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Understanding the digital divide: Empirical studies of Thailand

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ABSTRACT

The term *digital divide* was introduced in the 1990s to define the gap separating those who have access to new forms of information and communication technologies (ICTs) from those who do not. Later, scholars started looking more closely at the use of ICTs, instead of solely paying attention to access. The digital divide can exist at, for example, global (normally between developed and developing countries and between different regions), regional (between countries in the same region) and social level (within a particular country or society). The digital divide can thus be defined as the disparity between individuals, households, businesses and geographic areas at different socio-economic levels with regard to their opportunities to access information and communication technologies (ICTs) and their use of the Internet for a wide variety of activities.

This thesis aims to contribute to the understanding of the digital divide by existing literature and empirical studies. The main focus is on the digital divide in Thailand, considering telecommunications services and attempts to provide guidance to a national regulatory agency (NRA) and policymakers. A collection of papers has been put together by addressing the following main research question: What are the determinants explaining and the possible policies bridging the digital divide in Thailand? To answer this question, a quantitative research strategy of econometric and financial modelling is employed. The data come from primary and secondary sources.

The results of the thesis reveal that the digital divide in Thailand can be explained by several factors. The determinant factors for the regional divide are gross domestic product (GDP) per capita, urbanization, market competition, the existence of NRA, trade openness, the availability of infrastructure, market liberalization and privatization. The efforts to privatize state-owned enterprises and liberalize the market have not yet been successfully compared with those of other countries in the same region. In the context of the social divide, the findings suggest that not only market liberalization and privatization but also accessible infrastructure, social inequalities, media familiarity, availability of technology and service attributes, and the access price of mobile Internet are crucial factors in determining the digital divide in Thailand. These findings confirm that the issues of accessibility, availability and affordability of services and applications are all challenges facing the NRA and policy makers in bridging the digital divide. Alternative policies are discussed, and they reveal that combined policies integrated into the market mechanism and government intervention could be an option for bridging the digital divide in Thailand.

Keywords: accessibility, availability, affordability, digital divide, government intervention, market mechanism, social inequality, Thailand

APPENDED PAPERS

This thesis is based on the work in the following papers.

Paper I Srinuan, C., Rohman, I.K., Srinuan, P. & Bohlin, E. (2010). Digital divide in ASEAN countries: Explaining the gap. In P. Gugler and J. Chaisse, (Eds.), *Competitiveness of ASEAN Countries: Corporate and Regulatory Drivers, New Horizons in International Business* (pp. 153-162), London: Edward Elgar.

Paper II Srinuan, C., Srinuan P. & Bohlin, E. (2011). Entry relaxation and an independent regulator: Performance impact on the mobile industry in Asia. In D. Jarvis, M. Ramesh, X. Wu and E. Araral (Eds.), *Infrastructure Regulation: What Works, Why, and How do We Know? Lessons from Asia and Beyond* (pp. 83-108*),* Singapore: World Scientific Publishing.

Paper III Srinuan, C. (2011). Private costs of delayed privatization of TOT Public Company Limited. *Info*, *13* (1), 74-91.

Paper IV Srinuan, C. (2011). The third generation (3G) auction in Asia. *Keio Communication Review*, *33*, 184-198.

Paper V Srinuan, C. & Bohlin, E. (2011). What makes people go on-line? An empirical analysis of the digital divide in Thailand. Presented at the Annual International Conference on Micro and Macro Economics (MME 2011), 25-26 July 2011, Singapore (peer-reviewed). Awarded best student paper prize and in review for publication in *Technology in Society*.

Paper VI Srinuan, C., Teppayayon, O. & Bohlin, E. (2011). Analysis of fixed broadband access and use in Thailand: Drivers and barriers. Presented at the 10th International Conference on Mobile Business (ICMB 2011), 20-21 June 2011, Italy (peer-reviewed). Under second round review for special issue in *Telecommunications Policy*.

Paper VII Srinuan, C., Srinuan, P. & Bohlin, E. (2012). An analysis of mobile Internet access in Thailand: Implications for bridging the digital divide. *Telematics and Informatics*, *29*(3), 254-262.

List of additional papers

The following papers were also written during the PhD study, and some of them have parts that are relevant to the thesis.

Srinuan, C., Srinuan, P. & Bohlin, E. (2012). Exploring mobile pricing strategies and innovations in Thai mobile communication market. Presented at the Regional International Telecommunication Society (ITS) Conference, Delhi, India, 22-24 February. In review for publication in *Info*.

Srinuan, P., Srinuan, C. & Bohlin, E. (2012). Fixed and mobile broadband substitution in Sweden. *Telecommunications Policy*, *36* (3), 237-251.

Srinuan, C. & Bohlin, E. (2011). Understanding the digital divide: A literature survey and ways forward. Presented at the 22nd European Regional International Telecommunication Society (ITS) Conference, Budapest, Hungary, 18-21 September. In review for publication in a special issue of *Telecommunications Policy*.

Srinuan, P., Srinuan, C. & Bohlin, E. (2011). Would you prefer a set menu or à la carte? An empirical study of multiple services and choices of consumer in the Swedish telecommunications market. Presented at the 22nd European Regional International Telecommunication Society (ITS) Conference, Budapest, Hungary, 18-21 September. In review for publication in a special issue of *Telecommunications Policy*.

Srinuan, C. & Bohlin, E. (2010). Determinant of mobile broadband subscription. Presented at the 18th Biennial International Telecommunication Society (ITS) Conference, Tokyo, Japan, 27-30 June.

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Chalita Srinuan

May 2012, Göteborg

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ABBREVATIONS

ADSL	Asymmetric Digital Subscriber Line
AIS	Advance Information Service Public Company Limited
ASEAN	Association of Southeast Asian Nations
BTO	Build-Transfer-Operation
CAT	CAT Telecommunication Public Company Limited
CDMA	Code Division Multiple Access
DSL	Digital Subscriber Line
DTAC	Total Access Communication Public Company Limited
FCC	Federal Communications Commission
GDP	Gross Domestic Product
GHz	Gigahertz
GPRS	General Packet Radio Service
GSM	Global System for Mobile Communications
ICT	Information and Communication Technology
IIG	International Internet Gateway
ISDN	Integrated Services Digital Network
ISPs	Internet Service Providers
ITU	International Telecommunication Union
Kbps	Kilobits per second
MHz	Megahertz
MICT	Ministry of Information and Communication Technology
MOF	Ministry of Finance
NBTC	National Broadcasting and Telecommunications Commission
NRA	National Regulatory Agency
NSO	National Statistical Office
NTC	National Telecommunication Commission
NTIA	National Telecommunications & Information Administration
OECD	Organisation for Economic Co-operation and Development

PC	Personal Computers
SOE	State-Owned Enterprise
TBA	Telecommunications Business Act
THB	Thai Bath
TOT	TOT Public Company Limited
True	True Corporation Company Limited
TrueMove	Truemove Company Limited
TT&T	TT&T Public Company Limited
UMTS	Universal Mobile Telecommunications System
USB	Universal Serial Bus
USF	Universal Service Fund
USO	Universal Service Obligation
VOIP	Voice over Internet Protocol
WDI	World Development Indicators Database
Wi-Fi	Wide Fidelity
WiMax	Worldwide Interoperability for Microwave Access
WTO	World Trade Organization
2G	Second Generation
2.5G	Second and a half generation (2G combined with GPRS, or other services not generally found in 2G or former network)
3G	Third Generation

1. INTRODUCTION

1.1 Background

Information and communication technologies (ICTs) are important factors for economic growth and social development (Hardy, 1980; Madden & Savage, 1998; Röller & Waverman, 2001; Jacobsen, 2003; Waverman, Mesch & Fuss, 2005). The diffusion of ICTs drives access to information and knowledge: the inequality of distribution of ICTs within or between societies may have a very unequal impact on economic development and wealth. For example, people benefit from access to ICTs through lower costs for information and transportation, and this can thus increase productivity and enhance quality of life. After the report 'Falling Through the Net' was released in the late 1990s (NTIA 1995, 1998, 1999, 2000), the United States government, as well as other developed and developing countries, recognized the need to address this problem and actively work towards finding solutions to eliminate disparities in ICTs -the so-called digital divide. The digital divide has become an extremely important issue for many international organizations and a major challenge for policymakers and academic researchers (Billon, Marco & Lera Lopez, 2009)

At the beginning of the research into the digital divide, a broad definition was employed and the term was loosely used to express either the disparity between people's access to ICTs or, more specifically, the disparity in their access to the Internet. From the end of the 1990s onwards, attempts to accurately define the digital divide have frequently been seen. Scholarly literature, as well as that of international organizations (DiMaggio, Hargittai, Neuman & Robinson, 2001; Norris, 2001; OECD, 2001; Hargittai, 2002; van Dijk, 2002, 2006), has pointed out that the divide should be defined in terms of access and use of ICTs. DiMaggio et al. (2001) and Hargittai (2002) emphasized that the study of the digital divide should not limit its scope to binary classification of haves and have-nots of access to ICTs. A spectrum of inequality across segments of the population depending on the difference along several dimensions of ICT access and use should be also considered in order to understand the digital divide.

Norris (2001) and the OECD (2001) also noted that the digital divide can exist within and between countries. Norris (2001) explained the digital divide on three levels. The digital divide between countries, or so-called global divide, has become strikingly evident in the chasm between developed and developing countries. The social divide refers to the gap in access to and use of ICTs between different sections of a nation's society. It is apparent at the different levels of access to ICTs for groups with different socio-economic characteristics within a country. The last level is the democratic divide, which refers to the difference between those who do and do not use ICTs to engage in their public life.

Today, many countries seek to create a society in which all citizens can reach and share information by trying to form supportive policies that bridge the digital gap. For example, the e-rate programme in the United States, administered by the Universal Service Administrative Corporation under the direction of the Federal Communications Commission (FCC), has been instrumental in reducing the digital divide in America's schools (Jakayar, 2004). This programme aims to provide a discount to most schools and libraries in the United States so that they can acquire affordable telecommunications and Internet access. In the European Union, the term 'e-inclusion' was introduced in 2006 by the European Commission as part of the third pillar of the 2010 policy initiative (*i*2010) committed to halving the digital divide by 2010 (EIU, 2008). The Association of Southeast Asian Nations (ASEAN) also took the initiative for the e-ASEAN Framework Agreement in 2000. This initiative set four objectives that included reducing the digital divide within and between member countries. However, this has not yet been achieved, and there are still significant differences between individuals, groups,

regions and countries in terms of reaching and sharing ICTs. In order to design successful policies, it is essential to determine the differences in access and use of ICTs that exist between individuals, regions and countries. In this context, it becomes important to understand the concept of a digital divide (Çilan, Bolat & Coşkun, 2009)

Demand and supply can be considered as a basic framework for explaining and analysing the digital divide. Demand is driven by the consumer, whereas supply is driven by service providers and implemented regulations. As for most other products, the demand for telecommunications service depends on factors such as the demographic characteristics of consumers, their incomes, the price of the services and the price of other communication options. It should be noted that telecommunications demand is generally made up of two interrelated parts: access and usage. Access and usage are complements, for example, the consumer can only use the Internet at home if he or she has Internet access. A lack of Internet access will cause a potential consumer to ignore Internet services. For service providers, services are a function of consumer demand and will be related to income. The price of the service sold will also depend on the level of competition and the implemented regulation.

In the case of the digital divide, the demand-side factors can be defined as the determinants of the use of ICT services, regardless of location, demographic characteristics (accessibility) and affordability of prices of ICT services to consumers (affordability). On the supply side, the availability of services in parts of the country through the public community, and shared or personal devices can be described by the digital divide (ITU-infoDev, 2012). Availability presents the extent to which the provider has the requisite resources, such as technologies and applications, to meet the needs of the consumers. These three main conditions in the demand and supply analysis – accessibility, availability, and affordability of service and applications – need to be considered by policymakers and the NRA in order to narrow the digital divide (Gunasekaran & Harmantzis, 2007).

In Asia and the Pacific region, the income per capita differential and demographic factors are not only important in explaining the digital divide, but also the ICT infrastructures and the institutional environment in the form of regulatory effectiveness. Several countries have experienced continuous ICT infrastructure development and service uptake in the last decade, which has led the region to become a world leader in ICTs even though the penetration rates remain low. Moreover, the slow pace of reform has resulted in several countries - Brunei, Cambodia, Indonesia, Laos, Myanmar, the Philippines and Thailand - having partial competition in the domestic fixed line and Internet service markets (ITU, 2009). This is also reflected in the fact that these countries have not yet completed their liberalization process. It remains a challenge for them to make the benefit of ICTs available to a large part of their population.

The process of liberalization and its effect in this region may differ from the European experiences because of the economic background and lessons learned from developed countries. The transition from monopoly to competition has also been complex and time-consuming, with many procedural problems and delays. The delay of this transition not only limits firm investment and restricts firm growth but also discourages infrastructure investment by new entrants. It results in low speed of products and innovations introduced by telecom service providers, which creates high welfare losses (Prager, 1989; Hausman, 1997; Gruber & Verboven, 2001; Prieger, 2001, 2002 a, b, 2007). Further delays to the liberalization of the telecommunications market may widen the digital divide between people in the Asian countries.

Thailand has been among the slowest countries to liberalize, and it had to fully liberalize the fixed telephony markets by 2006 following Thailand's commitment to the World Trade Organization (WTO) (Hori, 2003). However, this process is still incomplete because of political and economic problems within the country. Despite the absence of a fully liberalized fixed telephony market, competition exists, for example, in the mobile phone and Internet markets. After the Telecommunications Development Master Plan was approved in 1997 and the independent regulatory body, the National Telecommunication Commission (NTC), was established in 2004 (NTC changed its name to the Office of the National Broadcasting and Telecommunications Commission or NBTC in 2011), competition in the mobile and Internet market intensified. In the mobile market, new entries by international telecommunications companies are allowed (Mavichak, 2004), and the Telecommunications Business Act (TBA) B.E. 2544 (2001) (with the 2006 amendment) has raised the limit on foreign holdings in telecommunications companies from 25% to 49% (Srinuan, 2011). The Internet service and International Internet Gateway (IIG) have gradually been liberalized since 2005. At the end of 2010, 85 active Internet service providers (ISPs) and close to 10 of the IIG-licensed providers were granted permits by the NTC. The liberalization policy on Internet services may not be able to stimulate Internet penetration in the country very much for broadband connection, however, as there are dominant players in this market.

In terms of Internet users, growth is still not high enough compared with other countries in Southeast Asia, with Thailand ranked fifth. According to the International Telecommunication Union (ITU), in 2009 Brunei Darussalam (79.78%) was ranked first, followed by Singapore (77.23%), Malaysia (57.61%), Vietnam (27.25%) and Thailand (25.80%). Even in the ICT network readiness index 2009-2010, Thailand is in third place after Singapore and Malaysia (Dutta & Mia, 2011). This evidence shows that the digital divide exists between Thailand and its neighbouring countries. Hence, there is a need to understand and investigate the factors determining the digital divide both within Thailand and between Thailand and the other countries in the region. Some guidance to policymakers and the Nation Regulatory Agency (NRA) on ways to encourage growth in ICT access and use will be discussed in this thesis.

1.2 Purpose of the thesis and research question

As mentioned in Section 1.1, there are at least two types of digital divide that can be observed in Thailand: the digital divide between countries, or so-called global divide, and the digital divide between groups of Thai society, or so-called social divide. In this case, the thesis analyses the global divide by comparing countries in the same region as Thailand, or so-called digital divide at regional level. The thesis also focuses on Thai society at social level. Moreover, this thesis will look at the possibilities of bridging the digital divide.

This thesis is thus conducted with the following main research question in mind:
RQ:

"*What are the determinants and possible policies for bridging the digital divide in Thailand?"*

The purposes motivating the main research question are

- To examine the determinant factors of the digital divide in Thailand
- To identify possible policies for bridging the digital divide in Thailand

To answer the main research question, the study was broken down into seven sub-studies. The reasoning for the sub-studies and the research question are as follows:

***Sub-RQ 1**: What are the determinants of the digital divide at regional level?*

The disparity in the diffusion of ICTs between developed and developing nation has been recognized by various agencies, including the OECD and the International Telecommunication Union, as it may also produce disparity in economic development between these nations. This research question is formulated to examine empirically whether regulatory and economic factors explain the digital divide phenomenon in the region. These determining factors are investigated in the appended papers. However, as the focus of this research question is on investigating the digital divide at regional level, it is also interesting to investigate the social divide as there is clear evidence that a decrease in the digital divide between countries does not mean that the digital divide at the domestic or social level disappears (Fuch & Horak, 2008; EIU, 2008). Thus, the second research question is:

***Sub-RQ 2**: What are the determinants of the digital divide in Thailand?*

There is also concern in literature about the growing digital divide at social level, referring to the inequalities in ICT access and use by different groups of people within society, even in countries at the forefront of the information society. In Thailand, the telecommunications market, in particular Internet service, is still emerging, partly due to the low Internet penetration rate and the percentage of Internet subscribers. This research question is therefore formulated to examine empirically whether the regulatory issues, technology and service attributes, access price, residential areas and socio-economic factors could explain the digital divide phenomenon at social level. Specifically, the determining factors of the digital divide could be categorized into two groups: the demand-side factors and the supply-side factors, as illustrated in Figure 1.

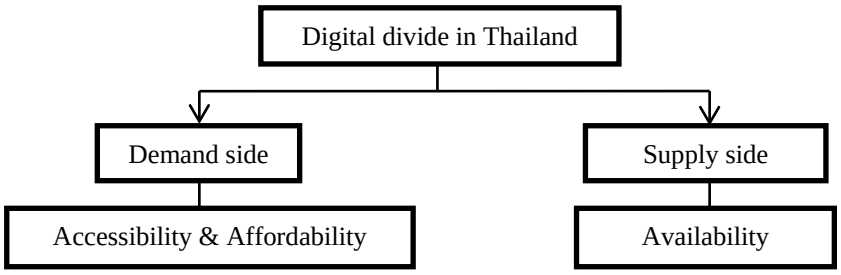


Figure 1. Framework of analysis

The demand-side factors are defined as determinants of the use of ICT services, including accessibility and affordability. These factors relate to the digital divide since lack of access to ICT services and high costs are barriers to adopting them. On the supply side, the availability of services in parts of the country through various types of technology and service attributes is considered. These determining factors are investigated in the appended papers as show below:

Sub-RQ 2.1: What are the determinant factors on the demand side?

The accessibility and affordability conditions are related to user- or demand-side issues. Accessibility is determined by how easily the individual can physically reach the ICT service. Affordability is determined by how the provider's charges relate to the individual's ability and willingness to pay for services. The factors considered for affordability include price of telecommunications service and individual income. The appended papers I, V, VI and VII investigate these two conditions by including possible factors based on previous literature and existing concepts. The method employed is econometric models, which vary depending on the aim of each paper.

Sub-RQ 2.2: What are the determinant factors on the supply side?

On the supply side, availability measures the extent to which the provider has the requisite resources, such as technologies and services, to meet the needs of the user. An Internet connection through a fixed network was still the main option for users in Thailand during the period of the study. Apart from fixed connection (dial-up and broadband), mobile Internet via a mobile handset and a USB modem is one option for the end-user, but there is a limitation due to the technology and frequency-allocation problem. The appended papers II, III and IV aim to explain the situation of the supply side in Thailand by including the regulatory issues (i.e. entry relaxation, privatization, 3G licensing and its delays), and the availability of fixed-line and wireless service, in particular, mobile Internet. At least three main methods are employed: discounted cash flow analysis, event study and econometric modelling. Although the employed methods are inconsistent, the findings aim to answer and contribute to the RQ and sub-RQ.

Sub-RQ 3: *What are the possible policies for bridging the digital divide in Thailand?*

This research question aims to synthesize the results of the first two research questions. ICTs are significant inputs to economic growth, but the potential of ICTs may serve to reduce or widen the existing digital divide. Without an understanding of the determinant factors, it will be difficult to discuss possible options for bridging this gap. The finding is expected to identify alternative policies for bridging the digital divide in the current circumstances in Thailand.

A series of studies show the determinant factors of the digital divide and the possibility of bridging the digital divide in Thailand according to the sub-research questions. The analysis and discussion identify the reasons the telecommunications regulator and policymakers should pay attention to this phenomenon. The analytical framework used in this thesis is presented in Figure 2.

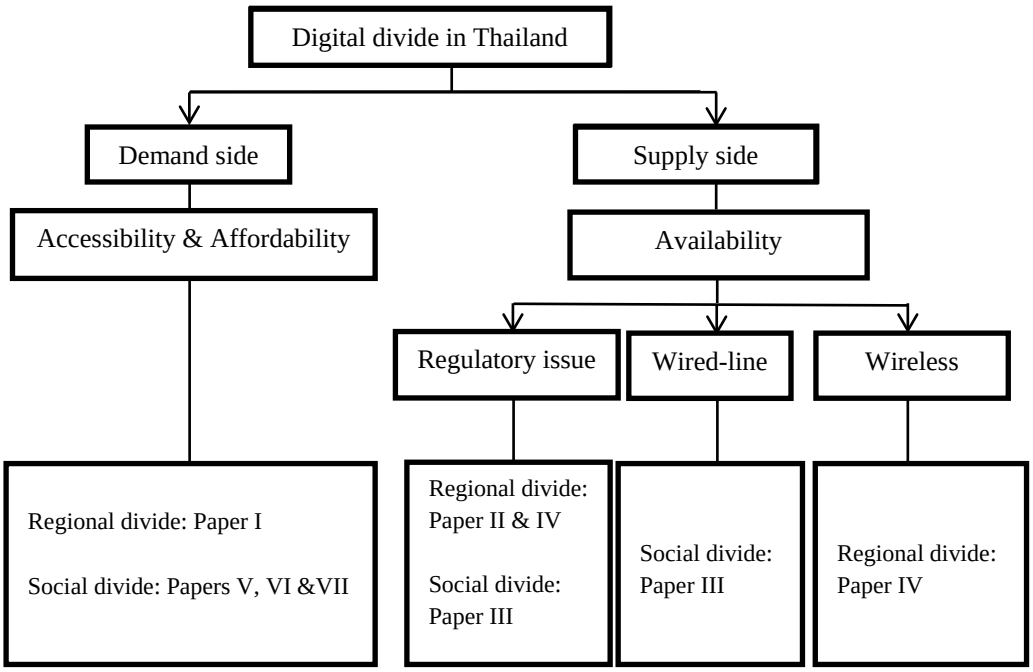


Figure 2. Framework for integrating the appended papers

1.3 Scope and limitation of the study

This thesis focuses on the determinant factors of the digital divide in Thailand. The digital divide is defined as the disparity between individuals, households, communities and/or countries at different socio-economic and institutional levels that do or do not have the opportunity to access and use ICTs. However, this thesis examines the digital divide on two levels: a country comparison (regional level) and Thai society (social level). Three services are considered in telecommunications in this thesis: mobile phone, fixed line and Internet. Specifically, Paper I uses the composite index, which combines three telecommunications services. Papers II and III focus on mobile phones and all three services, respectively, while the rest of the appended papers further explore different Internet services. Most of the appended papers discuss the digital divide in the context of access and use, but none of them emphasizes non-user behaviour. Data availability and sources of data are also important criteria for selecting the countries for the analysis.

This thesis consists of seven appended papers and uses multiple approaches to explain the digital divide phenomenon. This thesis attempts to include the various possible factors that could explain the digital divide in Thailand. Some of these appended papers, however, may not directly explain and provide in-depth discussion on how much the considered factors influence the digital divide due to differences in others in terms of the method logic and sample. This may lead to some difficulties in integrating the results smoothly. If these papers are re-considered, four of them, Papers I, V, VI and VII, can be seen to be related to the demand side, while Papers II, III and IV are connected to the supply side, as shown in Figure 2. The inclusion of all of them provides a presentation of the current situation and possible factors that could reduce or widen the digital divide, even if the studies of the supply side are quite scattered.

