority accessing the Internet at least once a week and almost half using it for less than half an hour and almost one-third using it for 1-2 hours at a time. The respondents who do not have a connection either at home or in the office/school were found to be accessing the Internet through community centers or local cyber cafés opened at the initiative of local businesses.

Table 5-4: General statistics of the survey data

Characteristics of Study Subjects (N = 286)			
	Frequency (%)		Frequency (%)
General characteristics		*Internet use experience*	
Gender		**Place of use**	
Female	91 (31.8)	Home	38 (16.7)
Male	195 (68.2)	School/college	41 (18.1)
Mean Age	28	Workplace	35 (15.4)
19-24	88 (30.8)	Community center	13 (5.7)
25-34	108 (37.8)	Internet café	39 (17.2)
35-44	69(24.1)	Cellular mobile (terminal)	61 (26.9)
45-54	13 (4.5)	**Frequency of use**	
55 & above	8(2.8)	Everyday	16 (5.6)
Education		Four times a week	52 (18.2)
Just literate	19 (6.6)	Thrice a week	6 (2.1)
High school level	172 (60.1)	Twice a week	26 (9.1)
College graduates or higher	95 (33.2)	Once a week	87 (30.4)
Profession		Once a month	59 (20.6)
Farming	17 (5.9)	None	40 (14.0)
Student	122 (42.7)	**Time spent per access**	
Own business	43 (15.0)	Half an hour or less	119 (41.61)
Housewife	13 (4.5)	More than ½ an hour to 2 hours	104 (36.36)
Service	82 (28.7)	More than 2 hours	18 (6.29)
No response	9 (3.1)	**Disconnection experience**	
Monthly household income	NRs. 14,271 (US$ 176.2)	Never	30 (10.5)
NRs. 10,000 or less	104 (36.4)	Once per usage	70 (24.5)
NRs. 20,000 or less	110 (38.4)	Twice per usage	26 (9.1)
Above NRs. 20,000	72 (25.2)	Many times	62 (21.7)
Family size	4.5	No response	98 (34.3)

PC at home		**Access mode**	
Yes	58 (20.28)	WiFi	104 (36.4)
No	228 (79.72)	Cellular	61 (21.3)
English proficiency		ADSL	22 (7.7)
None	5 (1.7)	Dial up	7 (2.4)
Little	67 (23.4)	cable	2 (0.7)
Normal	158 (55.2)	No response	90 (31.5)
Fluent	51 (17.8)		
No response	5 (1.7)		
Location			
Mountain	188 (65.7)		
Hills	98 (34.3)		

Segregating the respondents from the mountains, where telephone access is yet to be available at household level, and the respondents from the hills, where telephone access is relatively better, 65.7% of respondents are from the mountains while 34.3% of respondents are from the hills.

In terms of education, 6.6% of respondents are just literate; 60.1% of respondents are high school graduates (grade 10 or above up to grade 12); and 33.2% are college graduates, or have some higher education. In addition, 33.5% of respondents use the Internet at college or in the office, which means they do not pay for the Internet services. Similarly, 26.9% of respondents are found to use cellular mobiles for Internet access. The users at the Internet café are more (17.2%) than those at home (16.7%) with 5.7% of respondents using community centers as Internet access points. A considerable number of respondents were found to use the Internet at community centers and Internet cafés, which highlights the need for public Internet access.

Among the users, usage of the Internet is found to be satisfactory only with 5.6% using it on a daily basis and another 59.1% using it once, or more than once a week. The survey reports that 20.3% of respondents use the Internet once a month, while 15% of respondents have no experience of using the Internet. A significant number of respondents (53%) report frequent disconnection of Internet services while they are being used. In terms of household income, 36.4% of respondents reported NRs. of 10,000 or less as their income, 38.5% had NRs. of 20,000 or less, and 25.2% had NRs. of 30,000 or more. The average family size of the households is 4.5.

By analyzing the Internet usage experience according to Table 5-5, the majority of non-users (42%) fall under the literate group of respondents, followed by high school level educated (17%) respondents. This gives a clear message: the higher the level to which the consumers are educated, the higher the possibility of their Internet usage is. The Internet usage frequency is also affected by age, income, and location. The incidence of non-use and less use is much higher with more aged, low income and remote region households than that of frequent users. The gender issue is not strong in comparing use frequency. In essence, education, age, income, and location are found to be significant determinants of the Internet usage in rural Nepal.

Table 5-5: Internet usage experience by demographic types

	Gender		Age		Education			Income		Location	
	Male	Female	Below 30	Above 30	Literate	High school	College graduates	< NRs. 20,000	>NRs. 20,000	Mountain	Hills
Internet usage frequency (%)											
Never	14	13	12	18	42	17	2	19	8	16	10
Once a month	20	22	16	31	47	22	13	25	14	26	11
once a week	28	36	35	20	5	34	28	25	38	27	37
twice a week	10	7	10	7	0	6	16	7	13	8	11
thrice a week	3	0	2	3	5	1	3	2	3	2	3
four times a week	17	20	17	21	0	13	32	18	18	17	20
everyday	7	2	8	0	0	6	6	5	7	5	7
Total	100	100	100	100	100	100	100	100	100	100	100

The survey results, as in Table 5-6, show that the Internet is mostly (81.3%) used for communication, particularly for e-mail, Internet telephony and chat/text messaging, followed by 62.6% for access to information (web surfing, agricultural information, product/service information, news), 54.7% for education, 13.8% for health (telemedicine), 9.3% for entertainment (online games, listening to music, watching movies), and 7.6% for e-business. Only 6.2% respondents are willing to use the Internet for government services, which implies that rural people are typically unaware about e-government and e-commerce. Only 1.7% of respondents reported no English knowledge, which shows that the English content on the Internet may not be a big issue in the case of rural Nepalese. However, in the context where the operating systems of PCs, Internet navigation and content are mostly in English, it is imperative to take initiatives to promote the localization of computer software such as Unicode and other applications that would be suitable even in low-bandwidth mode.

Table 5-6: Applications to use by rural consumers

Applications	Frequency (%)
Communication (e-mail, Internet phone, chat/text messaging, social networking)	235 (81.3)
Access to information (web surfing, agricultural, product/service information, news)	181 (62.6)
Education	158 (54.7)
Health (telemedicine)	40 (13.8)
Entertainment (online game, listening music, watching movie)	27 (9.3)
E-business	22 (7.6)
Government service	18 (6.2)

5.3 Empirical results and discussion

5.3.1 Specific models of analysis

Chapter 4 has provided discussion with the methodological framework. This section, thus, specifies the model congruent with the random utility model as follows:

$$U_{njt} = \beta_{Ncell}NCELL + \beta_{WL}WL + \beta_{ConMod}CONMOD + \beta_{Speed}SPEED + \beta_{Fee}FEE + \beta_{DisPro}DISPRO + \beta_{Distance}DISTANCE + \varepsilon_{njt} \quad (5.1)$$

In Eq. 5.1, $NCELL$ and WL are dummy variables to represent ISPs; $CONMOD$ is a dummy variable that defines how a respondent wants to access the Internet;

$SPEED$ is the speed of the Internet; FEE is the monthly tariff; $DISPRO$ is the probability of disconnection as the proxy of reliability; and $DISTANCE$ is the variable to denote how much to walk to access the Internet, whether at home or at public place. With the first attribute, ISP, we have three levels, in which Nepal Telecom is chosen as the base alternative. As discussed in chapter 4, the rank-ordered logit is defined through the contingent ranking in conjoint survey.

We have also specified the above mentioned random utility model interacting with socio-demographic variables as in Eq. 5.2.

$$U_{njt} = \beta_{Ncell}NCELL + \beta_{WL}WL + \beta_{ConMod}CONMOD + (\alpha_0 + \alpha_{Edu}EDU + \alpha_{Income}INCOME + \alpha_{Usefreq}USEFREQ)\,SPEED + \beta_{Fee}FEE + \beta_{DisPro}DISPRO + (\gamma_0 + \gamma_{Gender}GENDER + \gamma_{Age}AGE + \gamma_{Income}INCOME)DISTANCE + \varepsilon_{njt} \quad (5.2)$$

In Eq. 5.2, EDU is the education level of respondents; $INCOME$ is the income level of respondents; $USEFREQ$ is the Internet usage frequency of the respondents; $GENDER$ is a dummy variable to define the respondent whether male or female; and AGE is the age of individuals.

5.3.2 Model estimates: Rank-ordered logit

A total of 286 usable survey responses on the rank-ordered choice questionnaire were received for the preference analysis to estimate the rank-ordered logit. Each respondent ranked from 1 for the most preferred to 4 for the least preferred for the four choice sets, resulting in 1,144 total observations for rank-ordered logit estimation. Using the LIMDEP program, the estimates were obtained as in Table 5-7.

The result shows a good fit in terms of the signs and parameters as assumed by the underlying theory and as per the current Nepalese Internet scenario in rural regions. This study interprets the parameters as a marginal utility: the change in utility for a one-unit increase in the variable. As presented in Table 5-7, the marginal utility order among ISPs is Nepal Telecom, Worldlink and Ncell, which is justified from the Nepali Internet market scenario. Nepal Telecom is the incumbent telecommunications company providing basic telephony and Internet services. Worldlink is the largest ISP with a customer base both in rural and urban areas, while Ncell is a GSM-based mobile telephony and Internet provider, basically popular among urban consumers.

