Broadband Internet Adoption Challenge: An Investigation of Broadband Utilization in the United States

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Abstract
There seems to be a consensus about the role of broadband internet in gaining competitive advantage. Few studies have explored broadband adoption and the potential utilization benchmarks. Based on the Internet utilization data in a number of states across the US, adoption models are developed using exploratory factor analysis.

Keywords: Broadband utilization, adoption, challenges, measurement

Background
In 1988, Robert Pepper of the office of plans and policy in federal communications commission (currently known as the office of strategic planning & policy analysis), mentioned in a report that the network infrastructure of the time is not "sufficient to meet growing user... demand" and that fiber optic network "promises soon to become the technology of choice". Delivering high definition television programs for home use, video content for personal computers, video conferencing, and document delivery were viewed as some of the primary applications for broadband[1] networks in the late 1980s (Pepper 1988). In the second decade of the 21st century, broadband internet – also discussed as *broadband communications*, in the late 20th century research and publications– has become the Information and Telecommunication Technology (ICT) of choice, but remains inaccessible in parts of many developing and developed countries. This is despite the fact that effective and efficient access to the internet is not just necessary for e-commerce, but it is also vital for the businesses and communities to "remain economically viable" in the non-virtual world (Hollifield, and Donnermeyer 2003).

Broadband Internet and Economic Development
Adoption of broadband internet by both individuals and businesses –in particular small and medium size businesses– has been a topic of interest since the early 2000s (Lee et al. 2003). Based on our research, the first study that measured the economic impact of the broadband internet was published in 2005 by Lehr, Osorio, Gillett, and Sirbu. Based on their analysis of broadband internet access in America during the period of 1999-2002, Lehr et al. (2005) concluded that communities with access to broadband internet were economically more

[1] Defined by Federal Communications Commission as a connection with 200 kbps or higher.

successful. More recent studies in this area include the work of Thompson, and Garbacz (2008) who explore the impact of broadband on GDP at the state-level in America, Katz's (2009) on broadband impact in Latin American economy and Majumdar, Carare, and Chang's (2010) study on the effect of broadband on firm productivity. Rao, Barry and Indrit (2011) explored the broadband adoption in rural Australia and Czernich et al. (2011) provided further evidence for the positive effect of broadband penetration on per capita growth. Although there had been significant attention in the past to "understand the impact of Internet technology", we had been "handicapped" to develop theoretical models due to the novelty of area, and constraints associated with the data availability (Flamm and Chaudhuri 2007). The goal of the present study is to identify the internet utilization indicators and develop internet adoption models. These adoption models are primarily measurement models that identify various aspects of internet adoption as well as mechanism (list and structure of indicators) to measure internet adoption. The utilization indicators and measurement models of internet adoption developed in this study can be used as foundations for more effective and efficient internet adoption as well as conducting more sophisticated impact analysis studies in this area.

Despite the known vital role of broadband internet, limited access to broadband caused by these concerns prohibits certain communities to remain competitive in the global knowledge economy (Hollifield, and Donnermeyer 2003). Broadband access is more limited in rural areas even in developed nations. Based on our research the first report on the internet access and its economic impact on businesses was delivered by congressman Mike Pence in 2001 where it argued that lack of access to such an infrastructure "severely undermines" the ability of small businesses to compete in rural America (Celli and Dreifach 2002). In absence of government support and the viability of a clear business case for service providers, the broadband expansion to some rural areas falls on the shoulders of local municipalities and non-profit organizations (LaRose, et al. 2007). Development of public-private partnerships has been successful in facilitating the broadband development in rural areas (Mitchell 2007; Nucciarelli et al. 2010). While the present study does not particularly focus on the internet utilization in the context of rural versus urban areas, this topic is of great importance that can be addressed in future studies. The domain of the present study is both rural and urban areas. While this may impose limitations to the customization of the application of findings, it provides guidelines for policy making at a more general level.

Two brief notes are discussed in the following. First, it is important to note here that while there seems to be significant supporting evidence as well as consensus for the positive role of broadband internet in economic development, some argue that there could be a speed and application limit on the positive correlation of broadband speed and economic benefits. For example, Kenny and Kenny (2011) argue that where superfast fiber (with the speed of 50 Mbps and above) is deployed in fiber to the home (FTTH) the benefits may not be necessarily more than the benefits of lower speed broadband access. In this study whenever we refer to the internet connection, it is the traditional broadband connection and does not reflect the lower speed connections or the superfast connections. The second note is about the differentiation of internet adoption and utilization. Adoption refers to the general "usage" of the service, while utilization refers to more specific application of the service (internet), which incorporates "intensity and quality" (Connecting America: National Broadband Plan, p. 169). In the present study we develop models for adoption of the internet. These models are built based on specific utilization applications of the internet.