1.4 Structure of the thesis

This thesis focuses on Thailand as a case by quantitatively examining the digital divide phenomenon. The cover paper consists of seven chapters. It gives an overview of the topic and summarizes how the appended papers are interrelated. The rest of the thesis is structured as follows. Chapter 2 presents relevant theories on the digital divide and literature with an understanding of different theories and concepts that are relevant to the topic. This is followed by an overview of Thai telecommunications in Chapter 3, which presents the background of the market and illustrates the current situation and legal instrument related to the digital divide in Thailand. The methodological approach is then discussed in Chapter 4 and a summary of the appended papers is given in Chapter 5. Chapter 6 discusses the main findings with regard to the research questions. The conclusions and future research are provided in Chapter 7. The thesis ends with the appended papers.

1.5 Notes on terminology

Throughout this thesis, the following terms are used to indicate their associated meanings.

Terms	Definitions
Access divide	Disparity between haves and have-nots in relation to access to ICTs
Accessibility	Use of services regardless of location and demographic characteristics (ITU-infoDev, 2012)
Affordability	Affordable price of ICT services to consumers (ITU-infoDev, 2012)
Availability	The presence of ICT services for inhabited parts of the country through the public community, shared or personal devices (ITU-infoDev, 2012)

Terms	Definitions
Digital divide	This term, defined by the OECD (2001, p.5), means the gap between individuals, households, businesses and geographic areas at different socioeconomic levels with regard to their opportunities to access ICTs and to their use of the Internet for a wide variety of activities. The digital divide reflects various differences among and within countries
Global divide	Gap in access to and use of ICTs between countries in different regions, normally relating to the gap between developed and developing countries (Norris, 2001)
Regional divide	Gap in access to and use of ICTs between countries in the same region
Social divide	Gap in access to and use of ICTs between different sections of a nation's society. It is apparent in the different levels of access to ICTs for groups with different socio-economic characteristics within a country (Norris, 2001).
Usage divide	Disparity between ICT users and ICT non-users, or between ICT users

2. FRAMEWORK AND LITERATURE SURVEY

This chapter aims to present a literature review in the field of digital divide research. Given the complexity of the digital divide, this chapter consists of three sub-chapters on relevant concepts for defining the digital divide, determinant factors and choices of policies. Based on the literature, the result provides insights into the digital divide research.

2.1 Relevant concept for defining the digital divide

The term *digital divide* entered public discourse and became very popular in the 1990s (van Dijk, 2000). NTIA (1999) defined the digital divide as the gap between those with and those without access to ICT. The discussion on the digital divide initially employed an element of technological determinism. The technological determinist view is a technology-led theory of social change. Technology is the sole or prime antecedent cause of changes in society, while human and social factors are seen as secondary (Smith & Marx, 1996). Many empirical studies (e.g. Lentz & Oden, 2001; Chowdary, 2002; Hartviksen, Akselson & Eidsvik, 2002; James, 2002, 2003; Lim, 2002; Meng & Li, 2002; Moss, 2002) focus on the equalization of access to ICTs in terms of physical access, using technological determinism theory in their hypotheses and conclusions.

The gap in access could also be understood as a phenomenon with three distinct aspects, including a global divide (referring to ICT disparities between countries), a social divide (referring to the gap in access to ICTs between different groups of a nation's society) and a democratic divide (referring to the difference between those who do and do not use the variety of digital means to engage in public life) (Norris, 2001). In accordance with technological determinism, liberalization and opening of markets are presented as being necessitated by the technology change. This implies that everyone has the same potential to use technology and to benefit from ICTs provided that everyone has access to them. Although the above-mentioned authors used technological determinism in their research, they also gave consideration to social factors by including, for example, socio-economic factors in their analysis. Hence, this suggests that the theory of technological determinism is not sufficient to explain the situation regarding the digital divide.

A number of sociological and economic perspectives have been applied to understand the digital divide (Mason & Hacker, 2003), for example, the diffusion of innovation theory, the knowledge gap hypothesis and public-private spheres. According to the diffusion theory, as innovative forms of technology emerge, they are not adopted 'en masse' (Rogers, 1995). Rather, as the popularity and personal resources of the adopters increase, innovation is adopted. Van Dijk (2000) noted that the path of the physical access divide may follow the diffusion S-curve of innovations. The path is much more complex, however, and differentiated between groups within the population than the S-curve projects and there are serious problems with the mainstream diffusion theory regarding computer and Internet technology[1]. The argument by van Dijk (2000) can be seen as related to the argument about the knowledge gap hypothesis by Tichenor, Donohue and Olien (1970). The hypothesis explicitly considers that knowledge regarding the use of adopted technologies is greater among those with high socio-economic status who are already well informed. Most scholars contend that the digital divide should be defined in terms of both access and use (e.g. DiMaggio et al., 2001; Hargittai, 2002; Hartviksen et al., 2002; Akhter, 2003; Brown & Licker, 2003; van Dijk & Hacker, 2003; Selwyn, 2003, 2006).

[1] van Dijk (2006) compares the adoption curve with the normalization model and with a stratification model of diffusion. The results show that the differences between groups only increase in the early stages of adoption and, if a normalization model applies, disappear with the saturation in the last stages, or, if the stratification model applies, the gap persists.

Hargittai (2002) discussed the five dimensions along which a digital divide may exist: technical means (software, hardware, quality of connectivity), autonomy of use (location of access, freedom of use of the medium for the user's preferred activities), use pattern (types of uses of the Internet, experience of using ICT), social support networks (availability of others who can be turned to for assistance with use, size of network to encourage use) and skill (the ability to use the new technology efficiently and effectively). This illustrated that there are factors beyond mere connectivity that need to be considered when discussing the digital divide. Hargittai also called the difference in people's online skills the second level digital divide. Similarly, van Dijk (2002, 2006) pointed out that the divide in access and use should be conceptualized as a continuous process of multiple dimensions. The disparity of access should be seen as a range of differences along dimensions for hardware, software, mode of Internet connection, etc., and the disparity of use should be seen as a range of differences along the dimensions of skills, literacy and types of usage (Lentz & Oden, 2001; van Dijk & Hacker 2003). van Dijk (2006) divided skills into three types: instrumental skills (the capacities to work with hardware and software), information skills (the ability to search, select and process information on computer and network sources) and strategic skills (the capacities to use computer and network sources as the means for particular goals and for the general goal of improving the user's position in society).

Apart from access and use, other dimension of the digital divide could be explained by the theory of public-private spheres. Keane (2000) explains that public spheres, which can be categorized into three levels (micro-, meso- and macro-sphere), serve as a platform for the negotiations of which society consists. ICTs allow citizens to move beyond the traditional idea of the public sphere and create new public spheres without the constraints of geography, time and political interest. In this way, they recreate the structure of society by renegotiating rules, roles and meaning. They also provide opportunities for citizens who have no connection to networks with other citizens. This theory presents the impact of ICTs on power, in particular of the Internet on society. It also implicitly reveals that an institutional perspective can act as a lens through which to explain the digital divide phenomenon at individual, national and global levels. A number of studies support this idea by considering the taxonomy of the institution that has influence over the policies, regulation and market mechanism of ICTs (e.g. Chowdary, 2002; Lim, 2002; Meng & Li, 2002; Wong, 2002; McSorley, 2003; Roseman, 2003; Roycroft & Anantho, 2003; Selwyn, 2003; Sharma & Gupta, 2003).

However, a number of studies showed that merely having access to an Internet-connected machine does not result in informed users (e.g. Hargittai, 2002, 2003a, 2003b, 2005; Freese, Rivas & Hargitai, 2006; Robinson, DiMaggio & Hargittai, 2003; Dobransky & Hargittai, 2006; Hargittai, 2008; Hargittai & Hinnant, 2008; Hargittai, 2010). If some people are unable to find information online while an increasing number of services relevant to daily life become easier to access on the web (e.g. financial services, product information, government forms), then the segment of the population with low digital-literacy levels will become increasingly disadvantaged. These studies show that there is unequal participation in social network sites and the digital divide remains since the user cannot use the Internet effectively and gain maximum benefit.

As well as the attempts to define the digital divide as a continuous disparity along multifaceted dimensions, there have been attempts to define the concept accurately in a quantitative manner, both at regional (Beynon-Davies & Hill, 2007) and global level (Corrocher & Ordanini, 2002; Bagchi, 2005; Hanafizadeh, Saghaei & Hanafizadeh 2009b; Emrouznejad, Cabanda & Gholami, 2010). At regional level, Beynon-Davies and Hill (2007) developed a digital divide index to highlight the multifaceted nature of this phenomenon within a regional context. The index allows a comparison of technology adoption rates, regarding access and use, in four 'at risk' groups (females, persons aged over 50,

persons with limited formal education and persons on a low income) with the technology adoption rates among the population average. They defined the digital divide as individuals who fall behind the population average in terms of Internet access and use.

Considering the global level, Corroher and Ordanini (2002) point out that there are six determinant factors of the digital divide between countries. They are markets, diffusion, infrastructures, human resources, competitiveness and competition. These factors were quantified and constructed into a single index. Similarly, Bagchi (2005), Hanafizadeh et al. (2009b), and Emrouznejad, et al. (2010) developed the digital divide index, which is built on defining and conceptualizing the ICT infrastructure, access and skill of the user. These indexes use core ICT indicators on which the international community and experienced modellers have reached the consensus that they provide suitable measurements of the information society.

The digital divide has been an area of interdisciplinary concern, and several types of technologies have been investigated from empirical and conceptual standpoints. The main ICT discussed in this field was the Internet. The reason might have been that the supply of information by the Internet is more heterogeneous and potentially unlimited than that by other ICTs while, on the other hand, access to the Internet is still restricted in many countries due to technical and economic barriers. Furthermore, compared with other ICTs, the use of the Internet requires a much more active and skilled user (Bonfadelli, 2002). As governments worldwide increasingly implement e-government services, concerns about the potential impact of the digital divide continue to grow. As an example, the digital divide has been identified as a major barrier to the effective deployment of e-government (Choudrie, Weerakkody & Jones, 2005; Helbig, Gil-Garcia & Ferro, 2009). Specifically, the issues of e-government, the ICT index, e-readiness and alternative technologies for bridging the digital divide have gradually increased, while the issue of ICT adoption and diffusion, public policy and regulation have remained important over time.

The definition of *digital divide* depends on several contexts, e.g. the investigated subject, research area and level of investigation. Previous studies have indicated that the digital divide for access and usage is discussed at several levels, for example, global, country, organization and individual level. Several factors are involved in explaining the digital divide. In light of all such circumstances, there appears to be convergence in the research community that the digital divide is not just about access to technology, but rather that it has socio-economic and institutional components.

2. 2 Determinant factors of the digital divide

The digital divide is not restricted to access to technical infrastructure, it also covers the social factors that support ICT (Rooksby, Weckert & Lucas, 2002).This includes socio-demographic factors such as income, gender, race, ethnicity, education, age and location, and institution (Choudrie et al., 2005). Helbig et al. (2009) proposed three levels of factors influencing the digital divide. The first level is the technology access approach, which is close to the idea of technological determinism. Based on this assumption, the important factors at this level should be availability of the infrastructure and infrastructure investment, as once everyone has access the digital gap will be bridged. The next level is the multi-dimension approach. Helbig et al. (2009) note that there are many dichotomous divides or multiple dimensions: it is not only a question of having or not having access. These dimensions could be, for example, socio-economic status, skills, geography and education. The last level considers that the digital divide may be understood by examining the various ways that different factors (e.g. age, gender race, etc.) interact to shape the experiences of the users. The literature was classified into three

broad categories - a technology access approach, a multi-dimension approach and a multi-perspective approach - and each of these was divided into sub-categories as shown in Table 1.

Table 1. Determinant factors of the digital divide

Factors	Rationale	Sources
1.Technology access		
1.1 Availability of infrastructure	The availability of infrastructure (including the availability of related technologies, e.g. fixed phone, mobile phone, Wi-Fi and WiMax) predicts the likelihood of adoption and the extent of use of ICT.	Lentz and Oden (2001), Chowdary (2002), Hartviksen et al (2002), James (2002, 2003), Lim (2002), Ming and Li (2002), Moss (2002), Ngini et al. (2002), Sexton et al. (2002), Wong (2002), Breiter (2003), Brown and Licker (2003), Cullen (2003), Fink and Kenny (2003), Robinson et al.(2003), Roseman (2003), Roycroft and Anantho (2003), Sharma and Gupta (2003), Bozionelos (2004), Eastman and Iyer (2004), Kanungo, S. (2004), Kebede (2004), Jayakar (2004), Mutula (2004), Mwesige (2004), Pook and Pence (2004), Simpson et al. (2004), Bagchi (2005), Chin (2005), Choudrie et al. (2005), Fairlie (2005), Hawkins (2005), Hubregtse (2005), Kalusopa (2005), Oyelaran-Oyeyinka and Lal (2005), Rao (2005), Sun and Wang (2005), Cava-Ferreruela and Alabau-Muñoz (2006), Cooke and Greenwood (2008), Deichmann (2006), Demoussis and Giannakopoulos (2006), Freese et al. (2006), Gibbons and Ruth (2006), Hassani (2006), Huang and Russell (2006), Igun and Olise (2008), Mutula and van Brakel (2006), Shim et al. (2006), Vicente Cuervo and López Menéndez (2006), Wood (2008), Xiong (2006), Alam and Ahsan (2007), Beynon-Davies and Hill (2007), Blackman (2007), Guasch and Ugas, (2007), LaRose et al. (2007), Ono and Zavodny (2007), Powell (2007), Reisenwitz et al. (2007), Robertson et al. (2007), Ryder (2007), Teo (2007), Warren (2007), Engelbrecht (2008), Ganapati and Schoepp (2008), Gómez-Barroso and Robles-Rovalo (2008), Hargittai (2008), Hohlfeld et al. (2008), Ishmale et al. (2008), Kim (2008), Noh and Yoo (2008), Singh and Sahu (2008), Szabó et al. (2008), Yuguchi (2008), Ashraf et al.(2009), Avila (2009), Çilan et al. (2009), Salinas and Sanchez (2009), Emrouznejad et al. (2010), Haßler and Jackson (2010), Klimaszewski and Nyce (2009), Liao and Chang (2010), Niehaves et al. (2010), Pal (2009), Emrouznejad et al. (2010), Haßler and Jackson (2010), Puga et al. (2010), Pieri and Diamantinir (2010), Wetzl, A. (2010), Wilbon (2010), Yu (2010)
1.2 Investment	A higher level of ICT infrastructure would lead to a greater diffusion rate and reduce the digital gap.	Chowdary (2002), Ming and Li (2002), Sharma and Gupta (2003), Pook and Pence (2004), Hawkins (2005), Cava-Ferreruela and Alabau-Muñoz (2006), Shim et al. (2006), Gómez-Barroso and Robles-Rovalo (2008), Noh and Yoo (2008), Avila (2009)
2. Multi-dimensional approach		
2.1 Education	People with higher education will be more likely to use and adopt ICTs than less educated people.	Hargittai (2002), Hartviksen et al. (2002), Lim (2002), Akhter (2003), Brown and Licker (2003), Hargittai (2003a), Hollifield and Donnermeyer (2003), Rice and Katz (2003), Robinson et al. (2003), Sharma and Gupta(2003), Mwesige

Factors	Rationale	Sources
		(2004), Simpson et al. (2004), Wareham et al. (2004), Eastman and Iyer (2004), Kanungo, S. (2004), Azari and Pick (2005), Bagchi (2005), Fairlie (2005), Kalusopa (2005), Cava-Ferreruela and Alabau-Muñoz (2006), de Koning and Gelderblom (2006), Demoussis and Giannakopoulos (2006), Deichmann (2006), Dobransky and Hargittai (2006), Hassani (2006), Peter and Valkenburg (2006), Schleife (2010), Selwyn (2006), van Dijk (2006), Xiong (2006), Yap et al. (2006), Beynon-Davies and Hill (2007), Dwivedi and Lal (2007), Flamm and Chaudhuri (2007), Ono and Zavodny (2007), Robertson et al. (2007), Warren (2007), Zhao et al. (2007), Ameen and Gorman (2008), Cooke and Greenwood (2008), Goldfarb and Prince (2008), Hargittai and Hinnant (2008), Noce and McKeown (2008), Noh and Yoo (2008), Prieger and Hu (2008), Rice and Katz (2008), Vie (2008), Alam et al. (2009), Ashraf et al. (2009), Avila (2009), Billon et al. (2009), Klimaszewski and Nyce (2009), Orviska and Hudson (2009), Shirazi et al. (2009), van Deursen, and van Dijk (2009a), van Deursen, and van Dijk (2009b), Emrouznejad et al. (2010), Engelbrecht (2008), Gauld et al.(2010), Liao and Chang (2010), Moon et al. (2010), Shirazi et al. (2010)
2.2 Geography	Urban populations may benefit from easier and cheaper access to ICT infrastructure because adoption costs will decrease with increases in population size and density.	Chowdary (2002), Cullen (2003), Rowe (2003), Simpson et al. (2004), Whaley (2004), Wareham et al. (2004), Bagchi (2005), Chaudhuri et al. (2005), Chin (2005), Choudrie et al. (2005), Mariscal (2005), Cava-Ferreruela and Alabau-Muñoz (2006), Dobransky and Hargittai (2006), Selwyn (2006), Shim et al. (2006), Akca et al. (2007), Gómez-Barroso and Pérez-Martínez (2007), Flamm and Chaudhuri (2007), Goldfarb and Prince (2008), Noce and McKeown (2008), Prieger and Hu (2008), Wood (2008), Yartey (2008), Yuguchi (2008), Billon et al. (2009), Orviska and Hudson (2009), Savage and Waldman (2009), Chen et al. (2010), Gauld et al.(2010), García-Jiménez and Gómez-Barroso (2009), Liao and Chang (2010), Moon et al. (2010), Park and Jayakar (2010), Schleife (2010)
2.3 Occupation	Professional, scientific and/or technical workers are more likely to access and use ICT tools than other workers.	Rice and Katz (2003), Wareham et al. (2004), Azari and Pick (2005), Chaudhuri et al. (2005), Demoussis and Giannakopoulos (2006), Dwivedi and Lal (2007), Flamm and Chaudhuri (2007), Billon et al. (2009), Salajan et al. (2010), Schleife (2010)

Factors	Rationale	Sources
2.4 Socioeconomic status/GDP per capita	Individuals and countries in more privileged socio-economic situations are expected to have a smaller digital gap.	Bosman (2002), Ming and Li (2002), Wong (2002), Akhter (2003), Fink and Kenny (2003), Rice and Katz (2003), Roycroft and Anantho (2003), Quibria et al. (2003), Bozionelos (2004), Eastman and Iyer (2004), Pook and Pence (2004), Whaley (2004), Wareham et al. (2004), Azari and Pick (2005), Bagchi (2005), Fairlie (2005), Mariscal (2005), Oyelaran-Oyeyinka and Lal (2005), Cava-Ferreruela and Alabau-Muñoz (2006), Deichmann (2006), Hassani (2006), Vicente Cuervo and López Menéndez (2006), van Dijk (2006), Yap et al. (2006), Beynon-Davies and Hill (2007), Dwivedi and Lal (2007), Flamm and Chaudhuri (2007), Hitt and Tambe (2007), LaRose et al. (2007), Ono and Zavodny (2007), Robertson et al. (2007),Warren (2007), Barrantes and Galperin (2008), Engelbrecht (2008), Goldfarb and Prince (2008), Hohlfeld et al. (2008), Noce and McKeown (2008), Noh and Yoo (2008), Prieger and Hu (2008), Billon et al. (2009), Orviska and Hudson (2009), Andrés (2010), Chakraborty and Emrouznejad et al. (2010), Gauld et al.(2010), Martinez and Williams (2010), Shirazi et al. (2009), Schleife (2010), Wilbon (2010)
3.Multi-perspective approach		
3.1 Access price	A low access price will increase the probability of access to and use of ICTs.	Chowdary (2002), Chaudhuri et al. (2005), Shim et al. (2006), Xiong (2006), Flamm and Chaudhuri (2007), Robertson et al. (2007), Barrantes and Galperin (2008), Engelbrecht (2008), Billon et al. (2009), Savage and Waldman (2009)
3.2 Age	The elderly show greater reluctance to adopt new technologies than teenagers do.	Hargittai (2002), Akhter (2003), Hargittai (2003a), Hollifield and Donnermeyer (2003), Rice and Katz (2003), Mwesige (2004), Whaley (2004), Chaudhuri et al. (2005), Fairlie (2005), de Koning and Gelderblom (2006), Demoussis and Giannakopoulos (2006), Dobransky and Hargittai (2006), Peter and Valkenburg (2006), Selwyn (2006), Beynon-Davies and Hill (2007), Dwivedi and Lal (2007), Flamm and Chaudhuri (2007), LaRose et al. (2007), Ono and Zavodny (2007), Goldfarb and Prince (2008), Noce and McKeown (2008), Prieger and Hu (2008), Rice and Katz (2008), Abbey and Hyde (2009), Alam et al. (2009), Middleton and Chambers (2009), Orviska and Hudson (2009), van Deursen, and van Dijk (2009a), Gauld et al.(2010), Moon et al. (2010), Pieri and Diamantinir (2010), Salajan et al. (2010), Schleife (2010)
3.3 Attitude	A favourable attitude towards ICT will influence its adoption.	Brown and Licker (2003), Cullen (2003), Jackson et al. (2003), Oxedine et al. (2003), Bozionelos (2004), Kebede (2004), Bagchi (2005), Hubregtse (2005), Broos and Roe (2006), Hinson and Sorensen (2006), van Dijk (2006), Vogelwiesche et al. (2006), Reisenwitz et al. (2007), Warren (2007), Carter and Weerakkody (2008), Hill et al. (2008), Klecun (2008), Das et al. (2009), Chen et al. (2010), Gomez and Gould (2010), Moon et al. (2010), Pieri and Diamantinir (2010), Waycott et al. (2010), Wilbon (2010)

Factors	Rationale	Sources
3.4 Content	Content suited to the preferences and needs of the user will reduce the digital gap.	Kuk (2002), Ngini et al. (2002), Hargittai (2003b), Robinson et al. (2003), Kebede (2004), Mwesige (2004), Simpson et al. (2004), Choudrie et al. (2005), Harrison et al. (2005), Kalusopa (2005), Rao (2005), Sun and Wang (2005), Freese et al. (2006), Ke and Wei (2006), Mutula and van Brakel (2006), Peter and Valkenburg (2006), Alam and Ahsan (2007), Teo (2007), Hohlfeld et al. (2008), Tien and Fu (2008), Rice and Katz (2008), Vie (2008), Alam et al. (2009), Orviska and Hudson (2009), Sang et al. (2009), Salajan et al. (2010), Waycott et al. (2010)
3.5 Culture[2]	People belonging to different cultures may have different perceptions of ICT, which could lead to different ICT adoption rates.	Hubregtse (2005), Praboteeah et al. (2005), Zhao et al. (2007), Hill et al. (2008), Recabarren et al. (2008), Srite et al. (2008), Al-Jaghoub and Westrup (2009), Klimaszewski and Nyce (2009)
3.6 Ethnicity	ICT adoption and use vary by ethnic group, e.g. white users have a higher rate of ICT adoption than Asian, African and Hispanic users do.	Jackson et al. (2003), Wareham et al. (2004), Chaudhuri et al. (2005), Fairlie (2005), Flamm and Chaudhuri (2007), Kim et al.(2007), Prieger and Hu (2008), Tien and Fu (2008), Middleton and Chambers (2009)
3.7 Family structure	The current use of ICTs by children at home will increase the probability of ICT use by other family members.	Rice and Katz (2003), Demoussis and Giannakopoulos (2006), Dobransky and Hargittai (2006), Hitt and Tambe (2007), Hargittai (2008), Goldfarb and Prince (2008), Prieger and Hu (2008), Noce and McKeown (2008), Liao and Chang (2010), Schleife (2010), Wilbon (2010)
3.8 Gender	Men are more likely to access and use ICT tools than women.	Sexton et al. (2002), Trauth (2002), Akhter (2003), Rice and Katz (2003), Chaudhuri et al. (2005), Winker (2005), de Koning and Gelderblom (2006), Dobransky and Hargittai (2006), Hargittai and Shafer (2006), Peter and Valkenburg (2006), Selwyn (2006), Flamm and Chaudhuri (2007), Ono and Zavodny (2007), Goldfarb and Prince (2008), Hargittai (2008), Hargittai and Hinnant (2008b), Prieger and Hu (2008), Rice and Katz (2008), Tien and Fu (2008), Alam et al. (2009), Orviska and Hudson (2009)
3.9 Institution, structure and type of government	Public policies and regulation play an important role in promoting or inhibiting ICT diffusion.	Chowdary (2002), Lim (2002), Ming and Li (2002), Wong (2002), McSorley (2003), Roseman (2003), Roycroft and Anantho (2003), Selwyn (2003), Sharma and Gupta (2003), Greco and Floridi (2004), Kebede (2004), Mutula (2004), Papazafeiropoulou (2004), Simpson et al. (2004), Azari and Pick (2005), Chin (2005), Goth (2005), Kalusopa (2005), Kasusse (2005), Mariscal (2005), Mistry (2005), Gibbons and Ruth (2006), Mutula and van Brakel (2006), Shim et al. (2006), Yap et al. (2006), Blackman (2007), Ryder (2007), Zhao et al. (2007), Åkesson et al. (2008), Blackman and

[2] Culture refers to the values, beliefs and practices that influence the ways individuals interpret the world and can manifest itself in a variety of social settings, including homes, schools and communities. Technologies are not culturally neutral or value-free and can have a significant impact on the habits, folkways, outlooks and identities normally associated with culture (Hill et al., 2008).

