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Digital Distance and Economic Development in Southeast Asia

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DIGITAL DISTANCE AND ECONOMIC DEVELOPMENT IN SOUTHEAST ASIA

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Abstract

In the global financial system the economic strength, competency, and development of national economies and populations is significantly affected by the availability and use of Information Communication Technology (ICT). While the wealthier, industrialized nations enjoy the widest availability and use of these key technologies, the capacity and access to ICT is limited in developing nations and least developed countries (LDCs). Consequently, the lack of technology in many Southeast Asian countries may contribute significantly to their status as underdeveloped nations with impoverished economies and populations. This study explores the extent to which key social, economic, ethno-linguistic and infrastructure indicators outlined in the model for determining factors that contribute to digital divide proposed by Kallol Bagchi (Bagchi, 2005, Factors contributing to global digital divide: Some empirical resutls) contribute to digital distance. Furthermore, this study compares the performance of these indicators in the Organization for Economic Cooperation and Development (OECD) and the Association of South East Asian Nations (ASEAN) for the years 2003 and 2005. The study concludes that the majority of factors tested correlated to digital distance for both the OECD and ASEAN nations and that the performance of these factors was consistent for both years studied. However, differences in the effect of the level of secondary education, inflation, and degree of urbanization were also observed between the two groups of nations and opportunities for further research presented.

Dedication

This dissertation is dedicated to my husband, Don, whose love, support, resilience, and steadiness are a constant blessing and encouragement to me in all my endeavors; and to my sons, Caleb and Gabriel, for their patience and perseverance.

Acknowledgments

I would like to acknowledge my dissertation committee chair, Dr. Raj Singh, and committee members, Dr. Cyd Strickland and Dr. Tarique Hossain, for their insightful, encouraging, and pragmatic guidance in the development and completion of this dissertation. I genuinely enjoyed working with each of you and am grateful for the time and input you shared with me on this dissertation adventure.

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CHAPTER 1. INTRODUCTION

Introduction to the Problem

In the global economy, the use of information technology (IT) appears to contribute significantly to the economic competency, strength, and development of the industrialized nations. Consequently, the lack of technology in developing nations in Southeast Asia may contribute significantly to their status as under developed nations with impoverished economies and populations, potentially, contributing to an ever-widening global *digital divide*. The potential unavailability of technology to promote economic development may hinder the economic growth, stability, and participation of developing nations in Southeast Asia in the global economy. This study explores the extent to which a relationship exists, if any, between potential contributing factors of digital distance with regard to Southeast Asian developing nations and Organization for Economic Cooperation and Development (OECD) developed economies.

Background of the Study

The concept of the digital divide has been explored by many scholars in recent years (Kvasny & Keil, 2002; Norris, 2001). James (2007) defined the *digital divide* as the difference in the level of benefit experienced by those who possess and use information communication technology (ICT) and those who do not. However, according to Hoffman and Novak (1998), the nature of the digital divide is still up for debate in academic circles. According to their research, the nature of the digital divide is viewed primarily

from one of two perspectives: either as an ongoing reality to contend with or as an alterable socioeconomic disadvantage that can be overcome. Additionally, Bagchi (2005) proposed that the digital divide can be viewed within two distinct contexts: as a comparison of ICT benefits between nations and national economies or as a comparative measurement between people groups within a nation.

James (2007), the United Nations (2007, 2009b), and United Nations Development Program (2008), and the International Telecommunications Union (ITU) (2007) further asserted that ICT is a general purpose technology because of the significant affect it can have on the overall productivity, efficiency and well-being of citizens. Spinello (2005) also asserted that due to the interconnectivity between nations and the vast extent to which ICT can benefit the people of less developed nations, the developed nations have an urgent responsibility to assist in increasing Internet diffusion (ICT availability and usage) in developing economies. Furthermore, the International Telecommunications Union (ITU, 2007) determined that there is a correlation between ICT utilization and economic growth. However, although the economic position of developing nations in the global economy is an acknowledged topic of concern (World Development Bank, 2006), the extent to which digital distance affects economic development is not fully known.

Zhao, Kim, Suh, and Du (2007) asserted that Internet diffusion (and consequently the degree of digital divide) may be affected by many factors such as economic capacity, social and cultural attitudes, social and regulatory institutions, infrastructure, and the national education system within a country. Additionally, the Bagchi (2005) model of digital divide measurement has identified key economic, social, ethno-linguistic, and

infrastructure factors that may affect the digital distance of a nation. Digital divide between nations is most commonly evaluated using the 50 distinct factors implemented by the United Nations and included in the Millennium Development Goals for 2015 (ITU, 2007; United Nations, 2009b).

The extent to which key contributing factors to digital distance have been shown to differ between industrialized and developing nations has not been quantified (Bagchi, 2005). However, distinct differences are known to exist between the digital skills (James, 2007), role of government in embracing or restricting Internet diffusion (Van Gelder, 2005), and the extent to which the mobile phone is used as the primary source for accessing ICT (ITU, 2007; James, 2007). Within this context, both academic research and industry reports have shown that the use of ICT, the role of government in promoting or limiting Internet access, and the use of mobile telephones differs between industrialized nations and the developing nations of Southeast Asia (ITU, 2007; James, 2007).

Furthermore, digital divide is viewed as a complex sociological phenomenon (Bagchi, 2005). In this theoretical context, the primary contributing factors to digital distance in Southeast Asia have not been clearly defined in the body of knowledge to date.

Statement of the Problem

The use of ICT contributes significantly to the economic competency, strength, and development of the industrialized nations whereas the capacity and access to ICT is limited in developing nations and least developed countries (LDCs). Consequently, the lack of technology in much of Southeast Asia may contribute significantly to their status

as under developed nations with impoverished economies and populations, potentially, contributing to an ever-widening global digital divide.

Currently, the economic position of developing nations and LDCs in the global economy is an acknowledged topic of concern (World Development Bank, 2006). The use and access to ICT has been identified as an important factor in the United Nations Millennium Development Goals for 2015 (World Development Bank, 2009) and a key measurement in the United Nations Brussels Program of Action for the Least Developed Countries. Additionally, the Bagchi (2005) model of digital divide measurement has identified key factors that may affect the digital distance of a nation. According to Bagchi, the degree to which key contributing factors to digital distance have been shown to differ between industrialized and developing nations has not been quantified. In this theoretical context, the primary contributing factors to digital distance in Southeast Asia have not been clearly defined in the body of knowledge to date.

This problem impacts the developing nations in Southeast Asia in the global economy because the potential unavailability of technology to promote economic development may further hinder the economic growth, stability, and participation of these developing nations in the global economy. Furthermore, the level of development of the national economies in Southeast Asia varies significantly. However, these economies can be evaluated in three distinct categories: S.E. Asian High Income Economies (Singapore and Brunei Darussalam), S.E. Asian Developing Nations (Thailand, Viet Nam, Indonesia, Malaysia, and The Philippines.), and S.E. Asian LDCs (Myanmar, Cambodia, and Loa People's Democratic Republic).

There are many possible factors contributing to the inequity in Internet diffusion, technology adoption, and progress toward alleviating the digital divide, among which are economic capacity, social and cultural attitudes, infrastructure, social and regulatory institutions, and the efficacy of the national educational systems.

This research project contributes to the body of knowledge needed to address this problem by providing a quantitative analysis of potential key indicators that affect digital distance in the national economies in Southeast Asia. More specifically, this study attempted to answer the following research questions:

1. For the entire group of all OECD and Association of Southeast Asian Nations (ASEAN) member nations, what economic, infrastructure, social, and ethno-linguistic indicators contribute to digital divide?

2. Are there differences in the indicators that contribute to digital divide for the industrialized OECD member countries and the developing economies of the ASEAN member nations?

3. Has the relationship of digital divide indicators changed over time for developing and industrialized nations in this population?

Purpose of the Study

The purpose of this study was to examine factors that contribute to the digital divide in the Southeast Asia and to compare/contrast the contributing digital distance factors in the Association of Southeast Asian (ASEAN) member nations to those of the 32 wealthiest, industrialized OECD nations.

Rationale

It was expected that this study would result in a greater understanding of the relationship between the availability of technology, the degree of digital distance, and the economic performance of countries in the impoverished regions of Southeast Asia. It was

hoped that this quantitative analysis would contribute empirical results to aid in developing a greater understanding of digital distance in Southeast Asia so that further work may be performed into how digital distance affects the developing economies in Southeast Asia, and perhaps, eventually into how to begin addressing the digital distance/economic development issues and opportunities there.

Research Questions

This research project contributes to the body of knowledge needed to address this problem by providing a quantitative analysis of potential key economic, social, and infrastructure indicators that affect digital distance in the national economies in Southeast Asia. More specifically, within the context of this study, the digital distance factor of a nation was determined through a principal component analysis of mobile phone subscriptions, number of computer users, number of Internet users, and number of telephones as compared to the same availability of these information technologies in the United States. The economic indicators of gross domestic product (GDP) and inflation were considered for their potential affect upon digital distance. The infrastructure indicator of availability of electricity; social indicators of income inequality, secondary education average, illiteracy level, and urbanization level; and ethno-linguistic indicator of ethno-linguistic fractionalization (ELF) were also considered. This study addressed the following research questions and tested the following hypotheses:

Research Questions and Hypotheses

Research Questions

1. For the entire group of all OECD and ASEAN member nations, what economic, infrastructure, social, and ethno-linguistic indicators contribute to

digital divide?

2. Are there differences in the indicators that contribute to digital divide for the industrialized OECD member countries and the developing economies of the ASEAN member nations?

3. Has the relationship of the digital divide indicators changed over time for developing and industrialized nations in this population?

Hypotheses

The following hypotheses were derived from the first research question:

- $H1_0$: There is no significant difference between economic indicators of GDP per capita and inflation; infrastructure indicator of availability of electricity; social indicators of income inequality, secondary education average, illiteracy level, urbanization level, and ELF index rating, and digital distance for the group of all nations.

- $H1_A$: There is a significant difference between economic indicators of GDP per capita and inflation; infrastructure indicator of availability of electricity; social indicators of income inequality, secondary education average, illiteracy level, urbanization level, and ELF index rating and digital distance for the group of all nations.

The second research question was addressed by the following hypotheses:

- $H2_0$: There is no significant difference between economic indicators of GDP per capita and inflation; infrastructure indicator of availability of electricity; social indicators of income inequality, secondary education average, illiteracy level, urbanization level, and ELF index rating and digital distance for OECD and ASEAN member nations.

- $H2_A$: There is a significant difference between economic indicators of GDP per capita and inflation; infrastructure indicator of availability of electricity; social indicators of income inequality, secondary education average, illiteracy level, urbanization level, and ELF index rating and digital distance for OECD and ASEAN member nations.

Research Question 3 was evaluated in terms of the following hypotheses:

- $H3_0$: There is no significant difference in the interaction of economic, social, infrastructure, and ethno-linguistic indicators and digital distance for the years 2003 and 2005.

- $H3_A$: There is a significant difference in the interaction of economic, social, infrastructure, and ethno-linguistic indicators and digital distance for the years 2003 and 2005.

Significance of the Study

Although previous research has been performed using the digital distance model applied in this study (Bagchi, 2005) to the OECD nations and the Economic Commission for Latin America and the Caribbean (ECLAC) countries, this model for determining factors that affect digital distance has not been applied to compare the developing, ASEAN member economies in Southeast Asia to the industrialized OECD nations. There are relatively few quantitative analysis studies of digital distance factors. This study contributes to the body of knowledge by providing a quantitative analysis of potential key indicators that affect digital distance in developing economies in Southeast Asia. This research provides a degree of quantitative insights that could be used to further the exploration into the relationship of digital distance in economic development in Southeast Asia.

Definition of Terms

For purposes of this study, key terms are defined as follows:

Association of Southeast Asian Nations (ASEAN). Member nations include Indonesia, Malaysia, Philippines, Singapore, Thailand, Brunei Darussalam, Viet Nam, Lao PDR, Myanmar, and Cambodia(Onn,Menan,Ananta,Phouphet,Kwek &Than ,2009).

Digital distance. The difference in the value of the Information Technology (IT) Index (comprised of Internet, PC, cell phone, and telephone adoption data) of a nation from that of the United States (Bagchi, 2005).

Ethno-Linguistic Fractionalization Index (ELF). Used to describe the ethno-linguistic diversity of the world population. The ELF Index describes the likelihood that two people chosen at random in the same country would not be from the same ethno-linguistic people group. Developed by Soviet Socialist Republic scientists in 1964, calculated by Charles L. Taylor and Michael C. Hudson in 1976, the ELF Index became a standard for measuring ethnic diversity in economics when introduced by Pablo Mauro in 1995 (Roeder, 2001).

Information and Communications for Development Database (IC4D). A publication providing information and a database delivering data on the role of information technology (IT) and communication in development efforts worldwide (World Development Bank, 2005).

Information communication technology (ICT). Telecommunications and information technology (IT) infrastructure, often measured in terms of cellular phone subscriptions, telephone lines, Internet usage, and personal computer users(James, 2007, ITU,2008, Tipton, 2002,).

Information Technology (IT) Index. A comparison of each nation's access to telephone, cell phone, personal computer, and Internet usage per 1,000 population compared to access to the same technology in the United States (Field, 2002).

Least developed countries (LDCs). Countries identified by the United Nations as the poorest and weakest members of the international community and, therefore, also the most vulnerable. These countries have been determined to have low income; human resource weakness; and economic, social, and environmental vulnerability (United Nations, 2007).

Millennium Development Goals. A list of worldwide development goals agreed to by all of the countries of the world. These goals target the elimination of poverty, provision of universal education, elimination of gender inequality, improvement of child and maternal healthcare, combat of HIV/AIDS, promotion of environmental sustainability, and provision of global partnership (United Nations, 2009b).

Millennium Development Goals (MDG) Database. A database consisting of national statistical information regarding key areas for measuring current conditions and progress toward the 2015 Millennium Development Goals provided by the World Bank Development Group (United Nations, 2009a).

Organization for Economic Cooperation and Development (OECD). A group of 32 industrialized nations who foster prosperity and fight poverty through economic growth and financial stability. OECD member nations are Australia, Austria, Belgium, Canada, Chile, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, Korea, Luxembourg, Mexico, the Netherlands, New Zealand, Norway, Poland, Portugal, Slovak Republic, Slovenia, Spain, Sweden, Switzerland, Turkey, United Kingdom, and the United States (Organization for Economic Cooperation and Development, 2005).

Partnership on Measuring ICT for Development. An international, multi-stakeholder initiative launched in 2004 to improve the availability and quality of ICT data and indicators, particularly in developing countries (United Nations Center for Technology Development, 2009).

United Nations Conference on Trade and Development (UNCTAD). Established in 1964 by the general assembly of the United Nations. UNCTAD promotes the

integration of developing countries into the global economy. (United Nations Conference on Trade and Development (United Nations Conference on Trade and Development, 2002).

Assumptions and Limitations

The IT Index rating and economic development measurements for each group of nations studied will be analyzed to determine their impact on digital distance (Field, 2002). It is assumed that the World Bank, United Nations, and Asia Development Bank statistics used are an accurate representation of the identified subject populations.

Limitations to this study include that the IT indexes were calculated from a sampling of data from developing nations in ASEAN and could have produced results that may or may not be representative of economic development in other impoverished regions of the world. Also, there are many factors that could affect digital distance. Additional population demographics such as gender and age disbursement for the national populations that could affect digital distance are in some instances unavailable and, therefore, not included in the scope of this study. Literacy data for the year 2003 is unavailable for many nations considered in this study. Therefore, a comparison of the literacy rate for the years 2003 and 2005 was not performed.