Regarding the access mode for the Internet, respondents prefer wireless access without a telephone line, showing a negative utility for the connection with a telephone line. Given very low dedicated telephone lines in households in rural parts of Nepal[17], this result is justified. In some villages, people have to walk a long way to get a public telephone booth to make a call if necessary. This can be seen also from the popularity of community-based wireless networking in rural parts of Nepal.

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[17] According to the Nepal Living Standard Survey (2011), 13% of the households have access to a land-line telephone facility in the country. The access to a telephone is highly pro-urban and pro-rich.

Table 5-7: Estimation results of rank-ordered logit model

Variables	Coefficient	t-value	WTP[a]
Ncell	0.087*		
	(0.052)	1.673	60.42
Worldlink	0.146**		
	(0.054)	2.695	101.39
Connection Mode	-0.160**		
	(0.044)	-3.642	-111.11
Speed	0.320**		
	(0.022)	14.313	2.21
Service Fee	-0.144**		
	(0.010)	-13.6	N/A
Disconnection Probability	-1.882**		
	(0.342)	-5.508	-13.07
Distance	-0.356**		
	(0.032)	-11.239	-247.22

*significant at 5% level; **significant at 1% level; log likelihood function -3346.711; standard errors in parentheses; [a] currency unit in NRs. 1.

Wireless technologies are apt, particularly in rural areas, because of their low level of initial investment and scalability, their relatively simple technical deployment, their low-cost and open standards, and their adaptability to voice and data requirements (Siochrú & Girard, 2005).

The attribute of most concern for the respondents is “distance,” which shows the negative marginal utility of consumers for the distance they have to walk to access the Internet, that is, consumers’ relative utility increases when the distance decreases. It is obvious that consumers do not necessarily intend to walk a long way to use

Internet services. This clearly implies promoting household Internet use. However, this argument may not be justifiable with other studies made previously, which discuss promoting Internet cafés or telecenters in the case of demand pooling to enhance the penetration rate of the Internet (James, 2003; 2006; Vaidya & Shrestha, 2002). It is not generalizable that rural consumers, on the whole, are not willing to use the Internet at community centers or cyber cafés. The reason for such a result may be the homogenous assumption and other restrictions of the multinomial logit model. In the case of rural Nepal, it is unusual for the entire population not to prefer Internet away from home. The application of the mixed logit model in the next section could relax the methodological assumption to examine whether all rural consumers prefer Internet usage at home.

Concerning the service fee, respondents prefer fewer tariffs to more, as stipulated. The "probability of disconnection" is also significant for the rural consumers, who are seen to value reliable services with lower disconnection rates. This conforms to the results of previous studies by Savage and Waldman (2005; 2009).

For speed, service fee, and probability of disconnection, people showed very natural preferences. Respondents choose the alternatives that give higher speed, less service fees, and less probability of disconnection. In the case of the preference of distance, it is estimated that the Internet service requiring less travel distance is more preferred.

On the whole, rural consumers rate “distance” as the most important and “ISPs” as the least important attributes. This estimation gives a clear message that rural consumers want Internet connections at home, without wired connections, at higher speed, with lower disconnection rates, and with lower service fees.

The result consists of the WTP for each attribute against the service fee, which gives more information on consumers’ WTP for the service. Referring to Table 5-7, it can be noted that consumers want to walk 1 km to access the Internet if they receive a compensation of NRs. 247.22/month. If we compare this with the bandwidth they are willing to pay for, it far exceeds what their WTP is for 56 kbps bandwidth (NRs. 123.76/month). Similarly, in the case of the Internet access with a phone line, if they opted to choose, they had a negative WTP of NRs. 111.11. Rural consumers tend to pay NRs. 2.21 for 1 kbps of additional bandwidth, which gives the figure of NRs. 424.32 for 192 kbps bandwidth per month. The WTP value is worth enough in the case of a rural Internet service. From the estimation, policy makers and service providers can establish their general subsidization and provision plans. However, with this homogenous estimation irrespective of individual characteristics, spatial and other considerations, the plans may be futile. It would be just like an improper diagnosis with the wrong medication given, which is why this study has developed a more flexible estimation model to bring out more flexible policies basically for the benefit of the underserved rural regions of Nepal.

The results in Table 5-7 are further analyzed by incorporating socio-demographic variables as defined in Eq. 5.2 to find more plausible results before resorting to the mixed logit estimation.

5.3.3 Model estimates: Interaction with socio-demographic characteristics (SDCs)

Table 5-8 shows the estimation results from the interaction of speed with income, education and usage frequency; and distance with gender, age and income.

The results of the interaction terms show that the sign and magnitude of the mean values of coefficients are more or less the same as those in Table 5-7. The order of the importance of partworths is also similar, except for the lower value of mean marginal utility in relation to speed. As distance and speed are seen as the most significant preferred attributes from the estimation in Table 5-7, this study further estimates interaction between distance and SDCs, and between speed and SDCs.

It can be inferred from the estimation that educated people with more income and frequent Internet usage want more bandwidth. The more aged the users are, the less they want to travel for Internet access. A most striking finding here is that female users tend to walk more to access the Internet. With this result, what we can infer from rural Nepal is that there is a high migration trend for males.

Table 5-8: Estimation results of rank-ordered logit with interaction

Variables	Coefficients	t-ratio
Ncell	0.091**	1.732
Worldlink	0.152***	2.791
Connection Mode	-0.163***	-3.689
Speed	0.126***	2.472
Service Fee	-0.147***	-13.753
Disconnection Probability	-1.86***	-5.433
Distance	-0.245**	-2.303
Speed and Education	0.057**	1.792
Speed and Income	0.005**	1.864
Speed and Usage frequency	0.008***	3.195
Distance and Gender	-0.085*	-1.447
Distance and Age	-0.007**	-2.280
Distance and Income	0.008***	2.383

*significant at 10%, **at 5% and ***at 1% levels;

log likelihood function -3329.889

Many young men go to cities or abroad in search of a better job or opportunities and their family members, particularly wives, use the Internet specifically for calling them through the Internet telephone, which is much cheaper than other international calls. This result is further augmented from the Nepal Living Standard Survey (2011)[18], which indicates that nearly 44% of households have at least one absentee (87% male) currently living abroad or within the country.

Another arresting result relates to the interaction between distance and income,

[18] http://cbs.gov.np/

which shows a positive relationship, which seems to be unrealistic. However, the descriptive statistics show that the incidence of Internet users is highest among students and service holders who belong to the higher income group. Given that most of these respondents (71.4%) use or are likely to use the Internet at college or work rather than at home, the result can be justified. It is plausible to argue that those users may not also want to use the Internet at home, since they can enjoy using the Internet without personal subscriptions.

5.3.4 Model estimates: Mixed logit

This section discusses the results obtained from the mixed logit model. For the estimation, Bayesian procedure with the sample size of 1,144 is used. Following the estimation method of Train (2003), Kim (2005), and Lee *et al.* (2006), 20,000 draws with Gibbs sampling is generated. Specifically, the first 10,000 iterations are discarded and considered as burn-in, and the draws of every tenth iteration of the second 10,000 draws are retained after convergence. The retained 1,000 draws are used to create inference in which the mean and standard deviation of these draws constitutes the estimates and standard errors. The Gauss 6.0 Program is used to estimate the results from random coefficients. Prior distribution of every marginal utility of each attribute is assumed to be in normal, log-normal and censored distributions. For qualitative attributes such as ISPs and mode of connection, dummy variables are used. In the case of ISPs, the first option (Nepal Telecom) is set as the base alternative. The results are shown in Table 5-9.

Table 5-9: Estimation results of the random coefficient model

	Mean (b) of B			Variance (W) of B		
Variables	Mean	St. error	t-value	Variance	St. error	t-value
Nepal Telecom			Base alternative			
Ncell	0.209**	0.080	2.62	0.527**	0.110	4.79
Worldlink	0.230**	0.092	2.51	0.922**	0.187	4.94
Connection Mode	-0.262**	0.077	-3.38	0.908**	0.165	5.49
Speed	0.072**	0.012	6.19	0.035**	0.003	11.03
Service Fee[a]	-1.670**	0.100	-16.74	0.851**	0.158	5.39
Disconnection Prob.	-2.950**	0.335	-8.82	5.734	4.978	1.15
Distance[a]	-0.274*	0.170	-1.61	2.055**	0.591	3.48

**significant at 5% and **significant at 1% levels*

[a]*The service fee and distance variables are entered as the negative of service fee and distance so that the distribution of the coefficients (transformed distribution) for service fee and distance are everywhere positive.*

As mentioned earlier, the results of the Bayesian procedure can be interpreted from both Bayesian and classical perspectives. Therefore, the estimated means and their variance are presented, in which most of the results are significant at the 1% significance level, the mean estimate of the parameter “distance” at a 5% significance level, but the variance estimate of the parameter “disconnection probability” is not significant.