Factors	Rationale	Sources
		Forge (2008), Kim (2008), Letch and Carroll (2008), Prieger and Hu (2008), Recabarren et al. (2008), Singh and Sahu (2008), Wood (2008), Xia and Lu (2008), Yartey (2008), Yuguchi (2008), Al-Jaghoub and Westrup (2009), Avila (2009), Billon et al. (2009), Pal (2009), Shirazi et al. (2009), Andrés (2010), Hohlfeld et al. (2010), Martinez and Williams (2010), Sang et al. (2009), Shirazi et al. (2010), Xia (2010)
3.10 Language	English is a potential predictor of the digital divide, in particular for the Internet.	Roycroft and Anantho (2003), Chin (2005), Gamage and Halpin (2007), Noce and McKeown (2008), Alam et al. (2009), Wetzl (2010)
3.11 Marital status	Marital status seems to have a highly significant effect on gaining access to ICTs.	Rice and Katz (2003), Wareham et al. (2004), Chaudhuri et al. (2005), Selwyn (2006), Flamm and Chaudhuri (2007), Goldfarb and Prince (2008), Rice and Katz (2008), Schleife (2010), Orviska and Hudson (2009)
3.12 Network effect	The number of ICT users (in a given country) in the previous year is a powerful determinant of the number of ICT users in the current year.	Robinson et al. (2003), Cava-Ferreruela and Alabau-Muñoz (2006), Demoussis and Giannakopoulos (2006), Yartey (2008), Andrés (2010)
3.3 Race	A major race in a given country is more likely to access and use ICT tools.	Chakraborty and Bosman (2002), Jackson et al. (2003), Whaley (2004), Chaudhuri et al. (2005), Fairlie (2005), Dobransky and Hargittai (2006), Selwyn (2006), Flamm and Chaudhuri (2007), Goldfarb and Prince (2008), Hargittai (2008), Prieger and Hu (2008), Alam et al. (2009)
3.4 Skills and experience	A lack of ICT skills and experience will widen the digital gap.	Hargittai (2002), Sexton et al. (2002), Brown and Licker (2003), Hargittai (2003a, 2003b), Hollifield and Donnermeyer (2003), Robinson et al. (2003), Eastman and Iyer (2004), James (2004), Kebede (2004), Hargittai (2005), Kalusopa (2005), Fisher and Bendas-Jacob (2006), Freese et al. (2006), Hargittai and Shafer (2006), Mutula and van Brakel (2006), Selwyn (2006), van Dijk (2006), Vicente Cuervo and López Menéndez (2006), Xiong (2006), Hitt and Tambe (2007), LaRose et al. (2007), Reisenwitz et al. (2007), Hill et al. (2008), Hargittai (2008), Hargittai and Hinnant (2008), Srite et al. (2008), Tien and Fu (2008), Vie (2008), Çilan et al. (2009), García-Jiménez and Gómez-Barroso (2009), Salinas and Sanchez (2009), van Deursen and van Dijk (2009a), Gauld et al. (2010), Salajan et al. (2010), Waycott et al. (2010), Wilbon (2010), Yu (2010)
3.15 Speed and quality of service	Higher quality of service and faster Internet connection speed will increase the adoption rate.	Kuk (2002), Ngini et al. (2002), Chin (2005), Rao (2005), Mutula and van Brakel (2006), Prieger and Hu (2008), Savage and Waldman (2009), Glass and Stefanova (2010)

A number of factors contribute to this disparity, all of which must be considered if the divide is to be bridged. These factors can be summarized as shown in Figure 3. Interestingly, there are several factors, for example, skill and experience, education, price of access, institutional structure, race, ethnicity, culture, psychological factors, network effects, content and speed and quality of service, that scholars have been paying attention to since 2005. These factors confirm that digital divide research has moved beyond the technological access concept.

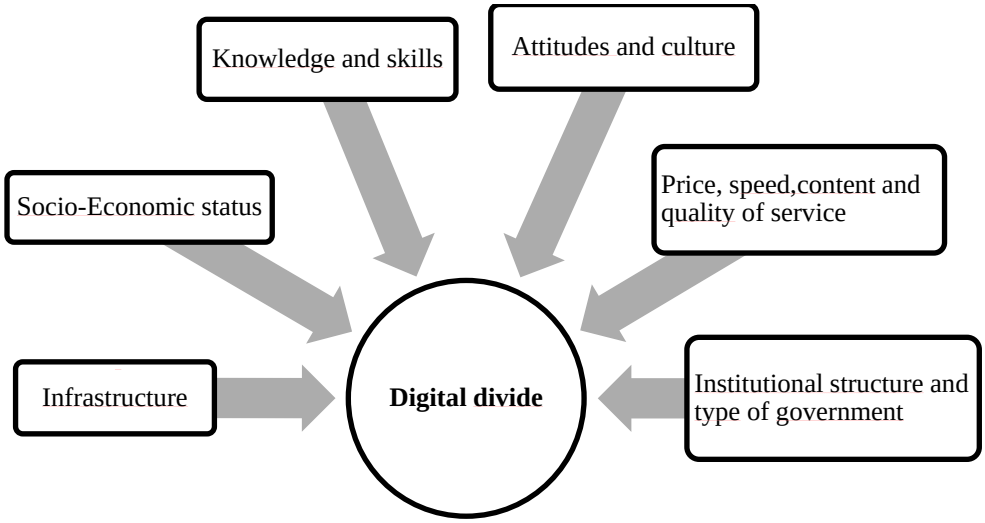


Figure 3. Determinant factors of the digital divide from a literature survey

2. 3 Choices of policies for bridging the digital divide

Most of the studies in the survey developed policy recommendations for tackling the issue of the digital divide. These recommendations are based on the definition of the digital divide and on the determinant factors, and they display a wide range of policies and actions. Three clusters of policy recommendations that can be found in research in developed and developing countries emerged from the literature survey (see Figure 4).

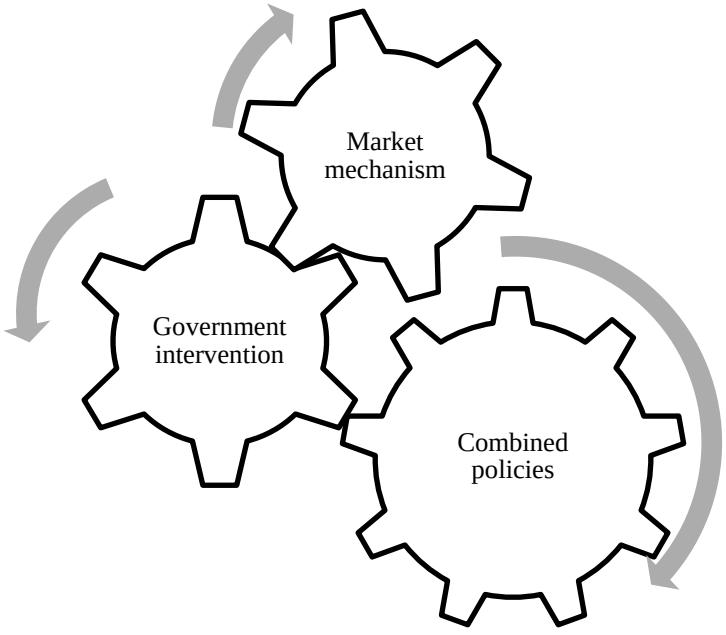


Figure 4. Clusters of policy recommendations

The first cluster contends that ICTs, like any other technological inventions in the past, will be spread by market forces to the vast majority in society. The current digital divide will only exist as a temporary phenomenon. There is no need for government intervention because subsidies from the government distort investment patterns and lead to inefficient resource allocation (as cited in Mariscal, 2005). A competitive environment will encourage technological innovation and prices will decrease for many users (Wareham et al., 2004; Lai & Brewer, 2006; Andrés et al., 2010; Haßler & Jackson, 2010). Developing countries, in particular, need to speed up the liberalization of their telecommunications sector (Billon et al., 2009). Recently, many studies have shown that the diffusion of technology can help developing countries and/or people in rural areas to catch up in terms of ICT access, in particular for Internet provided by wireless technologies (Gibbons & Ruth, 2006; Gunasekaran & Harmantzis, 2007; Gómez-Barroso & Robles-Rovalo, 2008; Ishmael et al., 2008; Middleton & Chambers, 2010). Genasekaran and Harmantizis (2007) reveal that the deployment of wireless services has three main characteristics – accessibility, availability and affordability of service and application – that provide an opportunity to advance digital inclusion. However, little research has been conducted that examines the use of this technology to bridge the digital divide.

The second cluster argues that the digital divide will not decrease without government intervention (Chowdary, 2002; Wong, 2002; Roycroft & Anantho, 2003; Mariscal, 2005; Mathur & Ambini, 2005). This cluster believes that a certain degree of government intervention is needed to bridge the digital gap. Cava-Ferreruela and Alabau-Muñoz (2006) categorized interventions into three levels -soft, medium and hard intervention –-using broadband as an example. Soft intervention tends to create the appropriate conditions for market development, for example, unbundling policies, right of way, increased radio spectrum allocation, reducing taxation and financial incentives for users (Barrantes & Galperin, 2008; Igun & Olise, 2008). There are two main arguments that support this idea. Firstly, the development of some ICT infrastructure is still at an early stage, and excessive government involvement may distort competition and affect future market development. Secondly, strong market competition is considered an essential requirement to ensure an efficient supply of services and technological innovation. However, there are geographic areas that are likely to remain underserved (rural areas and areas with low population density). It is reasonable to consider public funding for infrastructure supply in these areas. This strategy is referred to as medium intervention, while hard intervention can be seen as a strategy that is characterized by very proactive government involvement. With regard to medium intervention, several strategies have been recommended, for example, subsidizing Internet access to low-income and less-educated people (Demoussis & Giannakopoulos, 2006; Ono & Zavodny, 2007; Goldfarb & Prince, 2008; Ashraf et al., 2009; Park & Jayakar, 2010), collaboration between public and private partners to build infrastructure (Lattemann et al., 2009; Qiang, 2010) and public access facilities (Hartviksen et al., 2002; Billion et al., 2009). However, the majority of the studies focused on intervention in access rather than usage. Very few studies reported how government intervention could encourage disadvantaged people to adopt ICTs and content. Moreover, comparative studies of government intervention between countries, in particular between developed and developing countries, need to be discussed further because there are dissimilarities in institutional, economic and technological development.

The third cluster tends to emphasize the need to address social, political and cultural aspects of bridging the digital divide, not only market mechanisms. Several initiatives at country and regional levels, as well as international organizations, have also realized this issue. Consequently, the policymaker should design policies that integrate the needs and restraints of the users (McSorley, 2003; Mariscal, 2005; Mutula & van Brakel, 2006; Blackman, 2007; Fuch & Horak, 2008; Hanafizadeh et al., 2009a; Helbig et al., 2009). Recommendations proposed by these studies are

therefore likely to urge the government to take greater responsibility for ensuring equitable ICT access and use after the market has functioned.

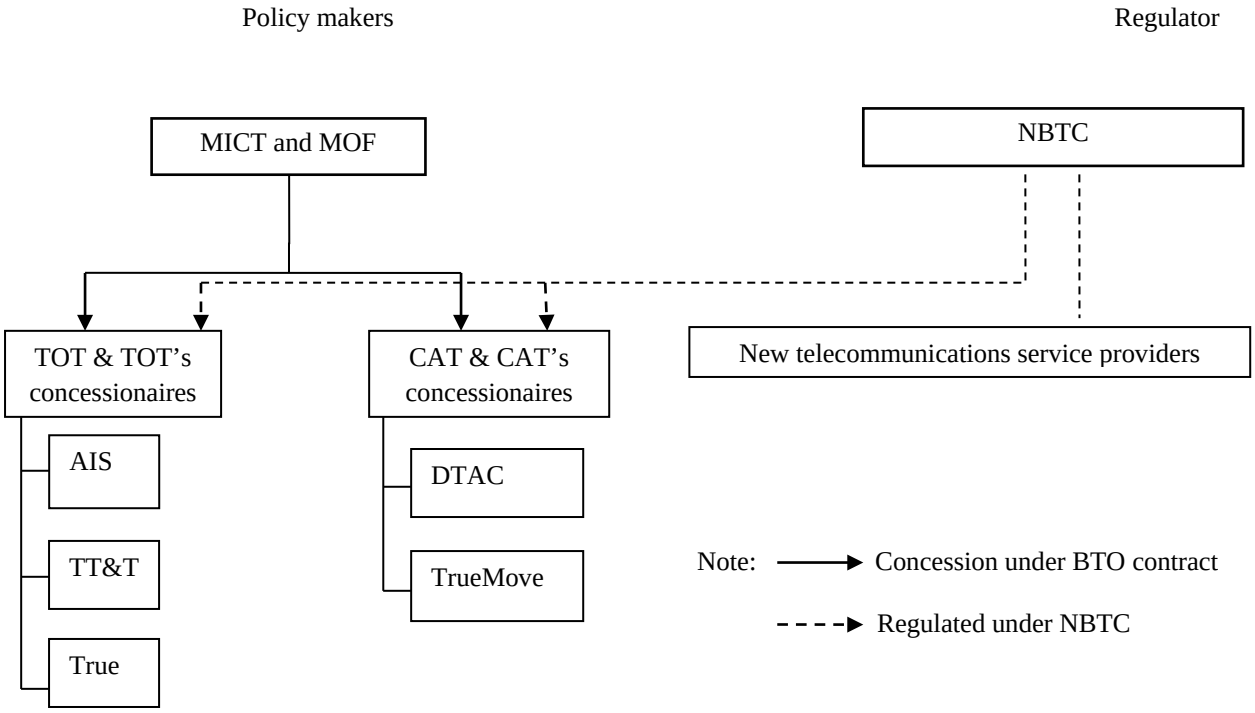
From the supply perspective, funding and supporting R&D in the country is a long-term initiative, but its need remains, in particular for developing countries (Azari & Pick, 2005). The introduction of localized technological innovations reduces technological dependency, makes the best use of the local endowments and provides major opportunities for taking advantage of new technological systems. A parallel effort to change the structure of relative prices may help in reducing the production costs (Antonelli, 2003). Similarly, Hollifield and Donnermeyer (2003) propose encouraging locally owned businesses to adopt information technologies as a means of maximizing local diffusion and increasing demand. From the demand perspective, the government can provide support to socially diverse groups. For example, it can encourage the development of a wide range of interesting local content and high quality of services in the community to which these groups belong (Gebremichael & Jackson, 2006; Akca et al., 2007; Billion et al., 2009). This may increase the perceived value of ICTs and, consequently, raise the proportion of ICT adoption. Moreover, improving institutional strength and aid effectiveness seems to be essential to bridging the digital divide. Notably, the improvement in educational conditions would provide an important catalyst for sustainable digital progress (Quibria et al., 2003; Wijers, 2010). Policy decisions should aim to reduce inequalities in access to and use of ICTs, and they must take into consideration the necessary investment in training and support (Hargittai, 2002; Freese et al., 2006; Hargittai & Hinnant, 2008). Hence, the ideas of this group strengthen the view that efforts to bridge the digital divide should not only pay attention to technological development and innovations. Rather, policymakers should holistically address matters of improving the human capital of a global society. Focusing on social, educational, diversity and skill aspects in the context of technological change will be beneficial for all stakeholders as these factors may affect economic development and country competitiveness in the long run. This may suggest that a combined policy is the current trend in digital divide policies.

3. AN OVERVIEW OF THE TELECOMMUNICATIONS MARKET AND DIGITAL DIVIDE IN THAILAND

This chapter is in three parts. The first presents the background of the Thai telecommunications market. The second illustrates the current situation of the digital divide in Thailand. The third section describes the legal instrument related to the digital divide.

3.1 The Thai telecommunications market

The telecommunications framework in Thailand is administered under three main laws: the 2007 Constitution, the Frequency Allocation Act (2010) and the Telecommunications Business Act (TBA) B.E. 2544 (2001) (with the 2006 amendment). As illustrated in Figure 5, the Ministry of Information and Communication Technology (MICT) is primarily responsible for setting national telecommunications and ICT policy and promulgating telecommunications and ICT development plans. The Ministry of Finance (MOF) is a major shareholder of state-owned enterprises (SOEs) while the NBTC is empowered to prescribe rules and regulations as well as promote fair competition among operators in the telecommunications market.



Source: Adapted from Srinuan (2011)

Figure 5. Current structure of Thailand's telecommunications market

In the past, telecommunications services in Thailand were monopolized by two SOEs: TOT Public Company Limited (TOT, formerly the Telephone Organization of Thailand), the monopoly provider of domestic telephony, and CAT Telecommunication Public Company Limited (CAT, formerly the Communications Authority of Thailand), which had a monopoly right over the international gateway services. Significant development of the Thai telecommunications began in the late 1980s with the initiation of a Build-Transfer-Operation (BTO) concession. Under these agreements, a private company was allowed to build a network and transfer ownership, but it had to operate the service through the revenue-sharing arrangement. This revenue-sharing agreement was contracted with TOT and CAT. In return, private enterprises were granted the right (15-30 years of exclusive right) to use

these networks to provide the public with services and share revenue returns from their operations with relevant state enterprises (Srinuan, 2011).

Under the BTO concession, a number of private service providers have been granted a concession from TOT and CAT. In fixed telephone services, two private service providers - True Corporation and TT&T Public Company Limited (TT&T) - have been granted a concession from TOT to provide fixed telephone service. TOT provides services to all provinces, True only provides fixed-line service in the Bangkok metropolitan area and TT&T serves provincial areas. Fixed-line subscribers have been decreasing since 2008 in Bangkok's metropolitan and provincial areas. In mid-2011, TOT dominated the fixed-line market with a market share of 58.95%, with True and TT&T having 27.53% and 13.52% of the total market share respectively (NTC, 2011). A major regulatory concern relating to the concession contract is that the regulator has no authority to regulate the concessionaires directly since the private service providers are protected, as stated in the BTO contracts. The regulator can therefore only regulate the concessionaires indirectly through SOEs.

In mobile service, Advance Information Service Public Company Limited (AIS) is the largest mobile phone company with 43.41% of the market share in mid-2011 (NTC, 2011). AIS was granted the concession from TOT to provide mobile service and operate services at 900 MHz from 1990. Total Access Communication Public Company Limited (DTAC) and TrueMove (formerly TA Orange) are the second (30.43%) and third (24.07%) largest mobile service providers that have been granted a concession from CAT since 1991 and 2002 respectively. In the following year, Hutch CAT wireless Multimedia (Hutch), which is a joint venture with Hong Kong-based Hutchison and CAT, entered the market by introducing CDMA technology (Bangkok Post, 2002). Hutch mainly serves 25 central provinces including Bangkok. It is acquired all the shares by Real Future Co., a True subsidiary, in January 2011 (Bangkok Post, 2011). The last mobile network operator has been Thai Mobile. It was a joint venture company between TOT and CAT and entered the market in 2004. TOT and CAT agreed to terminate the joint venture agreement on the mobile phone services project from September 30, 2008. All assets, rights and duties of the Thai Mobile Joint Venture were transferred to TOT as of September 29, 2008 (Srinuan, Srinuan & Bohlin, 2012). It is now solely owned by TOT and has been renamed TOT3G. Compared with fixed-line service, the mobile phone service is more competitive, with more private service providers, and competition on price and quality of service is widely seen in the market.

All international service, including Internet service in Thailand, shares the same history as fixed telephone service. They were monopolized by CAT. From 1995 to 2004, Internet service was provided through joint agreements between the Internet Service Providers (ISPs) and CAT. These joint agreements imposed the same criteria on all ISPs: 32% of the shares in ISPs must be held by CAT without real investment (Suriyasarn, 2002). All ISPs also had to lease an international circuit from CAT with that part of the value chain also monopolized by CAT, and all the equipment had to be transferred to CAT after the agreement ended. The situation for Internet connections in fixed networks and IIG was gradually liberalized until 2005, though the major ISPs were still the main fixed telephone service providers or subsidiary firms. NTC (2011) showed that True Internet had 36% of the market share of high-speed Internet service, followed by TOT (34.42%), 3BB (26.47%) and others (3.12%).

Thailand's telecommunications market has gradually been liberalized since 1997 in order to comply with the WTO Agreement on Basic Telecommunication Services. The commitments identified concerned competition and the market liberalization policy and were scheduled for completion by 2006. To conform to the WTO requirements, the Thai government approved the Telecommunications

Development Master Plan in 1997. The Master Plan provides for the privatization of TOT and CAT, converting the BTO concessions into operating licences, opening up the telecommunications market to competition through a step-by-step liberalization process, and establishing the NRA along the principles set forth by the WTO.

With regard to the establishment of the NRA, the 1997 Constitution laid the framework for a new telecommunications and broadcasting regulatory regime in Thailand. The cornerstone of the new regime was the establishment of two independent regulators: the National Telecommunication Commission (NTC) and the National Broadcasting Commission (NBC). The NTC would regulate the telecommunications industry while the NBC would regulate the broadcast media industry. The NTC and NBC were to be jointly responsible for frequency allocation, and this was to be formally constituted by way of a joint committee. However, the NTC, which was originally expected to be in place by the end of 2000, was finally established in 2004, whereas the NBC is still not in operation, as the process involves extremely contentious issues and numerous delays.

During 2000-2005, TOT and CAT transformed into TOT Corporation Public Company (later changing to TOT Public Company Limited) and CAT Telecommunication Public Company Limited under the State Enterprise Corporatisation Act B.E.2542 (1999). All business, rights and obligations, assets and liabilities related to the telecommunications of these two organizations were transferred to the newly established company. The government planned to privatize TOT and CAT in 2006 by listing them on Thailand's stock exchange according to WTO's specification. The shares of state enterprises have not been distributed to the public however. Privatization remains delayed because many actors have been circumspect about privatization. They include politicians, the public, some academics and journalists, and most importantly their employees. In this regard, TOT and CAT remain a state enterprise in which the Ministry of Finance is the sole shareholder according to the State Enterprise Fund Act B.E. 2542 (1999). The Act states that even if TOT and CAT have corporatized their organization, although the shares have been not distributed to the public, the management and investment decisions still depend on the Cabinet.