World Values Survey data has not been collected and therefore, is not available for four of the 10 ASEAN nations included in this study. Additionally, the alternate use of Hofstede's (2001) value dimensions data is also not available for all of the ASEAN member nations. As a result, the trust variable measured in the original Bagchi (2005) model for determining digital distance was not included in this study. Finally, data depicting the Internet Communications Technology expenditures as a percentage of GDP

is not available for Cambodia, Lao People Democratic Republic, or Myanmar for the years 2000 through 2009. Therefore, the potential effect of government ICT expenditures on digital distance and the unique approach to trust within these societies was not addressed within the scope of this study. In light of these limitations, this model focused on the potential difference that GDP, inflation, level of electricity, income inequality, secondary education, illiteracy, urbanization and ethno-linguistic fractionalization may have on digital distance within the Southeast Asian ASEAN member nations compared to the effect of the same variables on OECD nations. Consequently, significant opportunities for further research exist in the collection and assessment of World Values Survey data for the Southeast Asian cultures and by extension, how attitudes toward trust may affect the adoption and use of ICTs across the Southeast Asian region. Furthermore, although ICT as a percentage of GDP is included in the Millennium Development Goals (MDG) Database for all nations, it is not provided for many LDCs. Collection and reporting of this missing data would provide an opportunity to more fully explore the affect government ICT expenditures may have on national economic performance for developing nations in Southeast Asia and other regions.

Nature of the Study

The data collected and analyzed for this study was downloaded directly from the World Bank, World Development Group, World Development Indicators (WDI), and Information and Communications for Development Database (IC4D) databases and derived from the ELF Index (Roeder, 2001). The data reviewed in this study constitutes a secondary data analysis of public information. Data was analyzed for the group of

countries in Southeast Asia that are classified by the United Nations as developing and least developed economies as well as for the 32 industrialized OECD nations.

Theoretical/Conceptual Framework

The conceptual framework of this study asserts the primer of the research occurs at the convergence of the role of technology in economic development, economic performance of developing economies in Southeast Asia in the global economy, and the digital distance (IT Index) of these economies. Bagchi (2005) yielded plausible results in determining significant factors affecting digital distance when applied to ECLAC and OECD nations. Zhao et al. (2007) proposed that Internet diffusion creates platforms for business and social interaction, and increases economic performance.

Tipton (2002) asserted that greater economic prosperity is enjoyed by those who have access to ICT than those who do not. Spinello (2005) linked digital distance to economic performance. James (2007) and the ITU (2008) proposed that access to ICT has vast potential to improve productivity, efficiency, and well-being for the general population.

The formation of the United Nations Center for Technology and Development in 2004 and ithe inclusion of ICT as a contributing factor in the United Nations Millennium Development Goals have identified access to ICT as a contributing factor in economic development and performance (United Nations Development Program, 2008).

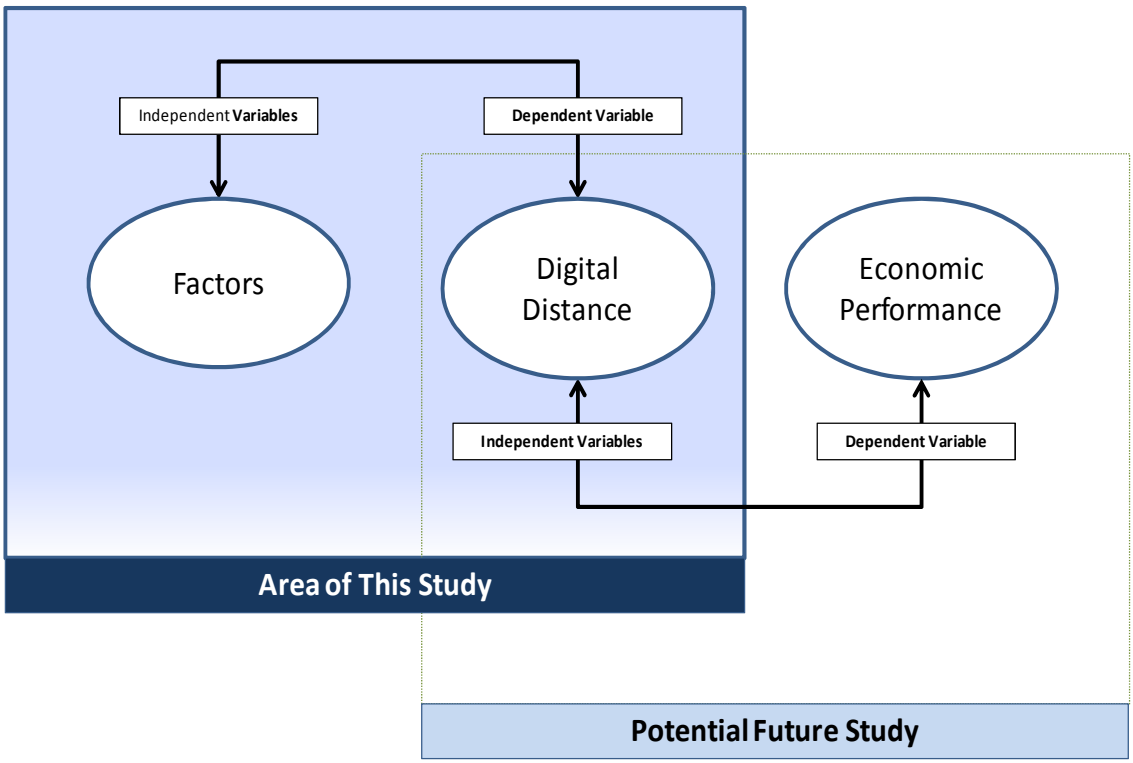

Figure 1. Conceptual framework.

Organization of the Remainder of the Study

This dissertation follows the traditional five-chapter dissertation format. Chapter 1 provides a brief introduction to the topic of the digital divide in Southeast Asia and a summary overview of the research to be performed. Chapter 2 consists of a review of pertinent literature related to this topic. The literature reviewed in Chapter 2 is organized into three categories: the role of technology in economic development, the national position within the global economy, and the digital divide factor. In Chapter 3, the quantitative research methodology and design are discussed in detail. In Chapters 4 and 5, the results of the study are shared, recommendations made, and areas of potential future study presented.

CHAPTER 2. LITERATURE REVIEW

There are many possible factors contributing to the inequity in Internet diffusion, technology adoption, and progress toward alleviating the digital divide, among which are economic capacity, social and cultural attitudes, infrastructure, social and regulatory institutions, and the efficacy of the national educational systems (Zhao et al., 2007). The literature reviewed was selected for its contribution to framing the discussion of the concept of the digital divide, digital distance, and technology's contribution to the field of economic development. Research into the economic condition of developing nations in Southeast Asia in the global economy and status of available technology in the countries reviewed were also considered.

The seminal works are presented to show the research and considerations that gave rise to the concepts of the digital divide and economic development. Subsequent articles and case studies conveying factors associated with the digital divide and Internet technology's role in economic development in developing economies were also included to provide context. The relationship between these works is depicted in Figure 2.

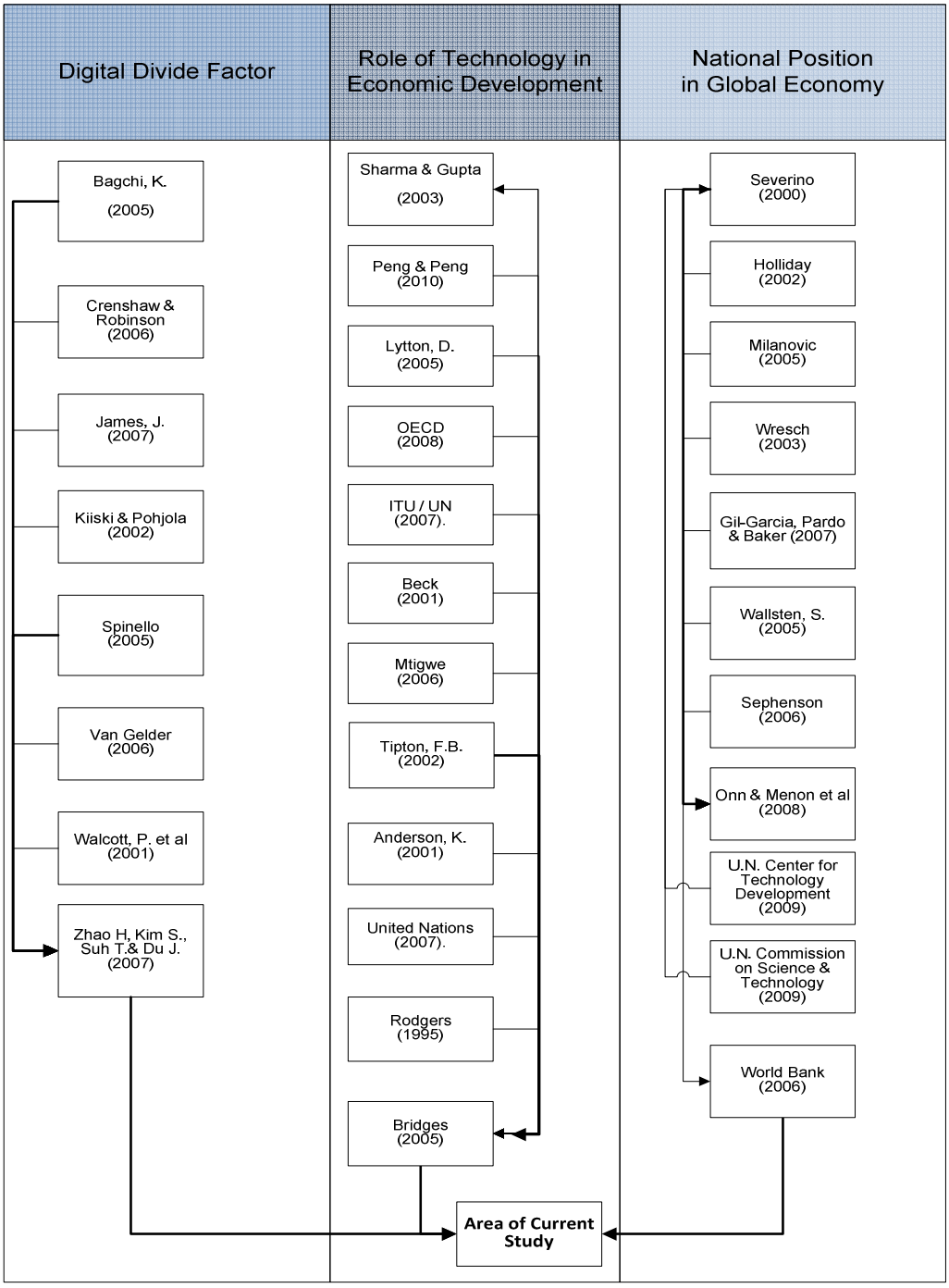

Figure 2. Seminal literature reviewed.

Digital Divide

The *digital divide* refers to the differing levels of benefit due to the production and use of information technology (IT), and more specifically, information communication technologies such as the mobile phones, computers, and the Internet, compared to those who do not (James, 2007). The digital divide in this study is discussed in two distinct contexts: as a comparison between countries and the benefits a nation experiences due to their Internet communications technology and as a comparative measurement between groups of people within a country as well (Bagchi, 2005).

The digital divide is in essence, a measurement of the difference in the benefit experienced by those who have and use IT and those who do not. Some scholars and policy makers have proactively addressed the information revolution and resulting IT as a general purpose technology, asserting its importance as a revolutionary technology that affects the entire economy by offering vast potential to improve productivity, efficiency and the overall well-being of the citizens of the country it is introduced into (ITU, 2007; James, 2007; United Nations, 2007, 2009b; United Nations Development Program, 2008).

As mentioned previously, digital divide research is often approached as a study of the digital divide between groups within a nation (News 2003) or as a comparison of the digital distance between multiple nations (Wolcott, Press, McHenry, Goodman, & Foster, 2001). Additionally, digital divide research may evaluate digital distance based on one or many distinct technologies. Many models and sets of technologies have been proposed for evaluating digital distance (Kiisiki & Pohjola, 2002). The most widely used set of technologies for evaluating digital distance on an international scale is the 50 key factors

for Internet diffusion used by the United Nations and prevalent in the Millennium Development Goals for 2015 (International Telecommunications Union, 2007; United Nations, 2007). Opinions vary regarding the importance of the digital divide and the degree of urgency in eliminating it. Milanovic (2005) identified that one perspective on the digital divide asserts that because there is not prevailing global society, any form of global inequality is irrelevant. Conversely, the United Nations, many scholars and policy makers function under the paradigm that being concerned with and addressing the digital divide is an ethical necessity. In this context, the necessity and urgency of eliminating the digital divide is driven by the interconnectedness of all nations and the responsibility of wealthier nations to ensure they do not perpetuate inequality on the societies or individuals in weaker, developing and least developed countries (LDCs; Spinello, 2005).

It is not uncommon for studies regarding the digital divide to focus on the "digital distance" (Bagchi, 2005, p.54) between individual industrialized nations such as the United States or groupings of industrialized nations such as the Organization for Economic Cooperation and Development (OECD) as a benchmark for measuring the Internet diffusion of developing and least developed nations (Bagchi, 2005).

However, it is also recognized that the digital divide is a complex sociological phenomenon. In response to the sociological aspects of the digital divide phenomenon, Bagchi (2005) proposed a model for measuring the digital divide that includes economic, social, ethno-linguistic, and infrastructure indicators.

In the case of Southeast Asia, 10 of the 11 SE Asian countries have become member nations of the Association of Southeast Asian Nations (ASEAN). The 10 ASEAN nations have realized the sociological factors involved in addressing the digital

divide and have established e-ASEAN to promote the coordinated development of Information Communications Technology and a new "knowledge society" (Severino, 2000, p. 84) in the ASEAN member countries. It is widely accepted that the digital divide is a very important phenomenon for developing nations to proactively address (James, 2007).

James (2007) asserted that the digital divide can be considered within a theoretical schema consisting of four sequential phases: generation of IT, diffusion of IT, impact of the digital divide, and policy towards the digital divide. Within these phases, there are specific issues that may arise. During the generation of IT issues related to the nature of technology and its role in relationships between technologically rich and poor populations. The diffusion of technology phases pose potential issues of how to measure the digital divide and what future course the digital divide phenomena will take. Considering the impact of the digital divide poses questions regarding the affect it may have on national poverty, wealth, and the potential marginalization of populations whereas policy toward the digital divide will be dependent upon how the previous three phases were approached and addressed. Based on the World Bank national income categories—high income, upper-middle income, low-middle income, and low-income, James compared the national level of economic development with their degree of information communication technology (ICT) diffusion. The results depict a tendency toward Internet diffusion to reflect a positive variance as national income category increases. James also compared changes in the degree of digital distance over time by comparing digital distance for the years 1994 and 2004. The trend depicted an increase in the number of ICT users in both wealthier and poorer nations and a reduction in the size

of the digital divide based upon Internet and mobile phone usage. However, the remaining gap was still significant, with Internet access being eight times more available in developed nations than developing countries and mobile phones being four times more accessible in developed nations than their developing nation counterparts.

Furthermore, James (2007) considered the potential effect of ICT diffusion on economic growth. Reiterating the general consensus that the implementation of information communications technologies has a positive effect on economic growth. However, he further asserts the economic benefit of ICTs is enhanced significantly when accompanied by a national approach to ICT infrastructure development. Citing the increased benefits enjoyed by the United States as compared to many European nations who achieved similar levels of ICT diffusion and the greater benefits experienced in Southeast Asian countries who invested in ICT infrastructure compared to their counterparts in Africa who also achieved similar increases in ICT but did not improve ICT infrastructure as significantly.