A striking result is that due to the heterogeneity in preferences among respondents, speed is less valued than service fee, which is a very important clue in terms of implications. What rural people need is a service with affordable tariffs, which coincides with the general economic theory. The variance of the attribute "disconnection probability" is not significant, which shows that respondents have a uniform preference toward this. Except for the case of disconnection probability, all the estimates of variance are statistically significant; that is, the hypothesis of no variance can be rejected and the use of the mixed logit model is justified.

As discussed in Chapter 4, this study follows the transformation procedure for the coefficients of each variable through simulation with 2,000 draws of β_n being taken from the normal distribution with a mean equal to the estimated values of b and with the variance equal to the value of W. As a result, a draw of transformed coefficients is obtained, as in Table 5-10.

Table 5-10: Transformed random coefficient estimates

Variables	Mean	Variance
Ncell	0.2243	0.509
Worldlink	0.2602	0.951
Connection Mode	-0.2869	0.908
Speed	0.0709	0.035
Service Fee	-0.2938	0.112
Disconnection Probability	-2.9586	5.905
Distance	-0.7119	0.866

The estimation assumes a log-normal distribution for the service fee and a censored normal distribution for distance. The signs of the coefficients in this estimation are similar to the estimates in the rank-ordered logit model. However, the order of the significance has changed with this estimation. In addition, the variances in random coefficient estimates are relatively large compared to their means with respect to ISPs, connection mode, service fee, and distance. This reveals a clear variation in consumer price and service attributes, showing an intense heterogeneity in the preferences of consumers with regard to the Internet usage in rural Nepal, which can be further explained from the results of the shares of population for each coefficient, as shown in Table 5-11.

According to the shares, there is no variation in terms of service fee. Every respondent wants an Internet service with lower tariffs. The interesting result we can see from Table 5-11 is that 43% of respondents are indifferent toward whether or not they have to walk to access the Internet. This indicates that the result we have obtained from the rank-ordered logit cannot be generalized, as rural people have a negative utility toward walking a certain distance for Internet access. This strongly implies that community centers and/or Internet cafés should be enhanced to cater for the needs of those who are underserved. Similarly, 37% of respondents still tend to enjoy a wired connection, although the overall result for this is negative. This evidences how people in rural areas intend to obtain a telephone line in their household, if available. It is worth mentioning that the descriptive statistics show that the share of the population using the Internet on cellular mobile phones is quite high; hence, it is imperative to enhance mobile Internet access in rural areas including community-based wireless networks if no wired access can be developed. This highlights the need for the subsidization (a tariff subsidy to household users and a capital subsidy to the community network operators) to complement the universal-service funding policy.

Table 5-11: Shares of population for coefficients

Variables	below zero	at zero	larger than zero
Ncell	38%	0%	62%
Worldlink	39%	0%	61%
Connection Mode	63%	0%	37%
Speed	35%	0%	65%
Service Fee	100%	0%	0%
Disconnection Probability	88%	0%	12%
Distance	57%	43%	0%

Regarding the speed of the Internet, 35% of respondents have a negative utility toward higher speed, which cannot be merely interpreted, as they do not need faster Internet connections, but that their preference is to get an affordable service first. It is obvious when examining the results for the probability of disconnection that 88% of consumers prefer Internet access with a less disconnected service, which confirms the findings of Savage and Waldman (2005; 2009) with the reliable service which rural American consumers prefer, and contradicts Long (2010), who finds that rural Vietnamese consumers have less priority for speed.

In addition, the WTPs in the random coefficient model are also calculated in the study. In a rank-ordered logit procedure, the WTPs for attributes are calculated by dividing their corresponding coefficients by the “service fee” coefficient to generate marginal WTPs (Lee *et al.*, 2006). With the mixed logit model, WTPs are calculated in a similar way but use a simulation from 2,000 draws, as in *Eq. 4.16*. However, there is a concern regarding the WTP calculation, as this study assumes a log-normal distribution for the price coefficient. Since the WTP coefficient is the denominator in the WTP calculation, some extreme values may produce extremely high WTPs due to the effect of outliers (Koh, 2007). As a solution, Balcombe *et al.* (2009) prescribe the use of a median WTP. Hence, this study employs the quartile that includes the median WTP with the argument that the "median provides a more equitable social choice rule for aggregating WTP for use in cost-benefit analysis" (Balcombe *et al.*, 2009). The marginal WTP calculation results are presented in Table 5-12.

The result for the median WTP is quite interesting. The values and signs back up the above discussions about the preferences of consumers to each attribute. Moreover, the median values are also similar to the WTPs derived in the rank-ordered logit model. It shows that Nepali rural consumers are willing to pay more for a wireless (without a phone line) Internet service (NRs. 108.5) and also for speed (NRs. 2.44 per kbps). For the 128 kbps service, which seems to be an appropriate service in Nepali rural areas, the MWTP is calculated at NRs 312.32, which is a reasonable price for bandwidth. Twenty-five percent of respondents have a negative WTP toward speed, which is justified, and in line with the previous discussion, where they are shown to primarily prefer a more affordable service. Regarding the probability of disconnection, all respondents have a negative MWTP. As far as the relative importance of each attribute, as calculated according to *Eq. 4.20*, is concerned, consumers regard the service fee as the most important attribute, followed by distance, connection mode, ISP, disconnection probability, and speed, as discussed above.

Table 5-12: Median WTP and relative importance

Quartile	Ncell	Worldlink	Connection Mode	Speed	Service fee	Disconnection Probability	Distance
1st	-104.3	-184	-490.5	-2.37	N/A	-29.063	0
Median	**80.6**	**83.2**	**-108.5**	**2.44**	N/A	**-12.569**	**-89.8**
3rd	351.4	446	146.9	9.81	N/A	-4.24	-390.6
Relative Importance (%)	11%	15%	15%	8%	25%	10%	17%

Similarly, the study has segregated the data into two strata: remote mountainous areas where there is no telephone service (even if telephone access exists, it is limited to only a public call office (PCO) booth or to very few points, such as government offices) and comparatively convenient rural areas, termed as hills, where telephone access has reached a limited number of households. The results from the estimations (Table 5-13 and Table 5-14) are mostly similar, with only some insignificant differences.

Comparing estimations between the hills and the mountain respondents, respondents from the hills seem to have more WTP than those from the mountains.

Unlike the main estimation model, distance, in both cases, is seen as insignificant.

Table 5-13: Estimation result (mountain)

Variables	Mean	Variance	WTP
Nepal Telecom		Base alternative	
Ncell	0.199**	0.592***	71.25
Worldlink	0.234*	1.171***	76.03
Connection Mode	-0.220**	1.079***	-85.43
Speed	0.073***	0.046***	2.42
Service Fee	0.295***	0.121***	N/A
Disconnection Prob.	-2.958***	4.401	-13.28
Distance	0.700	0.959***	-39.17

*N=188 *significant at 10%; **significant at 5%; and ***significant at 1% levels*

Table 5-14: Estimation result (hills)

Variables	Mean	Variance	WTP
Nepal Telecom		Base alternative	
Ncell	0.266**	0.678***	116.07
Worldlink	0.280**	1.056***	104.02
Connection Mode	-0.288**	0.938***	-126.50
Speed	0.071***	0.084***	2.56
Service Fee	0.280***	0.196***	N/A
Disconnection Prob.	-2.923***	4.600*	-14.88
Distance	0.675	0.722**	-117.74

*N=98 *significant at 10%; **significant at 5%; and ***significant at 1% levels*

To sum up, consumers value an affordable service fee most, followed by distance, and then connection mode. On the other hand, rural consumers do not have as place as much value on speed and ISPs as to the afore-mentioned attributes. The demand for Internet access and the service fee has a negative relationship, which is as per the expectation. Income and education have a strong influence on the demand and we also know that Internet access without a telephone line is a strong substitute for access with a telephone line.

5.4 Policy scenarios and efficiency: Shared and household access

Tallying the preference estimations in the previous sections, this section discusses different policy scenarios that are considered for prescribing the highest efficient funding design concerning the access at individual household level and in public places for shared access. The design functions as a bridge between the empirical analysis and policy implications. The most efficient scenario matches both consumer utility maximization and cost for the provision of the Internet at the last mile.

The scenarios are constructed with six hypothetical alternatives on display: four scenarios in the context of shared access, and two scenarios for household access. The cards are realistically designed to include the current rural Internet service situations in Nepal. The details of the designed cards are explained below. The cost estimates are obtained from the historical costs of a rural ISP. Equation 5.1 is used for estimating the efficiency of policy scenarios.

$$Efficiency\ index = \frac{Pr_i}{C_i - R_i} \times 1000 \qquad (5.1)$$

Where i stands for scenarios *1,2,..6*, Pr_i is the choice probability of a user choosing alternative i (mean values derived from the mixed logit estimation), and C_i is the cost of scenario i per user per month. Thus, the efficiency of the policy will be the level of the potential market share of each scenario divided by the net cost per user. It is important to note here that the absolute value of the index does not carry any other meaning than to compare the scenarios from the best to the worst cases for policy implications to stimulate Internet penetration in rural Nepal.