An exclusive monopoly right by TOT and CAT to provide telecommunications services in Thailand was replaced by the Telecommunications Business Act (TBA) B.E. 2544 (2001). Since the monopoly right was given under the Telegraph and Telephone Act B.E. 2477 (1934) and the Telegraph and Telephone Act (No. 2) B.E. 2517 (1974), the TBA 2001 has replaced previous acts, which implies that the monopoly right has been revoked. TOT and CAT have to give up their regulatory power to become only telecommunications service providers. Other legislation that governs the telecommunications market is the Act on Organization for Allocating Spectrum and Radio and Television Broadcasting Supervision and Telecommunication Businesses B.E. 2543 (2000) or the Frequency Allocation Act.

The Frequency Allocation Act (2000) and the TBA (2001) both provide new regulatory frameworks, including a licensing scheme for the completion of liberalization. Telecommunications operating licences Types 1 and 3, and the Internet service Type 1 were granted to TOT and CAT by the NTC in accordance with the operation of the TBA (2001). Many licences have also been issued by the NTC in the last seven years, as shown in Table 2. Most of the granted licences are Type 1, which is non-network services, whereas the network-based services or Type 3 remain limited.

Table 2. Number of licences granted by the NTC during 2005-2011

	2005	2006	2007	2008	2009	2010	2011	Total
Type 1	2	7	18	17	26	31	29	130
Type 2	-	3	5	1	3	3	2	17
Type 3	2	4	8	2	3	-	4	23
ISP 1	18	14	8	15	17	11	12	95
ISP 2	-	1	4	3	4	-	1	13
ISP 3	-	1	1	-	1	-	-	3
Total	22	30	44	38	54	45	58	281

Source: NBTC

Note: Licence authorizations in Thailand are categorized as Type 1, Type 2 and Type 3 for telecommunications and Internet service. Type 1 licences are granted to operators that provide services without their own networks. Type 2 licences are granted to operators that provide services either with or without their own networks but only when the services are intended for use by a limited group of people or have no significant impact on competition, public interest or consumers. Type 3 licences are granted to operators that provide services with their own networks that are intended for use by the general public or may impact competition, public interest or consumers.

In liberalizing the telecommunications industry, the NTC relaxed the foreign investment restriction imposed on foreign entities owning telecommunications facilities or operating telecommunications services through the Telecommunication Business Act in 2006. On 23 January 2006, the TBA 2001 (amended in 2006) became effective, raising the limit on foreign holdings in telecommunications companies to 49% from 25%. Several overseas companies have therefore taken strategic stakes, directly and indirectly, in Thailand's telecommunications companies. They include Temasek Holding (Singapore), Norway's Telenor, Hong Kong's Hutchison, France's Orange and the US's Verizon. In 2008, AIS and DTAC were owned to more than 49% by Temasek Holding (Singapore) and Norway's Telenor, both direct and indirect shareholders in the mobile service market. The slow pace of reform has led to a reduction in investors however. Orange and Verizon have divested their stakes, while Hutchison found the conditions difficult and was acquired by the True subsidiary later in 2011, as there was intense competition in the mobile market, and TOT continues to dominate the market in fixed-line service.

The 1997 Constitution was abrogated by an Interim Constitution on October 1, 2006 as a result of an army-led coup on September 19, 2006. The new Constitution B.E. 2550 (2007) became effective on August 26, 2007. The Constitution of 2007 specifies that the allocation and assignment of frequencies is to be managed by a single agency, namely, the National Broadcasting and Telecommunications Commission (NBTC), which was to be established by an amendment to the Frequency Allocation Act B.E. 2553 (2010). The NBTC is responsible for regulating and mapping out the master plans on frequency management, radio and television broadcasting services, and the telecommunications business. It is also required to allocate frequencies and give licences for radio, television and telecommunications service.

The issuing of 3G licences, which was prepared by the NTC during 2009-2010, has been officially stalled by the Supreme Administrative Court. The Supreme Administrative Court decreed that the NTC did not have authority to issue the 3G licence in September 2010 as the NBTC had constitutional responsibility for the auctions, not the NTC. The 3G auction may be delayed until 2012 or even longer and this may hamper network deployment by mobile operators and impede the growth of mobile Internet adoption. However, major mobile operators managed to launch 3G services in 2011. For

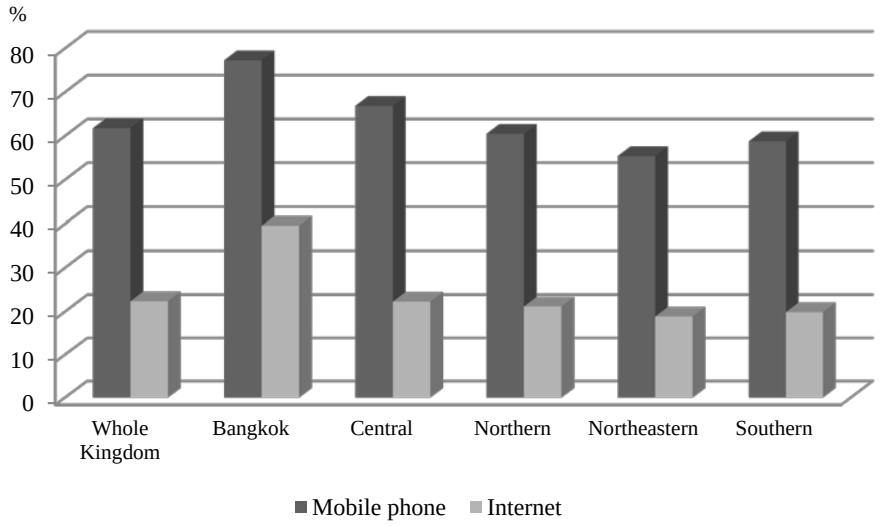
instance, AIS launched 3G-900 MHz and signed an agreement with TOT to use 3G-2.1 GHz for data services. Real Move, a subsidiary of True Corp, is jointly providing 3G services with CAT at a spectrum of 800 MHz for 14.5 years. DTAC has also managed to launch 3G services on the 850 MHz band in spite of protests from CAT (The Nation, 2011). Mobile operators will compete fiercely on both voice and data packages in the near future.

Telecommunications services in Thailand are coming to a transition, following the enforcement of the Frequency Allocation Act (2010) and the establishment of the NBTC. According to the Frequency Allocation Act (2010), which took effect in December 2010, 11 NBTC commissioners will be selected by the Senate and the selection process completed within 180 days of the enforcement of the law. In October 2011, the NTC was officially replaced by the NBTC. The NBTC assumed the NTC's responsibilities including the production of master plans (the Telecommunication Master Plan 2012-2016, the Spectrum Management Master Plan, the Broadcasting Master Plan and the Universal Service Obligation (USO) Master Plan). Moreover, most of concession agreements between SOEs and private operators in Figure 5 will have expired by 2013-2018, after the process of converting the concession has been debated for years. The first concession to expire is the BTO agreement between TrueMove and CAT in 2013, and it will be followed by AIS, True and DTAC in 2015, 2017 and 2018 respectively. This will bring about a significant change in the Thai telecommunications market.

3.2 A survey of the digital divide in Thailand

As elaborated in previous section, the digital divide should be defined in terms of access to and use of ICTs and it can exist in a particular country and between countries (Norris, 2001; OECD, 2001). The NTC (2010) shows that in Thailand, fixed telephony per 100 inhabitants is lower (10.50%) than in European countries (40.30%), America (28.10%) and the Commonwealth of Independent States (CIS) (26.6%). Moreover, the Thai fixed-line penetration rate is below the world average (17.10%) and that of Asia and the Pacific region (14.00%). The fixed line penetration rate in Thailand has declined over time since 2003 due to the limited availability of fixed lines and fixed-mobile substitution. These reasons have also been a barrier to the uptake of fixed broadband in the Thai telecommunications market. At the end of 2010, fixed Internet broadband penetration in Thailand was about 4.10%, while the averages for Asia and the Pacific region, and the world were 5.70% and 8.00% respectively. On the contrary, mobile telephony is experiencing growth in number of subscribers. The mobile penetration rate in Thailand (105.00%) was well above the average of Asia and the Pacific region (67.80%) and the world (79.40%) in 2010. This evidence indicates that the digital divide between Thailand and other countries clearly exists.

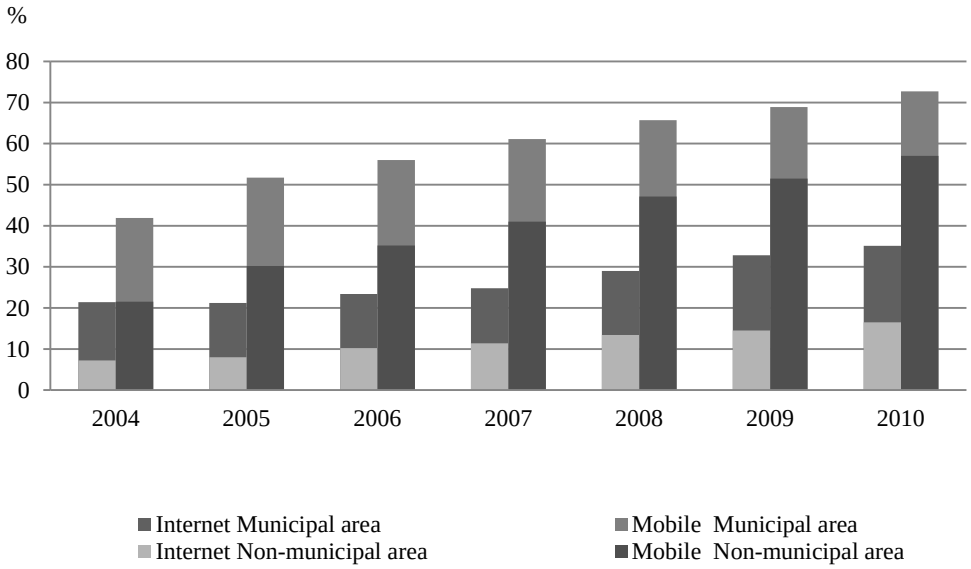
As discussed about the digital divide: there is digital divide within a country, or social divide. The NSO survey in 2010 (NSO, 2011) found that although the proportion of ICT access and use of ICT in Thailand had and was continuing to increase, there were gaps in ICT access and use of ICT between Bangkok's metropolitan area and other regions, and between municipal and non-municipal areas. Figure 6 shows that the disparity between Internet users in Bangkok and other regions is higher than for mobile subscribers in these two areas. Specifically, the proportion of mobile subscribers in Bangkok's metropolitan area is 77.3% and in the regional area 55-67%. In contrast to Internet users, Bangkok has 39.60% of Internet users, followed by the Central region (22.30%), the Northern region (21.20%), the Southern region (19.90%) and the Northeast region (18.90%).



Source: NSO (2011), Thailand

Figure 6. Percentage of the population aged 6 and over using a mobile phone/Internet by region

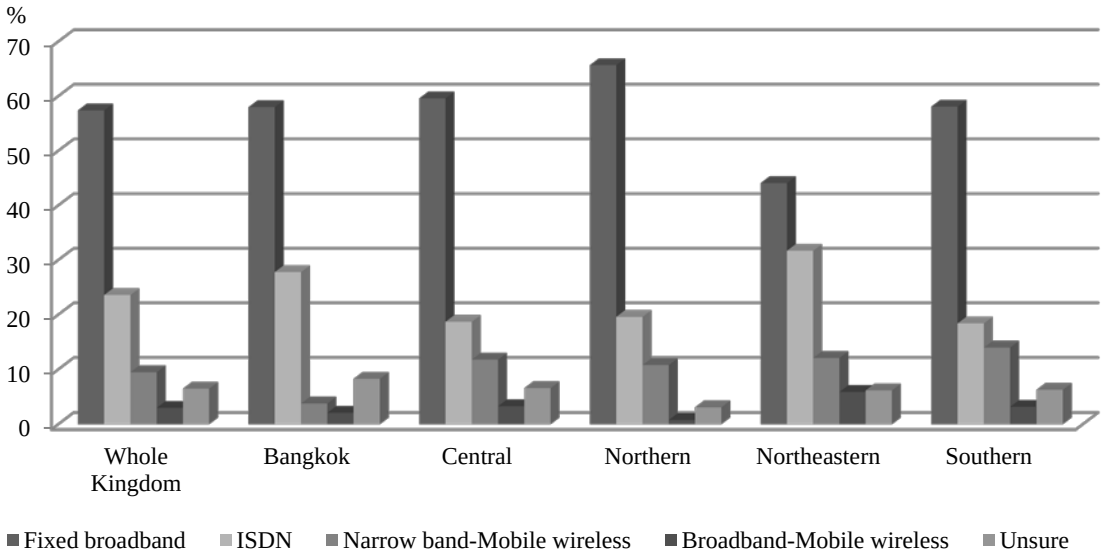
Figure 7 presents the proportion of mobile phone users by area. In the municipal area it was 72.70%, and the proportion of Internet users was 35.10%. While the proportion of mobile phone users in the non-municipal area was 57.00%, the proportion of Internet users was 16.50% at the end of 2010.



Source: NSO (2011), Thailand

Figure 7. Percentage of the population aged 6 and over using a mobile phone/Internet by area

As presented in Figure 8, the digital divide is likely to remain a major problem in Thailand, especially Internet uptake. There are at least four main types of Internet access. The majority of Thai households has access through fixed broadband, at 57.40%. Next is narrowband, which includes ISDN (23.60%) and mobile wireless 2G and 2.5G (9.5%), and broadband mobile wireless such as CDMA (3%).

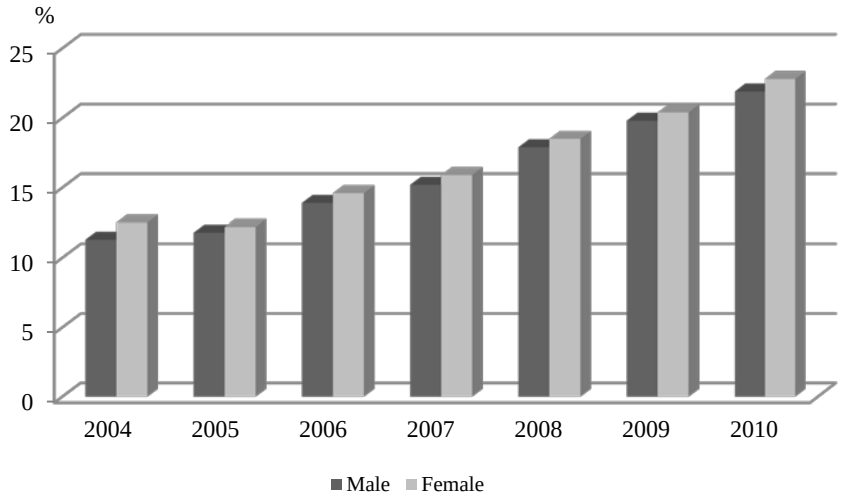


Source: NSO (2011), Thailand

Note: Fixed broadband refers to Internet service via DSL, cable modem, leased line, satellite Internet, fibre optic cable, fixed wireless and WiMAX. The user can communicate with high-speed bandwidth starting at 256 Kbps. Integrated Services Digital Network (ISDN) is a type of Internet connection using a modem dial-up connection. Narrowband-Mobile wireless refers to using mobile phones 2G and 2.5G, such as GSM, CDMA and GPRS, while broadband wireless accesses the Internet via mobile 3G phones such as CDMA.

Figure 8. Percentage of households that have access to the Internet by type of Internet access services and region

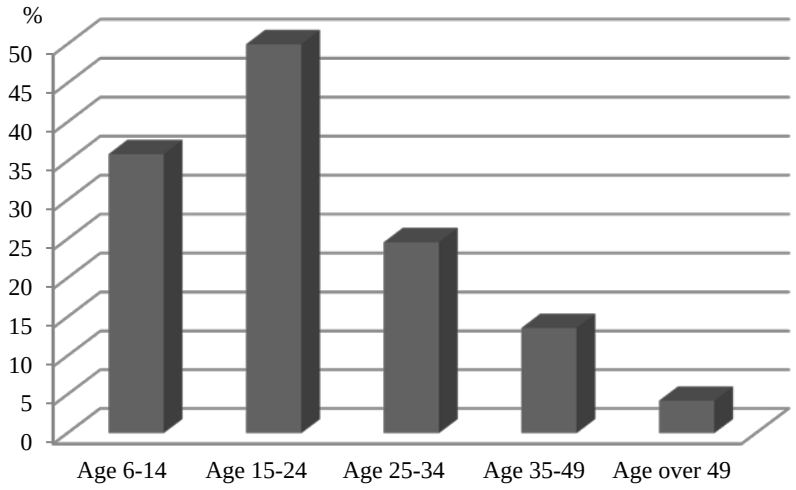
Figure 9 shows that there is no difference in the proportion of males and females using the Internet. The percentage of males using the Internet is 21.90% and of females 22.80%.This indicates that there is a narrow gender gap in terms of Internet use in Thailand.



Source: NSO (2011), Thailand

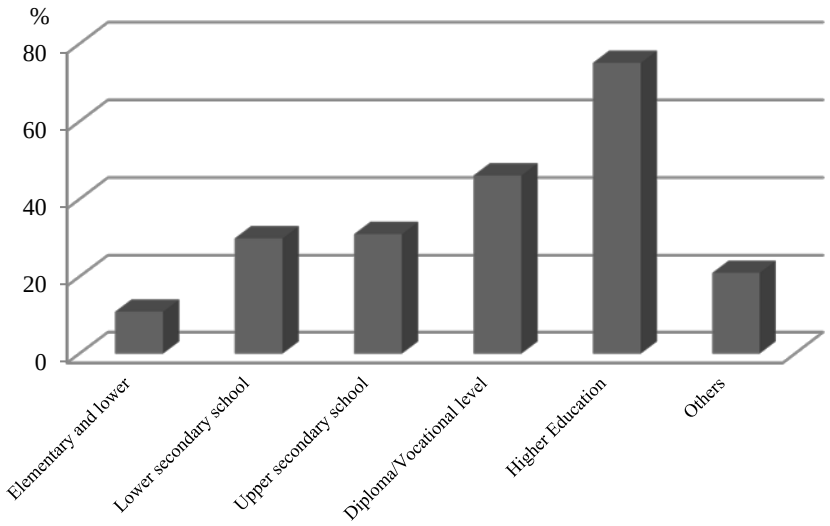
Figure 9. Percentage of the population aged 6 and over using the Internet by gender

Figure 10 shows an inverted U-shape by age group, with Internet use initially increasing and then decreasing as the population ages. Of the Internet users, 35.90% are aged 6-14, followed by the population aged 15-24 who use the Internet most at 50.00%. Internet use continuously declines, however, as the population ages. A large percentage of the population with elementary and lower levels of education does not use the Internet. Internet use increases if the population has higher education, as shown in Figure 11.



Source: NSO (2011), Thailand

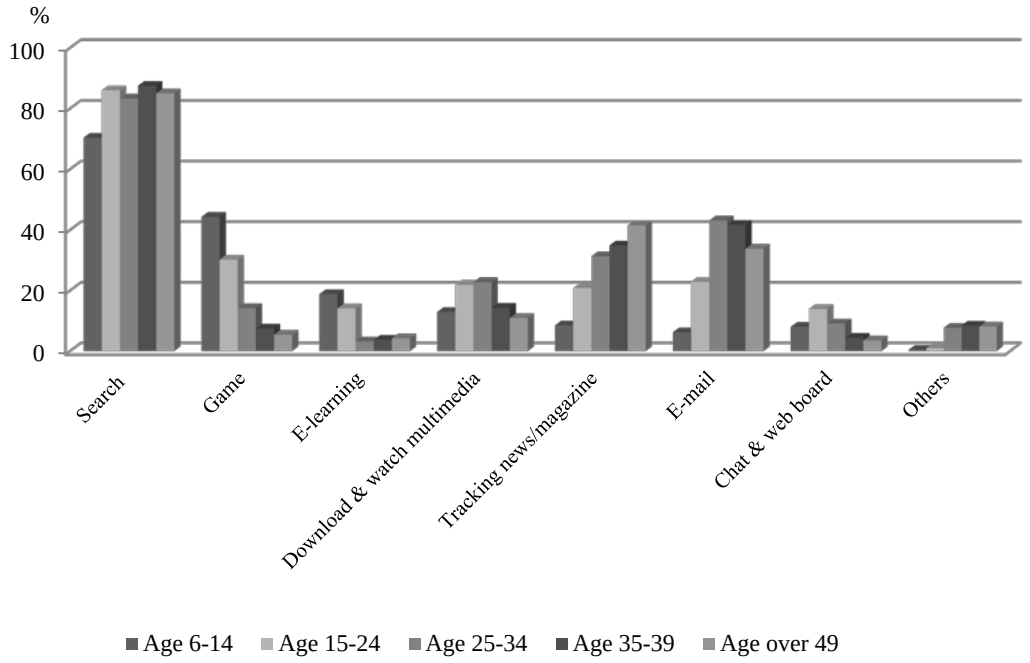
Figure 10. Percentage of the population aged 6 and over using the Internet by age



Source: NSO (2011), Thailand

Figure 11. Percentage of the population aged 6 and over using the Internet by education level

In terms of Internet activities, searching for information is a frequent activity by Internet users in every age group. The population aged 6-14 use the Internet for gaming and e-learning most, at 44.30% and 18.80% respectively. E-mail, downloading and watching multimedia, and tracking news are frequent activities for other age groups as shown in Figure 12.



Source: NSO (2011), Thailand
Note: Others included purchasing or ordering goods or services, using e-government services, Internet banking, voice over Internet protocol (VOIP), etc.

Figure 12. Percentage of the population aged 6 and over using the Internet by activity/age group

Figures 6-12 show that a digital divide exists in Thailand. This may result from insufficient supply and demand. For example, people who live in urban or municipal areas may have a better infrastructure that leads to higher access and use of the Internet compared with those who live in rural areas. One of the factors stems from current concession agreements and lack of interest in supplying service at the current market price. The demand side also reveals that there are groups of people that cannot access and use the Internet at the current price, particularly people with a low level of education and the elderly.

Although it is difficult to help people at every level and in every region of the country to gain access to the Internet and use the Internet in the short term, the government and NRA have tried to fix the digital divide through projects and regulations to reduce this gap, including through the universal service obligations (USO). Before the establishment of the NTC in 2004, many universal service projects were implemented by SOEs-TOT and CAT. They include the rural long distance public phone project, support for distance learning via satellite, public telephones for the disabled, the Schoolnet computer project for Thai schools, Internet Tambon[3], donated computers and ICT computers for the Thai people project. These universal service projects have created significant deficits for both SOEs as they are not profitable. TOT and CAT also had to use revenues from their monopoly services to cross-subsidize their losses.

3.3 Legal instruments relating to the digital divide

The TBA provides a framework for universal service provision by setting up a Universal Service Fund (USF) that can be distributed for the USO. Sections 17 and 18 of the TBA state that the NRA has a duty to administer the USO for basic telecommunications service and the power to prescribe a USO

[3] Tambon is a local government unit below the district and province.

licensee to provide telecommunications services in rural areas or low return-on-investment areas and for specific target groups (e.g. educational institutions, religious institutions, medical institutions and other social assistance agencies). If the USO licensee is unable to provide the telecommunications service as prescribed by the NRA, the licensee needs to allocate a certain portion of its income from the supply of telecommunications service to the Telecommunications Development for Public Benefit Fund under the Frequency Allocation Act (2000), Section 56. The goal of the USO in Thailand is characterized by the availability, accessibility and affordability of telephony and the Internet. Based on Sections 17 and 18 of the TBA, the USO telecommunications projects can clearly be used to promote the development of telecommunications services with non-discriminatory access and wired-spread affordability services in Thailand.

Since August 2005, the NTC has issued a Notification on the Criteria and Procedure for the Provision of Universal Basic Telecommunications and Social Services (2005) and Criteria and Procedure for the Provision of Universal Basic Telecommunications and Social Services No. 2 (2009). All network licensees have an obligation of universal service of telecommunications under these notifications. The licensees have two alternatives: to be a USO provider responsible for all costs incurred from its investments without any financial subsidy from the NTC or to contribute 4% of its revenue to the USF to finance providers interested in serving remote, rural areas and disadvantaged people, if they prefer not to be a USO provider. TOT and CAT have agreed to provide service in unserved rural areas or public places such as educational institutions, schools and hospitals in lieu of contributing to the USF, while other licensees have had to make financial contributions instead.

