INVESTIGATING THE IMPACT OF ICT INVESTMENTS ON HUMAN DEVELOPMENT

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Master of Commerce in Information Systems

By

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Abstract

In the last two decades, the worldwide information and communication technology (ICT) market has been growing at a rapid rate. This has led to the global net increase in ICT usage and investments. International organizations, ICT vendors, policy makers have been trying to determine if such huge investments are worthwhile. However, the result regarding this issue is inconclusive, for this research area is fraught with complexity and existing empirical study is limited.

Investigating the impact of ICT investments on human development requires appropriate methods that can provide a deeper understanding and which are based on IS perspective theory. Of particular importance are different aspects of ICT investments and the components of human development. For example, ICT investments consist of four aspects namely hardware, software, internal spending and telecommunication investments while human development components are GDP, literacy rates and life expectancy rates. If these variables are not modelled correctly, their effect on each other can be either under- or overestimated and the appropriate level of impact is therefore required.

A review of the literature revealed that ICT investments would improve economic development in both developed and newly industrialised economies (NIEs). The focus of this study was on investigating the impact of ICT investments on human development in a global perspective.

In this study, the four aspects of ICT investments as well as the three key components of human development were investigated using trend and regression analysis. Using this approach, 51 countries with the largest ICT markets were considered and were grouped into high, mid and low income countries based on their GDP per capita. The empirical analysis implies that all four aspects of ICT investments considered in this study have a significant impact on the components of human development.

Moreover, the results also indicate that telecommunication investments are important to improve standard of living in high, mid and low income countries. The study also found that the interaction of telecommunication investments and internal spending, software and hardware and internal spending is contributing to human development growth in all countries.

These findings show that the relationship between investments in ICT and human development is not straightforward, thus suggesting that each aspect of ICT investments has differential effects on the three key components of human development. The impact of ICT investments can only be manifested on human development when the aspects of ICT investments are complemented with each other and this complementarity varies from country to country as countries have dissimilar capacities for ICT investments utilization. This exploratory study analyzes the relationship between ICT investments and human development with the overall results showing that the deployment of the right aspects of ICT investment is primarily associated with the improvement in human development. Based on these empirical findings, this study proposes theoretical propositions to explain the impact of ICT investments on human development.

The value of this study is that the policy maker, economist or IS practitioner may find this study useful, as it directly addresses the effect of ICT investments on human development. It also bears some important implications for theory and policy.

Keywords: Dynamic Model Panel, Information and Communication Technology, Human Development Index.

List of acronyms and abbreviations

CAGR	Compound Annual Growth Rate
DAI	Digital Access Index
DOI	Digital Opportunity Index
EDI	Education Index
EIU	Economic Intelligence Unit
GDP	Gross Domestic Product
GDPI	Gross Domestic Product Index
GDI	Global Diffusion of Internet
GSM	Global Systems for Mobile Communication
HDI	Human Development Index
HDR	Human Development Report
IS	Information Systems
IT	Information Technology
ICT	Information and Communication Technology
ITU	International Telecommunication Union
IDC	International Data Corporation
KEI	Knowledge Economy Index
LEI	Life Expectancy Index
MDGs	Millennium Development Goals
NRI	Network Readiness Index
NIE	Newly Industrialised Economy
PCs	Personal Computers
TFP	Total Factor Productivity
UN	United Nations
UNICEF	United Nations Children's Fund
UNPAN	United Nations Division for Public Administration and Development Management
UNCTAD	United Nations Conference on Trade and Development
WITSA	World Information Technology and Services Alliance
WSIS	World Summit on the Information Society

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CHAPTER 1

1 Introduction

1.1 Background

The worldwide development of information and communication technology (ICT) has increased dramatically over the past few decades. This has been due to an increase in global economy as a result of technological advancement and market competition that led to price reduction in ICT equipments and services. ICT equipment offered a strong advantage for capital and labour replacement. With the trend and revolution in various ICT sectors, the loosening of trade policies increased the growth and expansion of ICT infrastructure (Zhen-Wei Qiang & Pitt, 2004).