The first scenario assumes a distance of 2 km to access the Internet with a 192 kbps data transfer speed at a 10% probability of disconnection at a service fee of NRs. 750 per user per month. It is wireless connection; that is, no telephone line is needed for the Internet connection. The service is provided by Worldlink. The second scenario holds Nepal Telecom as the ISP providing a telephone line for an Internet connection of 192 kbps bandwidth with no disconnection probability at the rate of NRs. 900 per month per user who is required to walk 0.5 km for the Internet service. Requiring a user to walk 1 km for Internet access, the third scenario assumes a service without a telephone line to be provided by Ncell at a data rate of 384 kbps with a 10% disconnection probability at a fee of NRs. 1350 per user per month. The fourth scenario assumes a 0.5 km walk to access the Internet at a 384 kbps data transfer speed, using a telephone line from Nepal Telecom, for which a user pays NRs. 1350 per month. The fifth scenario assumes the service is at home, for which Nepal Telecom provides the service through a telephone line. No disconnection probability is assumed for 384 kbps bandwidth with a subscription fee of NRs. 1450 per month. The sixth scenario also assumes a household wireless access of 192 kbps data speed with a 10% disconnection probability, to be provided by Worldlink with a subscription fee of NRs. 1000 per month.

While designing the scenarios, the real rural Nepalese Internet market is considered on the whole with due consideration to technological innovation such as the provision of higher bandwidth, and less probability of disconnection. With the growing competition among service providers, rural consumers have started enjoying more reliable Internet connection with more bandwidth, resulting in lower service fees.

Cost information plays a crucial role in defining the efficiency. Assuming different costs associated with wired or wireless connections, more or less bandwidth, and a stable or less stable service, the estimation includes the cost for infrastructure setup including human resource deployment, and bandwidth requirement for running Internet service kiosks (cyber cafés) or for providing the Internet services in homes. Infrastructure cost comprises devices, computers, rental of space, furniture, operating costs such as salaries for staff, utilities, rental, and incidental expenses[19]. Bandwidth cost is estimated assuming the average of the bandwidth utilized at a 192 and 384 kbps data transfer speed. The cost for computer and Internet training for households is also included.

Employing *Eq. 5.1*, the efficiency index in Table 5-15 is generated from the

[19] The average cost is estimated in consultation with a rural ISP operator. The estimation is for the total number of rural households of 4,543,537 as of the National Census 2011.

mentioned scenarios.

Table 5-15: Efficiency index for best vs. worse policy scenarios

Attributes	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5	Scenario 6
ISP	Worldlink	Nepal Telecom	Ncell	Nepal Telecom	Nepal Telecom	Worldlink
Connection mode	w/o telephone line	with telephone line	w/o telephone line	with telephone line	w/o telephone line	w/o telephone line
Speed	192 kbps	192 kbps	384 kbps	384 kbps	384 kbps	192 kbps
Service fee	NRs. 750	NRs. 900	NRs. 1350	NRs. 1350	NRs. 1450	NRs. 1000
Disconnection prob.	10%	0	10%	0	0	10%
Distance	2 km	0.5 km	1 km	0.5 km	0 km	0 km
Efficiency Index	**0.2928**	**0.2513**	**0.3102**	**0.2605**	**0.4547**	**0.4244**

In order to investigate how the efficiency changes following the distance needed to travel in addition to the changes in attribute levels, the efficiency index is estimated for the general case with mean values derived from mixed logit estimates. The simulation result clearly exhibits that the scenario of providing the Internet in homes brings about the highest efficiency (0.4547). In addition, the scenario consists of more bandwidth and a stable service without telephone lines. Contrary to this, the scenario for shared access with a telephone line and less bandwidth shows the worst case.

When comparing the scenarios of providing the Internet in homes, a stable connection (without disconnection probability) and more bandwidth are found to be valued by consumers. However, the scenarios of shared access with more bandwidth and a wireless connection, irrespective of disconnection probability, are valued by rural consumers. Consumers' quest for better bandwidth conditions, the value placed on wireless access versus a wired telephone connection, and a negative marginal utility for the distance they need to walk/travel in terms of the WTP estimates are commensurate with the above scenarios created to predict performance or efficiency in terms of policy measures. In short, the simulation results demonstrate the best policy option for household Internet (scenario 5) and shared access (public) Internet (scenario 3). With this relative comparison of policy options, we argue that the demand-side information which we obtain from choice probability should be supplemented by the supply-side information; that is, the cost and revenue for the provision of the Internet service, in defining the efficiency of policy measures to tackle the digital divide through the diffusion of Internet use in rural regions.

Chapter 6. Conclusion and policy implications

6.1 Conclusion

Today, the Internet plays a huge role in developing countries. Many Middle-East countries have experienced critical revolutions largely affected by Internet-based communication. There is no doubt that successful construction of Internet infrastructure in a developing country is a key factor for the country's political and socio-economical change. Considering this, the governments of developing countries should focus on promoting the adoption and usage of the Internet in rural areas to bridge the digital divide. Many policy frameworks have been developed; however, there is a need for such policies to centralize rural consumers' preferences toward Internet adoption.

This study reiterates Banerjee and Ware's (2003) argument that the combination of ranked stated preference data and mixed logit models can be a valuable tool for market analysis, as the dramatic transformation brought about by Internet adoption continues in rural and underserved parts of the world. Therefore, this study has incorporated heterogeneity into the models via a random coefficient model and the interaction between Internet service attributes and SDCs.

The estimation results are consistent in the conventional rank-ordered logit model and mixed logit models. They are also consistent with previous studies and have proved to be suitable under conditions of low market penetration. The results from the mixed logit model have widened the result horizon by finding heterogeneity and shifting preferences particularly in terms of speed and service fee. Therefore, it can be inferred that a conjoint analysis with Bayesian mixed logit estimation is a useful and accurate methodology for understanding consumer behavior with regard to Internet use and adoption.

The study is, thus, expected to contribute toward the empirical and theoretical background of the use of stated preferences and conjoint analysis for Internet usage in rural areas so as to enable the drawing up of policy measures for the bridging of the digital divide.

Some limitations remain. We have only focused on the basic factors of Internet services. It is expected that considerations about content and network effects would provide a deeper insight into this issue. In addition, combining stated preference and revealed preference data could generate rural as well as urban preferences.

6.2 Key findings and policy implications

From the results of the analysis, important implications can be drawn: the Nepalese in rural areas regard service fee and distance as the most important factors. Similarly, they would prefer to use the Internet stably and smoothly in their own homes with a more adequate bandwidth. They also prefer wireless access to wired connections. Although consumers have a negative marginal utility in terms of the distance they need to travel to access the Internet, a considerable number of consumers do not care about the distance they need to cover to access the Internet. In this respect, community wireless networks remain as valuable assets for the rural consumers who cannot afford or do not have the Internet at home. The next measure links to the mobile Internet as Howard and Mazaheri (2009) stress. Mobile telephony has been expanding rapidly in Nepal. Hence, the Nepalese government and service providers need to focus on providing reliable and fast mobile Internet services, not only in urban areas but also in rural areas, where, according to this study, they need to tap into rural consumers' WTP by more precisely matching the services on offer with their need for a reliable service with adequate bandwidth. As Whitacre (2010) argues, market forces alone are inadequate to induce companies to invest in those areas; consequently, the government should provide an enabling environment for competition, for instance, by providing a subsidy to service providers, thereby, creating service affordability and the awareness of the available services among rural consumers, which will energize the market for improved penetration. In addition, a favorable environment should be created for fostering community-based wireless networks for the rural areas. Moreover, the issues of affordability and accessibility are the most important concerns in bridging the so-called digital divide in the Nepalese rural scenario. Hence, ISPs should marry a participatory community-based wireless network to their hardheaded business model and service development, for which the government should provide a favorable regulatory and market-oriented environment. Again for ISPs, the results highlight how price can be less important for a certain market, and that there are some critical factors that cannot be ignored, in this case, for instance, the travel distance, wireless access, and reliability of the service. This study reinforces the reason why market analysis and consumer preference studies are essential for developing a strategy in the early stages.

The result can be applied to many developing countries whose rural areas are sparsely populated. For instance, our study is a good guide for some governments of developing countries in which the territory is covered with mountains, jungles, or deserts.

As the results of the study show that consumers prefer more bandwidth for Internet access, have a negative utility toward distance to walk and probability of disconnection, the immediate strategy to fill the gap requires intervention from the government to foster the sustainability of community centers through the adoption of public-private partnership schemes for cyber-cafés. In the meantime, the focus should be on how to lure consumers to such centers outside of their visits for essential matters such as Internet phone/video calls to their dear ones abroad or in the city or for getting their health checked through telemedicine services. One of the effective ways to raise Internet usage frequencies among rural consumers in terms of the frequency and quality of Internet usage is to house telecenters at such essential places as village development committees, where people must visit for any official transactions they require such as obtaining birth certificates for newborn babies or paying land tax, to name a few. This not only leads to Internet adoption in remote rural areas but also enables e-services in local government authorities. Similarly, use behavior of rural residents should be improved through digital literacy programs, training and the use of killer applications. As the long-term goal is to provide Internet access at the household level, the policy should be directed toward owning PCs at home. Utilization of the One Laptop per Child (OLPC) Program, for instance, can be an effective intervention toward filling the gap between the haves and haves-not in owning PCs. It is worth mentioning that Korea's comprehensive national broadband plan became successful owing to the push for a national fiber optic broadband network on the supply side, and the 10 Million People Internet Education Project on the demand side (Lee *et al.*, 2003). A similar policy focusing on educating homemakers, especially housewives, about the advantages of computer usage and the Internet would lead to improved Internet adoption in rural areas since the homemakers are the principal decision makers with regard to household finances.