To safeguard the benefits of the consumer, the NTC set out certain universal service goals for the licensee to achieve, for example, the installation of at least two public phones per village and at least two fixed lines or public phones in educational institutions, hospitals and other social service organizations, and the provision of free telephone cards for disabled persons, those on low incomes and the elderly. At the end of 2010, the NTC announced a Notification on the Implementation Plan for the Provision of Universal Basic Telecommunications and Social Services. Each targeted village in a rural area will have at least one public telephone, each targeted educational institute will have at least one fixed telephone and one public telephone, and an Internet centre will be set up for each village, as specified by the NTC.

The Telecommunications Development for the Public Benefit Fund was changed to Broadcasting and Telecommunications Research and Development Fund for the Public Interest under the Frequency Allocation Act (2010), Section 52, in 2010 after the NTC was transformed into the NBTC. The fund will be used to support and develop broadcasting and telecommunications industries, protect consumers and support community services. The start-up fund will be allocated by the government and other sources (e.g. money from a spectrum auction). The fund management committee has duties and powers in the management of the fund and provides recommendations on the fund allocation to the NBTC for its approval. Moreover, the NBTC finished the draft USO master plan at the end of 2011. The plan aims to cover 90 per cent of the populated areas with broadband networks within five years. This shows that the NBTC as the regulator has recognized the problem of the digital divide. However, the regulations that have been implemented by the NBTC are still at the initial stage. There may be some challenging issues for the NBTC to overcome, for example, identifying the universal service area, the amount of subsidies needed, the funding mechanism and efficiency of the funding. These concerns may require strategic considerations from both the NBTC and the government.

4. METHODOLOGY

4.1 Collected data

The data come from primary and secondary sources. The survey data were provided by the NTC. The ITU and the World Development Indicators Database (WDI) are the main sources of the sector and macroeconomic data. The data on financial information for each of the selected firms come from the mobile telecommunications sector in DataStream and its websites.

The sample included 15 countries in Asia: Brunei, Cambodia, Indonesia, Laos, the Philippines, Malaysia, Myanmar, Thailand, Singapore, Vietnam, Japan, Hong Kong, the Republic of South Korea, Taiwan and Thailand. The study period ran from 1990 to 2010. Different sample and study periods vary depending upon the objective of the appended papers.

4.2 Reflection on applied methodology

To answer the research question, the analysis in the research in this thesis is based on positivism in epistemology. According to Smith (1998), an epistemological issue concerns how to begin to understand the world and communicate this as knowledge to other human beings. Positivism characterizes epistemologies that seek to explain and predict what happens in the social world by searching for regularities and causal relationships between its constituent elements. Anti-positivism, on the other hand, states that the social world is essentially relativistic and can only be understood from the point of view of the individuals who are directly involved in the activities that are to be studied (Burrell & Morgan, 1979). On this basis, the concept of positivism fits the approach of this thesis better than anti-positivism, since the thesis aims to present the causal relationships of phenomena by measurable properties that are independent of the researcher and a tool for data collection. This implies that the researcher pursues some form of investigation without interfering with the phenomena being studied. The phenomena should be isolated and observations should be repeatable.

From the ontological perspective, the thesis is based on objectivism. Knowledge is obtained through the highly successful methods of the natural sciences to investigate social science phenomena. It rests on the belief that scientific knowledge connects directly with reality (Burrell & Morgan, 1979). The objectivist paradigm also provides the theoretical basis for quantitative research. For example, the telecommunications markets, telecommunications providers and users can be discussed as tangible objects and the digital divide as a social phenomenon.

In terms of research strategy, this thesis is concerned with a quantitative strategy, collecting numerical data and using research methods to focus on, for example, quantitative analysis and surveys. The relationship that is examined between theory and research can be considered deductive (Bryman & Bell, 2007). In particular, this thesis tends to specialize in quantities in the sense that numbers come to represent values and levels of theoretical constructs and concepts, and the interpretation of the numbers is viewed as strong scientific evidence of how a phenomenon operates.

As illustrated in Figure 13, the research process in this thesis is linearity since it is associated with the deductive research approach. The research process starts from a survey of pre-existing knowledge and literature in order to identify the research gap and formulate the research question. The literature review is an integral part of the whole research process since it helps to understand the subject area better and is a tool to contextualize research findings at the end. The research objective is formulated after the research problem is identified. Based on the research objectives, the hypotheses were constructed to enable the study to be framed, as these hypotheses provide information on which data to

collect and not collect. The hypotheses are set up based on observation and existing knowledge. The research problem, objective and hypothesis are formulated in each appended paper, while the main research problem, objective and hypothesis in the cover paper of this thesis are elaborated on more after the licentiate thesis.

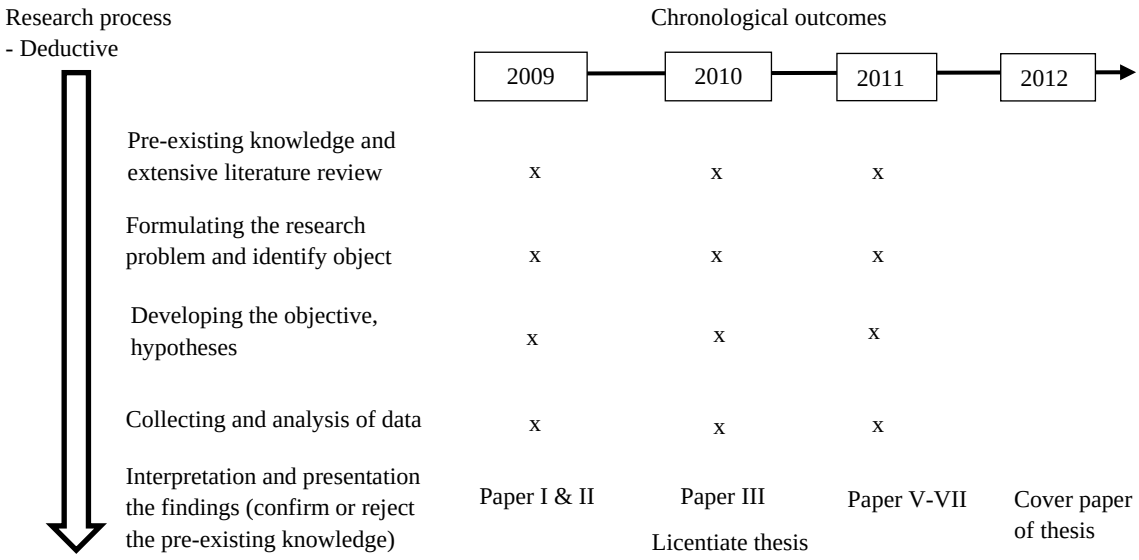


Figure 13. Research process in this thesis (adapted from Bryman, 1989; Bryman & Bell, 2007)

The preparation of the research design starts after the hypothesis is set. This step of the research process involves the method of data collection and data analysis. Two types of data were used in the thesis: the survey data and the secondary data from official sources. As mentioned in Section 3.1, the survey data were provided by the NTC. The survey was designed for a generic purpose, which is not always relevant to the underlying assumption in this study; a thorough review and confirmation are performed before using the data set. The survey was conducted as a nationwide face-to-face interview-based survey. The respondents were asked to supply information on their individual use of telecommunication means, including fixed telephony, mobile telephony and the Internet, as well as some other questions related to their socio-economic background and household. The rate of response was 72.32% of the total number of questionnaires distributed, which is high. Moreover, the official statistics are gathered from the ITU, the WDI, DataStream and websites of service providers. The survey and secondary data are publicity accessible on official request. Data credibility and reliability are therefore not an issue.

This thesis uses different data analysis approaches in different papers that are chosen mainly based on the research question/aims of each paper. Each approach is described in detail in each of the appended papers. The major approach in this thesis is econometric analysis. In econometric analysis, the concept is examined and tested through clear delineation of indicators that are observable and clearly defined. Testing of relationship between variables is achieved through an appropriate statistical test. This process can be replicated, and the issue of validity is therefore unquestionable for the measurement procedure. The final research process is interpreting and presenting the results. All findings are revealed and discussed whether the pre-existing knowledge is confirmed or rejected. This implies a process of deductive study. The summaries of method and data collection related to each study are described in Table 3.

Table 3. Summary of methodological choices in the appended papers

Papers	Research objective	Sources of data and period of study	Unit of analysis	Method
I	Examine whether a digital divide exists between developing countries and examine determinants of this digital divide in ASEAN countries.	ITU database (1995-2005)	ASEAN Countries (Brunei, Cambodia, Indonesia, Laos, the Philippines, Malaysia, Myanmar, Thailand, Singapore, Vietnam)	Econometric modelling-panel regression model
II	Empirically examine the effect of entry relaxation on the performance of mobile phone firms and the role of NRA in Asian countries.	ITU database, WDI database, DataStream and websites of companies (1990-2007)	Countries and Firms (Indonesia, Malaysia, Thailand, Singapore, Japan, Hong Kong, and the Republic of South Korea)	Econometric modelling-panel regression model and two-tailed Wilcoxon signed-ranked test
III	Examine the private costs of delaying privatization of TOT Public Company Limited, a state-owned enterprise telephony carrier.	Database of the NTC and the company' s annual reports (2002-2008)	Firm (Thailand)	Discounted cash flow analysis and sensitivity analyses
IV	Investigate the winners' curse in 3G auctions in Asian countries.	DataStream (2002-2006)	Firms (Hong Kong, Singapore, Taiwan and Indonesia)	Event study
V	Examine the determinant factors that can explain the digital divide phenomenon in Thailand.	Survey data were provided by the NTC (2010)	Individual (Thailand)	Econometric modelling-probit model
VI	Examine the key drivers of and barriers to fixed broadband access and use in Thailand.	Survey data were provided by the NTC (2010)	Individual (Thailand)	Econometric modelling-bivariate probit model
VII	Examine the determinant factor for mobile Internet adoption in Thailand .	Survey data were provided by the NTC (2010)	Individual (Thailand)	Econometric modelling- logit model

5. SUMMARY OF APPENDED PAPERS

This thesis is based on seven appended papers. In this chapter, the main findings from each paper will be presented briefly. These results will be developed further in the discussion.

5.1 Paper I: Digital divide in ASEAN countries: Explaining the gap

This paper examines the role of GDP per capita, urbanization, competition in the telecommunications market and the establishment of an independent regulator to explain the digital divide for a group of ASEAN countries. This relationship is analysed through econometric modelling with panel data (time series and cross-sectional data).

ASEAN countries are used as a sample of the developing countries to investigate the digital divide. The telecommunications services examined (fixed line, mobile phone and Internet) in ASEAN countries are spread unequally. All the data on the ASEAN countries are collected from the ITU database for the period 1995-2005. Only five countries have full competition (i.e. Indonesia, Malaysia, the Philippines, Singapore and Vietnam) and five have an NRA that is separate from the ministry or government (i.e. Indonesia, Malaysia, the Philippines, Singapore and Thailand). This information is an important factor in explaining and resolving the question of the digital divide. The digitization index for each country is introduced in order to present the level of digitization in three telecommunications services.

The first main finding is that the effect of income is positive, generating a higher digitization index. The second finding is that market competition has a positive relationship with the digitization index in ASEAN countries. This means that if market becomes more competitive, the digitization index increases. Thirdly, the urban population variable reveals that as more people live in the urban areas, the digitization index will increase. Thus, the digitization policy also depends on how governments implement the infrastructure sector on the road map of development programmes. Finally, the establishment of an independent regulator is not statistically significant, although it is positively correlated with the digitization index. The result suggests weak support for the idea that the existence of an independent regulator will promote the digitization index.

5.2 Paper II: Entry relaxation and an independent regulator: Performance impact on the mobile industry in Asia

The primary objective of this study is to determine whether entry relaxation impacts the performance of the mobile sector. Entry relaxation is part of liberalization in the telecommunications market. The relaxation should reduce the barrier to entry, leading to more competition in the affected market. The study also considers the establishment of the NRA prior to entry relaxation. The expected results would suggest that establishing a regulatory body before entry relaxation should yield greater improvement and investment in the mobile phone sector because of the greater transparency of regulation, and it should allow for non-discriminatory treatment among mobile operators. A second objective is to investigate whether the entry relaxation affects firm performance. Performance is measured by profitability, efficiency, output, employment and leverage. Since entry relaxation can foster competition and new entrants, the expected results would suggest that the incumbent firm performance would be worsened by the relaxation of entry.

To test the effect of entry relaxation on the sector and firm performances, the International Telecommunication Union (ITU) compiles sector data on mobile phone teledensity, GDP per capita, trade openness and competition. The data for trade openness come from the World Development Indicators Database (WDI). The data on financial information for selected firms come from the mobile

telecommunications sector in DataStream and its homepages. The sample includes 14 incumbent carriers from 7 countries, which consist of Japan, Hong Kong, the Republic of South Korea, Singapore, Malaysia, Indonesia and Thailand, liberalized over the period 1990-2007. All the carriers are dominant providers of mobile service and listed on the stock markets.

Econometrics is employed in order to determine the effect of entry relaxation on sector performance. The two-tailed Wilcoxon signed-rank test is also used in order to assess the significance of performance changes of carriers.

The relationship between mobile penetration and macroeconomic variables - GDP and trade openness and regulatory variables, which include entry relaxation, competition level and the establishment of a regulatory body as dummy variables – was examined using an econometric model. The findings show that macroeconomic variables have a positive impact on mobile penetration. Moreover, the regulatory variables improve mobile penetration. The NRA plays a particularly important role in setting up a regulatory system outside government intervention in order to promote competition.

The results of the comparison pre- and post-entry relaxation also show that relaxation leads to shrinkage in financial and operating efficiency performance of incumbent listed firms in the selected countries even for developed countries. This implies that entry relaxation can create intense competition and affect the financial and operating performance of incumbent firms. However, entry relaxation does not affect the profitability of incumbent firms significantly in either developed or developing countries. It suggests that the incumbents try to prevent competition during the period of entry relaxation. To ensure a level playing field, regulation and regulatory monitoring will be needed. The government and regulator should prepare the market conditions by introducing laws and regulations in order to facilitate new entrants. The new entrants can then enter the market with fewer constraints.

5.3 Paper III: The private costs of delayed privatization of TOT Public Company Limited

This paper has analysed the impact of delayed privatization in the case of TOT from 2007 to 2011. While most countries experienced liberalization in telecommunications, Thailand delayed privatization. To address the private costs of a delay in terms of privatization, a counterfactual forecasting model has been constructed for the years 2007-2012. The starting year of the evaluation is 2006, as this year was the deadline for privatization under the WTO agreement. The forecasting model uses the traditional investment approach as well as scenario analyses. The traditional investment approach and sensitivity analyses provide similar results. Both show that the benefit of delaying the privatization process could be higher than if the WTO-agreed time process for TOT privatization were followed, as the growth of revenue sharing and from concessionaires would be higher than if TOT were privatized. There are no benefits in the long run, however, as the growth rate of revenue in the base case is lower than that in the privatization case, leading to a reduction in the present value of the base case over time; hence, the longer the delay in privatization, the slower the firm growth.

5.4 Paper IV: The third generation (3G) auction in Asia

This study examines the winner’s curse in the third generation (3G) spectrum auction for selected Asian countries during 2000-2006. The winner’s curse is the phenomenon that a winner will tend to overpay in an auction, potentially making the licence unprofitable. An event study has been employed as a method in order to assess the winner’s curse through the analysis of security prices of the firms involved in the auction. The cumulative abnormal return of the stock price post auction indicates whether the firm in question paid too much for the licence. The results reveal that there is a mix of positive and negative cumulative abnormal returns of winner firms. Most of the winner firms have a

negative cumulative abnormal return until the end of the auctions. After fourteen days, there are signs of rewards as the stock prices of the winning bidders increase. This finding indicates that the 3G licences in Asian countries face a very short term of the winner's curse. The short period of a negative abnormal return is obtained by the reduction in the reserve price and relaxation of the licensing condition by the NRA.

5.5 Paper V: What makes people go on line? An empirical analysis of the digital divide in Thailand

This study aims to investigate the determinant factors that can explain the digital divide phenomenon in Thailand. The updated survey data set from 2010 was provided by the NTC, and it applies to the econometric model estimating Internet access. The availability of fixed telephony, mobile telephony subscription and media familiarity is the crucial factor for encouraging people to access the Internet. Moreover, socio-economic background is an important factor, for example, age, level of education and area of residence. To bring off-line users into the on-line world, policymakers and telecommunications regulators need to take action on fixed, fixed wireless and wireless infrastructure development and provide education or training programmes.

5.6 Paper VI: Analysis of fixed broadband access and use in Thailand: Driver and barriers

The aim of this paper is to analyse the demand for fixed broadband in Thailand. Data obtained from a national survey in 2010 by the National Telecommunications Commission (NTC) of Thailand have been used for this analysis. The bivariate probit model has been employed to examine empirically whether accessibility to fixed telephony infrastructure, socio-economic variables and the area of residence have a systematic link to fixed broadband access in the first stage, and then, specific usage, provided access exists, is estimated. Based on the findings, the variables, together with their potential impact, are as follows: fixed infrastructure, income, gender, level of education age of consumer and residential area. The impact of these factors varies with the service (i.e video download, social network, searching and e-mail). The implications for NRA are to encourage competition through the infrastructure and to permit more competition in infrastructure development. This could stimulate the growth of fixed broadband access and use. The government or policy maker could also implement policies which reduce the access and usage gap, for example income subsidisation and training programme.

5.7 Paper VII: An analysis of mobile Internet service in Thailand: Implications for bridging the digital divide

Mobile Internet is growing around the world, bypassing the poor legacy of wired infrastructure, in particular, in developing countries. This growth can also be observed in developing countries like Thailand. To cope with this trend, this study attempts to provide guidance to the NRA by addressing the following question: What are the key determinant factors for an individual consumer to access mobile Internet? A discrete choice model is employed to examine empirically whether price, service, application attributes, socio-economic variables and service provider have a systematic link to the decision of the consumer. The data from a national survey in 2010 commissioned by the NTC are used for the analysis.

The results show that price, availability of fixed telephony, age and area of residence are recognized as the strongest determinants for mobile Internet adoption. The findings also suggest that mobile Internet could be an alternative technology to bridge the digital divide, as the group of people that does not have fixed Internet connection at home can connect via mobile Internet. The price of mobile Internet service is inelastic, however, which means that an increase in price has less effect on the propensity to

access mobile Internet. This is a result of the lack of competition in fixed connection, and it leads to a limited choice for the consumer. Telecommunications regulators and policymakers therefore need to consider policies such as increasing competition and infrastructure investment in order to stimulate growth of mobile Internet adoption and close the digital divide in Thailand.

The outcomes of the paper that are relevant to addressing the research questions are summarized in Table 4.

Table 4. Summary of research findings

Papers	RQ	Finding
I	What are the determinants of the digital divide in ASEAN countries?	The determinants of the digital divide in ASEAN countries are income, the establishment of the NRA, market competition and urbanization.
II	What is the effect of entry relaxation and an independent regulator on the performance of the mobile phone sector and firms?	Entry relaxation and the NRA have a positive impact on mobile penetration. Entry relaxation also has effects on the financial and operating performance of incumbent firms, but it does not affect the profitability of incumbent firms significantly in developed or developing countries.
III	What is the private cost of delaying privatization of TOT?	The value of delaying the privatization process could be higher than by following the WTO-agreed time process for TOT privatization since the growth of revenue sharing and from concessionaires is higher than if TOT were privatized and did business itself. However, the benefits do not exist in the long run.
IV	Does the winner's curse exist in the 3G spectrum auction in Asia?	The 3G licences in Asian countries face a very short winner's curse. The short period of a negative abnormal return is obtained by the reduction in the reserve price and relaxation of the licensing condition by the NRA.
V	What are the determinants of the digital divide in Thailand?	The availability of fixed telephony, mobile telephony subscription and media familiarity are the crucial factors encouraging people to access the Internet. Moreover, socio-economic backgrounds are important, for example, age, education and residential area.
VI	What are the key determinant factors to explain the probability that an individual consumer accesses and uses fixed broadband?	The variables with potential impact on access and use are fixed infrastructure, income, gender, level of education, age of consumer and residential area. The impact of these factors varies across broadband services (i.e. video download, social network, searching and e-mail).
VII	What are the key determinant factors for an individual consumer to access mobile Internet?	Price of mobile Internet, availability of fixed telephony, age and living area are recognized as the strongest determinants for mobile Internet adoption. The findings also suggest that mobile Internet could be an alternative technology to bridge the digital divide, as the group of people that does not have fixed Internet connection at home can connect via mobile Internet. The price of mobile Internet service is inelastic, however, which means that an increase in price has less effect on the propensity to access mobile Internet.

6. DISCUSSION AND IMPLICATIONS

This section discusses the findings from the appended papers. The relevant results from the studies are synthesized in this section in an attempt to provide answers to the main research question. The overall discussion of the results of the studies is divided into two parts. The first part focuses on the digital divide (at regional level and in Thailand) and its determinants. The second part focuses on the possibilities for bridging the digital divide in Thailand.

6.1 The digital divide at regional level and its determinants

Market liberalization (Paper I and II)

The results of Paper I show that the digital divide in Thailand exists at the regional level. Market liberalization in the ASEAN countries has created greater potential for ICT access through a promotion of sector expansion as a whole by raising the number of new entrants and giving them an opportunity to move into new markets for incumbents and new entries. Market liberalization and the establishment of the NRA also encourage foreign investment. In this case, consumers have an opportunity to benefit more from new telecommunications services after liberalization. At the same time, however, market liberalization can widen the digital divide due to the difference in the institutional structure, and economic and technological development between countries. Empirical evidence confirms this argument as shown below.

The problem of unequal access to telecommunications services among ASEAN member countries exists. The leading country for all services is Singapore. Apart from Singapore, there are countries leading in specific services, which also have a higher penetration rate than the ASEAN average. For example, Vietnam, Brunei and Malaysia are leading countries in terms of the fixed telephone and Internet penetration rate. In the mobile phone service, Thailand, Malaysia, Brunei and the Philippines have a higher mobile phone penetration rate than the ASEAN average at the end of 2007. On the contrary, Myanmar, Cambodia and the Lao People's Democratic Republic (Laos) have the lowest penetration rates for all services compared with other ASEAN countries.

The factors that are identified as being important are income (GDP per capita), establishment of an NRA, market competition and urbanization. These factors are in line with a number of previous studies (e.g. Wong, 2002; Fink & Kenny, 2003; Chin, 2005; Mariscal, 2005; Noh & Yoo, 2008; Yartey, 2008). Specifically, the Thai telecommunications market had partial competition in 2007 even after the establishment of the NTC. The mobile telephony and Internet market has gradually been liberalized while the market of fixed line service is monopolized by the SOEs. This may be one of the obstacles to the ICTs penetration rate in Thailand followed by some ASEAN countries.

Paper II provides the empirical findings, specifically for the mobile telephony market. This market was intensified after the Thai Telecommunication Act (2006) became effective. This Act raises the limit on foreign holdings in telecommunications companies to 49% from 25%. In 2008, AIS and DTAC were owned to more than 49% by Temasek Holding (Singapore) and Norway's Telenor respectively, as direct and indirect shareholders. This is similar to other countries in the region, e.g. Indonesia, Malaysia and Singapore. As a result of introducing competition and setting up the NRA, mobile penetration is increasing. This implies that the consumer benefits from various pricing schemes, nationwide network coverage and better quality of services offered by mobile operators. These results are consistent with previous studies (e.g. Wong, 2002; Roycroft & Anantho, 2003; Mutala, 2004; Kasusse, 2005; Mariscal, 2005; Kim, 2008; Billion et al., 2009; Shirazi et al., 2010) showing that competition and the establishment of the NRA drive the ICTs penetration rates.