Broadband Internet Diffusion and Adoption: Concerns & Challenges

Several challenges and concerns have been on the way of broadband utilization since the early days of planning for broadband development. Based on a literature review the most cited concerns surrounding broadband internet diffusion from the late 1980s to present were identified. These concerns are presented in Table 1 based on the review of some mostly cited works, the area.

Table 1: Concerns Surrounding Broadband Internet Diffusion

Authors	Concerns
Pepper (1988)	regulatory body and policies, required substantial investment
Gonet (1986)	concerns for the principles governing integrated broadband
Coustel (1986) McGregor (1994)	competitive environment for service delivery
Solomon and Walker (1995)	"separation of network provision from service provision"
Higham and Lee (1996); Hausman et al. (2001)	consequences of vertical integration of content, service
	network infrastructure and end user equipment
Edmonds (1999); Hausman et al. (2001)	accessibility and pricing
Lessig (1999)	accessibility in light of technological and legal developments
Frieden (2002)	regulatory dichotomies related to small internet service providers vs. large telephone companies
Lee et al. (2003)	broadband adoption by households and small and medium size businesses
Grimes (2003)	development and deployment of broadband in rural areas
Prieger (2003); Flamm and Chaudhuri (2007); LaRose et al. (2007); Kruger, and Gilroy (2008)	digital divide (gap) at the household and business levels
Hollifield, and Donnermeyer (2003); van Gorp et al. (2006)	geographic (low population density), demographic, and policy
	strategies of service providers in rural broadband provision
Stanton (2004)	slow broadband adoption in the United States
Foros (2004)	pricing regulations
Warren (2004)	infrastructure, human capital, farm ownership structure, and complexity underlying the adoption process
Pociask (2005)	digital divide of small businesses in rural broadband internet utilization as a result of demand-side factors (demographic, wealth and education), and supply-side factors
Dwivedi and Choudrie (2006)	adoption and socioeconomic factors
van Gorp et al. (2006)	implementation of open access policies
Mitchell (2007)	deployment in rural areas
Flamm and Chaudhuri (2007); Crandail Lehr, W., and Litan (2007)	understanding the impact of broadband internet
Kruger, and Gilroy (2008)	broadband provision in the last mile
Mack and Grubesic (2009); Badasyan, Shideler, and Silva (2011)	broadband provision *versus* to broadband adoption or diffusion
Grubesic (2010)	price discrimination in absence of local broadband service provided
Given (2010), Oyana (2011)	partnership among all stakeholders; affordability;
Rao et al. (2011)	promoting broadband adoption

These concerns which were raised from the perspective of users, businesses, service providers and policy makers, range from policy and regulatory issues to access gap, technological and utilization of internet applications. Four major challenges that have affected effectiveness and efficiency of the Internet utilization, from the 1960s to the present time are early computer networks (1960s-1985), infrastructure expansion (1985-1995), internet communication (1995-earlet 21st century) and development of applications in terms of utilization and adoption (early 21st century to present) (Mowery and Simcoe 2005). The application development in terms of utilization and adoption are the main challenges of Internet adoption at the present time.

Accessibility may be viewed as one of the early first concerns and challenges facing businesses and communities to effectively and efficiently utilize the internet, but it is far from being the last concern and challenge facing various stakeholders. The factors affecting the accessibility range from policy and technical to the economics and ability to utilize broadband Internet.

From the review of the challenges during the past few decades it is evident that the attention is moving away from mere general access to the internet to adoption, and in particular the utilization of the broadband internet (Turk et al. 2008). This study is particularly focused on developing measurement models for broadband internet adoption and utilization at the business level. Investigation of broadband utilization at the individual level could be a subject of future studies.

Beyond Accessibility: the Role of Technological Mediations

To take advantage of the benefits associated with the broadband internet, we should note that broadband internet accessibility is not a goal but a tool, for transactional as well as transformational changes in businesses. The ultimate goal should focus on utilizing the internet to increase the performance of the existing works as well as finding new ways of doing things in addition to finding new business opportunities to stay competitive (Glasmeier et al. 2008).

The availability of technology does not automatically lead to its adoption and effective and efficient utilization. In many cases a natural gap may be created between the opportunities that technology provides and the user's immediate need and capabilities (Greenstein 2000). It is important to note that the user who is not experienced and knowable of the technology has a perceived need rather than in-depth understanding of technology utilization and potentials gains. Greenstein (2000 and 2001) discusses the case of internet adoption and the important role of technology mediators. In the late 1990s and early 2000s, the Internet Service Provider (ISP) naturally played a key role in internet adoption at technology mediators.