This study is not only limited to the preference structure of the consumer of the Internet at home (Goldfarb & Prince, 2008; Savage & Waldman, 2009) but also in public places such as community centers and cyber cafés since the Internet as an advanced technology is not accessible in every household in rural areas and universal use can only come about either as a community-led initiative or a government initiative. More importantly, we should not forget that the connection to the Internet itself does not accomplish the task of adoption. Therefore, from the perspective of Internet adoption by rural consumers, as they prefer wireless access for Internet connections, community wireless networks (CWNs) can serve as grassroots connectivity solutions for rural and underserved societies (Abdelaal & Ali, 2007; Sandvig, 2004; Meinrath, 2005; Abdelaal, Ali, & Khazanchi, 2009). The networks are beneficial in reducing the costs of Internet access, overcoming the technical barriers and for better processing of the information since they are clusters of socio-technical networks that are funded, implemented, and operated by the community in order to provide free or affordable Internet access to its members. Multipurpose community telecenters are public multifunctional loci of shared access where demand for connectivity can be pooled together, and where supply becomes commercially feasible and self-sustained after an assisted start-up period (Giovannetti, 2001).

Privatization and the introduction of competitive forces (liberalized market forces) into the telecommunication market are indeed reasons for rapid Internet penetration. However, there are other important factors, which should be considered for effective penetration. For example, Argentina's experience has brought several measures that include regulatory interventions regarding local access tariffs, an innovative calling plan, and concerted push to expand community Internet access programs (Choi, 2004).

On the other hand, as the majority of households do not own a PC, schools can play a significant role in the diffusion of the Internet. Schools can be selected to train local farmers and help them develop e-commerce. The schools can also serve as an important link to relay web-based content to the farmers. In rural Nepal, where the overall education of its residents is inadequate to cope with such an advanced communication technology as the Internet, schools as the powerhouses of knowledge in rural areas naturally help to fill in the gaps. On the one hand, schoolteachers tend to be the better-educated people in rural areas and, therefore, most receptive to new innovations. The students, on the other hand, serve as the best messengers due to their natural links to the farming households. As the Internet does not come to the local farmers as a natural step in the development of the rural telecommunication infrastructure, its diffusion and usage are very much influenced by the change agency. The rationale of the change agency for introducing the technology obviously shapes its diffusion patterns, which in turn influence its usage and implications for local development.

Besides the community center model, the Internet café has also been proved as an important factor to society in promoting adoption of the Internet both in developed and under-developed areas. The case of Internet cafés in Korea (Lim & Lee, 2007; Cho, 2004), and China (Xia & Lu, 2008) are good examples. Instead of totally investing in community centers, the private-sector partnership in supporting Internet cafés can be considered as an alternative or as a complementary option. The capital and maintenance costs of the government can then be managed more efficiently to reduce the financial burden on the government budget.

Therefore, in rural areas, governments should cooperate with the private sector or bring in incentives to promote Internet cafés, especially for remote and isolated areas. The success of the Internet café plus the community model is therefore a sensible way for the public center setting to promote the adoption and usage of the Internet in poor rural areas, where poor citizens have little financial opportunity to subscribe to household Internet packages.

As a result, such approaches stimulate the combination of the Internet in households and in public centers in the study. The inclusion of the distance variable allows the model to be investigated, and at the same time, the Internet at home and the Internet in public centers can be tackled, which hopefully could lead to adequate outputs and meaningful policy implications.

Given the situation that efficient and adequate action has not yet been taken in Nepal, the above-mentioned policy measures will be instrumental in addressing the potential expansion of Internet use in rural and remote regions, as the need for digital information and knowledge has been elucidated in the second chapter of this dissertation. In addition, the study of the preference structures of rural users is expected to help in carving such an Internet subscription plan that fosters efficient utilization of the Internet in Nepal and in other, similar underserved regions of the globe.

Bibliography

Abdelaal, A., & Ali, H. (2007). Typology for Community Wireless Network Business Models. *Proceedings of the Thirteenth Americas Conference on Information Systems, August 9-12th*. Keystone, Colorado, USA.

Abdelaal, A., Ali, H., & Khazanchi, D. (2009). The role of social capital in the creation of community wireless networks. *Proceedings of the 42nd Hawaii International Conference on System Sciences*.

Adamowicz, W., Boxall, P., Louviere, J., Swait, J., & Williams, M. (1999). Valuing environmental preferences: theory and practice of the contingent valuation methods in the US, EU, and developing countries. In I. Bateman, & K. Willis (Eds.), *Stated-preference methods for valuing environmental amenities* (pp. 460-479). New York: Oxford University Press.

Anderson, S., Palma, A., & Thisse, J. (1991). *Discrete Choice Theory of Product Differentiation*. The MIT Press, Cambridge, England.

Azevedo, C., Herrriges, J., & Kling, C. (2003). Combining revealed and stated preferences: Consistency tests and their interpretations. *American Journal of Agricultural Economics, 85*, 525-537.

Balcombe, K., Chalak, A., & Fraser, I. (2009). Model selection for the mixed logit with Bayesian estimation. *Journal of Environmental Economics and Management, 57*, 226-237.

Banerjee, A., & Ware, H. (2003). Mixed logit analysis of carrier market share with stated-preference data. In R. Cooper, G. Madden, D. Lloy, & M. Schipp, *Contribution to Economics, The Economics of Online Markets and ICT Networks* (pp. 185-202). Heidelberg: Physica-Verlag (2006).

Beggs, S., Cardell, S., & Hausman, J. (1981). Assessing the potential demand for electric cars. *Journal of Econometrics, 16*, 1-19.

Ben-Akiva, M., & Lerman, S. (1985). *Discrete Choice Analysis: Theory and Application to Travel Demand*. MIT Press, Cambridge.

Breidert, C. (2006). *Estimation of Willingness-to-Pay*. Wiesbaden: Deutsche Universitäts-Verlag.

Brownstone, D., & Train, K. (1999). Forecasting new product penetration with flexible substitution patterns. *Journal of Econometrics, 89*, 109-129.

Butkevičienė, E. (2005). Social implication of the internet diffusion in rural communities of Lithuania. In H. Rusu, & B. Voicu (Eds.), *Perspectives on the European postcommunist societies* (pp. 97-110). Sibiu: Psihomedia.

Calfee, J., Winston, C., & Stempski, R. (2001). Econometric issues in estimating consumer preferences from stated preference data: A case study of the value of automobile travel time. *The Review of Economics and Statistics, 83* (4), 699-707.

Cattin, P., & Wittink, D. (1982). Commercial use of conjoint analysis: A survey. *Journal of Marketing, 46* (3), 44-53.

Chaudhuri, A., Horrigan, K., & Flamm, J. (2005). An analysis of the determinants of Internet access. *Telecommunications Policy, 29*, 731-755.

Cho, C. (2004). Korea's effort to build telecenters as a tool to close the digital divide. *http://www.adbi.org/files/2004.12.08.cpp.korea.telecenters.tool.pdf* . ADBI.

Choi, J.Y., Koh, D., & Lee, J. (2008). Ex-ante simulation of mobile TV market based on consumers' preference data. *Technology Forecasting & Social Change*, *75*, 1043-1053.

Choi, S. (2004). Policies for Internet access: Cases of Mexico and Argentina. In M. Kagami, M. Tsuji, & E. Giovannetti, *Information technology policy and the digital divide: Lessons for developing countries* (pp. 206-228). UK: Edward Elgar Publishing Limited.

Coast, J., & Horrocks, S. (2007). Developing attributes and levels for discrete choice experiments using qualitative methods. *Journal of Health Services Research and Policy, 12*, 25-30.

Collins, J. L., & Wellman, B. (2010). Small town in the Internet society: Chapleau is no longer an island. *American Behavioral Scientist, 53* (9), 1344-1366.

Damsgaard, J., Parikh, M., & Rao, B. (2006). Wireless commons perils in the common good. *Communications of the ACM, 49* (2), 104-109.

DeShazo, J., & Fermo, G. (2002). Designing choice sets for stated preference methods: The effects of complexity on choice consistency. *Journal of*

Environmental Economics and Management, 44, 123-143.

Do, T., & Bennett, J. (2010). Using choice experiments to estimate wetland values in Viet Nam: Implementation and practical issues. In J. Bennett, & E. Birol, *Choice experiments in developing countries: Implementation, challenges and policy implications*. UK: Edward Elgar Publishing Ltd.