Martinez and Williams (2010) asserted that there are two competing approaches commonly applied to evaluating ICT diffusion and e-commerce: the concept of the role of institutional stability and the perspective of entrepreneurship theory. The theory of institutional stability promotes that stable, reliable and consistent institutions create the environment that constrains the activities of participants in ways that allow for the emergence and growth of e-commerce activity. Entrepreneurship theory asserts that where there are fewer limitations and more entrepreneurial attitudes, e-commerce and ICT will develop and expand in response to competition and in order to meet market expectations.

To test these competing theories, Martinez and Williams (2010) conducted a study utilizing data from the World Bank Development Indicators, CIA World FactBook, and Global Information Technology Report for 80 countries selected randomly.

Martinez and Williams (2010) hypothesized that ICT diffusion is associated with the institutional stability of a country, new business creation is associated with high ICT diffusion, positive relationship between institutional quality and ICT is stronger when new business creation is higher, developed economies will experience a positive correlation between institutional stability and new technology for emerging technologies but not for existing technology, and that developing countries will experience a positive correlation between institutional stability and mature as well as newer technologies.

The independent variables of interest were institutional quality as depicted in the averaged values of the World Governance Indicators for the years 1998–2006 for each country, and the new business density as reflected in the World Bank Group Entrepreneurial Survey data for number of new businesses divided by the number of working age individuals within a nation. Control variables used included economic status measured in terms of gross domestic product (GDP), market size derived from the national population as reported by the World Bank, and a dummy variable of 1 for OECD member nations and 0 for non-OECD countries.

To test these hypotheses, Martinez and Williams (2010) calculated the averaged for each independent variable for the years 2000–2006 for each of the 80 countries. This data was then used to conduct correlation analysis and multiple regression analysis. Their findings assert that GDP is positively correlated with ICT diffusion, that institutional quality has a strong correlation to ICT diffusion, but that the emergence of new business

had only a weak correlation. In addition, they also found that institutional quality has a strong affect upon the adoption of newer technology as well as mature technologies in developing countries.

Crenshaw and Robison (2006) conducted a study of 80 developing nations that measured the phenomenon of ICT diffusion in developing nations from a different perspective. Using longitudinal regression analysis for country data for the years 1995–2000, they measured NGO presence, foreign investment, export levels, tourism, political freedom, property rights and income levels and compared these variables to national income, telephone cost, education level, political structure, infrastructure and global contact for each country. Crenshaw and Robison's findings assert that global contact and national conduciveness to Internet contribute to ICT diffusion in developing countries. In addition their analysis yielded evidence that the presence of foreign investment, nongovernment organizations (NGOs), social democracy, exports, urbanization level, property rights and income may be predictive of ICT diffusion.

Bagchi (2005) asserted that the impact of economic, social, ethno-linguistic, and infrastructure variables may not be the same for all nations. Furthermore, the individual member countries of the ASEAN have approached the digital revolution and their nation's response to it very differently yielding results that vary dramatically between ASEAN member nations (Holliday, 2002; United Nations Development Program, 2008). The World Bank and United Nations also acknowledge that LDCs experience unique challenges in closing the gap and addressing the impact of the digital divide on their economy and population. This realization prompted the inclusion of ICT development

goals in the Least Developing Countries Brussels Program for 2001–2010 and the United Nations Millennium Development Goals for 2015 (United Nations, 2009b).

The ASEAN member nations of Cambodia, Lao People's Democratic Republic, and Myanmar are categorized by the United Nations as LDCs and as such are the focus of specific development goals for increasing ICT access in the form of increased access to fixed and mobile telephone services, as well as increasing the number of computer and Internet users (United Nations, 2007).

The 2007 United Nations Statistics Millennium Indicator Dataset indicates that only 3.6 out of every 1,000 Cambodia citizens had a personal computer in 2006 and only 4.8 out of every 1,000 people in Cambodia used the Internet as recently as 2007. People in Myanmar are reported to have higher instances of computer usage than those in Cambodia at 8.8 out of every 1,000 people in 2006. But, Myanmar experienced lower numbers of people who were Internet users than either Cambodia or Lao PDR at 0.83 people out of every 1,000 in 2007. Conversely, the Lao People's Democratic Republic reported that 16.9 out of every 1,000 people had a personal computer in 2005 and 17.1 out of every 1,000 people used the Internet in 2007.

It is important to note that significant differences have been identified in the user capabilities present in the populations of industrialized nations, developing nations, and LDCs. There is evidence that the digital skills of people in developing nations and LDCs are vastly less than those of the general population in industrialized nations (James, 2007). Hargittai (1999) asserted that the gap between the digital skill level of people in the industrialized nations and that of their counterparts in developing and least developed nations is in essence a second digital divide because having access to the information

communication technologies while lacking the digital skills to capitalize on their use also results in a gap in benefits for the population. The reduced digital skills of the general population of developing and least developed nations is not surprising considering the significantly lower access to ICT and the lack of time and resources to devote to ICT caused by the poverty they experience. Yet the obstacle caused by their reduced level of digital skills is very real and limits the country's ability to realize the potential benefits of IT.

Furthermore, the role of government in embracing or restricting Internet access may also be a significant factor in the degree of Internet diffusion experienced by their populations (Van Gelder, 2005). However, there have also been recent discussions about the merit of alternative strategies and technologies that appear to assist with mitigating many of the infrastructure and technology, challenges in LDCs (James, 2007). It has been proposed that innovations in information technologies and institutions that focus on the specific needs of the world's poor may be the most likely venue for more fully and expediently bridging the digital divide (James, 2007).

The introduction of the mobile phone in Southeast Asia and other developing and least developed nations has provided for a rapid increase in the level of technical skills and a very quick reduction in the digital divide for many LDCs. In addition, recent research has indicated that previously held assumptions that ICT adoption in developing nations would mirror that of their use in industrialized countries may in essence limit the effectiveness of Internet diffusion in developing nations and LDCs (James, 2007).

The recent explosion in mobile phone services across the developing world is an example of technology delivery that meets the real conditions and needs of the

developing world populations better than the industrialized nations' assumption that phone and Internet service would out of necessity evolve through the installation of fixed telecommunications and broadband connectivity. It is the simplicity of use and availability of mobile phone services in areas where fixed telecommunications lines are not accessible or affordable that have aided in the vast expansion of Internet communications technology in many developing countries. The introduction and adoption of the mobile phone, is a successful example of IT diffusion that has had a relevant and very positive effect on growth in developing countries (International Telecommunication Union, 2007; James, 2007).

Waverman, Meschi, and Fuss (2005) determined that mobile phone usage in developing countries has a positive and significant impact on economic growth. Waverman et al. studied the 102 member nations of the International Telecommunications Union whose populations had less than eight fixed-line telephones per 100 people and for whom the use of mobile phones was virtually nonexistent in 1995. Waverman et al. compared the 1995 data to the number of fixed and mobile phone lines per 100 people for the same countries in 2003.

The average number of phones for these nations collectively in 1995 was 2.5 for every 100 citizens (Waverman et al., 2005). However, this changed significantly with the rapid introduction of mobile phones between 1995 and 2003. In 2003, the average number of mobile phones alone per 100 people for the same population was 8, and increases in fixed-line phone access were between 0 and 18 phones per 100 people. In addition, countries that experienced the greatest amount of fixed-line telephone growth

also experienced very large increases in mobile use between 1995 and 2003 (Waverman et al., 2005).

However, upon review of the data compiled by Waverman et al. (2005), evidence of a divide was still apparent in the data. The data reflected that 22 nations experienced double-digit growth in mobile phone usage whereas 32 economically similarly situated countries experienced 2% or less growth in mobile phone use for the same period. In response to this difference, Waverman et al. further proposed that if existing gaps in the availability and use of mobile phones in developing countries persist, this gap will contribute to a significant difference in the growth rates for the affected developing nations.

According to the World Summit on the Information Society, the digital divide appears to be shrinking (United Nations Commission on Science and Technology for Development, 2009). In addition, Fink and Kenney (2002) proposed that the most striking characteristicof the digital divide is not its vast size or potential impact but how quickly it is closing. In addition, the ITU and some scholars asserted that the use of mobile telephones and other alternative Internet technologies may cause developing countries to experience a leapfrog affect, catapulting the advancement of their ICT forward at rates that are much more accelerated than those of the industrialized nations (ITU, 2008; James, 2007). The World Information Society 2007 Report (International Telecommunications Union, 2007) asserted that developing countries are increasing their access to telephone lines, mobile telephony, Internet usage, and broadband connectivity. The report further identified that LDCs are also making substantial progress in advancing access to mobile telephones, Internet, and even some progress toward broadband

connectivity. Conversely, the report also identifies that LDCs are being left behind due to their lack of fixed telephone lines as compared to the industrialized OECD nations.

The ITU (2007) estimated that by the end of 2008, more than half of the world's population will have access to a mobile phone. It is also important to note that Internet usage is on the rise in developing nations resulting in a narrowing of the digital divide in terms of Internet usage as well (International Telecommunications Union, 2007). The ITU further identified the "digital opportunity" (p.11) of each nation in their 2007 report. Digital opportunity is defined as the potential to fill the gap between Internet communications technology availability and forecast demand. Of the 181 nations considered, the digital opportunity rankings for the countries in Southeast Asia were widely dispersed, ranking between fifth and 179th out of 181 nations. The individual country rankings for digital opportunity in Southeast Asia are as follows: Singapore, fifth; Brunei Darussalam, 43rd; Malaysia, 57th; Thailand, 82nd; The Philippines, 101st; Indonesia, 116th; Viet Nam, 126th; Cambodia, 149th; Laos People's Democratic Republic, 150th; and Myanmar, 179th (International Telecommunications Union, 2007).

Furthermore, three Southeast Asian countries (Indonesia, Thailand, and The Philippines) ranked among the top 20 largest mobile phone markets in the world (International Telecommunications Union, 2007). However, as indicative of the shortage of fixed telephone lines in the developing and least developed nations in Southeast Asia, none of the Southeast Asian countries placed among the top 20 largest broadband markets globally (International Telecommunications Union, 2007).

Role of Technology in Economic Development

In the global economy, the use of telecommunications and IT appears to contribute significantly to the economic competency, strength, and development of the industrialized nations. Consequently, in 2006, the number of Internet subscribers in the world's 30 most economically affluent nations, member nations of the OECD, climbed to 309 million people and the United States was the largest user of broadband Internet services in the world with over 70 million broadband subscribers (OECD, 2008). In addition, 79% of businesses with 10 or more employees in OECD nations had a broadband connection in 2007. Conversely, for the world's developing and least developed nations, the Internet-based economic and social structures of the new Information Age also carry the challenge of overcoming the digital divide that threatens to widen the gap between those who enjoy economic prosperity and those who do not (Tipton, 2002). More specifically, Internet commerce has had a dramatic effect upon socioeconomic factors in a developing country as well as how firms perceive and carry out their business operations (Sharma & Gupta, 2003).

Sharma and Gupta (2003) conducted a study involving 500 respondents from four major urban cities and eight semi-urban areas in India. Participants were given a survey and 300 of the 500 were interviewed in person as well. Sharma and Gupta asked a series of questions designed to determine the socioeconomic impact of e-commerce adoption. The model proposed that the socioeconomic impact of e-commerce adoption could be assessed through measuring the degree of digital divide, marginalization of socioeconomically disadvantaged populations, social disparities and income distribution, social isolation, loss of individuality or privacy, influence on values, influence on

productivity and competitiveness, employment and community impacts, impacts on tax, trade, employment, and labor policy, and the impact on prices and small enterprises.

The results of Sharma and Gupta's (2003) study provide a framework for assessing and measuring the socioeconomic effects of ICT adoption on developing countries. Sharma and Gupta's research concluded that the use or lack of access to the Internet intensifies the socioeconomic differences between businesses, nations, and their citizens. Sharma and Gupta's findings further asserted that gaps in the adoption of ICT was evident for individuals and firms based on income level, education, and gender. Firms were also affected by industry, location and size of the firm, with larger, more profitable firms having greater access to ICT.

Sharma and Gupta's (2003) findings also concluded that ICT adoption results in an increased marginalization of specific segments of Indian society. Where higher income individuals can afford access to the Internet and lower socioeconomic groups cannot. Within the context of their study, Sharma and Gupta also found that the increase in productivity and competitiveness possible through the use of e-commerce was distributed disproportionately toward the larger or largest firms resulting in only mild productivity and competitive advantage benefits experienced by the smaller firms engaged in e-commerce. E-commerce was also found to cause significant shifts in the skill sets required for employment and a reallocation of labor based on the availability and importance of the new technology skill sets. In addition to proposing a model for assessing the socioeconomic impact of ICT adoption in developing countries, Sharma and Gupta also emphasized important aspects of the nature of Internet diffusion that are interesting within the larger, global context.

For purposes of this research, Sharma and Gupta's (2003) findings that ICT diffusion is most available and beneficial to the more socioeconomically advantaged populations and lack of ICT may marginalize the least socioeconomically advantaged, contributes to the larger discussion of whether ICT diffusion may benefit the socioeconomically advantaged populations globally in a similar manner and lack of ICT diffusion may marginalize the socioeconomically disadvantaged populations globally. Consequently, the independent variables in this study include socioeconomic indicators to explore this concept for the population of the Southeast Asian ASEAN member nations.

The IT revolution is viewed as equivalent in importance to the industrial revolution. In this context, IT has been identified as a general purpose technology due to the extensive potential it has to transform business and communications on a multifaceted level (James, 2007). From a technology perspective, a core group of ICTs has been identified that promote access to Internet commerce solutions and opportunities. These ICTs generally include telecommunications and IT infrastructure (Sharma & Gupta, 2003).

The use of ICTs has been widely expanded nationally and internationally in recent years. These technologies have revolutionized the way business, economic prosperity, and communications practices are perceived and addressed on a global level (Sharma & Gupta, 2003).

Tipton (2002) discussed the role of Asian governments in the development of ICT across Asia. Providing a historical review and comparative analysis of the role of governmental organizations and departments in the diffusion of information and

communication technology (ICT) in China and Singapore compared to the Internet diffusion efforts of the governments of Thailand, Malaysia, Viet Nam, and The Philippines. Further, Tipton asserted that the role of government is recognized by the United Nations and Asian regional governments as an essential component in ICT development for developing and least developed nations as evidenced in "The East Asian Miracle" (Tipton, 2002, p.89).

In 1998 and 1999, China and Singapore had each made a public commitment to international cooperation in the development of ICT within their countries. Singapore created the national Infocommunications Development Authority (IDA) and China implemented the Ministry of Information Industry (MII). With the introduction of each of these national ICT development departments, China and Singapore had proactively implemented specialized government pilot agencies provided with specialized staff, adequate resources and possess superior analytical capacity and provide policy advice and direct administrative responsibility for ICT and economic development coordination. In addition, Singapore's Economic Planning Board (EPB) and the ensuing national initiative to pursue ICT development and create a commerce hub for the region is promoted as a model for ICT development. In 1998, the Chinese MII, modeled after the successful MII implemented in Japan in 1968, began actively pursuing ICT development through collaboration with other Chinese government departments such as the Nationwide Enterprise Informationization Working and Leading Team established by the Chinese ministry of science and technology and the state economic and trade commission (Tipton, 2002).