Spectrum licensing (Paper IV)

The credibility and effectiveness of a regulatory framework and its ability to encourage private investment and support efficiency in the production and use of services vary with a country's political and social institutions (Levy & Spiller, 1996). The performance of mobile telecommunications will then depend on the transparency of the regulations and how neutral the regulator can be. For example, the regulator should prepare the market conditions by introducing laws and regulations in order to facilitate new entrants and ensure a level playing field. The new entrants can then enter the market with fewer constraints. Licensing is one of the most important mechanisms that establish a competitive framework and support effective distribution in the telecommunications market.

Although the Thai mobile market has gradually been liberalized, the issue of the spectrum licensing process has not been achieved compared with other countries in the region. An interesting aspect that has received considerable attention in this thesis is 3G or Universal Mobile Telecommunications System (UMTS) licences. It is an effort by the ITU to create global standards for wireless communications. This service will have greater impact on the revenue stream of mobile operators and provide an opportunity for rural dwellers to connect to the Internet. Hence, spectrum licensing can be seen as part of the policies to improve the number of ICTs inclusion in the country and not just to increase competition in the mobile market.

Four well-known methods have been used for spectrum assignment: first-come-first-served, lottery, beauty contest and auction (Hazlett, 1998). An auction allocates frequency to those operators that value the spectrum most highly and who are expected to make the most economically efficient use of the spectrum. However, the high bid prices of 3G auctions in the UK and Germany were major factors in explaining the loss in market value of the firms or the so-called winner's curse, since the licences were a burden for firm growth in the long run. The licensees may resell their licences in the secondary market or not activate the licences. Those firms who acquire the licences may have financial constraints post award or they may not roll out the infrastructure and start their operation as they have committed themselves to doing, since they do not have enough funding for their investment. Moreover, a higher licence fee may result in a lower number of firms sustained by the market. The market structure will then become much more concentrated with incumbents, and the market growth will be lower and could, in turn, delay innovation.

Many countries in Asia allocated the 3G spectrum to telecommunications service providers during 2000-2006. The assignment approach can be categorized into two main methods: auction and beauty contest. Hong Kong was the first country to implement the 3G auction in September 2001, and it has been followed by many countries in subsequent years. The results of this thesis show that the 3G licences in Asian countries face a very short term of the winner's curse. This also suggests that the NRAs in Asian countries are aware of the high reserve price from the Europeans' experience. They then reduced the reserve prices and relaxed the licence condition, which finally led to the short period of the curse. Thailand can also learn from this finding, though there has been a delay in issuing new 3G licences. The main goal of 3G assignment cannot only be considered as a method for raising revenue for the government but also for using the spectrum with optimum efficiency. However, NRAs need to monitor the inefficiency loss from their reserve prices in the long run to improve their reserve prices for the future auction and promote the development of the industry in order to protect the interests of the consumers.

6.2 The digital divide in Thailand and its determinants

The digital divide in a particular society is equally important to the digital divide at regional level. Several factors are investigated in this thesis, e.g. technology access, socio-economic factors, access price of ICT services and the institutional factor. In light of this discussion, these factors are categorized into two groups: demand-side factors and supply-side factors. The demand-side factor is defined as determinants of the use of ICT services, which include accessibility and affordability. On the supply side, the availability of service in parts of the country through various types of technology and service attributes is considered.

6.2.1 Determinant factors on the demand side: Accessibility and affordability (Papers V-VII)

The results of this thesis show that demand-side factors, which are commonly found in the United States and the European Union, are also evident in Thailand. Beginning with income, the income gap for Internet users across the whole region of Thailand proved substantial. The low- and medium-income earners are less likely to access the Internet than those who earn more, in particular for fixed broadband access, as shown in Papers V and VI. The access price of ICT services also plays an important role in explaining how the provider's charges relate to the individual's ability and willingness to pay for services. Paper VII takes the access price of mobile Internet into account. Mobile subscribers have increased gradually year on year, and, by 2010, the mobile penetration rate had reached 100%. At the same time, the number of mobile Internet users has been growing. At the end of 2010, 30% of mobile subscribers used mobile Internet (NTC, 2010). This suggests that mobile Internet has the potential to become a common means of access to the Internet in Thailand where the fixed Internet infrastructure is far from well developed. The results of Paper VII reveal that demand for mobile Internet access has a negative relationship to the price of mobile Internet. The elasticity is determined to show how the provider's charges relate to the individual's ability and willingness to pay for services. The elasticity with respect to the price of mobile Internet is -0.1898. This means that a 1% increase in the price of mobile Internet service will lead to a 0.1898% decrease in the demand for mobile Internet. The price of mobile Internet service is inelastic, however, which means that an increase in price has less effect on the propensity to access mobile Internet. It may be due to the lack of competition in fixed connection, and it leads to limited choice for the consumer.

The generational difference in Internet adoption is perhaps the most significant for the future diffusion of the Internet. Papers V-VII show that the early adopters in Thailand were concentrated among the youngest age groups, with minimal access in Thai society among senior citizens. The elderly may have a greater reluctance to adopt new technologies than teenagers. Another social factor is gender. The gender gap in the online community has been the subject of widespread study. The relative access to the Internet of males and females is equal for mobile Internet but not for broadband. Many plausible reasons may account for any gender differences in the access and use of the Internet, for example, the applications.

Paper VI also shows that education is a stronger determinant of Internet access, in particular for fixed broadband, than other demographic variables. From the literature, people with a higher education are more likely to access and use the Internet than less educated people. Norris (2001) emphasizes that schools and colleges provide an environment that is relatively rich in all forms of ICTs. In fact, they have been among the first institutions to access the Internet in most countries. Education can be expected to improve the skill of the Internet user (van Dijk & Hacker, 2003; van Dijk, 2006; van Deursen & van Dijk, 2009a, b).

Internet access and use also vary across the region of living. People who live in the Bangkok are more likely to access and use the Internet than those who live anywhere else in the country, in particular, fixed broadband services. This may indicate that the fixed infrastructure is more developed in Bangkok than in regional areas, which is important to Internet development.

Moreover, media familiarity plays an important role in Internet adoption. A wide distribution of other ICTs such as radio, television and mobile phones could encourage people to access the Internet due to familiarity with multimedia content and applications. Evidence from Paper V shows that cable TV and mobile phone influence Internet adoption. This is similar to the study by Norris (2001). In terms of using service applications, the results of Papers VI and VII indicated that usage depended on demographic factors. For example, males are more likely to use the applications than females. Like the younger respondents they are more likely to use search and video streaming, and download and play online games. Elderly people are also less likely to use the applications. Interestingly, low- and medium-income earners are more likely to use applications related to entertainment (social networking, video streaming, and downloading and playing online games) than those with a high income, even though they are less likely to access fixed broadband at home. Moreover, they are less likely to use an information application (i.e. search and e-mail). One idea is that differences in the opportunity cost of leisure time may drive this result. As Goldfrab and Prince (2008) noted, low-income individuals are much more likely to use the Internet for gaming and chat as these are relatively inexpensive and often time-consuming Internet applications. The finding from Paper VII also suggests that searching applications are used more frequently than e-mail and social network applications via mobile Internet. An estimated coefficient is not statistically significant however.

6.2.2 Determinant factors on the supply side: Availability (Paper III)

Internet connection through a fixed network is still the main option for users in Thailand. Paper III empirically shows that one of the obstacle factors on the supply side is the delay in the privatization of TOT. The aim of privatization in many parts of the world is for private ownership to improve corporate performance (e.g. overcome borrowing or boundless investment decisions) and social welfare. Currently, TOT remains a state enterprise in which the Ministry of Finance is the sole shareholder according to the State Enterprise Fund Act B.E. 2542 (1999). The Act states that even if TOT has corporatized its organization, although the shares have not been distributed to the public, management and investment decisions still depend on the Cabinet.

The structure of carrier ownership is also important to competitiveness. Managers of SOEs pursue objectives that differ from those of private firms (political view) and face less monitoring (management view). Not only are the managers' objectives distorted, but the budget constraints they face are softened. The soft-budget constraint emerges since bankruptcy is not a credible threat to public managers. These conditions create inefficiency. The finding shows that privatization increases profitability and efficiency through increased productivity. However, privatization *per se* does not guarantee improved performance, at least not in the short to medium term. The important factors that matter for firm restructuring and performance are the type of private ownership, corporate governance, access to expertise and markets, and the legal and institutional system.

The delay in privatization could lead to inequality in fixed infrastructure development between Bangkok and other regions since there is lack of competition in infrastructure development and quality of service. The fixed-line telephone market in Thailand is monopolized by TOT to provide a domestic telephone service. Private service providers can only operate in the industry if they work in conjunction with one of the SOEs through a collaborative partnership in the form of BTO contracts.

Specifically, there are only two service providers -TOT and True-in the Bangkok metropolitan area, while TT&T and TOT provide fixed-line service in the provincial area. Due to a lack of competition, the price of fixed-line telephone service also remains very high compared with other countries in the region. Hence, the slow pace of privatization of fixed-line service not only affects the development of fixed infrastructure but may also result in low Internet access, as fixed infrastructure is important for Internet connection.

Apart from fixed connection (dial-up and broadband), mobile Internet via a mobile handset and a USB modem to the end-user is one alternative, but there is a limitation due to the technology and frequency allocation problem. Mobile operators are expected to migrate from 2.5G-based mobile systems to 3G-based systems or beyond, which will allow for multimedia transmission. Currently, mobile operators have run limited trials migrating on the existing networks to 3G networks in the 850 MHz (for TrueMove and DTAC) and 900 MHz bands (for AIS). This has unfortunately resulted in EDGE currently being the best option for nationwide coverage. Allocation of a 3G licence is one of the most critical steps for the NBTC, a new national regulatory agency, after the previous auction was suspended by the Supreme Administrative Court in September 2010. This delay could hamper network deployment by mobile operators and it may widen the digital divide.

At this point, this thesis demonstrates that the digital divide exists in Thailand at regional and social level. The digital divide depends on several factors, as summarized in Table 5.

Table 5. Summary of the main determinants of the digital divide in Thailand

Level	Type of divide	Description	Investigated technologies	Determinants	
				Demand side: accessibility and affordability	**Supply-side: availability**
Regional	Access	Difference between countries that can and cannot access ICTs	Composite index and mobile	GDP per capita, urbanization	Level of competition, existence of the NRA, trade openness, availability of infrastructure, spectrum licensing, market liberalization
Social (Thailand)	Access	Difference between individuals who can and cannot access ICTs within a particular society or country	Internet, fixed broadband and mobile Internet	Income, gender, age, education, area of living, media familiarity, access price of mobile Internet and service application	Market liberalization, privatization, availability of infrastructure and technology, spectrum licensing
	Use	Difference between individuals who do and do not use ICTs within a particular society or country	Fixed broadband	Income, gender, age, education, area of living and service application	Availability of infrastructure and service application

6.3 Alternative policies to bridge the digital divide in Thailand

The results of this thesis show that the digital divide in Thailand is shaped by the interaction of several factors from the demand and supply sides. Initiatives from both the demand and the supply side are required to promote further gains in Internet adoption and to bridge the digital divide. The relative proportion of the two will need to be based on the specific situation in each region (Cava-Ferreruela & Alabau-Muñoz, 2006). The main findings from this thesis explicitly show how much the demand-side factors influence the digital divide while the supply-side factors may narrow or widen the digital divide. Hence, alternative policies to bridge the digital divide are discussed in this part. The various

types of policy are categorized according to three main barriers to adoption from the previous section: high access price, low income and lack of literacy.

6.3.1 Access price

High price of access as a barrier to access has been accepted in a number of studies since it was the most important barrier preventing the consumer from adopting services (e.g. Chowdary, 2002; Chaudhuri et al., 2005; Flamm & Chaudhuri, 2007; Savage & Waldman, 2009). This thesis shows that mobile Internet is growing as another means of Internet connection. There is a weak response to a price change in mobile Internet service however. This means that an increase in price is less likely to affect the propensity to access mobile Internet. The speed of wireless Internet connection is two to three times higher than that of dial-up Internet connections, while the price of mobile Internet is about the same as that of dial-up. The average monthly payment is 458 THB or 3.82% of the individual monthly income, which is cheaper than an ADSL connection. The inelastic access price of mobile Internet may be due to a lack of choice for consumers. The NRA therefore needs to promote fiercer competition in order to drive the price down. In the long term, the quality of service of mobile Internet needs to be announced explicitly by the regulator to ensure consumers gain the benefits.

Policies that stimulate Internet adoption are crucial. Two main options have been pursued: infrastructure competition (the United States model) vs service competition, i.e. local loop unbundling (the European model). Under the infrastructure competition, the NRA encourages service providers to build their own networks for the last miles. It is costly for new entrants, however, and it cannot fully attract them to invest in the current situation. The NRA may need to consider the implementation of local loop unbundling. Local loop unbundling would be introduced as a way to overcome the bottleneck control over the last mile of copper cable owned by incumbent operators, which has proved very hard and very expensive to replicate. This would provide an opportunity for new entrants to introduce Internet service. It would also result in greater choice for the consumer and drive down the price of the service. However, the implementation of local loop unbundling might reduce the investment incentive for the incumbent since this regulation aims to provide access to the incumbent's local network. While the jury is still out on which policy is best, the general implication is to stimulate Internet adoption. The tailor-made policy is a possible alternative to the NRA, i.e. encouraging infrastructure competition in rural areas while implementing service competition in urban areas.

Mobile Internet can play an important role in bridging the digital divide in Thailand, as mobile phones are now reaching consumers in Thailand much more rapidly. The demand for Internet has grown rapidly since 2001, but there is an issue of concession that creates some difficulties for the Internet service providers to offer fixed Internet connection (Srinuan, 2011). The NRA should consider wireless infrastructure as an option for solving the digital divide. Although Thailand faces a digital disparity due to the underdeveloped fixed-line network, there has apparently been leap-frogging of mobile over fixed line both in terms of infrastructure and subscription in the Thai market and in the growth of mobile applications. Moreover, the spectrum licensing from the NRA would facilitate more competition in the Internet market. This could provide an opportunity for the Thai citizen to access the Internet via wireless (i.e. mobile broadband) and fixed wireless technology (e.g. Wi-Fi and WiMAX).

Governments are responding in many ways, including by developing ICTs and Internet accessibility policies to ensure that all citizens can use ICTs profitably (e.g. McSorley, 2003; Mariscal, 2005; Mutula & van Brakel, 2006; Fuch & Horak, 2008; Hanafizadeh et al., 2009a). In the case of Thailand, the first priority should be privatization and liberalization of the fixed telephony market. As there are currently more than 80 fixed-Internet service providers, the price of the service should decrease as a result of market competition. The access price to the Internet is not much lower, however, as there are

few fixed-line providers. Moreover, there are only five Internet service providers that have been providing both mobile Internet services. One of them is TOT, which is the SOE. TOT had 3G wireless broadband on the 2.1 Gigahertz (GHz) spectrum licence without bidding since this licence was jointly owned by TOT and CAT in 2000. Subsequently, TOT took over the spectrum rights from CAT to become sole spectrum owner. TOT is planning to use the 2.1 GHz spectrum to provide 3G service on its existing Bangkok metropolitan network. This will increase the choice of technology available in the Internet market.

6.3.2 Low income

The results of this thesis clearly indicate that low- and medium-income earners are less likely to access the Internet, in particular fixed broadband access, than those who earn more. Most direct policies to increase adoption should involve subsidies from the government. Although the USF has been set up, it has not yet been used to finance any telecommunications services. Current designated USO providers in Thailand mainly provide service in unserved rural areas or public places such as educational institutions and schools, according to certain goals set by the NTC. This may not cover some groups of low-income people however. It also indicates that telecommunications services have some public good and social (fairness and equity) features (Crandall & Waverman, 2000) and the role of the government may therefore be needed.

The thesis considers specific examples of government policy aimed at Internet adoption in Thailand: the rural long-distance public phone, distance learning via satellite, public telephones for the disabled, the Schoolnet computer, Internet Tambon, and ICT computers for the Thai people project. All of these projects were implemented by SOEs, while the last project was directly implemented by the government in 2003. The government at the time aimed to make personal computers (PC) and notebooks more affordable by making a deal with PC dealers. In May 2003, the Thai ICT ministry launched a budget PC programme to spur computer ownership in the country. This project could be considered a pilot project for ICT adoption. However, the government should also consider alternative policies to increase Internet access for low-income households, for example, free or low-cost Internet access for low-income households or tax reductions for costs related to installing broadband access in the home or apartments (Shim et al., 2006). This would increase Internet and broadband adoption for low-income people.

6.2.3 Lack of literacy

Many skills are necessary for Internet adoption, including literacy. The findings of this thesis are in line with other previous studies that have emphasized the importance of literacy (e.g. Akhter, 2003; van Dijk & Hacker, 2003; Selwyn, 2006; van Dijk, 2006). The findings show that educated people are more informed about access and use of the Internet. Education is a crucial determinant of Internet access compared with other demographic variables. This also confirms the knowledge gap hypothesis by Tichenor et al. (1970) that knowledge regarding the usage of adopted technologies is greater by well-informed people. The less educated people are, the more likely they are to be digitally excluded. Moreover, the availability of more information for the user on the Internet does not guarantee that he or she will be able to use it and navigate efficiently. Users may use the Internet in different ways due to their skills and experiences (e.g. Hagittai, 2002, 2003a, b; Robinson et al., 2005; van Dijk, 2006; Hargittai & Hinnant, 2008). The lack of literacy, in particular digital literacy, could lead to the second level of the digital divide as noted by Hargittai (2002). Hence, the digital divide cannot be bridged without an education or training programme, particularly for under-educated, elderly and low-income persons and those in rural areas.

At the end of 2010, the NTC announced a Notification on the Implementation Plan for the Provision of Universal Basic Telecommunications and Social Services. One of the objectives of this Notification is to set up an Internet centre for each village, as specified by the NTC. This is an important step in increasing the capability and experience of using the Internet for people in rural areas. This aim may be difficult to accomplish, however, if the NTC only provides the physical access, since most of those who live in rural areas lack basic education and are less likely to see the benefits of using the Internet. The government therefore needs to increase awareness and the perceived value of the Internet.

The government should consider a demand-stimulating programme that aims to increase literacy, in particular digital literacy, for example, by encouraging the use of ICTs in teaching and learning in education with priority emphasis on basic education. Training programmes and education materials for different disadvantaged groups (i.e. disabled persons and the elderly) should be provided in order to ensure that they can access information in an equitable manner. The results of this thesis also reveal that applications play an important role in attracting Internet users. Low- and medium-income users use ICT for entertainment (social networks, video streaming, downloading and online games) more than for education purposes, commercial or government transactions, however. This variable should also be considered in bridging the digital divide.

To increase accessibility, the government should provide support to socially diverse groups. Learning resources and applications that are user-friendly and searchable through a computer or mobile phone should be developed to assist in improving livelihoods. A number of studies indicate that encouragement from the government in the development of a wide range of interesting local content and disseminating it in the communities to which these groups belong will increase the perceived value of ICTs and, consequently, raise the proportion of ICT adoption (Gebremichael & Jackson, 2006; Akca et al., 2007; Billion et al., 2009).

The empirical findings from this thesis confirm that the digital divide is rooted in various factors. A combined policy from the NRA and the government is needed to reduce barriers to ICT access and use. The NRA can propose regulations that encourage investment by providing rules that are broadly perceived to be fair, allow investors a profit and inspire confidence in the stability of the business environment. Regulation supports efficiency by encouraging competition and market-based pricing and by requiring efficient pricing where competition alone is inadequate (Levy & Spiller, 1996). At the same time, policymakers or the government can offer incentives and coordinate efforts to the private sector that consider local needs and capacities. This might be a good opportunity for disadvantaged groups since these people can benefit from the technical innovations occurring today in the ICT industry. It is also possible to create growth faster and at a greater level than ever before. The combined policies that will be designed by the NRA and policymakers are therefore a necessity to ensure equitable ICT access and use in the Thai society.

7. CONCLUSIONS AND FUTURE RESEARCH

The purpose of the thesis is to examine the factors that determine the digital divide and the possible alternatives for bridging this divide in Thailand. The section below discusses the extent to which the knowledge gained from the work conducted in the thesis achieves this purpose.

7.1 Conclusions

Policy makers and international organizations like the ITU and OECD have raised concerns about the growing digital divide since the 1990s. As well as direct economic benefits for trade and tourism, ICTs may accelerate the long-term investment in human capital. In order to yield these benefits, there is a need to understand the digital divide between countries, different regions (global level) or the same region (regional level), and within a country (social level). To understand the digital divide, this thesis investigates and analyses its determinant factors in Thailand at regional and social level as a case. Data are gathered from primary and secondary sources, and a quantitative research methodology is employed.

The main reasons for the regional divide are GDP per capita, urbanization, market competition, the existence of NRA, trade openness, availability of infrastructure, market liberalization and privatization. The liberalization and privatization of telecommunications services, in particular, have been debated and pursued with varying speed and success by countries throughout the world. In Thailand, efforts to privatize SOEs and liberalize the telecommunications regime have not yet been successful, as in other countries in the region.

Multiple factors also affect the digital divide on a social level. These factors are related to both supply and demand and can be categorized into three domains: availability, accessibility and affordability. Availability of service through various types of technology and service attributes is investigated in parts of the country. The findings show that there is inequality in fixed infrastructure across the country due to the lack of competition in infrastructure development, price and quality of service. The fixed-line telephony market remains monopolized by SOEs. The inequality of fixed infrastructure leads to disparity in fixed Internet connection in different parts of the country. In the case of mobile telephony, it is well developed and more competitive than the fixed-line market. The growth of mobile Internet use is also increasing. Mobile Internet can be considered an alternative technology for solving the digital divide. Current 3G service offerings are very limited, however, due to the legal difficulties of allocating the new 3G frequencies.

In terms of accessibility and affordability, findings suggest that socio-economic factors (income, gender, age, education and area of living) are associated with Internet access and use. People who have higher socio-economic status could benefit more from the Internet. Related ICT services, for example, cable TV and mobile phone and service applications (i.e. social network, video streaming and e-mail) could encourage people to access and use both fixed and mobile Internet connection. Further empirical findings show that the access price of mobile Internet is highly inelastic. One possible reason is the lack of choice, with the consumer not able to switch to another option. This confirms that the digital divide is not restricted to access to technical infrastructure but includes the socio-economic factors that support ICT access and use.

The challenges for the NRA and policy makers to bridge the digital divide are: (1) a lack of ICT infrastructure resulting from the delay in liberalization and privatization; (2) the delay in spectrum allocation; (3) further barriers due to mobile Internet service being expensive; and (4) gaps in the way the Internet is used. Various types of policy are discussed according to these barriers, for example, infrastructure competition vs. local loop unbundling, privatization of SOEs, spectrum licensing, a tax

subsidy, USO and training programmes[4]. The policies discussed indicate that the roles of the NRA and government are needed at different levels of the digital divide. The access and usage gap at regional and social level continue even under efficient market conditions because of the price of ICT services and social inequalities. The combined policies, which urge government intervention to ensure equitable ICT access and use after the market has functioned, can be considered a policy option. However, an assessment of the potential impacts of the implemented policy from the NRA and the government need to be made in order to contribute more consistent and coherent policies and to ensure that the ICTs are beneficial to Thai society. Hence, the conclusion of the thesis is presented below in Figure 14.