Dowdeswell, E. (1995). *Global Biodiversity Assessment*. Cambridge: Cambridge.

Evans, D. (2011, April). The Internet of things: How the next evolution of the Internet is changing everything. *Whitepaper*. CISCO Internet Solutions Business Group.

Falch, M. (2007). Penetration of broadband services: The role of policies. *Telematics and Informations, 24*, 246-258.

Flores, F. (1993). Innovation by listening carefully to customers. *Long Range Planning, 26* (3), 95-102.

Giovannetti, E. (2001). Internet access and regulatory reform, the experience of South Africa. In M. Kagami, and M. Tsuji (Eds.), *The 'IT' revolution and developing countries: Late-comer advantage?* (228-249) Chiba, Japan: Institute of Developing Economies.

Goldfarb, A., & Prince, J. (2008). Internet adoption and usage patterns are different: Implications for the digital divide. *Information Economics and Policy, 20*, 2-15.

Green, P., & Srinivasan, V. (1978). Conjoint analysis in consumer research: Issues and outlook. *Journal of Consumer Research, 5* (2), 103-123.

Green, P., & Srinivasan, V. (1990). Conjoint analysis in marketing: New developments with implications for research and practice. *The Journal of Marketing, 54* (4), 3-19.

Grosh, M., & Glewwe, P. (2000). *Designing household survey questionnaires for developing countries: Lessons from 15 years of the living standards measurement study*. Washington DC: World Bank.

Hair, J. F., Black, W. C., Babin, B. J., Anderson, R. E., & Tatham, R. A. (2006). *Multivariate Data Analysis* (6th ed.). New Jersey: Pearson Prentice Hall.

Hauge, J., & Prieger, J. (2009). *Demand-side programs to stimulate adoption of broadband: What works?* SSRN: http://ssrn.com/abstract=1492342.

Heeks, R. (2008, June). The next phase of applying ICT for international Development. *IEEE Computer magazine*, pp. 26-33.

Hensher, D., & Green, W. (2001). The mixed logit model: The state of practice and warnings for the unwary. *Working paper*. School of Business, The University of Sidney.

Hensher, D., Rose, J., & Greene, W. (2005). *Applied Choice Analysis: A Primer*. New York: Cambridge University Press.

Hensher, D., Shore, N., & Train, K. (2005). Households' willingness to pay for water service attributes. *Environmental and Resource Economics, 32* (4), 509-531.

Howard, P.N.; Mazaheri, N. (2009). Telecommunications reform, Internet use and mobile phone adoption in the developing world. *World Development, 37* (7), 1159-1169.

Huber, J., & Zwerina, K. (1996). The importance of utility balance in efficient choice designs. *Journal of Marketing Research, 33* (3), 307-317.

Ida, T., & Sato, M. (2006). Conjoint analysis of consumer preferences for broadband services in Japan. *The Kyoto Economics Review, 75*, 115-127.

Intven, H., & Tetrault, M. (2000). *Telecommunications Regulation Handbook.* Washington DC: Worldbank.

ITU. (1999). *Challenges to the network: Internet for development*. Geneva: International Telecommunications Union (ITU).

ITU. (2011). *ICT facts and figures 2011*. Geneva: International Telecommunication Union.

James, J. (2003). Sustainable Internet access for the rural poor? Elements of an emerging Indian model. *Futures,* 461-472.

James, J. (2006). The Internet and poverty in developing countries: Welfare economics versus a functionings-based approach. *Futures*, 337-349.

James, J. (2004). The internet and rural development: Elements of a new paradigm. *International Journal of Development Issues, 3* (2), 93-108.

James, J. (2002). Universal access to information technology in developing countries.

Regional Studies, 36 (9), 1093-1097.

Jeong, G. (2008). Development and application of choice models with simultaneity and endogeneity. *PhD Dissertation.* Korea: Seoul National University.

Katz, J.E, & Rice, R.E. (2002). Social consequences of Internet use: Access, involvement, and interaction. Cambridge: The MIT Press.

Kasuga, N., Zeng, L., & Shishikura, M. (2008). An analysis of demand for new devices in the transition from terrestrial broadcasting to digital: The case of digital televisions. *International Telecommunications Society, 17th Biennial Conference.* Montreal, Canada.

Kim, Y. (2005). Estimation of consumer preferences on new telecommunications services: IMT-2000 service in Korea. *Information Economics and Policy, 17*, 73-84.

Kim, Y., Lee, J., & Koh, D. (2005). Effects of consumer preferences on the convergence of mobile telecommunications devices. *Applied Economics, 37* (7), 817-826.

Koh, D. (2007). Advances in demand analysis and forecasting of new products using discrete choice models and empirical applications. *PhD Dissertation*. South Korea: Seoul National University.

Lancaster, K. (1966). A new approach to consumer theory. *Journal of Political Economy, 74* (2), 132-157.

Lancsar, E., & Louviere, J. (2008). Conducting discrete choice experiments to inform healthcare decision making: A user's guide. *Pharmacoeconomics, 26* (8), 661-677.

Layton, D. (2000). Random coefficient models for stated preference surveys. *Journal of Environmental Economics and Management, 40*, 21-36.

Lee, H.J., O'Keefe, R.M., Yun, K.L. (2003). The growth of broadband and electronic commerce in South Korea: Contributing factors. *The Information Society*, 19 (1), 81-93.

Lee, J., Kim, Y., Lee, J., & Park, Y. (2006). Estimating the extent of potential competition in the Korean mobile telecommunications market: Switching costs and number portability. *International Journal of Industrial Organization, 24*, 107-124.

Lee, J. & Lee, M. (2009). Analysis on the growth of telecommunication services: A global comparison of diffusion patterns. *Applied Economics*, *41* (24), 3143-3150.

Lenk, P., DeSarbo, W., Green, P., & Young, M. (1996). Hierarchical Bayes Conjoint Analysis: Recovery of parthworth heterogeneity from reduced experimental designs. *Marketing Science, 15* (2), 173-191.

Lim, S., & Lee, M. (2007). Use of ICT for bridging digital opportunity: A Korea's case. *IEEE. DOI 10.1109/ICCIT.2007.186*.

Loader, B. (1998). *Cyerspace Divide: Equality, agency and policy in the information society*. London: Routledge.

Long, N. V. (2010). Study on consumer preference for Internet service in rural area of Vietnam. *PhD Dissertation.* Korea: Seoul National University.

Louviere, J., Hensher, D., & Swait, J. (2000). *Stated choice methods*. Cambridge, UK: Cambridge University Press.

McFadden, D. (1973). Conditional logit analysis of qualitative choice behavior. In P. Zarembka (Ed.), *Frontiers in Econometrics* (pp. 105-142). New York: Academic Press.

McFadden, D., & Train, K. (2000). Mixed MNL models for discrete response. *Journal of Applied Econometrics, 15* (5), 447-470.

Meinrath, S. (2005). Community wireless networking and open spectrum usage: A research agenda to support progressive policy reform of the public airwaves. *The Journal of Community Informatics, 1* (2), 204-209.

Min, J., Sukhumaran, B., & Varghese, S. (2001). *Internet-based economic development for rural communities*. Economic Development Administration, U.S. Department of Commerce.

Mwesige, P. (2004). Cyber elites: A survey of Internet café users in Uganda. *Telematics and Informatics, 21*, 83-101.

Nelson, P. (1999). Multiattribute utility models. In P. Earl, & S. Kemp, *The Elgar Companion to Consumer Research and Economic Psychology* (pp. 392-400). Massachusetts, USA: Edward Elgar Publishing Limited.

Netzer, O., Toubia, O., Bradlow, E., Dahan, E., Evgeniou, T., Feinberg, F., *et al.* (2008). Beyond conjoint analysis: Advances in preference measurement. *Marketing Letters, 19* (3-4), 337-354.

Okazaki, S. (2006). What do we know about mobile Internet adopters? A cluster analysis. *Information and Management, 43,* 127-141.

Proenza, F. (2001). Telecenter sustainability: Myths and opportunities. (Wattenbach, & Dixon, Eds.) *Journal of Development Communication, 12* (2), 110-124.

Rossi, P., Allenby, G., & McCulloch. (2005). *Bayesian Statistics and Marketing*. Wiley.

Rosston, G., Savage, S., & Waldman, D. (2010). Household demand for broadband Internet in 2010. *The B.E. Journal of Economic Analysis & Policy, 10* (1), 1-43.

Ruth, S., & Giri, J. (2007). Defying the odds: A success story from the mountains of Nepal. *Information Technology in Developing countries, 17* (3).

Ryan, M., Scott D.A., Reeves, C., Bate, A., van Teijlingen E.R., Russell, E.M., Napper, M. & Robb, C.M. (2001). Eliciting public preferences for health care: A systematic review of techniques. *Health Technology Assessment, 5* (5).

Sandvig, C. (2004). An initial assessment of cooperative action in WiFi networking. *Telecommunications Policy, 28,* 579-602.

Savage, S., & Waldman, D. (2009). Ability, location and household demand for internet bandwidth. *International Journal of Industrial Organization, 27,* 166-174.