In comparison, in July 2000, Thailand introduced the e-Thailand initiative directed towards transforming Thailand into a knowledge-based economy with the public goal of transitioning from a dynamic adopter of ICT to a potential leader in the adoption and use of information and communication technologies. In 1991, Malaysia announced Vision 2020 and introduced the National Information Technology Agenda (NITA) (Tipton, 2002).

Malaysian development goals for the year 2020 include attaining developed country status through the application of ICT across the Malaysian economy and society. Viet Nam introduced a national Information Technology Master Plan in 2001 with the intention of extending ICT services across Viet Nam. The Viet Nam IT Master Plan is addressing ICT adoption challenges such as the need to expand telecommunications and Internet sectors, human resource development in ICT, as well as obstacles in the Vietnamese legal and regulatory environment (Tipton, 2002).

The Philippines implemented IT21: The National Information Technology Action Agenda for the 21st Century in 1998 and the Internet Strategy for The Philippines in 1999. Furthermore, the Philippine Electronic Commerce Act was also implemented in 2000, the Philippine Government Online initiative, and creation of a central committee for ICT development were also launched to further national ICT diffusion (Tipton, 2002).

The approaches to ICT have differed across the Southeast Asian nations considered in Tipton's (2002) review partly because of the differences in paradigm and style of government across the region. China and Viet Nam work within the context of their ruling political parties whereas Thailand, Malaysia, and Singapore's ICT policies operate in an environment of democratically elected and potentially changing political

leadership. In addition, Tipton reiterated that lack of established infrastructure is a prevalent source of challenges in ICT diffusion across rural Asia and Southeast Asia. Furthermore, Tipton proposed that the extent to which each country's national ICT development group is embedded and empowered by central authority to advise on national policy and administer ICT-related aspects within the country directly affect the degree of ICT diffusion success they produce.

Tipton's (2002) discussion of the approaches for implementing ICT provide context for considering the factors that contribute to ICT adoption and therefore digital distance in Southeast Asia. It is important to note that the status of Southeast Asian ASEAN member nations as high-income economies, developing nations, or LDCs occurs within a recent history of national efforts to implement wider Internet diffusion that have resulted in varying degrees of success. It is also interesting to note that countries who adopted a well-defined pilot agency approach to ICT diffusion have experienced significant economic growth and greater degrees of Internet diffusion simultaneously.

In *The Diffusion of Innovation* (Rogers, 1995), the adoption of new ICTs is evaluated in terms of diffusion. Yet, there are two distinct approaches to ICT diffusion. In the first approach, ICT diffusion is a measurement of the communication of the technologies through specific channels within a social system. In the second approach, ICT diffusion is viewed as a means of changing the organizations that adopts the ICTs. Regardless of the paradigm applied to ICT development, both conduciveness to Internet technology and external contact with potential partners and markets are important factors in effectively spreading Internet diffusion worldwide (Crenshaw & Robison, 2006). As Internet diffusion has been shown to create new platforms for business and social

interaction, it has become very important to understand the phenomenon of Internet diffusion (Zhao et al., 2007).

Furthermore, the body of research addressing the relationship between technology and other non-technological factors that affect Internet diffusion (and consequently, digital divide) is increasing. Zhao et al. (2007) posed a study to determine the most significant factors that contribute to Internet diffusion across a sample of 39 nations over a span of 9 years. This research determined that national legal systems, education systems and the degree of industrialization significantly increased the nation's degree of Internet diffusion. More specifically, Zhao et al. found that nations with stronger regulatory systems and institutions experienced much higher instances of Internet diffusion than those with less advanced or defined legal systems. In addition, the study found that the education systems of LDCs were lacking the capacity to educate students in the skill sets required for electronic commerce and Internet diffusion. Furthermore, countries with a higher level of industrialization not only required greater ICT but also provided greater opportunities for using and expanding ICT through their business interactions. National culture and the approach to individualism were identified as prevalent factors in the level of ICT adopted by a nation.

Although Hofstede's (2001) value dimensions are not available for many LDCs, Zhao et al. (2007) approached the potential impact of three of Hofstede's four cultural dimensions in the study (individualism, power distance, and uncertainty avoidance). Nations with a higher value on individualism tend to experience higher instances of Internet diffusion whereas nations with a high degree of uncertainty avoidance will experience lower rates of Internet diffusion. Finally, countries whose populations

perceive greater differences in the power or position of society members do not experience as high a degree of Internet diffusion as societies where members are perceived as more inherently equal.

Due to the varied political structures, approaches to individuality, power distance, and uncertainty found in the Southeast ASEAN member nations, the findings of Zhao et al. (2007) provide many interesting areas to consider beyond the infrastructure and economic indicators in evaluating ICT adoption in Southeast Asian ASEAN member nations.

However, quantitative research yielding empirical analysis is still less common in the study of Internet diffusion (Bagchi, 2005; Dutta & Roy, 2003; James, 2007). Much of the research identifies that GDP and the cost of Internet service appears to have a direct correlation on Internet diffusion in both industrialized and developing countries (Bagchi, 2005; Kiiski & Pohjola, 2002; Norris, 2001). However, there is also evidence that a combination of additional factors have an effect upon the speed and degree of Internet diffusion experienced in industrialized nations, developing nations, and LDCs (Bagchi, 2005; Zhao et al., 2007). Furthermore, Internet diffusion, technology adoption, and progress toward alleviating the digital divide has been shown to be affected by social and regulatory institutions, economic capacity, social and cultural attitudes and norms, as well as the educational systems (Zhao et al., 2007).

Zhao et al. (2007) conducted a review of secondary data derived from the World Development Indicators (WDI) database (World Bank, 2005) for the years 1995–2003 for 39 countries. The rate of Internet diffusion calculated in Internet users per 1,000 population was the dependent variable. Independent variables analyzed were rule of law

following the model of Kauffman &Techatassanasoontorn . (2005), economic institution was derived from government expenditures as a percent of GDP. Level of education and level of industrialization were also taken from the WDI database.

The findings support the concept that Internet diffusion factors differ between developed nations and LDCs because of inherent differences in the stability of the national legal system, education system, and cultural attitudes toward power/authority, individuality, and uncertainty avoidance.

Bagchi (2005) performed an empirical study comparing the factors that contribute to digital distance for the 30 wealthiest nations in the world (OECD nations) to those experienced by the 33 developed and developing economies of the Economic Commission for Latin America and the Caribbean (ECLAC) countries. Data from the World Bank database was analyzed for the years 1995 and 2001. The dependent variable digital distance and independent economic, social, infrastructure, and ethno-linguistic variables were identified and analyzed to determine differences in the factors that contribute to digital distance between the OECD and ECLAC nations.

The Bagchi (2005) study found that the factors affecting the degree of Internet diffusion in the ECLAC nations differ from those experienced by the OECD developed nations. In addition, Bagchi proposed that it is possible to establish policies to reduce the digital distance between developed and developing nations. The level of GDP was found to have the greatest effect on Internet diffusion across both populations studied. However, the level of education for ECLAC developing countries was found to be a significant factor in reducing digital distance whereas increases in the level of education in OECD nations had little impact. Personal wealth was also found to affect ICT for both OECD

and ECLAC nations. However, social attitudes about trust and personal wealth were among the more significant differences between developed and developing countries studied. In both instances, a higher degree of trust and personal wealth correlated to a lower digital distance.

The Effect of Digital Divide on National Position in the Global Economy

The potentially detrimental effect of low Internet diffusion on the economy and incomes of developing nations has been a point of concern for scholars and policy makers in recent decades (Wallsten, 2005). The apparent difference in the degree of Internet diffusion in the affluent, industrialized nations compared to the much lower rates of Internet diffusion in developing and least developed nations is the catalyst for an emergent and growing body of political and scholarly work. Abrahams, Parenzee, and Chong (2001) determined that e-commerce adoption results in increased participation and inclusion of some segments of the society in Internet communications while also increasing the degree to which others in the society are marginalized and excluded from information and communications. In addition, Beck (2001) proposed that every year that developing nations experience a lack of telecommunications service as compared to developed economies, they fall further behind the wealthier, developed nations. Furthermore, the ITU (2007) determined that there is a distinct correlation between ICT and economic growth.

Successful entry into Internet commerce presents an economic opportunity for both the developing and least developed nations to improve their economic conditions. Consequently, many developing and least developed nations are making significant investments in improving their telecommunications and IT infrastructure and promoting

the use of Internet commerce in their communities, governments and business sectors (Sharma & Gupta, 2003). This perceived opportunity has also prompted the United Nations to sponsor development programs, conferences and prepare global initiatives targeting the development of Internet diffusion and commerce in developing nations and LDCs (Wresch, 2003).

In response to the international consensus that ICTs are beneficial for economic growth, the United Nations established the United Nations Center for Technology and Development (UNCTAD). However, it was not until 2004 that UNCTAD implemented the Partnership on Measuring ICT for Development, expanding their scope to actively measure the availability and use of ICTs in developing nations (UNCTAD, 2009). The United Nations Conference on Trade and Development hosts conferences to specifically address LDCs and ecommerce. In 2004, the UNCTAD began gathering statistical data from the developing countries related to the availability and use of ICTs in their nations. The UNCTAD ICT data is compiled into an annual internationally available Information Economy Report (United Nations, 2009b).

According to the Millennium Development Goals Progress Report 2008 (United Nations, 2008) , there were 1.2 billion Internet users worldwide in 2006. Fifty-eight percent of people in developed countries used the Internet whereas only 11% of the people in developing countries use the Internet and significantly fewer—just 1%—of the people in LDCs used the Internet in 2006. The United Nations further asserted that the provision of Internet connectivity to the people of the developing world will help improve health, education, employment, and poverty reduction.

Furthermore, the importance of national participation in global Internet commerce is underscored by Castells' (2000) assertion that the ICT revolution is comparable to the importance of the industrial revolution of the 19th century. Consequently, Castells (2000) also proposed that the product of this ICT revolution is the information society.

In addition to the technological advances of the digital revolution and the emergence of the information age, there have also been significant changes in national governments in order to attempt to embrace and manage the information revolution and the realities of the new global economy (Anderson, 2001). The governments of OECD member nations acknowledge the benefit of ICT diffusion on economic position and actively pursue programs to develop, infrastructure, networks, and clusters to increase ICT usage and foster innovation in ICT for business use (Organization for Economic Cooperation and Development, 2005). Partnerships between government, academia, and industry are a common priority for many OECD nations. In addition more than 50% of OECD nations place a high value on the continuation of existing programs to increase Internet diffusion for individuals in addition to efforts to expand diffusion to firms and government entities (Organization for Economic Cooperation and Development, 2005).

In Southeast Asia, Singapore, Thailand, Malaysia, Viet Nam, and The Philippines have all developed targeted government offices and national plans for the development of greater ICT competencies and performance in Internet commerce (Tipton, 2002). Although, in many cases, these government agencies have received mixed results, the level of ICT in each country has increased noticeably since their creation (International Telecommunications Union , 2007).

Beyond the national focus, there are significant changes occurring at the international level as well. In addition to individual government programs designed to address ICT development, the ASEAN nations of Southeast Asia have also introduced a partnership program to develop knowledge communities (and greater ICT) referred to as *e-ASEAN* (Severino, 2000). E-ASEAN is intended to coordinate the ASEAN members' efforts to develop IT as well as a broader knowledge society across and within the 10 ASEAN member nations. The promise of a more dynamic and enriching economic reality for the member nations and citizens is central to the purpose of the e-ASEAN initiative (Severino, 2000).

There is a varied selection of academic research (Anderson, 2001; Beck, 2001; Bagchi, 2005; James, 2007; Tipton, 2002; Waverman et al., 2005; Wresch, 2003; Zhao et al., 2007) and government information (International Telecommunications Union2007; Severino, 2000; United Nations, 2009b; UNCTAD, 2009) to support the validity of this studies quantitative exploration of the phenomenon of digital distance and consideration of factors that may affect it within the Southeast Asian region and the ASEAN member nations specifically.

It is also important to note that this research occurs within a context where international government, national governments, academic research, and industry are publishing information and interacting simultaneously to evaluate, research, compile data and affect change in relation to ICT diffusion on the national, regional, and multinational scales.

As mentioned previously, the literature to date consists of three related but distinct areas of study that converge to provide a premise for this research study: The

assessment of the digital divide factor, the role of technology in economic development, and effect of the digital divide on national position in the global economy. Significant work by Bagchi (2005), James (2005), and Zhao et al. (2007) provide context regarding approaches to the nature of the digital divide and propose distinct economic, social, and infrastructure factors to consider in assessing this phenomenon. In addition, the model of measuring potential indicators of digital distance proposed and applied by Bagchi offers a foundation for using available data to explore the extent to which economic, infrastructure, social, and ethno-linguistic factors may affect digital distance.

Consequently, James (2005), Waverman et al. (2005), Bagchi (2005), and Martinez and Williams (2010) provided a foundation for this studies consideration of the potentially significant economic affect the diffusion of information communication technology (ICT) may have on developing countries.

Furthermore, methods for assessing potentially important social factors through the application of Hofstede's (2001) value dimensions as identified in Zhao et al.,(2007) or the World Value Survey (Bagchi, 2005), which appear to be beyond adequate measurement at this time for the population of this study, were explored and show merit for future research. In addition to Bagchi (2005) and Zhao et al. (2007), Sharma and Gupta (2003) also provide analysis to support the importance of this studies inclusion of the level of education available to the population and its potential effect on the adoption and diffusion of ICT.

Consistent themes within the previous works include

1. The appearance of a possible positive correlation between ICT diffusion and economic development (Bagchi, 2005; James, 2007; Kiiski & Pohjola, 2002;

Martinez & Williams, 2010; Norris, 2001; Waverman et al., 2005).

2. The inclusion of social (Bagchi, 2005; James, 2007; Sharma & Gupta, 2003; Zhao et al., 2007), economic (Bagchi, 2005; James, 2007; Kiiski & Pohjola, 2002; Norris, 2001; Waverman et al., 2005; Zhao et al., 2007) and infrastructure factors (Bagchi, 2005; Tipton, 2002; Waverman et al., 2005; Zhao et al., 2007) in models proposed for identifying areas that may affect ICT diffusion.

3. The potential marginalization of populations and economies due to a lack of ICT diffusion, including but not limited to mobile phone service and infrastructure (Abrahams et al., 2001; Anderson, 2001; Bagchi, 2005; James, 2007; Sharma & Gupta, 2003; Zhao et al., 2007).

4. The use of United Nations Millennium Development Goal indicators and database in evaluating digital distance/ICT diffusion nationally and multi-nationally (Bagchi, 2005; James, 2007; Martinez & Williams, 2010; Waverman et al., 2005; Zhao et al., 2007).

5. The appearance of an increasing level of collaboration and coordination of ICT diffusion and data collection efforts nationally and internationally in conjunction with United Nations, World Bank, ITU, and national governments (Tipton, 2002; Waverman et al., 2005; ITU, 2007; United Nations, 2009b; UNCTAD, 2009; Zhao et al., 2007).

This review of academic literature has revealed a significant variation in the types of research and approaches to the topic of the digital divide phenomenon as well as variation in perceptions about the role of ICT diffusion and digital divide in economic development and prosperity. The government generated information has portrayed an environment where international data collection efforts are improving and databases in most instances are becoming increasingly more complete from 2002 forward. The expansion of the availability of complete data for a wider population of nations, in conjunction with academic research conversations are providing a dynamic catalyst for increasing the level of awareness and understanding of the digital divide, its contributing factors, and potential opportunities to develop measures to positively affect economic

conditions for targeted populations (Onn, 2009/2010; Tipton, 2002; United Nations, 2009b).