During the past decade ISPs have started to offer broadband services due to "competitive forces" (van Gorp et al. 2006). In the current business environment, while the businesses have become more knowledgeable about the application and capabilities of the internet, at the same time the use of internet in businesses has expanded from conducting simple tasks such as email communication and web presence, to more fundamental and complex tasks, related to virtually all major business functions and processes such as marketing, sales, procurement, research and development, banking, data management, and virtual collaborations, just to name a few. In this environment, on one hand the ISPs can no longer be effective technological mediators and on the other hand businesses can lose their competitive advantage significantly should they not be knowledgeable and capable of effective and efficient internet utilization. Whether technological mediation is provided by internal organizational resources, a third party organization,

government agencies or the third sector organizations, these mediators provide vital assistance to organizations with two major types of challenges: technological challenges and commercial challenges[2] (Greenstein 2001; van Gorp et al. 2006). The patterns of internet utilization developed through the measurement models in this study will be crucial tools for businesses as well as policy makers to effectively and efficiently overcome both technological and commercial challenges.

In the following section, internet adoption has been explored from different perspectives and a list of mostly utilized internet applications is developed. Based on data collected from the sample of US businesses, measurement models are developed to demonstrate different aspects of internet utilization across different business sectors.

Taxonomy of Internet Utilization

Utilization of internet has been studied and documented from various perspectives. The unit of analysis is one of the differentiating factors. While some studies focus on individual residents and explore their internet utilization (e.g. Stern and Adams, 2010; Goldfarb and Prince, 2008), others explore adoption at the business level (e.g. Burke 2005 and Valadares de Oliveira et al. 2011). Another dimension is the scope of utilization. For example, in Stern and Adams (2010) the scope of internet utilization is narrow and focused on one particular application (social networking), while in other studies such as Valadares de Oliveira et al. (2011) the scope is more broadly defined. In the case of the latter mentioned study various internet utilizations around supply chain processes are explored.

Another dimension of internet utilization is the geographic characteristics, regardless of scope of utilization and unit of analysis. From this perspective, utilization can range from focusing on rural users to suburban and urban users (e.g. Stern, Adams and Elsasser 2009). The present study considers firms as units of analysis, in various geographic locations and takes a broad view of internet applications rather than focusing on one of a few numbers of applications. Moreover, while some studies in this area focus on some aspects of organizational characteristics such as the firm sizes (e.g. Burke 2005), the present study as the first study in this domain takes a more general approach and includes all firm sizes in various businesses. The goal is to construct a model which has a general application and higher reliability that can be achieved by a larger sample size. While development of measurement models for particular firm size categories (e.g. small, medium, and large) is useful it will be a subject of future studies.

Delphi method, a “popular tool” in this domain is used to develop the preliminary list of indicators in the internet utilization model (Okoli and Pawlowski 2004). Based on an extensive literature review a list of broadband internet utilizations was developed. In many cases a single application was presented in different names or wording. We also had a major challenge with overlapping descriptions of applications. We pre-tested the comprehensiveness of the indicators using a panel of experts. To facilitate the group communication Delphi method was employed with several rounds of contribution and feedback among a group of 5 experienced practitioners in the area internet utilization. The outcome of the literature search and feedback from experts is a list of 17 indicators of internet utilization. These indicators are: Selling goods or services with or without on-line payment, Purchasing goods or services with or without on-line payment, Web

[2] Greenstein (2000, 2001) identified three challenges (technological, commercial and structural), however he mentions that "commercial and structural challenges are not necessarily distinct". In the present study, commercial challenges includes that the structural challenges that represent organizational services, domain and operations.

site for the organization, Advertising and promotion online, Deliver services and content (e.g. video streaming, digitized products), Customer service and support, Research by staff (e.g. market or technical information), Rich media or service creation (e.g. multimedia content, interactive tools), e-Banking (online banking and financial services), Electronic document transfer, Supplier communication and coordination, Access government information (e.g. information, downloads, requests), Government transactions (e.g. payments, form submission)
Staff training and skills development, Tele-working (employees work from home), Accessing collaborative tools (e.g. file sharing, shared document editing, wiki pages, Blogs), and Social networking with peer groups and colleagues. In the following section the data collection and data analysis is explained. Finally a conclusion section is presented which includes discussion of the findings as well as directions for future studies.

Data Collection

The data is provided to the researcher by SNG company, a global leader in broadband internet development. The data is recently collected across two states in the US by email and phone with a response rate of 7.6%. The data is collected from both residential as well as business users; however, this study only uses the data collected from businesses. Initially the goal was to conduct the study across three major industries: manufacturing, service and agriculture. For the manufacturing sector, businesses in the North American Industry Classification System (NAICS) 31, 32, and 32 are used. For the service sector the majority of respondents were in NAICS 71 (arts, entertainment, and recreation). We decided to take this opportunity and develop a measurement model of service industry which is customized to the tourism sector. The dataset from agriculture sector was not large enough for an exploratory analysis with high reliability. In total, 866 observations are used in this study; 525 observations are from businesses in manufacturing sector and 341 observations in tourism sector.