Savage, S., & Waldman, D. (2005). Broadband Internet access, awareness, and use: Analysis of United States household data. *Telecommunications Policy, 29*, 615-633.

Sciadas, G. (Ed.). (2003). *Monitoring the digital divide and beyond*. Montreal, Canada: Orbicom.

Shields, R. (2009). The landlocked island: Information access and communications policy in Nepal. *Telecommunications Policy, 33*, 207-214.

Siochrú, S.O, & Girard, B. (2005). Community-based networks and innovative technologies: New models to serve and empower the poor. Series: *Making ICT Work for the Poor*, UNDP, retrieved from http://propoor-ict.net on October 23, 2011.

Stern, M. J., & Adams, A. E. (2010). Do rural residents really use the Internet to build social capital? An empirical investigation. *American Behavioral Scientist, 53* (9), 1389-1422.

Thierer, A. (2000). Is the 'Digital Divide' a virtual reality? *Consumers' Research Magazine, 83* (7), 16-20.

Torero, M., & Braun, J. (2006). *Information and communication technologies for development and poverty reduction: The potential of telecommunications.* Baltimore: The Johns Hopkins University Press.

Train, K. (2003). *Discrete choice methods with simulation*. New York: Cambridge

University Press.

Train, K. (1998). Recreation demand models with taste differences over people. *Land Economics, 74* (2), 230-239.

Train, K., & Sonnier, G. (2003). Mixed logit with bounded distributions of correlated partworths. *Working paper*. Berkley: University of California.

Vaidya, B., & Shrestha, J. (2002). Rural digital library: Connecting rural communities in Nepal. Lecture Notes in Computer Science. 2555, pp. 354-365. *Digital Libraries: People, Knowledge, and Technology*.

Verma, R., & Plaschka, G. (2003). The art and science of customer choice modeling: Reflections, advances, and managerial implications. *Cornell Quarterly, 44*, 156-165.

Vermeulen, B., Goos, P., & Vandebroek, M. (2011). Rank-order choice-based conjoint experiments: Efficiency and design. *Journal of Statistical Planning and Inference, 141*, 2519-2531.

Wareham, J., & Levy, A. (2002). Who will be the adopters of 3G mobile computing devices? A probit estimation of mobile telecom diffusion. *Journal of Organizational Computing and Electronic Commerce, 12*, 161-174.

Whitacre, B.E. (2010). The diffusion of Internet technologies to rural communities: A portrait of broadband supply and demand. *American Behavioral Scientist, 53* (9), 1283-1303.

World Summit on the Information Society. (2003, December 12). Retrieved December 12, 2011, from WSIS: Plan of Action: *http://www.itu.int/wsis/docs/geneva/official/poa.html*

Xia, J., & Lu, T. (2008). Bridging the digital divide for rural communities: The case of China. *Telecommunications Policy, 32*, 686-696.

Yang, J.-C., Pattanayak, S. K., Jonson, F. R., Mansfield, C., van den Berg, C., & Jones, K. (2006). *Unpackaging demand for water service quality: Evidence from conjoint surveys in Sri Lanka*. World Bank.

Zubey, M., Wagner, W., & Otto, J. (2002). A conjoint analysis of voice over IP attributes. *Internet Research: Electronic Networking Applications and Policy, 12* (1), 7-15.

Appendices

Annex 1 – Variable definition

Variable name	Description	Definition	Distribution
Nepal Telecom	Dummy variable for ISP	1' if Nepal Telecom; '0' otherwise	normal
Ncell	Dummy variable for ISP	1' is Ncell, '0' otherwise	normal
Worldlink	Dummy variable for ISP	1' if it is Worldlink, '0' otherwise	normal
Without telephone line	Dummy variable for mode of connection	1' if without telephone, '0' otherwise	normal
With telephone	Dummy variable for mode of connection	1' if it is with telephone; '0' otherwise	normal
Speed	Internet access speed (divided by 10 for normalization)	5.6; 25.6; 31.2 (10 kbps)	normal
Service fee	Monthly service fee (divided by NRs. 100 for normalization)	2.0; 5.0; 8.0 (NRs. 100/month)	log-normal
Disconnection probability	likelihood of disconnection/usage in percentage as a proxy of reliability	0.05; 0.2	normal
Distance	distance in km to walk/travel for Internet access	0; 1; 2 (km)	censored normal

Annex 2 – Map of Nepal with survey sites

Map extracted from
http://www.mapsofworld.com/nepal/nepal-district-map.html

Annex 3 – Survey Questionnaire (in English)

Survey on Internet adoption and usage in the rural area of Nepal 2011

In cooperation with the Nepal Wireless, International IT Policy Program of Seoul National University, Korea, is carrying out the survey in order to study consumer preference structure of Internet service in rural Nepal

All the information provided to us will be kept strictly confidential and used only for academic research purpose, not for any commercial or other purposes.

Should you have any comments, suggestions or questions about this survey, kindly contact us via e-mail at shisir@temep.snu.ac.kr

This survey questionnaire has two parts.

The first part contains **rank-ordered choice questionnaire** in which 4 choice sets are given. Each choice set has 4 packages comprising different alternatives of above mentioned 6 attributes for the Internet services. If you were to subscribe an Internet service today and the alternatives were only your choice options, what kind of Internet service package would you choose? Please rank your choice in order – 1 for the most preferred, 2 for less preferred than 1, 3 for less preferred than 1 and 2, similarly 4 for the least preferred. Before ranking the packages, please consider the attributes and their levels as explained in the next page.

The second part consists of questions on Internet access and usage information and you in general.

Thank you very much for your time, patience and contribution!

Very Important!

Please spend a few minutes to understand the attributes and their levels with their descriptions in this box carefully before answering the questions.

Attributes	Levels	Description	
Internet Service Provider (ISP)	Nepal Telecom (NTC)	NTC is the government owned telecommunication company of Nepal.	
	Ncell	Ncell is the first private sector GSM mobile service operator.	
	WorldLink	WorldLink is an Internet service provider in Nepal.	
Mode of connection	With phone line	You can obtain Internet service using a telephone line.	
	Without phone line	You don't need a phone line to use the Internet service, which means you will get the Internet service wirelessly.	
Speed of connection	56 kbps	The time of opening website is almost 4 times shorter than in 256 kbps speed. The real speed may be less than 20 kbps, even sometimes 12-15 kbps, depending upon the throughput provided.	Speed refers to the time it takes to send and receive information to and from home computer and/or device, responding server. It affects in web browsing with response times (slow or fast), transfer of video images, transfer of audio files (CD quality), downloads of large files, playing real time interactive games.
	256 kbps	At the speed of 256 kbps, you can listen to high quality of radio, fast web browsing, and acceptable video on demand in the Internet.	
	312 kbps	You can have much better access to web browsing with good online experience at this speed. You can enjoy live video streaming.	
Service fee/month	Rs. 200	It means you need to pay Rs. 200 per month to get the Internet service.	Service fee covers the price that you pay for the Internet service.
	Rs. 500	You need to pay Rs. 500 per month.	
	Rs. 800	You need to pay Rs. 800 per month.	
Probability of disconnection	0.05	This indicates that there is 5% probability of disconnection (rare chance) while using the Internet.	Average probability of disconnection
	0.2	This indicates that there is 20% probability of disconnection (intermittently) while using the Internet.	
Distance	0 km	'0 km' means you use the Internet at home; you don't need to go out of home to use the Internet.	Use of the Internet at home or out of home; if out of home, how far to travel
	1 km	You have to commute 1 km from your home to use the Internet.	
	2 km	You have to commute 2 km from your home to use the Internet.	

Part A: Rank-ordered choice questionnaire

Choice set-A

Attributes	Package A1	Package A2	Package A3	Package A4
ISP	WorldLink	NCell	NTC	NTC
connection mode	with phone line	with phone line	without phone line	without phone line
connection speed	56 kbps	56 kbps	256 kbps	312 kbps
service fee	Rs. 500	Rs. 200	Rs. 200	Rs. 800
disconnection pr	0.05	0.2	0.2	0.2
distance	1 km	2 km	0 km	2 km
your ranking				

- Please tick the most preferred package in Choice Set –A A1 A2 A3 A4
- If you are offered the best option you have mentioned above, will you subscribe the Internet service as per the specification given in the package? ☐ Yes ☐ No

Choice set-B

Attributes	Package B1	Package B2	Package B3	Package B4
ISP	NCell	WorldLink	NTC	NCell
connection mode	without phone line	with phone line	with phone line	without phone line
connection speed	256 kbps	312 kbps	256 kbps	56 kbps
service fee	Rs. 500	Rs. 200	Rs. 500	Rs. 200
disconnection pr	0.2	0.05	0.2	0.2
distance	0 km	1 km	1 km	1 km
your ranking				

- Please tick the most preferred package in Choice Set –B B1 B2 B3 B4
- If you are offered the best option you have mentioned above, will you subscribe the Internet service as per the specification given in the package? ☐ Yes ☐ No