ICT investments have wn substantially in developed and developing countries. The cumulative annual grov ate of ICT spending in developing countries was 12 percent while it was percent in devel countries between 1993 to 2001 (Zhen-Wei Qiang & Pitt, 2004).

Worldwide ICT sp accounted for $1.8 trillion in 1997; this is 6% of the aggregate global GDP and 4 ger than in 1992. The growing rate was 27% faster than the overall GDP which had 5% annually (WITSA, 1998). ICT investments have grown in every economy world gardless of GDP or population growth rates. Asia, Latin America and Eastern Europ enced the fastest growing ICT investments market with five year annual growt f 14.5%, 13.6% and 9.5% respectively between 1992 to 1997 (WITSA, 2002). Alsc African countries have been increasing investment in their ICT infrastructu 995 in response to social and business demands (Bollou, 2006).

The glo growth rate of ICT investments peaked in 2004 at 12.3 % following a slowdc . ICT growth was moderated to 7.7% and 7.9 % in 2005 and 2006

respectively. Year 2007 was a transition year in ICT investment. The recession in the US economy and other developed nations affected the ICT sectors and ICT investments accounted for a growth rate of 10.3% in 2008 at moderate global economy growth (WITSA, 2008).

The International Data Corporation (IDC) predicted that the moderate global economic growth and increased ICT penetration will support ICT investments growth by 2011.The demand for ICT products will decrease in developed countries due to slowing economies and the weak US dollar will encourage the exportation of ICT goods from the US to emerging economies (WITSA, 2008). The total ICT investments will be $ 4.4 trillion in 2011 compared to $2.1 trillion recorded in 2001 at a compound annual growth rate of 7.7% (WITSA, 2008). The increase in ICT spending will enhance ICT production and use thereby contributing to the economic growth.

It is clear that ICT investment is an important element of the global economy. The ICT sectors are contributing significantly to the overall economic health of the global economy. An average growth increase in total factor productivity (TFP) of 1/3 % per annum based on ICT investments in industrial countries during 1995 to 2000 was estimated (Lam & Lam, 2005). The United States ICT investment recorded TFP of ½ % per annum during this period. ICT and productivity growth in England contributed 1/5 % GDP growth during 1989 and 1998 (Oulton, 2004). It was also demonstrated in African countries that ICT investments increased TFP (Bollou & Ngwenyama, 2008).

The positive impact of ICT investments on global economic growth in developed and developing nations has been established in most literature.
However, the focus of this study is to investige the effect of ICT investments on human development.

1.2 Motivation and Problem Statement

Over the past ten years, the field of information systems has not been deeply engaged in the study of the IT artefact (Orlikowski & Iacono, 2001). IT artefacts have been seen to be unproblematic and taken for granted by IS researchers. This has resulted in a lack of theories about IT artefacts and their emergent, interdependent nature in social and economic context (Orlikowski & Iacono, 2001). This study is motivated by the inadequate research on IT artefacts as to technology effects, context and capabilities in the IS field (Orlikowski & Iacono, 2001).

IT artefacts have been viewed in several ways. They are as follows: (Orlikowski & Iacono, 2001).

- Tool View of Technology: Tool view of technology means a tool for labour substitution, enhancing productivity, information processing and changing social relations. This can be expressed as an engineered artefact that is designed for a specific purpose and is independent of the social or organizational environment in which it was developed or used.

- Proxy View of Technology: Proxy view of technology is captured by individual perception, diffusion rates and investments (Capital). This is seen as the importance of technology as viewed by users, the diffusion and penetration of technology in industries or countries and the amount of technological investments in organizations and, countries recorded over time so as to understand the impacts.

- Ensemble View of Technology: Ensemble view of technology focuses on the interactions between technology and people as well as, the implementation and use in an organization. It is expressed in terms of how technology was developed and used.

- Computational View of Technology: Computational view of technology involves the development of algorithms or the running of codes and use of computational abilities to simulate a specific phenomenon.