CHAPTER 3. METHODOLOGY

The research approach was quantitative and focused on determining the factors that affect digital distance in developing Association of Southeast Asian Nations (ASEAN) member economies and in comparing these factors to those affecting the wealthiest developed nations, members of the Organization for Economic Cooperation and Development (OECD). This chapter discusses the research design, instruments, and measurements of this study. Furthermore, the research questions that were examined are restated, and a summary overview of the population and sample size utilized for this study are addressed. In addition, this chapter discusses the validity and reliability of the data analyzed, methods of data collection, and the ethical considerations involved in the performance of this research.

Research Design

The research approach will be a quantitative study, focused on determining the factors that affect digital distance in ASEAN member and in comparing these factors to those affecting the high income economies of the 32 OECD nations.

In response to Hypothesis 1, the independent variables of gross domestic product (GDP) per capita, inflation, availability of electricity, income inequality, secondary education, illiteracy, urbanization, and ELF index rating were analyzed to determine if any differences exist when compared to the dependent variable of digital distance. A principle component analysis of key information technologies for Southeast Asian

ASEAN member nations will be used to determine the dependent variable of degree of digital distance between these nations and the United States. Independent social, economic, infrastructure, and ethno-linguistic variables for all 10 ASEAN nations and 32 OECD nations were analyzed collectively utilizing data for 2005 from the United Nations Millennium Development Goal (MDG) database. A Pearson's correlation test and Ordinary Lest Squares regression analysis were performed for the 2005 data for the combined group of ASEAN and OECD nations.

Hypothesis 2 was addressed through the performance of a two-way analysis of variance (ANOVA) and Levene's test for population variance on 2005 MDG data for the ASEAN and OECD groups of nations separately.

In response to Hypothesis 3, a Pearson's correlation test and regression analysis were performed for the ASEAN and OECD groups of nations separately for the years 2003 and 2005.

Sample and Population

The research approach was a quantitative study focused on determining the factors that affect digital distance for a group of 40 nations: 30 industrialized OECD nations and 10 Southeast Asian countries. These Southeast Asian ASEAN member nations, in order from poorest to wealthiest, are Myanmar, Cambodia, Lao People's Democratic Republic, Thailand, Viet Nam, Indonesia, Malaysia, The Philippines, Singapore, and Brunei Darussalam (U.N.,2008). The OECD member nations are Australia, Austria, Belgium, Canada, Chile, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, Korea, Luxembourg, Mexico, the Netherlands, New Zealand, Norway, Poland, Portugal, Slovak Republic, Slovenia,

Spain, Sweden, Switzerland, Turkey, United Kingdom, and the United States (OECD,2005).

Furthermore, this study compared potential factors affecting digital distance in the ASEAN developing economies to those affecting the OECD economies. The population for this study includes the 10 ASEAN member countries containing just over 563 million individuals residing in these nations (United Nations, 2007) and 1,168,530,000 individuals residing in the OECD member nations (Organization for Economic Cooperation and Development, 2005). In accordance with the Bagchi (2005) model for determining digital distance, digital distance for each country will be determined through the use of an Information Technology (IT) Index that compares mobile phone subscriptions, number of computer users, number of Internet users, and number of telephones for each national population as compared to the same availability of these Information technologies in the United States.

The independent variables considered in this study included economic indicators, social indicators, infrastructure indicators, and an ethno-linguistic indicator. World Bank World Development Group MDG, WDI, and Information and Communications for Development Database (IC4D) database data regarding the economic, infrastructure, and social indicators were collected as follows:

1. Economic indicators: GDP per capita and inflation
2. Social indicators: income inequality, secondary education average, illiteracy level, and urbanization level
3. Infrastructural indicator: level of electricity or number of televisions (where specific level of electricity data is not available)

The sample consisted of World Bank–reported data for the years 2003 and 2005 and ELF Index data for each of the countries in the population. The MDG, WDI, and IC4D databases consisted of World Bank and United Nations reported statistics on the total national population, percent of the national population living in urban centers, the number of computer users, number of telephones, mobile phone subscriptions, Internet usage, income inequality (as measured in the Gini Coefficient Index), GDP, level of education, and television adoption per 100 people to determine electricity level. Ethno-linguistic fractionalization for each country in the sample was determined using the ELF index (Roeder, 2001).

Table1. Population of ASEAN Member Nations

	Population	
Country	2005	2007
Brunei Darussalam	373,831	389,252
Cambodia	13,955,507	14,446,056
Indonesia	22,0558,000	225,630,065
Lao People's Democratic Republic	5,663,910	5,859,891
Malaysia	2,5652,985	2,6549,518
Myanmar	47,967,266	48,782,825
Philippines	84,566,163	87,892,094
Singapore	4,265,800	4,588,600
Thailand	63,002,911	63,832,135
Viet Nam	83,106,300	85,154,900
Total	549,112,673	563,125,336

Note. Table created from The World Bank IC4D Database, World Development Bank (2009).

WDI and IC4D data was queried and downloaded directly from the World Bank online MDG, WDI, and IC4D database portals, analyzed using SPSS software version 16.0 and retained as SPSS files with Excel backup documentation as needed.

Analysis of the ethno-linguistic indicator, which depicts the ethno-linguistic division of a nation, will be performed using Roeder's (2001) Ethno-Linguistic Fractionalization (ELF) Indices. Furthermore, the IT Index for each nation was determined by comparing WDI and IC4D data reflecting each nation's level of mobile phone, personal computer, and Internet usage per 1,000 population to that of the United States for the same years (Bagchi, 2005).

Instrumentation and Measures

Measurement occurred through the use of quantitative indexes and tools. This study will apply the following measurements identified in the Bagchi (2005) model:

The key dependent variable of interest for this study was the identified digital distance. The digital distance index was determined through the use of a principal component analysis of each nation's mobile phone subscriptions, number of computer users, number of Internet users, and number of telephones as compared to the same availability of these information technologies in the United States (comparison of WDI and IC4D data).

The key independent variables were economic indicators, infrastructure indicators, social indicators, and ethno-linguistic indicators. Economic indicators for purposes of this research are identified as the World Bank records of national GDP per capita and inflation level of the national economy for each country studied. A key Infrastructural Indicator, the level of electrical service available within each nation

studied will also be considered. Social indicators are defined as the degree of secondary education, income inequality, illiteracy, and urbanization of each nation as reported by the World Bank. Ethno-linguistic indicators were assessed through the use of the ELF Index, calculated as

$$\text{ELF} = \sum_{i=1}^{I} \left(\frac{n_i}{N}\right)^2$$

In which N is the total national population, n_i is the population of the group, and I is the number of ethno-linguistic groups present in the country. The ELF Index can be used to measure the ethnic and linguistic division within a nation's population

Data Collection

The data utilized in this study was collected and analyzed using the same approach that was applied to the Bagchi (2005) model for evaluating the factors that affect information communication technology (ICT) adoption and diffusion. Following the Bagchi model, the James (2007) research study, and the Zhao et al. (2007) approach to measuring ICT on a multinational scale, secondary data will be extracted directly from the World Bank, World Development Group, WDI, IC4D, and MDG databases. In addition, the ethno-linguistic fractionalization values were derived from Roeder's (2001) ELF Index.

Data Analysis

Statistical Package for the Social Sciences (SPSS) software was used to perform the data analysis. Generally accepted standards (Cooper & Schindler, 2005) for performing regression and correlation analysis, and implementing widely used tools for

evaluating the data will be applied consistently throughout this study. All statistical analyses procedures were conducted utilizing SPSS version 16.0 and retained in SPSS 16.0 and Excel 2007 file formats.

The quantitative variables identified to address Research Question 1 were analyzed to calculate each OECD and Southeast Asian Nations IT Index rating (Field, 2002) and digital distance (Bagchi, 2005). For purposes of this study, the IT Index was determined by comparing each nation's access to four key information communication technologies as compared to access to the same technology in the United States (Bagchi, 2005).

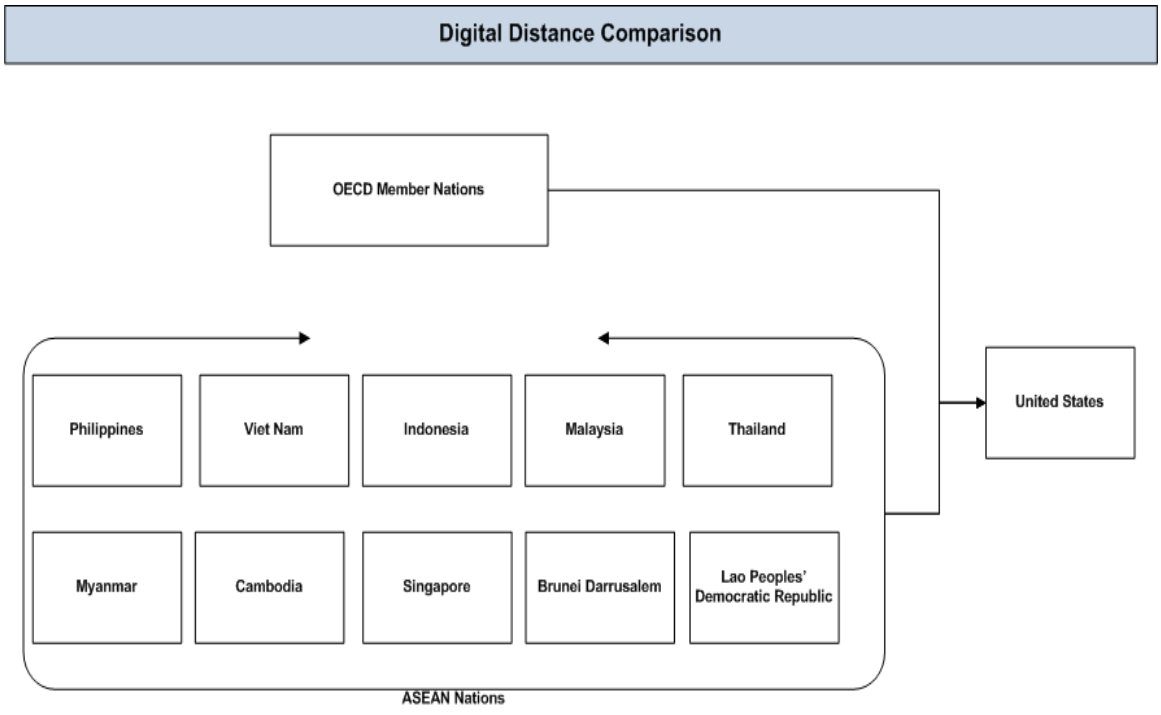

Figure 3. Digital distance/IT index.

The digital divide factor *digital distance* was determined through the use of principle component analysis of four information technologies: telephone, mobile phone, personal computer, and Internet usage per 100 population. In addition, the Kaiser-Meyer-Olkin test for sample adequacy and the Bartlett's test of sphericity were performed on the digital distance data.

To address Research Question 1, the researcher performed a Pearson's correlation test and Ordinary Least Squares (OLS) regression analysis on data for the independent variables for the year 2005 for the group all nations which consists of all OECD and ASEAN member countries. Research Question 2 was addressed by evaluating the ASEAN and OECD nations as two separate groups and comparing indicators between the OECD and ASEAN groups. To achieve this, 2005 indicator values for each group were averaged and divided by the highest value of that indicator in 2005. Once this was complete, a two-way ANOVA and Levene's test for population variance were performed. A Hotchberg's GT2 test was performed in the event the means of these groups differ greatly. A regression analysis of the OECD and ASEAN groups was conducted for the year 2005 as well. Research Question 3 is addressed by performing a Pearson's correlation test for the OECD and ASEAN groups separately for the years 2003 and 2005.

Validity and Reliability

For purposes of this study, the interpretation and analysis of quantitative data included independent-samples *t* tests, which were utilized to compare the means of OECD developed countries with those of ASEAN developing countries. This enabled the

researcher to determine if the degree of digital distance was or was not affected by economic status for the groups studied.

In addition, the Bagchi (2005) model for determining digital distance displays content validity to the extent that it measures factors that may contribute to the digital distance of a nation based on a four sets of indicators that are well supported in the literature to date. Bagchi also employed well-defined statistical tests and measurements to these indicators throughout the model. The data evaluated in the Bagchi model was relevant in terms of criterion-related validity in as much as it reflected the World Bank perceptions of measurements of value in developing and developed nations worldwide. The use of MDG, WDI, and IC4D data also meets the expectation of freedom from bias as it was gathered and reported under the oversight of a reputable, objective, third-party organizations (World Bank Development Group and the United Nations). The WDI and IC4D database data is compiled under the guidance and observation of the United Nations and World Development Bank and in accordance with the United Nations Statistical Commission Fundamental Principles of Official Statistics (United Nations, 2006).

The Bagchi (2005) study also yielded plausible results in determining significant factors affecting digital distance when applied to Economic Commission for Latin America and the Caribbean (ECLAC) and OECD nations. By extension, this research is intended to utilize key components of the digital distance model Bagchi applied to ECLAC nations in an attempt to progress toward identifying factors that contribute to digital distance in the ASEAN member nations.

A review of country-specific United Nations reports regarding the sophistication of Southeast Asian national statistical reporting systems show a wide variation between these countries individual development of statistical capabilities. However, the MDG, WDI, and IC4D data is compiled and distributed through a combination of national self-reporting processes under the oversight of the World Bank and United Nations, and technical assistance of the Asia Development Bank, World Bank Development Group, and United Nations. Therefore, the statistical information and processes involved in the collection and production of the MDG, WDI, and IC4D is held to the standards of the United Nations Fundamental Principles of Official Statistics, which includes standards for the relevance, impartiality, professional principles and conduct, accountability, transparency and sources of statistical data (United Nations, 2006). The 2004 report on the Implementation of the Fundamental Principles of Official Statistics prepared by the United Nations Statistical Commission, found that overall, the Fundamental Principles of Official Statistics were well implemented (United Nations, 2006). Furthermore, various reports identify that national improvements in statistical standards and availability of data have occurred in Southeast Asian countries in recent years (Onn et al., 2008/2009; United Nations Commission on Science and Technology for Development , 2009). Therefore, in the interest of producing the most reliable results possible for all countries included in the population, country-specific MDG, WDI, and IC4D database data for years prior to 2002 was not considered in this study.

A review of the MDG dataset for the Southeast Asian ASEAN member nations and OECD nations for the years 2000 to 2009 revealed that data for all components for determining digital distance and all independent variables outlined in this study were

available for each of these nations for the years 2003and 2005. Although data regarding mobile phone usage, Internet use, and telephone use is provided consistently for all countries in the population from 2005 forward, data depicting the number of computer users per 100 population is not available for various Southeast Asian ASEAN member nations for the years 2006–2009 (World Development Bank, 2010). Therefore, the scope of this research was limited to MDG, WDI, and IC4D databases for the years 2003 and 2005.

Ethical Considerations

The data collected and analyzed for this study followed the Bagchi (2005) model. Therefore, the data analyzed in this study is public information compiled by the World Bank World Development Group and Asian Development Bank. The data reviewed in this study constitutes a secondary data analysis of public information. Consequently, the risk of harm to the subjects of this study is minimal.

To ensure satisfactory ethical standards were met throughout the course of this research study, the researcher was vigilant in establishing clear parameters and intentions for conducting the study and releasing the results before undergoing the research study. The researcher successfully completed the Collaborative Institutional Training Initiative (CITI) Human Subjects Research training and received approval form the Capella University Internal Review Board (IRB) to conduct this research as described in this study. Participant privacy and confidentiality was assured through the use of published demographic data that is compiled at the national level and therefore does not contain identifying information about any of the individual respondents or any specific vulnerable populations within the demographic categories. The potential for any conflict

of interest or bias on the part of the researcher was analyzed in the Internal Review Board process. No conflict of interest or research bias was present and IRB approval was granted.