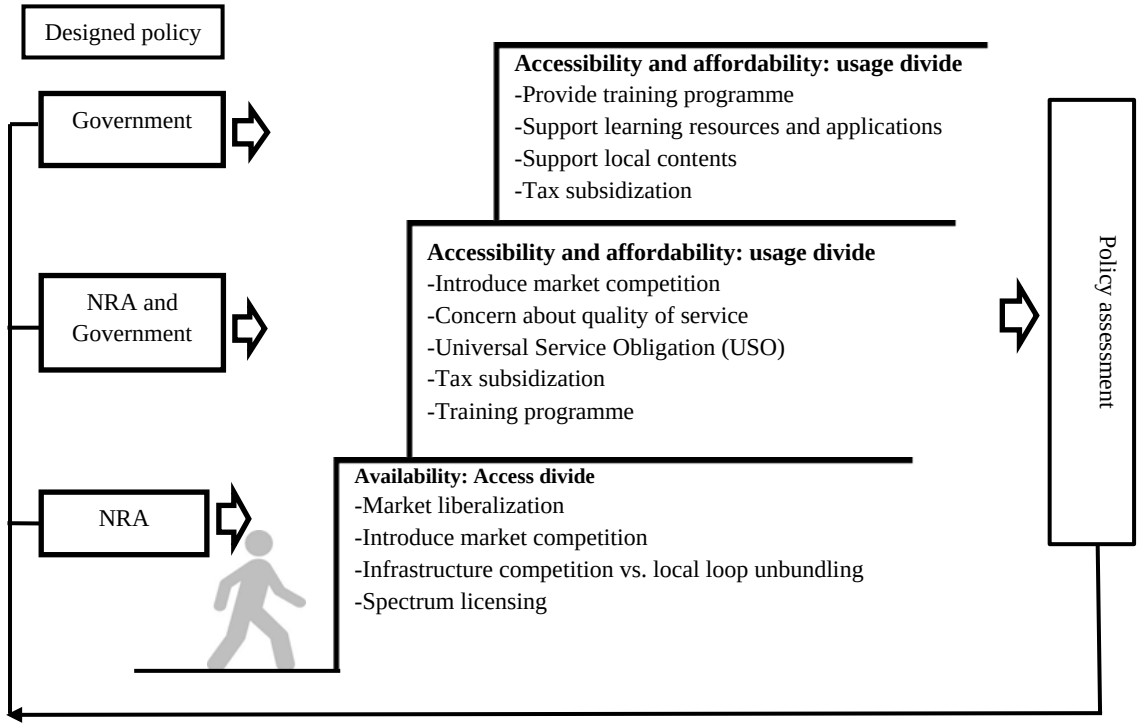


Figure 14. Summary of findings and implications

7.2 Future research

This thesis has investigated the determinants of the digital divide in Thailand and discussed alternatives for bridging the digital divide. Future research is needed, however, as one of the critical questions in the digital divide research relates to whether the digital divide is in fact widening. Availability of longitudinal data is necessary and will benefit future research. It offers an opportunity to gain a deeper understanding from the observation of the evolution of the digital divide at regional and social level rather than by merely surveying different cross sections.

A number of determinants can explain the digital divide. Some determinants have been pointed out as main factors in this thesis; others need to be investigated further, in particular, skills, culture, psychological factors, content and quality of service. Future research on this issue would provide insights into how diverse people in different areas adopt ICTs. Moreover, several policies have been implemented in Thailand, as mentioned in this thesis. Future research on policy evaluation is also needed in order to assess what does and does not work. A qualitative research method (i.e. in-depth interview and focus group) can be considered a complementary method. This method would add a

[4] The detailed discussions of each policy are not included in this thesis due to the scope of the study.

more in-depth understanding of the digital divide, potentially indicate how and why some people are digitally excluded and help us to interpret and better understand the complex reality of the digital divide.

The impact of market liberalization on the digital divide and competition in the telecommunications market has been discussed in this thesis, but much research remains to be done as no specific regulation has been addressed in the appended papers. It would be possible for future research to conduct a comparative study on specific regulations, for example, entry regulation and price regulation, in particular among the ASEAN countries or in Thailand. The results would provide insights for the NRA to better understand how these regulations affect the telecommunications market and service providers. Specifically, this thesis shows how the market has been liberalized and how the issue of delayed privatization has affected the growth of SOEs in the long run. This result only presents the impact of delayed privatization on the service provider with no discussion about the social cost. An interesting point is that delayed privatization may not only affect the service provider but also the costs to society as a whole. The social cost should therefore be taken into account in future research.

Moreover, the Thai telecommunications market is not yet mature compared with other countries in the region, particularly on the issue of spectrum management. The results of this thesis also show that mobile Internet can be considered an alternative technology to bridge the digital divide. However, there are different licence award processes, post-award obligations and a spectrum payment mode that could affect telecommunications investment and diffusion of mobile Internet according to the 3G assignment approach. In particular, service providers need to roll out their networks in order to meet the licensing obligation. Research is therefore needed to analyse whether and how the spectrum assignment approach affects telecommunications investment and mobile Internet diffusion. The result would be useful for the NRA in terms of increasing availability to the Internet user.

REFERENCES

Abbey, R. & Hyde, S. (2009). No country for older people? Age and the digital divide. *Journal of Information, Communication & Ethics in Society, 7* (4), 225-242.

Akca, H., Sayili, M. & Esengun, K. (2007). Challenge of rural people to reduce digital divide in the globalized world: Theory and practice, Government Information Quarterly, *24* (2), 404-413.

Akhter, S.H. (2003). Digital divide and purchase intention: Why demographic psychology matters. *Journal of Economic Psychology, 24* (3), 321-327.

Al-Jaghoub, S. & Chris Westrup, C. (2009). Reassessing social inclusion and digital divides. *Journal of Information, Communication & Ethics in Society, 7* (2-3), 146-158.

Alam, S.S. & Ahsan, N. (2007). ICT adoption in Malaysian SMEs from services sectors: Preliminary findings. *Journal of Internet Banking and Commerce, 12* (3), 1-11.

Alam, S.S., Abdullah, Z. & Ahsan, N. (2009). Cyber café usage in Malaysia: An exploratory study. *Journal of Internet Banking and Commerce, 14* (1), 1-13.

Andrés, L., Cuberes, D., Diouf, M. & Serebrisky, T. (2010). The diffusion of the Internet: A cross-country analysis. *Telecommunications Policy, 34* (5-6), 323-340.

Ashraf, M., Hanisch, J. & Swatman, P. (2009). ICT intervention in the "Chandanbari" village of Bangladesh: Results from a field study. *Information Systems Frontiers, 11* (2), 155-166.

Ameen, K. & Gorman, G.E. (2009). Information and digital literacy: a stumbling block to development? A Pakistan perspective. Library Management, *30* (1-2), 99-112.

Antonelli, C. (2003). The digital divide: Understanding the economics of new information and communication technology in the global economy. *Information Economics and Policy*, 15 (2), 173-199.

Avila, A. (2009). Underdeveloped ICT areas in Sub-Saharan Africa. *Informatica Economică, 13* (2), 136-146.

Azari, R. & Pick, J. (2005). Technology and society: socioeconomic influences on technological sectors for United States counties. *International Journal of Information Management, 25* (1), 21-37.

Åkesson, M., Skålén, P. & Edvardsson, B. (2008). E-government and service orientation: gaps between theory and practice. *International Journal of Public Sector Management, 21* (1), 74-92.

Bangkok Post (2002). 'Hutch' mobile launch imminent. The Bangkok Post. Retrieved 06 January 2012 from http://search.proquest.com/docview/308879412?accountid=10041

Bangkok Post (2011). Hutch deal costs four baht … plus a bit more. The Bangkok Post. Retrieved 06 January 2012 from http://search.proquest.com/docview/822481421?accountid=10041

Bagchi, K. (2005). Factors contributing to Global Digital Divide: Some empirical results. *Journal of Global Information Technology Management, 8* (3), 47-65.

Barrantes, R. & Galperin, H. (2008). Can the poor afford mobile telephony? Evidence from Latin America. *Telecommunications Policy, 32* (8), 521-530.

Beynon-Davies, P. & Hill, R. (2007). Evaluating a digital divide index in a regional context. *Journal of Systems and Information Technology, 9* (1), 46-59.

Bijker, W.E., Hughes, T.S. & Pinch, T.J. (Eds.) (1987). *The Social Construction of Technological Systems: New Directions in the Sociology and History of Technology*, MIT Press, Cambridge, MA.

Billon, M., Marco, R. & Lera-Lopez, F. (2009). Disparities in ICT adoption: A multidimensional approach to study the cross-country digital divide. *Telecommunications Policy*, 33 (10-11), 596-610.

Blackman, C. (2007). The public interest and the global, future telecommunications landscape. *Info, 9* (2), 6-16.

Blackman, C. & Forge, S. (2008). The future of universal service in Europe. *Info, 10* (5), 152-165.

Bonfadelli, H. (2002). The Internet and knowledge gaps: A theoretical and empirical investigation. *European Journal of communication*, *17* (1), 65-84.

Bozionelos, N. (2004). Socio-economic background and computer use: the role of computer anxiety and computer experience in their relationship. *International Journal of Human-Computer Studies, 61* (5), 725-746.

Broos, A. & Roe, K. (2006). The digital divide in the play station generation: Self-efficacy, locus of control and ICT adoption among adolescents. *Poetics*, 34 (4-5), 306-317.

Brown, I. & Licker, P. (2003). Exploring differences in internet adoption and usage between historically advantaged and disadvantaged groups in South Africa. *Journal of Global Information Technology Management, 6* (4), 6-26.

Breiter, A. (2003). Public Internet usage point in schools for the local community – Concept implementation and evaluation of a project in Bremen, Germany. *Education and Information Technologies, 8* (2), 109-125.

Bryman, A. (1989). *Quantity and Quality in Social Research.* London: Unwin Hyman.

Bryman, A. & Bell, E. (2007). *Business Research Method* (2nd ed.). New York: Oxford University Press.

Burrell, G. & Morgan, G. (1979). *Sociological Paradigms and Organizational Analysis*. Ashgate Publishing Limited.

Carter, L. & Weerakkody, V. (2008). E-government adoption: A cultural comparison. *Information Systems Frontiers, 10* (4), 473-482.

Cava-Ferreruela, I. & Alabau-Muñoz, A. (2006). Broadband policy assessment: A cross-national empirical analysis. *Telecommunications Policy*, *30* (8-9), 445-463.

Cave, M. & Hatta, K. (2008). Universal service obligations and spectrum policy. *Info, 10* (5), 59-69.

Chakraborty, J. & Bosman, M. (2002). Race, income, and home PC ownership: a regional analysis of the digital divide. *Race & Society, 5* (2), 163-177.

Chaudhuri, A., Flamm, K. & Horrigan, J. (2005). An analysis of the determinants of internet access. *Telecommunications Policy, 29* (9-10), 731-755.

Checchi, R.M., Po-An Hsieh, J.J. & Straub, D.W. (2003). Public IT policies in less developed countries: A critical assessment of the literature and a reference framework. *Journal of Global Information Technology Management, 6* (4), 45-64.

Chen, D., Lin, Z. & Lai, F. (2010). Crossing the chasm – understanding China's rural digital divide. *Journal of Global Information Technology Management, 13* (2), 4-36.

Chin, S.Y. (2005). Diverging information societies of the Asia Pacific. *Telematics and Informatics, 22* (4), 291-308.

Choudrie, J., Weerakkody, V. & Jones, S. (2005). Realising e-government in the UK: rural and urban challenges. *Journal of Enterprise Information Management, 18* (5), 568-585.

Chowdary, T.H. (2002). Diminishing the digital divide in India. *Info, 4* (6), 4-8.

Çilan, Ç.A., Bolat, B.A. & Coskun, E. (2009). Analyzing digital divide within and between member and candidate countries of European Union. *Government Information Quarterly, 26* (1), 98-105.

Cooke, L. & Greenwood, H. (2008). "Cleaners don't need computers": bridging the digital divide in the workplace. *Aslib Proceedings, 60* (2), 143-157.

Corrocher, N. & Ordanini, A. (2002). Measuring the digital divide: A framework for the analysis of cross-country differences. *Journal of Information Technology, 17* (1), 9-19.

Crandall, R.W. & Waverman, L. (2000). *Who Pay for Universal Service? When Telephone Subsidies Become Transparent*. USA: Brookings Institution Press.

Cullen, R. (2003). The digital divide: a global and national call to action. *The Electronic Library, 21* (3), 247-257.

Das, J., DiRienzo, C. & Burbridge, J. (2009). Global E-government and the role of trust: A cross country analysis. *International Journal of Electronic Government Research, 5* (1), 1-18.

de Koning, J. & Gelderblom, A. (2006). ICT and older workers: no unwrinkled relationship. *International Journal of Manpower, 27* (5), 467-490.

Deichmann, J.I., Eshghi, A., Haughton, D. & Masnghetti, M. (2006). Exploring break-points and interaction effects among predictors of the international digital divide. *Journal of Global Information Technology Management, 9* (4), 47-47-71.

Demoussis, M. & Giannakopoulos, N. (2006). The dynamics of home computer ownership in Greece. *Information Economics and Policy, 18* (1), 73-86.

DiMaggio, P.J., Hargittai, E., Neuman, W.R. & Robinson, J. (2001). Social implications of the Internet. *Annual Review of Sociology*, 27, 307-336.

Dobransky, K. & Hargittai, E. (2006). The disability divide in Internet access and use. *Information, Communication and Society, 9* (3), 313-334.

Dutta, S. & Mia, I. (2011). *The Global Information Technology Report 2010-2011*. World Economic Forum and INSEAD. Switzerland: Geneva. Retrieved 24 April 2011 from http://www.ifap.ru/library/book494.pdf

Dwivedi, Y. & Lal, B. (2007). Socio-economic determinants of broadband adoption. *Industrial Management & Data Systems, 107* (5), 654-671.

Eastman, J. & Iyer, R. (2004). The elderly's uses and attitudes towards the Internet. *Journal of Consumer Marketing, 21* (3), 208-220.

Economist Intelligence Unit (EIU) (2008). Closing Europe's digital divide. Retrieved 22 August 2011 from http://graphics.eiu.com/upload/Intel_Digital_Divide.pdf

Emrouznejad, A., Cabanda, E. & Gholami, R. (2010). An alternative measure of the ICT-Opportunity Index. *Information & Management, 47* (4), 246-254.

Engelbrecht, H.-J. (2008). Internet-based "social sharing" as a new form of global production: The case of SETI@home. *Telematics and Informatics, 25* (3), 156-168.

Evans, D. & Yen, D.C. (2005). E-government: An analysis for implementation: Framework for understanding cultural and social impact, *Government Information Quarterly, 22* (3), 354-373.

Fairlie, R.W. (2005). The effects of home computers on school enrollment. *Economics of Education Review, 24* (5), 533-547.

Fink, C. & Kenny, C.J. (2003). W(h)ither the digital divide? *Info, 5* (6), 15-24.

Fisher, Y. & Bendas-Jacob, O. (2006). Measuring Internet usage: The Israeli case. *International Journal of Human-Computer Studies, 64* (10), 984-997.

Flamm, K. & Chaudhuri, A. (2007). An analysis of the determinants of broadband access. *Telecommunications Policy, 31* (6-7), 312-326.

Freese, J., Rivas,S. & Hargittai, E.(2006). Cognitive ability and Internet use among older adults. Poetics, *34* (4-5), 236-249.

Fuchs, C. & Horak, E. (2008). Africa and the digital divide. *Telematics and Informatics, 25* (2), 99-116.

Gamage, P. & Halpin, E.F. (2007). E-Sri Lanka: bridging the digital divide. *The Electronic Library, 25* (6), 693-710.

García-Jiménez, M.C. & Gómez-Barroso, J.L. (2009). Universal service in a broader perspective: The European digital divide. *Informatica Economică, 13* (2), 155-165.

Gauld, R., Goldfinch, S. & Horsburgh, S. (2010). Do they want it? Do they use it? The "Demand-Side" of e-Government in Australia and New Zealand. *Government Information Quarterly, 27* (2), 177-186.

Gebremichael, M.D. & Jackson, J.W. (2006). Bridging the gap in Sub-Saharan Africa: A holistic look at information poverty and the region's digital divide. *Government Information Quarterly, 23* (2), 267-280.

Glass, V. & Stefanova, S.K. (2010). An empirical study of broadband diffusion in rural America. *Journal of Regulatory Economics, 38* (1), 70-85.

Gibbons, J. & Ruth, S. (2006). Municipal Wi-Fi: Big wave or wipeout? *IEEE Internet Computing*, 10 (3), 66-71.

Godfrey, M. & Johnson, O. (2009). Digital circles of support: Meeting the information needs of older people. *Computers in Human Behavior, 25* (3), 633-642.

Goldfarb, A. & Prince, J. (2008). Internet adoption and usage patterns are different: Implications for the digital divide. *Information Economics and Policy, 20* (1), 2-15.

Gomez, R. & Gould, E. (2010). The "cool factor" of public access to ICT. *Information Technology & People, 23* (3), 247-264.

Goth, G. (2005). Digital-divide efforts are getting more attention. *IEEE Internet Computing*, 9 (4), 8-11.

Gómez Barroso, J.L. & Pérez Martínez, J. (2007). ADSL deployment in the Community of Madrid: Investigating the geographical factors of the digital divide. *Telematics and Informatics, 24* (2), 101-114.

Gómez-Barroso, J.L. & Robles-Rovalo, A. (2008). Wireless hopes for universal service in developing countries: An assessment in the Mexican context. *Info, 10*(5), 83-91.

Greco, G.M. & Floridi, L. (2004). The tragedy of the digital commons. *Ethics and Information Technology, 6* (2), 73-81.

Gruber, H. & Verboven, F. (2001). The evolution of markets under entry and standards regulation – The case of Global Mobile Telecommunications. *International Journal of Industrial Organization,* 19 (7), 1189-1212.

Guasch, J.C. & Ugas, L. (2007). The digital gap in Maracaibo city in Venezuela. *Telematics and Informatics, 24* (1), 41-47.

Gunasekaran, V. & Harmantzis, F.C. (2007). Emerging wireless technologies for developing countries. Technology in Society, 29(1) 23-42.

Haßler, B. & Jackson, A.M. (2010). Bridging the bandwidth gap: Open educational resources and the digital divide. *IEEE Transactions on Learning Technologies*, 3 (2), 110-115.

Hanafizadeh, P., Hanafizadeh, M.R. & Khodabakhshi, M. (2009a). Taxonomy of e-readiness assessment measures. *International Journal of Information Management, 29* (3), 189-195.

Hanafizadeh, M.R., Saghaei, A. & Hanafizadeh, P. (2009b). An index for cross-country analysis of ICT infrastructure and access. *Telecommunications Policy, 33* (7), 385-405.

Hardy, A.P. (1980). The role of the telephone in economic development. *Telecommunications Policy, 4* (4), 278-286.

Hargittai, E. (2002). Second-level digital divide: Differences in people's online skills. *First Monday,* 7 (4).

Hargittai, E. (2003a). Informed web surfing: The social context of user sophistication, in P. Howard and S. Jones (Eds.), *Society Online I,* pp. 257-274. Thousand Oaks, CA: Sage Publications, 257-274.

Hargittai, E. (2003b). Serving citizens' needs: Minimizing hurdles to accessing government information online. *IT & Society,* 1 (3), 27-41.

Hargittai, E. (2005). Survey measures of web-oriented digital literacy. *Social Science Computer Review, 23*(3), 371-379.

Hargittai, E. (2008). Whose space? Differences among users and non-users of social network sites. *Journal of Computer-Mediated Communication, 13 (1),* 276-297.

Hargittai, E. & Hinnant, A. (2008). Digital inequality: Differences in young adults' use of the Internet. *Communication Research, 35* (5), 602-621.

Hargittai, E. (2010). Digital na(t)ives? Variation in Internet skills and uses among members of the "Net Generation". *Sociological Inquiry,* 80(1), 92-113.

Harrison, T.M., Zappen, J.P. & Adali, S. (2005). Building community information systems: The connected kids case. *Computer, 38* (12), 62-69.

Hassani, S.R. (2006). Locating digital divides at home, work, and everywhere else. *Poetics, 34* (4-5), 250-272.

Hartviksen, G., Akselson, S. & Eidsvik, A.K. (2002). MICTS: Municipal ICT schools – A means for bridging the digital divide between rural and urban communities. *Education and Information Technologies, 7* (2), 93-109.

Hausman, J. (1997). Valuing the effect of regulation on new services in telecommunications. Brookings Papers on Economic Activity, *Microeconomics*, 1-54.

Hawkins, E.T. (2005). Creating a national strategy for Internet development in Chile. *Telecommunications Policy, 29* (5-6), 351-365.

Hazlett, T. (1998). Assigning property rights to radio spectrum users: Why did FCC license auctions take 67 years? *Journal of Law and Economics, 41*, 529-575.

Helbig, N., Gil-Garcia, J.R. & Ferro, E. (2009). Understanding the complexity of electronic government: Implications from the digital divide literature. *Government Information Quarterly, 26*(1), 89-97.

Hill, R., Beynon-Davies, P. & Williams, M.D. (2008). Older people and internet engagement: Acknowledging social moderators of internet adoption, access and use. *Information Technology & People, 21* (3), 244-266.

Hinson, R. & Sorensen, O. (2006). E-business and small Ghanaian exporters: Preliminary micro firm explorations in the light of a digital divide. *Online Information Review, 30* (2), 116-138.

Hitt, L. & Prasanna Tambe, P. (2007). Broadband adoption and content consumption. *Information Economics and Policy, 19* (3-4), 362-378.

Hohlfeld, T.N., Ritzhaupt, A.D., Barron, A.E. & Kemker, K. (2008). Examining the digital divide in K-12 public schools: Four-year trends for supporting ICT literacy in Florida. *Computers & Education, 51* (4), 1648-1663.

Hohlfeld, T.N., Ritzhaupt, A.D. & Barron, A.E. (2010). Connecting schools, community, and family with ICT: Four-year trends related to school level and SES of public schools in Florida. *Computers & Education, 55* (1), 391-405.

Hollifield, C.A. & Donnermeyer, J.F. (2003). Creating demand: influencing information technology diffusion in rural communities. *Government Information Quarterly, 20* (2), 135-150.

Huang, J. & Russell, S. (2006). The digital divide and academic achievement. *The Electronic Library, 24* (2), 160-173.

Hori, N. (2003). *Developments of the IT Revolution and Informatization in East Asia*. Economic and Social Research Institute Working Paper. Retrieved 24 May 2009 from http://www.esri.go.jp/en/tie/ea/ea6-e.pdf

Hubregtse, S. (2005). The digital divide within the European Union. *New Library World, 106* (3-4), 164-172.

Igun, S.E. & Olise, F.P. (2008). Unified Licensing: Facilitator for ICT Empowerment and National Development in Nigeria. *Library Hi Tech News, 25* (2-3), 8-10.

Ishmael, J., Bury, S., Pezaros, D. & Race, N.J.P. (2008). *Deploying Rural Community Wireless Mesh Networks*. *IEEE Internet Computing, 12* (4), 22-29.

International Telecommunication Union (ITU). (2009). *Information Society Statistical Profiles 2009 – Asia and the Pacific*. Retrieved 26 September 2011 from http://www.itu.int/pub/D-IND-RPM.AP-2009/en

International Telecommunication Union and the World Bank (ITU-infoDev). (2012). ICT Regulation Toolkit. Retrieved 01March 2012 from http://www.ictregulationtoolkit.org/en/section.3126.html

Jackson, L.A., von Eye, A., Barbatsis, G., Biocca, F., Zhao, Y. & Fitzgerald, H.E. (2003). Internet attitudes and Internet use: some surprising findings from the HomeNetToo project. *International Journal of Human-Computer Studies, 59* (3), 355-382.

Jacobsen, K.F.L. (2003). *Telecommunications – A Means to Economic Growth in Developing Countries? Development Studies and Human Rights, Chr*. Michelsen Institute Report.

James, J. (2002). Low-cost information technology in developing countries: current opportunities and emerging possibilities, *Habitat International, 26* (1), 21-31.

James, J. (2003). Sustainable Internet access for the rural poor? Elements of an emerging Indian model. *Futures, 35* (5), 461-472.

James, J. (2004). Reconstructing the digital divide from the perspective of a large, poor, developing country. *Journal of Information Technology, 19* (3), 172-177.