- Nominal View of Technology: In nominal view, technology is absent and IT artefacts are not described, conceptualized or theorized.

Theoretically, this study is situated on upon the *proxy view* perspectives of IT artefacts described above, and, in particular the *investments view*.

The increase in ICT investment has been used in developed nations and newly industrialized economies (NIEs) to foster economic development (Mansell, 1999; Wang, 1999; Avgerou, 1998; Ngwenyama, Andoh-Baidoo, Bolou & Morawczynski, 2006), while several countries like United States, Singapore, Spain and South Korea have used their ICT sectors to support economic growth. For example, South Korea led the global Digital Opportunity Index (DOI) table for ICT access, use and affordability in 2005 (Brown & Brown, 2008).

With the rapid increase in ICT spending in many nations, international organizations, country leaders, scholars and professionals have not stated clearly the benefit of such investments to human development and the empirical studies in this regard are few (Ngwenyama et al., 2006; Morawczynski & Ngwenyama, 2007; Bollou & Ngwenyama, 2008; Kim, Kang, Sanders & Lee, 2008).

Moreover, ICT investment aspects consist of hardware, software, internal spending and telecommunication investments while human development components are of GDP, literacy rates and life expectancy rates. These need to be assessed at country level as their effect on national performance differs across countries. For example the returns on ICT investment for high income countries might be different from low income countries due to structural differences like ICT investment policy, existing infrastructure, human capital development and non-capital Items (Kim et al., 2008).

A review of the literature revealed that the increase in ICT investments in countries should be properly addressed to enable policymakers to fully understand how resources should be allocated. This research is an attempt to clarify these issues.

1.3 Research questions

Defining appropriate research questions is one of the important steps to be taken in any study, most importantly in empirical study (Dube & Pare, 2003; Mays & Pope, 1995; Benbasat, Goldstein & Mead, 1987). A clear and accurate research question shows the essence of the research and easily links the study to its contributions which serves as the backbone of a solid research design (Mason 1996).

Based on the above contention, this research's primary is: what are the impacts of ICT investments on human development in high, medium and low income countries? While the secondary questions are :

- What are the impacts of the four aspects of ICT Investments on the standard of living?
- What are the impacts of the four aspects of ICT Investments on education?
- What are the impacts of four aspects of ICT Investments on health?
- What are the interaction effects of four aspects of ICT Investments on three key components of human development?

The analysis of the impact of ICT Investments on the three components of human development in high, medium and low income countries will provide an in-depth understanding of the country ICT utilization.

1.4 Objective of the study

The primary objective of this study is to investigate and assess the impact of investments in ICT on human development .The secondary objectives are:

- To provide an overview of the impact of ICT investments on the standard of living.
- To provide insight into additional impact between the facets of ICT investments and the three key components of human development.
- To show interaction among the facets of ICT investments on the standard of living, education and health.

1.5 Outline of the study

Chapter two is the literature review that provides a general overview of Information Communication Technology (ICT) and human development. The relevant studies that involve the concept of ICT investment, human development and methodology are also discussed. Chapter three provides the methodological approach of the study.

In Chapter four, the trend data analysis used in this study is discussed, while chapter five presents the regression analysis of the study. Chapter six provides the results and discussion while Chapter seven presents the implication of the findings.

CHAPTER 2

2 Literature Review

2.1 Introduction

Information and Communication Technologies (ICTs)

Information and communication technologies (ICTs) have brought communication and access to information to the forefront of development. People are forming new social networks, and learning and sharing knowledge together across geographical boundaries. Computers, mobile communications and the Internet have become part of the daily life of millions of people around the world, providing them with instant access to voice, video telephony, messages, video streaming, e-mail, file transfer and other computer applications. More than 118 million PCs are installed in homes and schools worldwide (WITSA, 1998).

The global system for mobile communication (GSM) also accounts for over 66 percent of the world's total market (Vriendt, Laine, Lerouge, Xu & Alcatel, 2002), and the global diffusion of the internet (GDI) conducted across countries shows high levels of internet pervasiveness (Brown, Collins, Maleka, Morrison, Muganda & Speig, 2007). Internet is referred to as the linking together of two or more computers into global network of fibre optic cable, satellites and telephones for the purpose of information exchange (Morrow, 2002).