The benefit of this study to the populations whose data is being analyzed includes potential insights that could further the understanding of economic, social, infrastructure, and ethno-linguistic indicators and their potential effects on the populations' access to and use of IT. The risks to the population of this study are very minimal and limited to the potential effects of publishing the findings of this secondary analysis of public information.

CHAPTER 4. RESULTS

Results of this study indicated that for the combined population of all Organization for Economic Cooperation and Development (OECD) and Association of Southeast Asian Nations (ASEAN) member nations, the economic indicators of inflation and gross domestic product (GDP) had a significant correlation to digital distance. Furthermore, infrastructure indicators of level of electricity and degree of urbanization as well as the social indicators of secondary education and income inequality also reflected a significant correlation to digital distance. However, the socioeconomic indicator of ethno-linguistic fractionalization did not reflect a significant correlation to digital distance.

When comparing the OECD member countries and the ASEAN member nations, differences in the correlation between digital divide and the indicators of GDP, income inequality, level of urbanization, secondary education, level of electricity, and inflation rate were observed. However, there did not appear to be a significant difference in the correlation of ethno-linguistic fractionalization to digital distance between these groups.

Furthermore, the comparison of 2003 and 2005 data for the OECD and ASEAN nations reflected that the relationship of digital divide indicators did not change significantly between the years 2003 and 2005 for OECD or ASEAN nations in this population.

Indicators of Digital Divide

IT Index, All Nations, 2005

A principle component analysis was performed and a factor extracted to measure digital distance for the year 2005. In summary, the correlation results among the four digital distance variables used to compile the Information Technology (IT) Index for 2005 were compared to determine singularity. The descriptive statistics and results of this comparison are contained in tables 2 and 3. The corresponding correlation coefficient was less than 0.9 therefore, singularity was not an issue. Mulit-collinearity was tested and revealed that the determinant value for the data was greater than 0.0001, multi-collinearity was also not an issue in this instance. The Kaiser-Meyer-Olkin (KMO) sampling adequacy measurement, although lower than in 2003, was still considered high (0.766), suggesting that the factor analysis could produce valid and reliable factors for the data considered. In addition, the output of the Bartlett's test of sphericity was significant, suggesting that factor analysis was appropriate. See table 4 for the KMO and Bartlett's test results. Principal component analysis as shown in tables 5 and 6, revealed that one factor accounted for 82.4% of all variance. Communalities extracted showed that the factor explained the variance of each variable to a high degree (83–94%).

IT Index principal component analysis, digital distance, all nations, 2005

Table2. Digital Distance Descriptive Statistics, 2005

	Mean	Std. deviation	Analysis *N*
Telephone	37.6295	19.95152	40
Mobile phone	77.5693	32.29660	40
Internet	44.7625	25.89064	40
PC	38.3815	28.54668	40

Table3. Digital Distance Correlation Matrix, 2005

	Telephone	Mobile phone	Internet	PC
Telephone	1.000	.754	.827	.822
Mobile phone	.754	1.000	.707	.593
Internet	.827	.707	1.000	.882
PC	.822	.593	.882	1.000

Table4. Digital Distance KMO and Bartlett's Test, 2005

KMO measure of sampling adequacy		.766
Bartlett's test of sphericity	Approx. chi square	138.458
	Df	6
	Sig.	.000

Note. Factor analysis reliability (KMO = .766) is high. Factor analysis is appropriate.

Table 5. Digital Distance Principal Component Analysis Communalities, 2005

	Initial	Extraction
Telephone	1.000	.881
Mobile phone	1.000	.695
Internet	1.000	.891
PC	1.000	.832

Table 6. Digital Distance Principal Component Analysis Total Variance Explained, 2005

	Initial Eigen values			Extraction sums of squared loadings		
Component	Total	% of variance	Cumulative %	Total	% of variance	Cumulative %
1	3.299	82.484	82.484	3.299	82.484	82.484
2	.436	10.903	93.387			
3	.168	4.207	97.594			
4	.096	2.406	100.000			

Table 7. Digital Distance Principal Component Analysis Component 1 Extraction, 2005

Telephone	.939
Mobile phone	.833
Internet	.944
PC	.912

Table 8. Digital Distance Ratings, ASEAN Nations, 2005

Country	Rating
Brunei Darussalam	-0.52
Cambodia	-0.97
Indonesia	-0.88
Lao People's Democratic Republic	-0.94
Malaysia	-0.40
Myanmar	-0.99
Philippines	-0.80
Singapore	0.02
Thailand	-0.71
Viet Nam	-0.82

In 2005, the mean digital distance (IT Index rating) of ASEAN member nations was -0.7005. The median digital distance for the same population in the same year was -0.81.

In 2005, the mean digital distance (IT Index rating) of OECD member nations was- 0.1286. The mean digital distance for the group of all nations in 2005 was -0.2716.

Table 9. Digital Distance Ratings, OECD Nations, 2005

Country	Rating
Australia	NA
Austria	-0.02
Belgium	-0.14
Canada	-0.03
Chile	-0.52
Czech Republic	-0.24
Denmark	0.14
Finland	-0.03
France	-0.14
Germany	0.06
Greece	-0.33
Hungary	-0.35
Iceland	0.08
Ireland	-0.12
Italy	-0.14
Japan	NA
Korea	-0.06
Luxembourg	0.08
Mexico	-0.65
Netherlands	0.13
New Zealand	-0.11
Norway	0.05
Poland	-0.43
Portugal	-0.28

Table 91. Digital Distance Ratings OECD Nations, 2005 *(continued)*

Country	Rating
Slovakia	-0.29
Slovenia	-0.21
Spain	-0.20
Sweden	0.20
Switzerland	0.16
Turkey	-0.60
United Kingdom	0.13
United States	0.00

For purposes of this analysis, the indicators of interest are represented as variables with the following naming convention: Level of electricity is measured in terms of percentage of households with a television set in specified year (TV), ethno-linguistic fractionalization index rating (ELF), inflation rate for specified year (Inflation), GINI average for years 2000–2005 (GNIAve), percent of population living in an urban environment for specified year (Urban), average percent of population completing secondary education 2000–2005 (SecEDAve), and GDP per capita for specified year (GDP per capita). The dependent variable digital distance for the years of interest is identified as DD.

IT Index regression analysis, all nations, 2005

A regression Analysis for the group of all nations (combined set of OECD and ASEAN nations) was conducted. Digital divide factor for the year 2005 was used as the

dependent variable. The indicators of interest (TV, ELF, Inflation, GNIAve, Urban, SecEDAve, GDP per capita) were used as the independent variables.

A review of the data for the group of all nations (OECD and ASEAN member nations collectively) in 2005 identifies the variables level of electricity (TV2005), degree of urbanization (Urban), GINI average (GNIAve), secondary education (SecEd), inflation rate (Inflation), and GDP were significant at the 1% level. In addition a review of the coefficients reflected a positive score for GNIAve, GDP, and TV for the year 2005. However, the Ethno-Linguistic Fractionalization Index variable did not reflect significance at the 1% or 5% levels. The initial Pearson's correlation revealed a score of -.311 and a significance level of 0.051 for the variable ELF.

The Pearson's correlation data compared with the outputs of the Kruskal-Wallis test revealed that the asymmetric significance (0.471) of the variable ethno-linguistic fractionalization (ELF) is also higher than the Pearson's correlation (-0.311) for each of these variables. Therefore, the Pearson's correlation and Kruskal-Wallis test results reflected that the ethno-linguistic fractionalization (ELF) was not significant.

The complete set of results of the Pearson's correlation comparison between digital distance and the factors of interest for the group of all nations for the year 2005 appear in Table 12.

Table10. ANOVA Results for Digital Divide Dimensions, All Nations, 2005

Indicators of digital divide	
Gross domestic product (GDP)	25205.2733
N	40
F	87.125
P	0.000000002**
*R*2	0.696
Ethno-linguistic fractionalization (ELF)	0.3177
N	40
F	4.055
P	0.051
*R*2	0.073
Income inequality (GNIAve)	17423.5225
N	40
F	115.124
P	0.0000000000046**
*R*2	0.752
Level of secondary education (SecEDAve)	94.37
N	37
F	80.43
P	0.0000000135**
*R*2	0.697
Level of electricity (TV)	0.8753
N	39
F	39.877
P	0.000004376**
*R*2	0.555
Degree of urbanization (Urban)	67.98
N	40
F	52.19
P	0.0000001244**
*R*2	0.567
Inflation rate	3.8281
N	37
F	9.923
P	0.003**
*R*2	0.221

*Correlation is significant at the 0.05 level (two-tailed). **Correlation is significant at the 0.01 level (two-tailed).

Table11. All Nations Nonparametric/Kruskal-Wallis Test Statistics, 2005

	GDP per capita	Inflation	SecEDAve	GNIAve	Urban	ELF	TV
Chi square	41.000	38.000	38.000	41.000	41.000	41.000	35.000
Df	41	38	38	41	41	41	35
Asymp. sig.	.471	.469	.469	.471	.471	.471	.468

Note. Grouping variable: CASENUM.

Table 12. All Nations Pearson Correlations, 2005

GDP per capita	Pearson's correlation	.834**
	Sig. (two-tailed)	.000
	N	40
Inflation	Pearson's correlation	-.470**
	Sig. (two-tailed)	.003
	N	37
SecEDAve	Pearson's correlation	.835**
	Sig. (two-tailed)	.000
	N	37
GNIAve	Pearson's correlation	.867**
	Sig. (two-tailed)	.000
	N	40
Urban	Pearson's correlation	.760**
	Sig. (two-tailed)	.000
	N	40
ELF	Pearson's correlation	-.311
	Sig. (two-tailed)	.051
	N	40
TV	Pearson's correlation	.745**
	Sig. (two-tailed)	.000
	N	34

**Correlation is significant at the 0.01 level (two-tailed).

When analyzed collectively the analysis of variance (ANOVA), model summary, coefficients, and Pearson's correlation data reflect the following: GDP reflected a *p*-value of 0.000000002 and R^2 of .696. Therefore, the data is significant at the 1% level and has a moderately strong positive linear relationship. Level of electricity (TV) reflected a *p*-value of 0.000004376 and an R^2 of .555. The data is significant at the 1% level and has a moderate positive linear relationship. The urbanization level (Urban) displayed a *p*-value of 0.0000001244 and an R^2 of .567. The data is significant at the 1% level and has a moderate positive linear relationship. Income inequality (GNIAve) had a *p*-value of 0.0000000000046 and an R^2 of .752. Therefore, the data is significant at the 1% level and has a strong positive linear relationship. Secondary education (SecEdAve) displayed a *p*-value of 0.0000000135 and an R^2 of .697. Therefore, the data is significant at the 1% level and has a strong positive linear relationship. Ethno-linguistic fractionalization (ELF) reflected a *p*-value of 0.051 and an R^2 of .073. Therefore, the data is not marginally significant at the 5% level and has a weak positive linear relationship. The final variable considered, Inflation rate, displayed a *p*-value of 0.003 and an R^2 of 0.221. Therefore, the data is statistically significant at the 5% level and has a weak positive linear relationship. When considering the ANOVA, model summary, coefficients, and Pearson's correlation data for the ASEAN nations in 2005, there is sufficient evidence to reject the null hypothesis ($H1_0$) for the variables of GDP, income inequality, level of urbanization, secondary education, level of electricity, and inflation rate. However, there is insufficient evidence to reject the null hypothesis ($H1_0$) for the ELF index rating variable for the group of all nations in 2005.

Comparison of OECD and ASEAN Digital Divide Indicators

Research Question 2 addresses the issue of whether the factors that contribute to digital distance are the same or different between OECD and ASEAN countries in the year 2005. The indicator values for each set of nations were averaged then divided by the highest score for that indicator in that group for the same year. Figure 4 shows that although the pattern is somewhat similar, there are differences in these indicators between these two groups of nations.

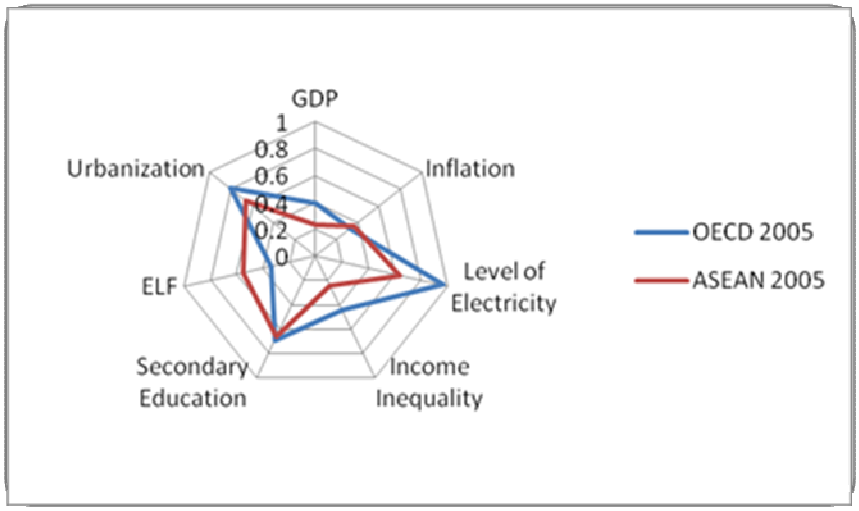

Figure 4. OECD and ASEAN, all nations, 2005.

Figure 5 provides a more linear depiction of the different levels of each variable of interest for the ASEAN and OECD groups of nations. The mean digital distance for each group is also provided in Figure 5 as an item of interest. The inclusion of digital distance is not intended to imply relationship or correlation with any specific variables of interest.

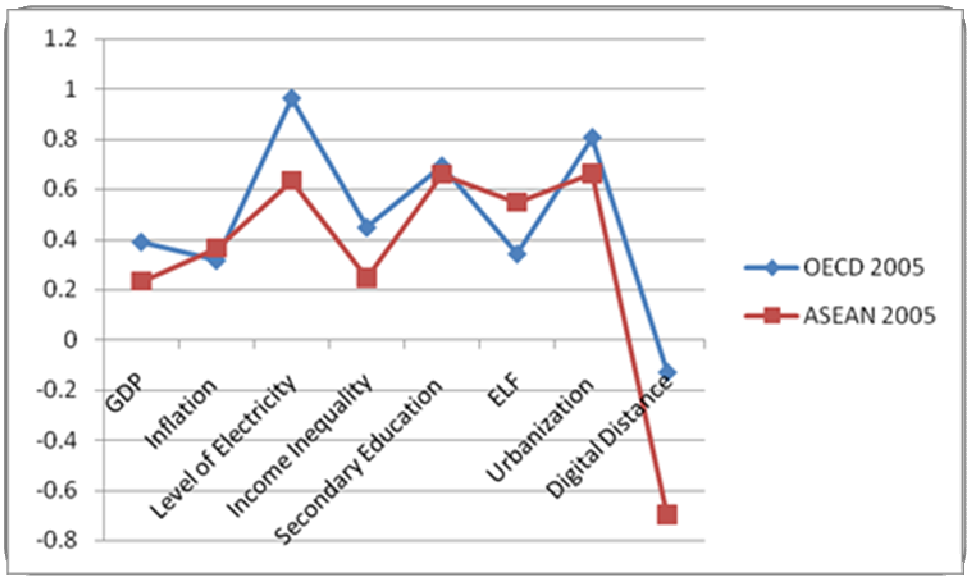

Figure 5. OECD and ASEAN indicators of interest, 2005.