Data Analysis

The data analysis was conducted in two steps: 1. Exploratory Factor Analysis (EFA); and 2. Confirmatory Factor Analysis (CFA). The EFA was conducted with SPSS software and CFA was done using LISREL software. Through a dimension reduction process in EFA, a number of indicators were removed from the list of utilization indicators in both manufacturing and tourism samples. Accessing collaborative tools, staff Training and tele-working were removed from the sample of manufacturing firms while access to collaborative tools, staff training, website, e-banking and social networking were removed from the sample of tourism industry. Through EFA using SPSS software a three factor model was developed for tourism sector while a five factor model was found to be the best fit for manufacturing sector. CFA was conducted using LISREL software to verify that the measurement models are appropriate to represent the two sample populations. Several factors contribute to the model fit in a measurement model, including factor loadings, RMSEA, normed fit index (NFI), comparative fit index (CFI), incremental fit index (IFI), relative fit index (RFI) and goodness of fit index (GFI). While factor loadings in the tourism model are above the recommended limit of 0.4, two factors in the manufacturing model are marginally below the recommended 0.4 limit. However, other measures of model fit such as RMSEA, NFI, CFI, IFI, RFI and GFI provide supportive evidences for the model goodness of fit. Overall we conclude that the present models are acceptable structures to represent the internet adoption in our samples.

Discussion of the Findings and Implications

This study provides the first models of internet adoption and utilization based on an empirical study. Two main contributions can be drawn from the results of this study. The first contribution is the list of internet utilization indicators for each business sector. The second major contribution is about the measurement models which represent the factors of internet adoption. These two contributions and their implications are described in the following.

With regards to the indicators of internet utilizations, our EFA result recommends the removal of five indicators from the tourism measurement model as well as removal of three indicators from the manufacturing measurement model. While 'access to collaborative tools' and 'staff training' were removed from both models, 'tele-working' was only removed from the manufacturing measurement model. Also, 'web-site', 'e-banking' and 'social networking' were only removed from the sample of businesses in the tourism sector.

When an indicator is removed from the model, it means that the particular internet utilization has not been in line with other indicators. The removal of an indicator can be generally interpreted in one the following two ways: 1) that particular indicator does not have a meaningful application because of the nature of business sector or other contextual factors; or 2) the removed indicator has not been widely or correctly utilized in the sample of particular business sector. In the latter mentioned case, it is possible that although the removed indicator can provide significant benefits if utilized, it has not been utilized (or not effectively utilized).

For example, 'tele-working' is only removed from the sample of manufacturing firms. Naturally in the manufacturing sector the utilization of tele-working is less feasible in compression to the tourism sector. Or, social networking is only removed from the measurement model of tourism sector. This could be a sign of a gap in effective utilization of social networking (as one internet utilization application) across businesses in the tourism sector. This result can represent an opportunity for businesses in tourism sector to increase their competitiveness through effective and efficient utilization of social networking in their business.

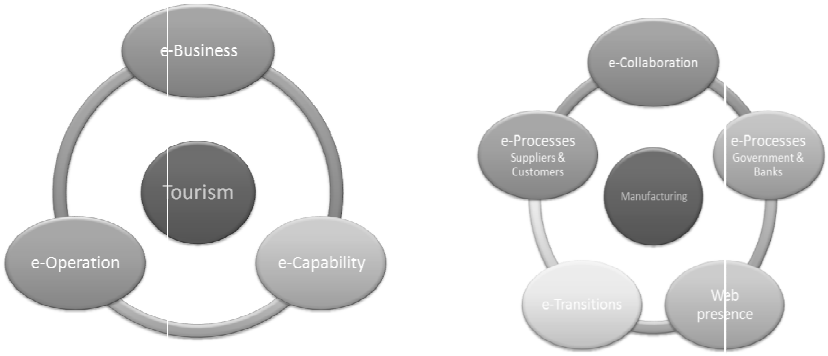

Figure 1: Internet Adoption measurement Models: Manufacturing vs. Tourism

We discussed above the contributions and implications of the first set of findings of this study. The second contribution of this study is with regards to the development of measurement models based on EFA and CFA. Based on the review of indicators that construct each the factors the various internet adoptions were named (e.g. e-process, e-operation, e-business, etc.). Figure 1 displays a schematic presentation of the two measurement models of manufacturing and tourism business sectors. The measurement models have several applications for academics as well as practitioners. For example the models can be used as benchmarks for improving competitiveness of businesses and communities, as frameworks for measuring economic impacts of internet

utilization, and as tools for policy making at different levels. While the present study does not particularly focus on the internet utilization in the context of rural versus urban areas, this topic is of great importance that can be addressed in future studies. Also, future studies can investigate internet utilization at the individual (user) level. Another subject for future studies is developing measurement models for particular firm size, geographic location, and business type.

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