The rapid growth in the ICT sector is bringing digital opportunities to new constituencies, yet the general impact of the increase in ICT spending on development is difficult to capture as a result of variations in the different structure of returns from ICT investments among countries.

The opinions on the impact of ICT in human development are in two categories- ICT when adopted has the potential to empower communities and countries while, on the other hand, the ICT revolution can lead to imbalances and inequalities that may occur through ICT access and adoption(UNDP,2003).

In view of these two standpoints, this study investigates the successful role which ICT access and adoption has been playing towards development through investment. In an attempt to examine the relationship between ICT and development, it is therefore imperative to understand the meaning of ICT in broader terms. In terms of knowledge and a people- centric perspective, ICT is described as an initiative of people to seek ***information*** and ***communicate*** it to people who appreciate its value (*Figure 2.1*). This becomes ***knowledge*** and value to human development while the ***technology*** serves as a channel to disseminate the knowledge. This shows the role of people as agents for ICT and development (UNDP, 2003).

From the technological perspective, ICT is born out of the interaction of internet and telecommunications revolution as an electronic means of capturing, processing, storing and disseminating information which includes telecommunications, computer networks, radio and television (*Figure 2.2*). Simply put, it is a means of disseminating information through a combination of complementary technologies (UNDP, 2003; ITU, 2007).

This study conceptualizes ICT in terms of the technological perspective to bring about the impact of increased investment in technology that disseminates knowledge for human development.

The remainder of this chapter provides a review of the theoretical literature on ICT and how it is related to development. In addition, selected studies relevant to the impact of ICT investments on human development are reviewed.

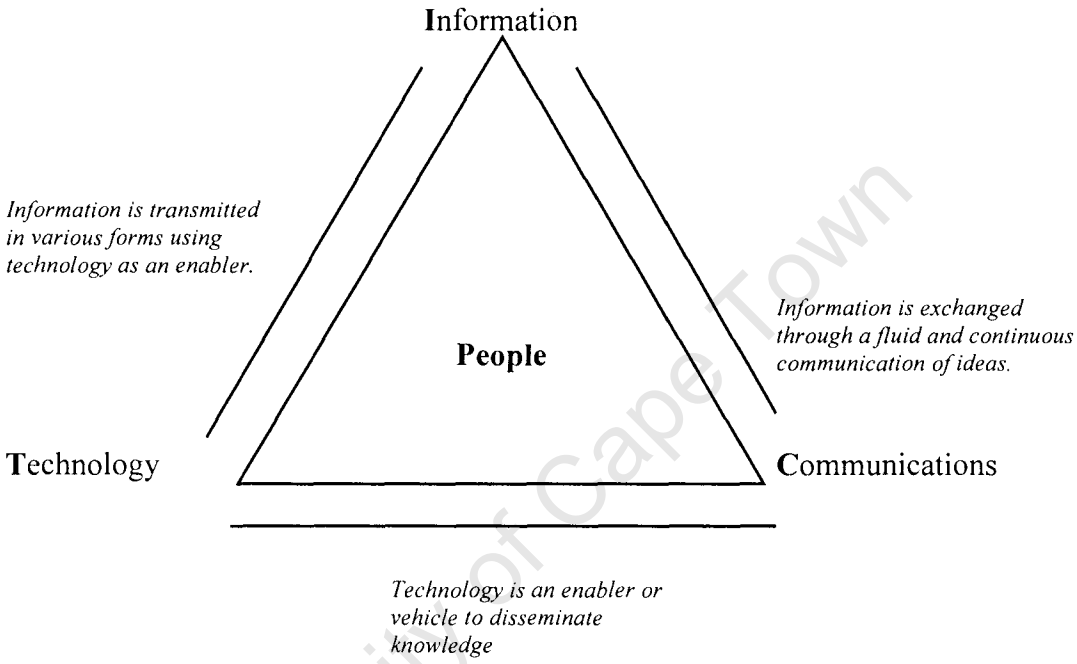


Figure 2.1: Knowledge and People centric perspective model of ICT.