The literacy rate data for 41 of the 42 nations in the study was not reported in the World Development Indicators (WDI) database for the year 2003. The literacy rate data for 38 of the 42 nations was not reported for 2005. Therefore, the literacy rate component of the social indicator for this study was excluded due to lack of data.

Table13 . ANOVA Results for Digital Distance Dimensions, 2005

Indicators of digital divide	All nations (3)	ASEAN (4)	OECD (5)
GDP	25205.2733	6648.2985	31390.9316
N	40.0000	10.0000	30.0000
F	87.1250	18.0190	48.3600
P	.000000002**	.003**	.0000007**
R^2	0.6960	0.6540	0.6330
ELF	0.3177	0.5345	0.2455
N	40.0000	10.0000	30.0000
F	4.055	0.0210	0.3370
P	0.0510	.889[a]	.566[a]
R^2	0.0730	0.0030	0.0120
GNIAve	17423.5225	5036.5450	21552.5150
N	40.0000	10.0000	30.0000
F	115.124	26.8920	74.8560
P	.0000000000046**	.001**	.000000004**
R^2	0.7520	0.7710	0.7280
SecEDAve	94.3700	61.8200	103.3400
N	37.0000	8.0000	29.0000
F	80.43	6.9600	13.1500
P	.0000000135**	.039*	.001**
R^2	0.6970	0.5370	0.3280
TV	0.8753	0.6300	0.9636
N	39.0000	9.0000	30.0000
F	39.877	7.7040	6.4790
P	0.000004376**	.027*	.018*
R^2	0.5550	0.5240	0.2200
Urban	67.9800	48.8300	74.3633
N	40.0000	10.0000	30.0000
F	52.19	30.1570	4.8840
P	.0000001244**	.001**	.035*
R^2	0.5670	0.7900	0.1490
Inflation	3.8281	6.8639	2.8523
N	37.0000	9.0000	28.0000
F	9.923	0.2160	4.3660
P	0.003**	.657[a]	.047*
R^2	0.221	-0.109	0.143

[a]Not significant

*Correlation is significant at the 0.05 level (two-tailed). **Correlation is significant at the 0.01 level (two-tailed).

Table14. ANOVA Comparison Results for Digital Distance Dimensions, 2005

Indicators of digital divide	Hochberg's GT2 means comparison test between groups		
	Compare all nations to ASEAN	Compare ASEAN to OECD	Compare all nations to OECD
GDP	19099.3795	-25067.935	-5968.5561
ELF	-0.22114*	.29023*	.06911
GNIAve	12948.6281	-16995.074	-4046.4462
SecEDAve	34.166*	-42.983*	-8.817
TV	.25083	-0.33444*	-0.08361
Urban	19.58429	-25.70438*	-6.12009
Inflation	-3.16655	4.11651*	0.94996

*Mean difference significant at the .05 level.

Table 15 2. ANOVA *F*- and *P*-Values Results for Digital Distance Dimensions, 2005

Indicators of digital divide	*F*	*P*
GDP	7.317	.001
ELF	6.050	.004
GNIAve	6.890	.002
SeEdAve	14.45	.000
TV	10.533	.000
Urban	7.849	.001
Inflation	4.377	.016

Regression, ANOVA, and correlation, ASEAN, 2005

A regression analysis for the ASEAN nations was conducted. Digital divide factor for the year 2005 was used as the dependent variable. The indicators of interest (TV, ELF, Inflation, GNIAve, Urban, SecEDAve, GDP per capita) were used as the independent variables. The independent variables displayed a strong linearity and the distribution was acceptably normal.

A review of the data for the ASEAN member nations in 2005 reveals that the variables degree of urbanization (Urban), income inequality (GNIAve), and GDP were significant to the 0.01 level whereas variables of level of electricity as measured by percentages of households with a television (TV) and percentage of populations with a secondary education (SecED) were significant to the .05 level. The initial correlation data did not reflect that the ethno-linguistic fractionalization (ELF) or inflation rate (Inflation) were significant at the 5% level. The Pearson's correlation data compared with the outputs of the Kruskal-Wallis nonparametric test revealed that the asymmetric significance of the variables Inflation (Inflation2005) and ethno-linguistic fractionalization (ELF) are also higher than the Pearson's correlation for each of these variables.

Table 16. ASEAN Kruskal-Wallis Test Statistics, Digital Distance Dimensions, 2005

	GDP per capita	Inflation	SecEDAve	GNIAve	Urban	ELF	TV
Chi square	9.000	8.000	7.000	9.000	9.000	9.000	8.000
Df	9	8	7	9	9	9	8
Asymp. sig. (*p*-value)	.437	.433	.429	.437	.437	.437	.433

Note. Grouping variable: CASENUM.

Table 17 3. ASEAN Pearson's Correlations, Digital Distance Dimensions, 2005

GDP per capita	Pearson's correlation	.832**
	Sig. (two-tailed)	.003
	N	10
Inflation	Pearson's correlation	-.173
	Sig. (two-tailed)	.657
	N	9
SecEDAve	Pearson's correlation	.733*
	Sig. (two-tailed)	.039
	N	8
GNIAve	Pearson's correlation	.878**
	Sig. (two-tailed)	.001
	N	10
Urban	Pearson's correlation	.889**
	Sig. (two-tailed)	.001
	N	10
ELF	Pearson's correlation	.051
	Sig. (two-tailed)	.889
	N	10
TV	Pearson's correlation	.724*
	Sig. (two-tailed)	.027
	N	9

*Correlation is significant at the 0.05 level (two-tailed). **Correlation is significant at the 0.01 level (two-tailed).

When analyzed collectively the ANOVA, model summary, coefficients, and Pearson's correlation table 17 data reflect the following: GDP reflected a *p*-value of 0.003 and an R^2 of .654. Therefore, the data is significant to the 0.3% level and has a moderately strong positive linear relationship. Level of electricity (TV) reflected a *p*-value of 0.027 and an R^2 of .524. The data is significant to the 2.7% level and has a moderate positive linear relationship. The urbanization level (Urban) displayed a *p*-value of 0.001 and an R^2 of .790. The data is significant to the 0.1% level and has a strong positive linear relationship. Income inequality (GNIAve) had a *p*-value of 0.001 and an R^2 of .771. Therefore, the data is significant to the 0.1% level and has a strong positive linear relationship. Secondary education average (SecEdAve) displayed a *p*-value of 0.039 and an R^2 of .537. Therefore, the data is significant to the 3% level and has a strong positive linear relationship. Ethno-linguistic fractionalization (ELF) reflected a *p*-value of 0.889 and an R^2 of .003. Therefore, the data is not statistically significant at the 5% level and has a weak positive linear relationship. The final variable considered, Inflation rate, displayed a *p*-value of 0.657 and an R^2 of -0.109. Therefore, the data is not statistically significant to the 5% level and has a weak negative linear relationship. When considering the ANOVA, model summary, coefficients, and Pearson's correlation data for the ASEAN nations in 2005, there is sufficient evidence to reject the null hypothesis for the variables of GDP, income inequality, level of urbanization, secondary education, and level of electricity. However, there is insufficient evidence to reject the null hypothesis for the variables of ELF index rating and inflation rate for ASEAN member nations in 2005.

Regression, ANOVA, and correlation, OECD, 2005

A regression analysis for the OECD nations was conducted. Digital divide factor for the year 2005 was used as the dependent variable. The indicators of interest (TV, ELF, Inflation, GNIAve, Urban, SecEDAve, GDP per capita) were used as the independent variables.

A review of the ANOVA, coefficients, model summary, and Pearson's correlation data for the OECD member nations in 2005 reveals that following for each digital distance dimension (independent variable of interest). GINI average (GNIAve), secondary education average (SecEDAve), and GDP were significant to the 0.01 level and variables level of electricity as measured by percentages of households with a television (TV), degree of urbanization (Urban), and rate of inflation (Inflation) were significant at the 5% level. The initial Pearson's correlation revealed a Pearson's correlation score of .109 and a significance level of .544 for the variable ELF.

Consequently, a Kruskal-Wallis nonparametric test was performed for the ELF variable. The Pearson's correlation data compared with the outputs of the Kruskal-Wallis test revealed that the asymmetric significance (0.466) of the variable ethno-linguistic fractionalization (ELF) is also higher than the Pearson's correlation (0.109) for each of these variables. Therefore, the Pearson's correlation and Kruskal-Wallis test results did not reflect that the ethno-linguistic fractionalization (ELF) was significant.

Table 18. OECD Pearson's Correlations, 2005

GDP per capita	Pearson's correlation	.796**
	Sig. (two-tailed)	.000
	N	30
Inflation	Pearson's correlation	-.378*
	Sig. (two-tailed)	.047
	N	28
SecEDAve	Pearson's correlation	.572**
	Sig. (two-tailed)	.001
	N	29
GNIAve	Pearson's correlation	.853**
	Sig. (two-tailed)	.000
	N	30
Urban	Pearson's correlation	.385*
	Sig. (two-tailed)	.035
	N	30
ELF	Pearson's correlation	.109
	Sig. (two-tailed)	.566
	N	30
TV	Pearson's correlation	.469*
	Sig. (two-tailed)	.018
	N	25

*Correlation is significant at the 0.05 level (two-tailed). **Correlation is significant at the 0.01 level (two-tailed).

Table 19 4. OECD Kruskal-Wallis Test Statistics for Digital Distance Dimensions, 2005

	GDP per capita	Inflation	SecEDAve	GNIAve	Urban	ELF	TV
Chi square	31.000	29.000	30.000	31.000	31.000	31.000	26.000
Df	31	29	30	31	31	31	26
Asymp. sig.	.466	.465	.466	.466	.466	.466	.463

Note. Grouping variable: CASENUM.

When analyzed collectively, the ANOVA, model summary, coefficients, and Pearson's correlation table 18 data for the OECD nations in 2005 reflect the following: GDP reflected a *p*-value of 0.0000007 and an R^2 of .633. Therefore, the data is significant at the 0.00007% level and has a moderately strong positive linear relationship. Level of electricity (TV) reflected a *p*-value of 0.018 and an R^2 of .220. The data is statistically significant at the 1.8% level and has a weak positive linear relationship. The urbanization level (Urban) displayed a *p*-value of 0.035 and an R^2 of .149. The data is significant to the 3.5% level and has a weak positive linear relationship. Income inequality (GNIAve) had a *p*-value of 0.000000004 and an R^2 of .728. Therefore, the data is significant at the 1% level and has a strong positive linear relationship. Secondary education average (SecEdAve) displayed a *p*-value of 0.001 and an R^2 of .328. Therefore, the data is significant to the 0.1% level and has a weak positive linear relationship. Inflation rate, displayed a *p*-value of 0.047 and an R^2 of 0.143. Therefore, the data is statistically significant to the 5% level and has a weak positive linear relationship. The final variable considered ethno-linguistic fractionalization (ELF) reflected a *p*-value of 0.566 and an R^2 of .012. Therefore, the data is not statistically significant at the 5% level and has a very weak positive linear relationship.

When considering the ANOVA, model summary, coefficients, and Pearson's correlation data for the ASEAN nations in 2005, there is sufficient evidence to reject the null hypothesis for the variables of income inequality, level of urbanization, secondary education, level of electricity, and inflation rate. However, there is insufficient evidence to reject the null hypothesis for the ethno-linguistic fractionalization index rating for OECD member nations in 2005.

A summary of Research Question 2 hypothesis testing outcomes by independent variable are as follows:

- GDP: Reject the null hypothesis ($H2_0$) for ASEAN, OECD, and group of all nations.
- Income inequality: Reject the null hypothesis ($H2_0$) for ASEAN, OECD, and group of all nations.
- Secondary education: Reject the null hypothesis ($H2_0$) for ASEAN, OECD, and group of all nations.
- Level of electricity: Reject the null hypothesis ($H2_0$) for ASEAN, OECD, and group of all nations.
- Level of urbanization: Reject the null hypothesis ($H2_0$) for ASEAN, OECD, and group of all nations.
- Inflation rate: Reject the null hypothesis ($H2_0$) for OECD and group of all nations. Do not reject the null hypothesis for ASEAN countries.
- Ethno-linguistic fractionalization: Do not reject the null hypothesis ($H2_0$) for ASEAN, OECD, and/or group of all nations.

Comparison of Digital Divide Indicators Over Time

IT index, all nations, 2003

The same process used to determine digital distance for the 2005 data was implemented to determine the 2003 IT Index (digital distance). A principle component analysis was performed and a factor extracted to measure digital distance. The correlation results among the four digital distance variables used to compile the IT Index for 2003 were compared to determine singularity. The corresponding correlation coefficient was less than 0.9 suggesting that singularity was not an issue. As the correlation coefficient was greater than 0.0001, multi-collinearity was also not an issue in this instance. The KMO sampling adequacy measurement was .801, which is considered high, revealing

that the factor analysis could produce valid and reliable factors for the data considered. In addition, the output of the Bartlett's test of sphericity was significant, suggesting that factor analysis was appropriate. Principal component analysis revealed that one factor accounted for 85.2% of all variance. Communalities extracted showed that the factor explained the variance of each variable to a high degree (75–88%).

IT index principal component analysis, digital distance, all nations, 2003

Table 20 5. Digital Distance Factor Analysis Descriptive Statistics, 2003

	Mean	Std. deviation	Analysis *N*
Telephone	39.2436	21.10511	42
Mobile phone	65.0800	31.25541	42
Internet	38.6164	24.27724	42
PC	30.5019	23.01574	42

Table 21 6. Digital Distance Factor Analysis KMO and Bartlett's Test, 2003

KMO measure of sampling adequacy		.801
Bartlett's test of sphericity	Approx. chi square	142.770
	Df	6
	Sig.	.000

Note. Factor analysis reliability (KMO = .801) is high. Factor analysis is appropriate.

Table 22. Digital Distance Principal Component Analysis Total Variance Explained, 2003

	Initial Eigen values			Extraction sums of squared loadings		
Component	Total	% of variance	Cumulative %	Total	% of variance	Cumulative %
1	3.342	83.552	83.552	3.342	83.552	83.552
2	.354	8.859	92.411			
3	.193	4.814	97.225			
4	.111	2.775	100.000			

Table 23. Digital Distance Ratings, ASEAN Nations, 2003

Country	Rating
Brunei Darussalam	-0.43
Cambodia	-0.97
Indonesia	-0.91
Lao People's Democratic Republic	-0.98
Malaysia	-0.35
Myanmar	-0.99
Philippines	-0.78
Singapore	0.39
Thailand	-0.67
Viet Nam	-0.92

The mean digital distance (IT Index) for all ASEAN nations in 2003 was -0.661.

Table 24. Digital Distance Ratings, OECD Nations, 2003

Country	Rating
Australia	0.38
Austria	0.32
Belgium	0.20
Canada	0.26
Chile	-0.41
Czech Republic	0.01
Denmark	0.62
Finland	0.42
France	0.15
Germany	0.39
Greece	-0.08
Hungary	-0.16
Iceland	0.64
Ireland	0.19
Italy	0.12
Japan	0.15
Korea	0.36
Luxembourg	0.62
Mexico	-0.61
Netherlands	0.39
New Zealand	0.21
Norway	0.51
Poland	-0.34
Portugal	-0.01

Table 24. Digital Distance OECD Nations, 2003 *(continued)*

Country	Rating
Slovakia	-0.10
Slovenia	0.08
Spain	0.07
Sweden	0.72
Switzerland	0.66
Turkey	-0.52
United Kingdom	0.43
United States	0.00

The mean digital distance (IT Index) for all OECD nations was -0.1556.