James, J. (2009). Information technology use among individuals in rich and poor countries: The disappearing divide. *Telematics and Informatics, 26* (4), 317-321.

Jayakar, K.P. (2004). Reforming the e-rate. *Info, 6* (1), 37-51.

Jayakar, K.P. & Harmeet Sawhney, H. (2004). Universal service: beyond established practice to possibility space. *Telecommunications Policy, 28*(3-4), 339-357.

Kalusopa, T. (2005). The challenges of utilizing information communication technologies (ICTs) for the small-scale farmers in Zambia. *Library Hi Tech, 23* (3), 414-424.

Kanungo, S. (2004). On the emancipatory role of rural information systems. *Information Technology & People, 17* (4), 407-422.

Kasusse, M. (2005). Bridging the digital divide in Sub-Saharan Africa: The rural challenge in Uganda. *The International Information & Library Review, 37* (3), 147-158.

Ke, W. & Wei, K.K. (2006). Understanding E-government project management: A positivist case study of Singapore. *Journal of Global Information Technology Management, 9*(2), 45-61.

Keane, J. (2000). Structure transformations of the public sphere, in K.L. Hacker and J. van Dijk (Eds.), *Digital Democracy: Issues of Theory and Practice*, pp. 70-79. Thousand Oaks, CA: Sage.

Kebede, G. (2004). The information needs of end-users of Sub-Saharan Africa in the digital information environment. *The International Information & Library Review, 36*(3), 273-279.

Kendra, S. & Albright, K.S. (2005). Global measures of development and the information society. *New Library World, 106* (7-8), 320-331.

Klecun, E. (2008). Bringing lost sheep into the fold: questioning the discourse of the digital divide. *Information Technology & People, 21* (3), 267-282.

Kim, D. (2008). Widening universal service in Korea to include broadband and mobile communications. *Info, 10* (5), 70-70-82.

Kim, E., Lee, B. & Menon, N.M. (2009). Social welfare implications of the digital divide. *Government Information Quarterly, 26* (2), 377-386.

Kim, Y- C., Jung, J-Y. & Ball-Rokeach, S.J. (2007). Ethnicity, place, and communication technology: Effects of ethnicity on multi-dimensional internet connectedness. *Information Technology & People, 20* (3), 282-303.

Klimaszewski, C. & Nyce, J. (2009). Does universal access mean equitable access? What an information infrastructure study of a rural Romanian community can tell us. *New Library World, 110* (5-6), 219-236.

Kuk, G. (2002). The digital divide and the quality of electronic service delivery in local government in the United Kingdom. *Government Information Quarterly, 20* (4), 353-363.

Lai, B. & Brewer, G.A. (2006). New York City's broadband problem and the role of municipal government in promoting a private-sector solution. *Technology in Society, 28*(1-2), 245-259.

Lattemann, C., Stieglitz, S., Kupke, S. & Schneider, A.-M. (2009). Impact of PPPs to broadband diffusion in Europe. *Transforming Government: People, Process and Policy, 3* (4), 355-374.

LaRose, R., Gregg, J.L., Strover, S., Straubhaar, J. & Carpenter, S. (2007). Closing the rural broadband gap: Promoting adoption of the Internet in rural America. *Telecommunications Policy, 31* (6-7), 359-373.

Lentz, R.G. & Oden, M.D. (2001). Digital divide or digital opportunity in the Mississippi Delta region of the US. *Telecommunications Policy, 25* (5), 291-313.

Letch, N. & Carroll, J. (2008). Excluded again: Implications of integrated e-government systems for those at the margins. *Information Technology & People, 21*(3), 283-299.

Levy, B. & Spiller, P. (1996). *Regulations, Institutions and Commitment: Comparative Studies of Telecommunications*. Cambridge: Cambridge University Press.

Liao, C. H. & Chang, H.-S. (2010). Explore the influences to Taiwan students' information literacy with the urban-rural differences from the perspective of globalization. *Procedia Social and Behavioral Sciences, 2* (2), 3866-3870.

Lim, J. (2002). East Asia in the information economy: Opportunities and challenges. *Info, 4* (5), 56-63.

Madden, G. & Savage, S.J. (1998). CEE telecommunications investment and economic growth. *Information Economics and Policy, 10* (2), 173-195.

Malecki, E.J. (2003). Digital development in rural areas: potentials and pitfalls. *Journal of Rural Studies, 19* (2), 201-214.

Mariscal, J. (2005). Digital divide in a developing country. *Telecommunications Policy, 29* (5-6), 409-428.

Martinez, C. A. & Williams, C. (2010). National institutions, entrepreneurship and global ICT adoption: A cross-country test of competing theories. *Journal of Electronic Commerce Research, 11* (1), 73-91.

Mason, S. M. & Hacker, K.L. (2003). Applying communication theory to digital divide research. *IT & Society, 1*(5), 40-55.

Mathur, A. & Ambani, D. (2005). ICT and rural societies: Opportunities for growth. *The International Information & Library Review, 37* (4), 345-351.

Mavichak, V. (2004). *Telecommunication Sector: Moving Towards Free Competition*. Retrieved 24 May 2009 from http://www.thailandoutlook.com/thailandoutlook1/download/special/
telecom.pdf

McSorley, K. (2003). The secular salvation story of the digital divide. *Ethics and Information Technology, 5 (2)*, 75-87.

Meng, Q. & Li, M. (2002). New economy and ICT development in China. *Information Economics and Policy, 14* (2), 275-295.

Middleton, K.L. & Chambers, V. (2010). Approaching digital equity: Is Wi-Fi the new leveler? *Information Technology & People, 23*(1), 4-22.

Mistry, J.J. (2005). A conceptual framework for the role of government in bridging the digital divide. *Journal of Global Information Technology Management, 8*(3), 28-46.

Moon, J., Park, J., Jung, G.H. & Choe, Y.C. (2010). The impact of IT use on migration intentions in rural communities. *Technological Forecasting & Social Change, 77* (8), 1401-1411.

Moss, J. (2002). Power and digital divide. *Ethics and Information Technology, 4* (2), 159-165.

Mutula, S.M. (2004). Making Botswana an information society: Current developments. *The Electronic Library, 22* (2), 144-153.

Mutula, S.M. & van Brakel, P. (2006). E-readiness of SMEs in the ICT sector in Botswana with respect to information access. *The Electronic Library, 24* (3), 402-417.

Mutula, S.M. & van Brakel, P. (2006). An evaluation of e-readiness assessment tools with respect to information access: Towards an integrated information rich tool. *International Journal of Information Management, 26* (3), 212-223.

Mwesige, P.G. (2004). Cyber elites: a survey of Internet cafe users in Uganda. *Telematics and Informatics, 21* (1), 83-101.

Ngini, C.U., Furnell, S.M. &. Ghita, B.V. (2002). Assessing the global accessibility of the Internet. *Internet Research, 12* (4), 329-338.

Noce, A.A. & McKeown, L. (2008). A new benchmark for Internet use: A logistic modeling of factors influencing Internet use in Canada, 2005. *Government Information Quarterly, 25*(3), 462-476.

Noh, Y.-H. & Yoo, K. (2008). Internet, inequality and growth. Journal of Policy Modeling, *30*(6), 1005-1016.

Niehaves, B., Plattfaut, R., Gorbacheva, E. & Vages, P.H. (2010). Analysis of e-inclusion projects in Russia, Austria and Switzerland. *Interactive Technology and Smart Education, 7* (2), 72-84.

Norris, P. (2001). *Digital Divide: Civic Engagement, Information Poverty, and the Internet Worldwide.* New York: Cambridge University Press.

NSO (2011). *ICT Household Survey 2010.* Online. Retrieved 05 January 2012 from http://service.nso.go.th/nso/nsopublish/download/files/ICThouseRep54.pdf

NTC. (2010). *Thai Telecommunications Indicators Yearbooks*. Online. Retrieved 05 January 2012 from http://www.nbtc.go.th/index.php?option=com_content&view=article&id=344:2011-06-29-07-00-11&catid=32:2011-05-31-04-11-31&Itemid=56

NTC. (2011). *Telecommunications Market Report Quarter 2, 2011*. Online. Retrieved 05 January 2012 from http://www.nbtc.go.th/index.php?option=com_content&view=article&id=235&Itemid=1

NTIA. (1995). *Falling Through the Net: A Survey of the "Have Nots" in Rural and Urban America*. U.S. Department of Commerce, Washington DC, 1995.

NTIA. (1998). *Falling Through the Net II: More Data on the Digital Divide*. U.S. Department of Commerce, Washington DC, 1998.

NTIA. (1999). *Falling Through the Net III: Defining the Digital Divide*. U.S. Department of Commerce, Washington DC, 1999.

NTIA. (2000). *Falling Through the Net IV: Towards Digital Inclusion*. U.S. Department of Commerce, Washington DC, 2000.

Ono, H. & Zavodny, M. (2007). Digital inequality: A five country comparison using microdata. *Social Science Research, 36* (3), 1135-1155.

Organisation for Economic Co-operation and Development (OECD). (2001). *Understanding the Digital Divide*. Paris: OECD. Online. Retrieved 14 April 2009 from http://www.oecd.org/dataoecd/38/57/1888451.pdf

Orviska, M. & Hudson, J. (2009). Dividing or uniting Europe? Internet usage in the EU. *Information Economics and Policy, 21* (4), 279-290.

Oxendine, A., Borgida, E., Sullivan J.L. & Jackson, M.S. (2003).The importance of trust and community in developing and maintaining a community electronic network. *International Journal of Human-Computer Studies, 58* (6), 671-696.

Oyelaran-Oyeyinka, B. & Lal, K. (2005). Internet diffusion in sub-Saharan Africa: A cross-country analysis. *Telecommunications Policy, 29* (7), 507-527.

Pal, J. (2009). If the state provided free computer literacy, would it find takers? Evidence and propositions from the Akshaya project in India. *Information Systems Frontiers, 11*(2), 105-116.

Papazafeiropoulou, A. (2004). Inter-country analysis of electronic commerce adoption in South Eastern Europe: Policy recommendations for the region. *Journal of Global Information Technology Management, 7* (2), 54-69.

Park, E.-A. & Jayakar, K. (2010). Patterns of e-rate funding to school districts: An eight state comparison. *Info, 12* (3), 46-58.

Peter, J. & Valkenburg, P.M. (2006). Adolescents' internet use: Testing the "disappearing digital divide" versus the "emerging digital differentiation" approach. *Poetics, 34* (4-5), 293-305.

Pieri, M. & Diamantinir, D. (2010). Young people, elderly and ICT. *Procedia Social and Behavioral Sciences, 2* (2), 2422-2426.

Pook, L.A. & Pence, N.E. (2004). Evaluation of information infrastructures and social development among the Visegrad-four countries of Central Europe. *Journal of Global Information Management, 12* (2), 63-83.

Powell, A.H. (2007). Access(ing), habits, attitudes, and engagements: Re-thinking access as practice. *Computers and Composition, 24* (1), 16-35.

Praboteeah, D., Parboteeah, K.P., Cullen, J.B. & Basu, C. (2005). Perceived usefulness of information technology: A cross-national model. *Journal of Global Information Technology Management, 8* (4), 29-48.

Prager, R.A. (1989). Policies on the cost of debt for electric utilities: An empirical investigation. *Journal of Business, 62* (1), 33-53.

Prieger, J.E. (2001). Telecommunications regulation and new services: A case study at the state level. *Journal of Regulatory Economics, 20* (3), 285-305.

Prieger, J.E. (2002a). A model for regulated product of innovation and introduction with application to telecommunications. *Applied Economics Letters, 9* (10), 625-629.

Prieger, J.E. (2002b). Regulation, innovation, and the introduction of new telecommunications services. *Review of Economics and Statistics, 84* (4), 704-715.

Prieger, J.E. (2007). Regulation delay and timing of product innovation. *International Journal of Industrial Organization, 25* (4), 219-236.

Prieger, J.E. & Hu, W.-M. (2008). The broadband digital divide and the nexus of race, competition, and quality. *Information Economics and Policy, 20* (2), 150-167.

Puga, P., Cardoso, G., Espanha, R. & Mendonça, S. (2009). Telecommunications for the needy: How needed are they? *Informatica Economică, 13* (2), 175-188.

Reisenwitz, T., Iyer, R., Kuhlmeier, D. & Eastman, J. (2007). The elderly's internet usage: an updated look. *Journal of Consumer Marketing, 24* (7), 406-418.

Quibria, M.G., Ahmed, S.N., Tschang, T. & Mari-Len Reyes-Macasaquit, M.L. (2003). Digital divide: Determinants and policies with special reference to Asia. *Journal of Asian Economics, 13* (6), 811-825.

Rao, S.S. (2005). Bridging digital divide: Efforts in India. Telematics and Informatics, 22(4), 361-375.

Recabarren, M., Nussbaum, M. & Leiva, C. (2008). Cultural divide and the Internet. *Computers in Human Behavior. 24* (6), 2917-2926.

Rice, R.E. & Katz, J.E. (2003). Comparing internet and mobile phone usage: Digital divides of usage, adoption, and dropouts. *Telecommunications Policy, 27* (8-9), 597-623.

Rice, R.E. & Katz, J.E. (2008). Assessing new cell phone text and video services. *Telecommunications Policy, 32* (7), 455-467.

Robertson, A., Soopramanien, D. & Fildes, R. (2007). A segment-based analysis of Internet service adoption among UK households. *Technology in Society, 29* (3), 339-350.

Robinson, J., DiMaggio, P.J. & Hargittai, E. (2003). New social survey perspectives on the digital divide. *IT & Society, 1* (5), 1-22.

Rogers, E. M. (1995). *Diffusion of Innovations* (4th ed.). New York: Free Press.

Rooksby, E., Weckert, J. & Lucas, R. (2002). The rural digital divide. Rural Society, *12* (3), 197-209.

Roseman, D. (2003). The digital divide and the competitive behaviour of Internet backbone providers: Part 2 – a way forward. *Info, 5*(6), 34-44.

Rowe, B. (2003). Rural technology deployment and access: Successes upon which to build. *Government Information Quarterly, 20* (2), 85-93.

Roycroft, T.R. & Anantho, S. (2003). Internet subscription in Africa: Policy for a dual digital divide. *Telecommunications Policy, 27* (1-2), 61-74.

Röller, L. &Waverman, L. (2001).Telecommunications infrastructure and economic development: A simultaneous approach. *American Economic Review, 91* (4), 909-923.

Ryder, G. (2007). Debunking the optimists: An evaluation of conventional wisdom about the digital divide and e-government in the British Isles. *Transforming Government, 1* (2), 112-130.

Salajan, F.D., Schonwetter, D.J. & Cleghorn, B.M. (2010). Student and faculty inter-generational digital divide: Fact or fiction? *Computers & Education, 55* (3), 1393-1403.

Salinas, A. & Sanchez, J. (2009). Digital inclusion in Chile: Internet in rural schools. *International Journal of Educational Development, 29* (6), 573-582.

Sang, S., Lee, J-D. & Jongsu Lee, J. (2009). E-government adoption in ASEAN: The case of Cambodia. *Internet Research, 9* (5), 517-534.

Savage, S.J. & Waldman, D.M. (2009). Ability, location and household demand for Internet bandwidth. *International Journal of Industrial Organization, 27* (2), 166-174.

Schleife, K. (2010). What really matters: Regional versus individual determinants of the digital divide in Germany. *Research Policy, 39* (1), 173-185.

Selwyn, N. (2003). Apart from technology: understanding people's non-use of information and communication technologies in everyday life. *Technology in Society, 25* (1), 99-116.

Selwyn, N. (2006). Digital division or digital decision? A study of non-users and low-users of computers. *Poetics, 34* (4-5), 273-292.

Sexton, R.S., Richard, A., Johnson, R.A. & Hignite, M.A. (2002). Predicting Internet/ e-commerce use. *Internet Research, 12* (5), 402-410.

Singh, A.K. & Sahu, R. (2008). Integrating Internet, telephones, and call centers for delivering better quality e-governance to all citizens, *Government Information Quarterly, 25* (3), 477-490.

Smith, M.J. (1998). *Social Science in Question*. London: Sage Publications.

Smith, M. & Marx, L. (1996). *Does Technology Drive History? The Dilemma of Technological Determinism*. Cambridge, Mass: MIT Press.

Sharma, S.K. & Gupta, J.N.D. (2003). Socio-economic influences of e-commerce adoption. *Journal of Global Information Technology Management, 6* (3), 3-21.

Shim, Y., Lee, H. & Yun, K. (2006). The growth of broadband Internet in Sweden: Contributing factors. *International Advanced Media and Communication, 1* (2), 122-138.

Shirazi, F., Gholami, R. & Higon, D.A. (2009). The impact of information and communication technology (ICT), education and regulation on economic freedom in Islamic Middle Eastern countries. *Information & Management, 46* (8), 426-433.

Shirazi, F., Ngwenyama, O. & Morawczynski, O. (2010). ICT expansion and the digital divide in democratic freedoms: An analysis of the impact of ICT expansion, education and ICT filtering on democracy. *Telematics and Informatics, 27* (1), 21-31.

Simpson, L., Daws, L. & Pini, B. (2004). Public internet access revisited. *Telecommunications Policy, 28* (3-4), 323-337.

Srinuan, C. (2011). Private costs of delayed privatization of TOT Public Company Limited. *Info, 13* (1), 74-91.

Srinuan, C., Srinuan, P. & Bohlin, E. (2012). An analysis of mobile Internet access in Thailand: Implications for bridging the digital divide. *Telematics and Informatics, 29* (3), 254-262.

Srite, M., Thatcher, J.B. & Galy, E. (2008). Does within-culture variation matter? An empirical study of computer usage. *Journal of Global Information Technology Management, 16* (1), 1-25.

Sun, Y. & Wang, H. (2005). Does Internet access matter for rural industry? A case study of Jiangsu, China. *Journal of Rural Studies, 21* (2), 247-258.

Suriyasarn, B. (2002). *Analysis of Thai Internet and Telecommunications Policy Formation during the period 1992-2000*. PhD Thesis. Ohio University. Retrieved 06 January 2011 from http://etd.ohiolink.edu/send-pdf.cgi/Suriyasarn%20Busakorn.pdf?ohiou1020103463

Szabó, C., Farkas, K. & Horváth, Z. (2008). Motivations, design and business models of wireless community networks. *Mobile Networks and Applications, 13* (1-2), 147-159.

Teo, T.S.H. (2007). Organizational characteristics, modes of internet adoption and their impact: A Singapore perspective. *Journal of Global Information Technology Management, 15* (2), 91-117.

Tichenor, P.J., Donohue, G.A., & Olien, C.N. (1970). Mass media flow and differential growth in klowldge. *Public Opinion Quarterly, 34* (2), 159-170.

Tien, F.F. & Fu, T.-T. (2008). The correlates of the digital divide and their impact on college student learning, *Computers & Education, 50* (1), 421-436.

The Nation. (2011). 3G battle set to begin as real move and CAT are poised to launch service. Retrieved 12 January 2012 from http://www.nationmultimedia.com/2011/07/18/business/3G-battle-set-to-begin-as-real-move-and-CAT-are-po-30160467.html

Trauth, E.M. (2002). Odd girl out: An individual differences perspective on women in the IT profession, Information Technology & People, *15* (2), 98-118.

Van Dijk, J. (2000). Widening information gaps and polices of prevention. In: Hackers, K., van Dijk, J. (Eds.) *Digital Democracy: Issue of Theory and Practice* (pp.166-183), London: Sage Publications.

van Dijk, J. (2002). A framework for digital divide research. *The Electronic Journal of Communication/ Revue de Communication Electronique, 12* (1), 1-6. Retrieved 10 August 2011 http://www.cios.org/EJCPUBLIC/012/1/01211.html

van Dijk, J. & Hacker, K. (2003). The digital divide as a complex and dynamic phenomenon. *The information Society, 19* (4), 315-326.

van Dijk, J. (2006). Digital divide research, achievements and shortcomings. *Poetics, 34*(4-5), 221-235.

van Deursen, A. & van Dijk, J. (2009a). Improving digital skills for the use of online public information and services. *Government Information Quarterly, 26* (2), 333-340.

van Deursen, A. & van Dijk, J. (2009b). Using the Internet: Skill related problems in users' online behavior. *Interacting with Computers, 21* (5-6), 393-402.

Vicente Cuervo, M.R. & López Menéndez, A.J. (2006). A multivariate framework for the analysis of the digital divide: Evidence for the European Union-15. *Information & Management, 43* (6), 756-766.

Vie, S. (2008). Digital divide 2.0: "Generation M" and online social networking sites in the composition classroom. *Computers and Composition, 25* (1), 9-23.

Vogelwiesche, U., Grob, A. & Winkler, B. (2006). Improving computer skills of socially disadvantaged adolescents: Same-age versus cross-age tutoring. *Learning and Instruction, 16* (3), 241-255.

Whaley, K. (2004). America's digital divide: 2000-2003 Trends. *Journal of Medical Systems, 28(2),* 183-195.

Wareham, J., Levy, A. & Shi, W. (2004).Wireless diffusion and mobile computing: implications for the digital divide. *Telecommunications Policy, 28* (5-6), 439-457.

Warren, M. (2007). The digital vicious cycle: Links between social disadvantage and digital exclusion in rural areas. *Telecommunications Policy, 31* (6-7), 374-388.

Waverman, L., Mesch, M. & Fuss, M. (2005). *The Impact of Telecoms on Economic Growth in Developing Countries*. In: Vodafone policy paper series (no.2), Africa: The impact of mobile phones (pp. 10-24). Retrieve October 07, 2011 from http://www.vodafone.com/center/index/about/about/_us/policy/policy_papers.html

Waycott, J., Bennett, S., Kennedy, G., Dalgarno, B. & Gray, K. (2010). Digital divides? Student and staff perceptions of information and communication technologies. *Computers & Education, 54* (4), 1202-1211.

Wetzl, A. (2010). Digital education in Eastern Europe: Romania's modern affair with technology. *Computers and Composition, 27* (2), 112-123.

Wijers, G.D.M. (2010). Determinants of the digital divide: A study on IT development in Cambodia. *Technology in Society, 32* (4), 336-341.

Wilbon, A.D. (2003). Shrinking the digital divide: The moderating role of technology environments. *Technology in Society, 25* (1), 83-97.

Winker, G. (2005). Internet research from a gender perspective searching for differentiated use patterns. *Journal of Information, Communication & Ethics in Society, 3*(4), 199-207.

Wong, P.-K. (2002). ICT production and diffusion in Asia digital dividends or digital divide? *Information Economics and Policy, 14* (2), 167-187.

Wood, L.E. (2008). Rural broadband: The provider matters. *Telecommunications Policy, 32*(5), 326-339.

Xia, J. (2010). Linking ICTs to rural development: China's rural information policy. *Government Information Quarterly, 27* (2), 187-195.

Xia, J. & Lu, T.-J. (2008). Bridging the digital divide for rural communities: The case of China. *Telecommunications Policy, 32* (9-10), 686-696.

Xiong, J.A. (2006). Current status and needs of Chinese e-government users. *The Electronic Library, 24* (6), 747-762.

Yap, A., Das, J., Burbridge, J. & Cort, K. (2006). A composite-model for E-commerce diffusion: Integrating cultural and socio-economic dimensions to the dynamics of diffusion. *Journal of Global Information Technology Management, 14*(3), 17-38.

Yartey, C.M. (2008). Financial development, the structure of capital markets, and the global digital divide. *Information Economics and Policy, 20* (2), 208-227.

Yu, L. (2010). How poor informationally are the information poor? Evidence from an empirical study of daily and regular information practices of individuals. *Journal of Documentation, 66* (6), 906-933.

Yuguchi, K. (2008). The digital divide problem: An economic interpretation of the Japanese experience. *Telecommunications Policy, 32* (5), 340-348.

Zhao, H., Kim, S., Suh, T. & Du, J. (2007). Social institutional explanations of global internet diffusion: A cross-country analysis. *Journal of Global Information Technology Management, 15*(2), 28-55.