Source: ICT for Development, UNDP, 2003.

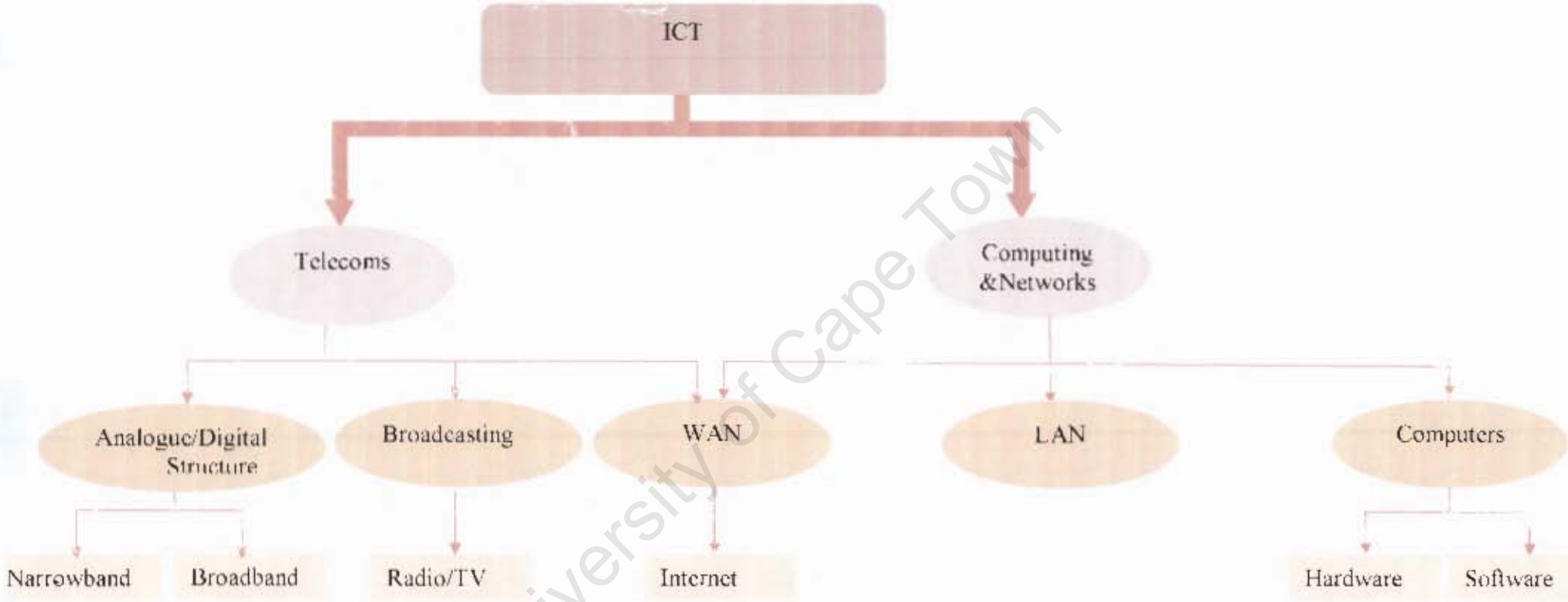


Figure 2.2: Technological perspective model of ICT

2.2 Telecommunications and Internet

On a global level, the telecommunication system consists of wireless communications such as Wimax, satellite, mobile and fixed communication systems. These systems are made up of hardware and software structures that are required to set up the links (Bullock & Cliff, 2004). Telecommunication enables organizations operating from several locations to run as a single unit. This encourages information to be shared and controlled from a central location in an organization. It also allows collaboration by means of electronic data interchange among suppliers and customers. Telecommunication systems consist of many components that interact through the information flow. The global telecommunication network has become the largest distributed network that is characterised with heterogeneity (Amyot & Eberlein, 2003).