Multiyear comparisons

Table 25. Pearson's Correlation Results for Digital Distance Dimensions, 2003 and 2005

Indicators of digital divide	OECD		ASEAN	
	2003	2005	2003	2005
GDP	.811**	.796**	.880**	.832**
N	32	30	10	10
ELF	0.029[a]	0.109[a]	0.031[a]	0.051[a]
N	32	30	10	10
GNIAve	.811**	.853**	.906**	.878**
N	32	30	10	10
SecEDAve	0.533**	.572**	.748*	.733*
N	31	29	8	8
TV	NA	.469*	NA	.724*
N	0	25	0	9
Urban	.388*	.385*	.902**	.889**
N	32	30	10	10
Inflation	-.631**	-.378**	-0.544[a]	-0.173[a]
N	30	28	10	9

[a]Not significant.
*Correlation is significant at the 0.05 level (two-tailed). **Correlation is significant at the 0.01 level (two-tailed).

Research Question 3 hypothesis testing outcomes by independent variable are as follows:

- GDP: Do not reject the null hypothesis ($H3_0$) for ASEAN. Do not reject the null hypothesis ($H3_0$) for OECD.
- Income inequality: Do not reject the null hypothesis ($H3_0$) for ASEAN. Do not reject the null hypothesis ($H3_0$) for OECD.
- Secondary education: Do not reject the null hypothesis ($H3_0$) for ASEAN. Do not reject the null hypothesis ($H3_0$) for OECD.

- Level of electricity: There is insufficient evidence/data to reject the null hypothesis ($H3_0$) for ASEAN or OECD. (2003 TV data is unavailable).

- Level of urbanization: Do not reject the null hypothesis ($H3_0$) for ASEAN. Do not reject the null hypothesis ($H3_0$) for OECD.

- Inflation rate: Do not reject the null hypothesis ($H3_0$) for ASEAN. Do not reject the null hypothesis ($H3_0$) for OECD.

- Ethno-linguistic fractionalization: Do not reject the null hypothesis ($H3_0$) for ASEAN. Do not reject the null hypothesis ($H3_0$) for OECD.

Summary

The results of Research Question 1 reflected that the indicators GDP, income inequality, level of urbanization, secondary education, level of electricity and inflation were correlated to digital distance for the combined group of OECD and ASEAN nations. However, the ELF index rating for the group of all nations did not reflect a significant relationship to digital distance.

In assessing Research Question 2, the results of this study further reflected that varying degrees of correlation (0.1–0.05) existed for both OECD and ASEAN nations for indicators of GDP, income inequality, secondary education, level of electricity, and level of urbanization. In addition, OECD nations also appeared to experience a correlation between inflation rate and digital distance. However, no significant correlation was evident between inflation rate and digital distance in ASEAN countries, and no significant correlation was reflected between ethno-linguistic fractionalization for either the OECD or ASEAN nations.

Finally, in Research Question 3, a comparison of data for the OECD and ASEAN nations detected no significant change in the performance of the potential digital distance indicators for the years 2003 and 2005.

CHAPTER 5. DISCUSSION AND RECOMMENDATIONS

Summary and Discussion of Results

The use and availability of information communication technology (ICT) appears to contribute to the economic development and competency of industrialized nations worldwide. Conversely, a lack of technology or its availability in impoverished and developing regions of the world such as Southeast Asia, may hinder economic growth and development. Furthermore, the unavailability of ICT in Association of Southeast Asian Nations (ASEAN) nations may reduce the national economic condition and level of participation in the global economy while contributing to an ever-widening global digital divide. This study was based upon the Bagchi (2005) study and explored potential key contributing factors and their relationship to digital divide in ASEAN nations of Southeast Asia and Organization for Economic Cooperation and Development (OECD) developed economies.

In preparation for this study, literature was reviewed from various sources including academic research, United Nations publications, World Bank materials, International Telecommunications Union publications, economic development reports, and various industry and academic articles related to ICT, digital divide, and economic development.

The literature reviewed reported the appearance of a possible positive correlation between the availability of ICT within a country and that nation's economic development

(Bagchi, 2005; James, 2007; Kiiski & Pohjola, 2002; Martinez & Williams, 2010; Norris, 2001; Waverman et al., 2005). It further proposed that research efforts to identify contributing factors to digital distance should consider and include social (Bagchi, 2005; James, 2007; Sharma & Gupta, 2003; Zhao et al., 2007), economic (Bagchi, 2005; James, 2007; Kiiski & Pohjola, 2002; Martinez & Williams, 2010; Norris, 2001; Waverman et al., 2005, Zhao et al., 2007), and infrastructure factors (Bagchi, 2005; Tipton, 2002; Waverman et al., 2005; Zhao et al., 2007). It is also important to note that much of the literature reviewed supported the concept that there is a very real potential for economies with a lack of ICT diffusion to be marginalized in the global economy (Abrahams et al., 2001; Anderson, 2001; Bagchi, 2005; James, 2007; Sharma & Gupta, 2003; Zhao et al., 2007). The literature further reflected that it is a common and acceptable practice to use United Nations Millennium Development Goal indicators and databases in evaluating digital distance nationally and multi-nationally (Bagchi, 2005; James, 2007; Martinez & Williams, 2010; Waverman et al., 2005; Zhao et al., 2007). In addition, an increase in the coordination of international data collection and ICT diffusion was observed as the result of the increased participation of national governments in United Nations data collection and development efforts (ITU, 2007; Tipton, 2002; United Nations, 2009b; UNCTAD, 2009; Waverman et al., 2005; Zhao et al., 2007). According to the literature, this expansion of the breadth of data available, occurring within the context of emerging academic and industry research is contributing to an increasing the level of awareness of the digital divide, its contributing factors, and opportunities to develop measures to positively affect economic conditions for targeted populations (Onn, 2009/2010; Tipton, 2002; United Nations, 2009b).

The research was conducted as a quantitative study, focused on determining the factors that affect digital distance in ASEAN national economies and comparing these factors to those affecting the OECD countries. Independent variables from the following categories were explored: economic indicators, social indicators, infrastructure indicators, and an ethno-linguistic indicator.

This study compared the potential factors affecting digital distance in the ASEAN developing economies to those affecting the OECD economies. The population for this study included the 10 ASEAN member nations and the OECD member nations. The digital distance for each country was determined through the use of an Information Technology Index (Bagchi, 2005) comparing mobile phone subscriptions, number of computer users, number of Internet users, and number of telephones for each nation as compared to the same availability of these ICTs in the United States.

The research questions posed were as follows:

1. For the entire group of all OECD and ASEAN member nations, what economic, infrastructure, social, and ethno-linguistic indicators contribute to digital divide?

2. Are there differences in the indicators that contribute to digital divide for the industrialized OECD member countries and the developing economies of the ASEAN member nations?

3. Has the relationship of the digital divide indicators changed over time for developing and industrialized nations in this population?

The following hypotheses were tested in response to the first research question:

- $H1_0$: There is no significant difference between economic indicators of gross domestic product (GDP) per capita and inflation; infrastructure indicator of availability of electricity; social indicators of income inequality, secondary education average, illiteracy level, urbanization level, and ELF index rating and digital distance for the group of all nations.

- $H1_a$: There is a significant difference between economic indicators of GDP per capita and inflation; infrastructure indicator of availability of electricity; social indicators of income inequality, secondary education average, illiteracy level, urbanization level, and ELF index rating and digital distance for the group of all nations.

In Hypothesis 1, the independent variables of GDP per capita, inflation, availability of electricity, income inequality, secondary education, illiteracy, urbanization, and ELF index rating were analyzed to determine if any differences exist when compared to the dependent variable of digital distance. A principle component analysis of key information technologies for ASEAN nations was used to determine the dependent variable of degree of digital distance between these nations and the United States. Independent social, economic, infrastructure, and ethno-linguistic variables for all 10 ASEAN nations and 32OECD nations were analyzed collectively utilizing data for 2005 from the United Nations Millennium Development Goal (MDG) database. A Pearson's correlation test and Ordinary Least Squares regression analysis was performed for the 2005 data for the combined group of ASEAN and OECD nations.

The following hypotheses were used to evaluate the second research question:

- $H2_0$: There is no significant difference between economic indicators of GDP per capita and inflation; infrastructure indicator of availability of electricity; social indicators of income inequality, secondary education average, illiteracy level, urbanization level, and ELF index rating and digital distance for OECD and ASEAN member nations.

- $H2_A$: There is a significant difference between economic indicators of GDP per capita and inflation; infrastructure indicator of availability of electricity; social indicators of income inequality, secondary education average, illiteracy level, urbanization level, and ELF index rating and digital distance for OECD and ASEAN member nations.

Hypothesis 2 was addressed through the performance of a two-way analysis of variance and Levene's test for population variance on 2005 MDG data for the ASEAN and OECD groups of nations separately.

The third research question was tested through the use of the following hypothesis:

- $H3_0$: There is no significant difference in the interaction of economic, social, infrastructure, and ethno-linguistic indicators and digital distance for the years 2003 and 2005.

- $H3_A$: There is a significant difference in the interaction of economic, social, infrastructure, and ethno-linguistic indicators and digital distance for the years 2003 and 2005.

In testing Hypothesis 3, a Pearson's correlation test and regression analysis were performed for the ASEAN and OECD groups of nations separately for the years 2003 and 2005.

Digital divide indicators

For the combined group of OECD and ASEAN nations, GDP, income inequality, level of urbanization, secondary education, level of electricity, and inflation displayed a correlation to digital distance whereas the ELF index rating for this group did not show a significant relationship to digital distance.

Comparison of OECD and ASEAN digital divide indicators

The results of this study support that a strong correlation existed for both OECD and ASEAN nations for the indicators of GDP and income inequality. For ASEAN nations the degree of urbanization was also strongly correlated with digital distance (at the 0.1 level) and the level of electricity and secondary education level completed were

also significant (at the 0.05 level). The OECD countries experienced strong correlation between secondary education and digital distance (at the 0.1 level) whereas level of electricity, degree of urbanization, and inflation rate were significant (at the 0.05 level). Inflation was correlated to digital distance for OECD countries but did not show a correlation to digital distance for ASEAN nations. Ethno-linguistic fractionalization did not appear to affect digital distance for either the OECD or ASEAN countries.

Relationship of digital divide indicators over time

This study found that the performance of potential digital distance indicators was relatively constant for the OECD and ASEAN nations separately between the years 2003 and 2005. No statistically significant differences occurred in the performance of any of the indicators studied for either group of nations between the year 2003 and 2005. However, the ability to study the indicators over a larger span of time was not present at the time of this study.

The strong correlation between economic indicators and digital distance reported in this study is consistent with many of the more recent literature and research available to date (Bagchi, 2005; James, 2007; Kiiski & Pohjola, 2002; Martinez & Williams, 2010; Norris, 2001; Waverman et al., 2005). The difference in the degree of significance between OECD and ASEAN nations for factors such as inflation, secondary education, and degree of urbanization is consistent with United Nations and academic research that depicts the indicators of digital divide in developing countries and least developed countries (LDCs) may differ from those of the developed nations (Bagchi, 2005; United Nations Development Program, 2008; Zhao et al., 2007).

Conclusions

This study explored the relationship between economic indicators of GDP and inflation; Social indicators of income inequality, secondary education, ethno-linguistic fractionalization, and degree of urbanization; and the infrastructure indicator of level of electricity to digital distance and compared the relationships of these factors between ASEAN and OECD nations for the years 2003 and 2005. The results of this study furthered the discussion of the problem of digital distance and its potential affect in the global economy specifically for ASEAN nations. The findings contributed to the overall body of knowledge regarding ASEAN digital distance, ICT diffusion, and some key factors potentially affecting digital distance. The factors that appear to affect digital distance for ASEAN member nations were GDP, income inequality, level of electricity, and degree of urbanization.

So far as this study was able to evaluate the correlation of specific variables of GDP, inflation, income inequality, secondary education, degree of urbanization, level of electricity, and ethno-linguistic fractionalization, its findings support the validity of the Bagchi (2005) model for determining factors that affect digital distance. However, this study did not replicate the Bagchi (2005) model in its entirety as data for ICT expenditures as a percentage of GDP, the nations' disposition toward trust, and literacy rate were unavailable for the population of this study. However, this study did apply the same methodology and analysis techniques outlined in the Bagchi study to explore all other indicators of the model for the ASEAN and OECD populations for the years 2003 and 2005.

The application of the Bagchi (2005) model for determining factors that affect digital distance beyond the Economic Commission for Latin America and the Caribbean (ECLAC) nations considered in the original study to include the ASEAN nations and the consistent identification of key contributing factors to digital distance between the two applications of the Bagchi model contribute to the potential replicability of the model. It is possible that the combination of the Bagchi research and this study of ASEAN nations may further the study of ICT diffusion, potentially contributing to further research into reducing digital distance in developing countries internationally. Finally, by applying the Bagchi model to the ASEAN population this study also broadened the discussion regarding the role of the indicators tested in digital distance and contributed to the potential discussion of the effect of digital distance on economic development.

Recommendations

Although the ASEAN average digital distance differed from the OECD average digital distance significantly for the years 2003 and 2005, digital distance measurements were much more similar between the ASEAN nations and four of the least wealthy OECD nations (Chile, Mexico, Poland, and Turkey). In light of this anomaly, it would be interesting to observe the digital distance of these four OECD countries as compared to the ASEAN nations over time, to more thoroughly understand potential contributors to digital distance.

At the time of this study, complete databases were not available for the population examined for years prior to 2003. Therefore, it would be beneficial to compare the performance of these indicators in the future across a larger span of time once the United Nations Millennium databases have more complete data for a larger number of years.

Further and broader research into the effect of a society's disposition toward trust on ICT diffusion and digital distance would also be helpful at such a time as the Hofstede's (2001) value dimensions or World Values Survey is completed for populations in Southeast Asia and Islamic cultures.

Further research regarding potential differences in the factors that contribute to digital distance between developed countries, developing countries, and LDCs is needed. Specific, targeted research into the differences in factors that contribute to digital distance between the ASEAN member nations, whose members consist of developed nations, developing nations, and LDCs, would be insightful and beneficial to the larger conversation regarding the factors that affect digital distance in the developing world economies.

Further study to apply the Bagchi (2005) model for determining factors that affect digital distance in LDCs in different regions of the world would is also recommended. Additionally, a comparison of all LDCs to the OECD nations could be helpful in providing greater context to digital divide research as a whole. Based upon Bagchi, Zhao et al. (2007), James (2007), various earlier works, and this study, digital distance and economic performance appear to have a strong correlation. Therefore, further research is needed into formulating and evaluating strategies for effectively implementing ICT diffusion in developing economies as a means for providing greater economic potential for their populations and economies.

Research to compare the factors that affect digital distance in China, South Korea, and other strong national economies in Asia to those of the ASEAN nations could

provide valuable insights into region-specific factors and their interaction on digital distance.

Further research into the role of government and government ICT expenditures in ASEAN countries and the effect of these activities on digital distance would be beneficial.

Research into the role of digital devices in the ICT diffusion and economic development of developing and LDCs could augment current theories and approaches to economic development. Research to explore the theory that greater ICT diffusion within a nation may result in marginalized segments of society (Sharma & Gupta, 2003) would also be beneficial when considering ICT diffusion and economic development in LDCs, or to compare phenomenon across groups of countries in various regions of the world.

Research into the effect a country's degree of contact with the larger world has on ICT diffusion could be helpful in determining what impact access to global communications has on reducing the digital divide.

Finally, further research into methods for effectively measuring the impact of ICT diffusion on economic performance could also contribute meaningful insights to the study of the digital divide and economic development.

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