Choice set-C

Attributes	Package C1	Package C2	Package C3	Package C4
ISP	NTC	NTC	NCell	WorldLink
connection mode	without phone line	with phone line	with phone line	without phone line
connection speed	56 kbps	256 kbps	256 kbps	256 kbps
service fee	Rs. 200	Rs. 500	Rs. 800	Rs. 800
disconnection pr	0.2	0.05	0.05	0.05
distance	2 km	1 km	0 km	2 km
your ranking				

- Please tick the most preferred package in Choice Set –C C1 C2 C3 C4
- If you are offered the best option you have mentioned above, will you subscribe the Internet service as per the specification given in the package? ☐ Yes ☐ No

Choice set-D

Attributes	Package D1	Package D2	Package D3	Package D4
ISP	NTC	NCell	WorldLink	NTC
connection mode	with phone line	without phone line	with phone line	without phone line
connection speed	56 kbps	312 kbps	56 kbps	56 kbps
service fee	Rs. 500	Rs. 500	Rs. 800	Rs. 800
disconnection pr	0.05	0.2	0.2	0.05
distance	2 km	0 km	0 km	1 km
your ranking				

- Please tick the most preferred package in Choice Set –D D1 D2 D3 D4
- If you are offered the best option you have mentioned above, will you subscribe the Internet service as per the specification given in the package? ☐ Yes ☐ No

- Now please mention the best option, according to your preference, from among the ones you have indicated as the most preferred in each set. ☐

Part B-1 (Internet access and usage information)

Please respond to the questions in the following box if you have subscribed/used the Internet. If not, please go directly to question no. 9.

1. From which ISP have you received the service?
   ☐ Nepal Telecom ☐ Ncell ☐ Worldlink ☐ others.....
2. How often do you use the Internet?
   ☐ Everyday ☐ more than 4 times per week ☐ once a week ☐ once a month
   ☐ Other than the above alternatives, if any....
3. How long do you use the Internet at one access?
   ☐ Less than 10 minutes ☐ half an hour ☐ one hour ☐ two hours
   ☐ If more than two hours, please specify........
4. How much time do you spend for Internet connection per month?
   ☐ 5 hours ☐ 10 hours ☐ 15 hours ☐ 20 hours ☐ 30 hours ☐ more than 30 hours
5. Where do you use the Internet?
   ☐ At home ☐ at office ☐ at school/college ☐ at community center ☐ at internet café
   ☐ at.........

   5.1 If you need to use the Internet at a community center or at an Internet café, how much time do you have to walk or travel?
   ....minutes/hours
6. You are currently connected to the Internet via
   ☐ Wireless connection ☐ dial-up connection ☐ cellular mobile phone ☐ cable TV ☐ ADSL
7. If you have subscribed the Internet, please mention your subscription plan.
   (For example, 128 kbps ADSL, Rs. 1000 per month)
   ....
8. How often do you find the service disconnected?
   ☐ never ☐ once per usage ☐ twice per usage ☐ many times

9. If you have never used the Internet, when do you intend to use the Internet?
   ☐ Within 6 months ☐ in 1 year ☐ 1 year later ☐ no plan to use
10. The reason to use the Internet (please tick as many as you use/would use it for):
    ☐ E-mail ☐ Web surfing ☐ Internet phone calling/voice chatting
    ☐ Chat/text messaging ☐ education ☐ agriculture information
    ☐ Telemedicine ☐ online shopping ☐ music and movie download
    ☐ Product/service information ☐ online gaming ☐ government services
    ☐ E-business ☐ others (if any)................................
11. In one year ahead, do you intend to subscribe any of the following services? (Please tick the one or more that you intend to subscribe if available)
    ☐ Fixed telephone (landline) ☐ cellular mobile ☐ cable TV
    ☐ Wireless Internet ☐ other....
12. Do you have a personal computer at home?
    ☐ Yes ☐ No
13. If not, when do you intend to buy a PC?
    ☐ Within 6 months ☐ within 1 year ☐ 1 year later

Part: B-2 (Respondent characteristics)
(Please check (√) at correct answer.)

1. Gender: ☐ Female ☐ Male
2. Age: ☐ less than 20 ☐ 20-30 ☐ 31-40 ☐ 41- 50 ☐ 50+
3. Education: ☐ Literate ☐ High school ☐ Undergraduate ☐ Graduate ☐ Post-graduate
4. Profession: ☐ student ☐ service ☐ business ☐ farming ☐ housewife ☐ other
5. Your ability of reading and understanding English:
   ☐ None ☐ A little ☐ Normal ☐ Fluent
6. Number of family members: ....
7. Your family income per month:
   ☐ Below Rs. 5,000 ☐ Rs. 5,000-10,000 ☐ Rs. 10,000-15,000
   ☐ Rs. 15,000-20,000 ☐ Rs. 20,000-25,000 ☐ above Rs. 25,000

Thank you very much for your cooperation!

초록(抄錄)

인터넷 채택에 대한 소비자 선호의 실증적 평가: 이산선택 접근

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인터넷 유저 선호도를 이해하는 것은 정보통신기술 정책 및 계획 수립에 유용하다. 이 연구의 목표는 개인 및 공공 인터넷 접속과 관련하여 인터넷 사용에 대한 지방 거주 소비자들의 선호 구조를 제대로 이해하는 것이다. 이 분야에 대한 연구는 특히 실험적인 측면에 있어서 매우 제한적이다. 이 논문은 개발도상국가들의 지방 소비자 조사, 정보통신기술 보급 및 채택에 대해 학문적, 전문적으로 가치 있는 이해를 제공한다. 이 연구는 인터넷 사용에 대한 지방 소비자들의 선호도를 끌어내기 위해 진술선호방법을 채택했다. 총 16가지의 선택이 있는, 등급이 매겨진 선택 과업들을 포함한 무작위효용이론을 바탕으로 이산선택 모형을 만들었다. 이 이산선택모형을 네팔의 극 서부, 서부, 동부, 중부 지역에 샘플 적용하였다. 이렇게 수집한 데이터는 소비자들의 기호 변화를 이끌어내기 위해 무작위 계수가 설정된,

혼합로짓모형(mixed logit model)에 기초하여 분석되었다. 또한, 인터넷의 인구통계학적 특성과 응답자들의 실제 인터넷 접속 및 인터넷 사용 패턴의 상호작용을 통해 소비자들의 이질성을 조사했다. 인터넷 서비스 제공자(ISPs : Internet service providers), 연결 모드, 대역폭, 가격, 프록시 신뢰도에 따른 접속 단절 가능성, 개인별 가정용 접속 및 공공 장소 접속에 따른 거리감의 차이와 같은 특성들을 실험했다.

최종 연구 분석에서 발견된 점은, 접속 거리감을 느낀 소비자들은 인터넷 접속을 위해 돌아다녀야 하며, 이로써 한계효용이 체감하게 된다. 그러나 43%의 소비자들은 접속 거리감으로 인해 이리 저리 이동하는 것에 대해 무관심했는데, 이것이 상징하는 바는, 지방과, 도시로부터 멀리 떨어진 곳에 공공 인터넷 접속이 필요함을 뜻한다. 인터넷 서비스 요금이 선호도 형성에 가장 큰 영향을 미쳤고, 뒤이어 연결 모드(무선접속 또는 유선접속)가 두 번째로 큰 영향을 미쳤다. 소비자들은 적절한 대역폭과, 연속적인 안전한 서비스를 가진 무선 접속을 선호했다. 조사 데이터에서 나타난 점은, 상당한 수의 응답자들이 서비스 요금을 낼 필요가 없는 대학교나 직장에서 인터넷을 사용한다는 것이었다. 이것은 소비자들이 가격에 민감함을 뜻한다. 정부는 인터넷을 가정에 보급시키기 위한 방법으로, 대학 서비스 의무 규정을 통해 이 문제를 해결해야 한다.

이 조사 결과가 뜻하는 바는, 네팔의 지방에, 향상된 인터넷 보급을 위해서는 다음과 같은 정책들이 고안되어야만 한다는 것이다: 지역 문화 센터

발전을 위해 지역 무선 네트워크를 강화, 가정 인터넷 보급을 가능케 하는 환경 조성, 믿을 수 있고 신속한 서비스를 제공하는 무선 인터넷 확장.

이 연구는 전체적으로 개발도상국가들 내, 지방 주민들의 인터넷 채택 선호도를 분석하였다. 이러한 연구 분석 결과를 기초로 하여, 인터넷 수요의 필요가 정당화됐으리라 기대한다. 그리하여 소위 말하는 ‘디지털 심연(digital abyss)’에 대해 맥락 중심의 해결이 구축되기를 기대한다. 지방 소비자들의 위치, 경제적/사회적 상황들, 그 외의 상황들을 고려하여, 지방 소비자들은 어떠한 종류의 인터넷 접속과 서비스를 채택할 의향이 있는지, 그들은 자신들이 가입한 서비스를 얼마의 가격에 이용할 의향이 있는지 조사하여 그들이 선호하는 구조를 구축하기를 바란다.

키워드: 인터넷 서비스, 진술선호방법, 혼합로짓(mixed logit), 지불용의, 이질성, 결합 조사, 이산선택모형, 네팔의 지방
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