The telecommunication industry is widely known as competitive and comprised of different sections such as internet service provision, (ISP), mobile network, fixed-line network, television and radio broadcasters. The worldwide expansion of telecommunications has been attributed to technological development and liberal policy reformation in the sector (Sawyer & Rosenbaum, 2000).

In developed countries, telecommunication has reached a high level of liberalization while this has been a complex and relatively new issue in most developing countries (Fink, Matoo & Rathindran, 2002). In spite of this, telecommunications continue to expand globally and remain the largest component of ICT. The continuous advancement in information and communication technologies provides an opportunity for development. The consensus that the provision of telecommunication infrastructure is a suitable condition for sustainable growth and development identifies the importance of increasing investments in this sector (Makhaya & Roberts, 2003)

The emergence of the internet has been described as being as important to society as the development of computer and telephone services. The internet is one of the world's largest computer networks consisting of several computers that are communicating with each other (Mowery & Simcoe, 2002). The internet is one of the major drivers for telecommunication services and the development of global information infrastructure (ITU, 2007). The growth of internet has been a universal and astounding phenomenon. It has changed the way of life, created new businesses and brought families close together (ITU, 1999). An attempt to overcome physical and psychological isolation is a major driving factor of the internet usage.

In a global scope, internet networks from 213 host computers to more than 56 million internet hosts supporting over 190 million internet users (ITU, 1999). The provision of telecommunication infrastructure enables the internet ease of use and implementation (ITU, 2002). The use of internet has been playing a great role in development, and alleviation of social exclusions among nations (Chigona, Vally, Beukes & Tanner, 2009). To buttress this point is the case of Singapore where the use of internet in education and social activities has been promoted by government making over one-third of its inhabitants internet users with over 50 PCs per 100 inhabitants. Today Singapore is considered as one of the most ICT connected and adept nations worldwide and a world leader in ICT use (ITU, 2002).

The rapid expansion and diffusion of internet provides adequate potentials for all countries to participate in the global economy. Internet provision is based on telecommunication infrastructure which enables the marriage between the economic and social impact of ICT (WITSA, 1998). Internet standards are simple to install and use. This encoura ges rapid returns on investments as well as taking advantage of global World Wide Web (WWW) (World Bank Report, 2003).

In most developed and developing countries, broadband services have been used as a lever to unlock the bottleneck for internet access created by narrowband which consists of analogue copper telephones line that are not suitable for moving large volumes of data. For example, South Korea accelerated the development of their broadband services such as fibre optic cable, cable modem and local multipoint distributed systems (LMDS) for the more effective

internet access. This enabled South Korea to become a world leader in broadband services (World Bank Report, 2003).

In the face of the recent economic recession, broadband internet access continues to grow at an amazing rate that US$ 137 billion will be needed to upgrade the internet to meet with the demand over the next five years (ITU, 2009). The governments of many nations around the world are amending their policies to improve digital inclusion through investments in internet access, as a stimulus to economic growth. For example, the Italian government announced plans to invest in their NGN infrastructure in September 2008 while China and India have completed the initial phase of their broadband expansion (ITU, 2009).

It has been predicted that network connections in the world's forty largest broadband markets will expand from 393 million to 442 million between December 2008 and December 2009 (ITU, 2009). This reveals that the demand for broadband will continue to increase in spite of the recession. The benefit of internet access is seen in a number of areas of social and economic development of a country such as commerce, education and health (ITU, 1999).

Internet commerce has penetrated all sectors of the economy both in the developed and developing world. This has enabled the countries to operate in the digital economy with internet banking and online businesses. Internet based sales accounted for US $ 95 billion in 1999 were estimated to reach between US$ 1trillion and US$ 3 trillion in early 2000s (ITU, 1999).

Internet use in the health sector is a means of opening and exchanging of information resources to ensure adequate and wider dissemination among health professionals, health officers and ministries of health. This allows monitoring of disease evolution, communication support for planning and epidemic control through rapid mobilisation. Internet access in the educational sector is one of the most important factors of development as education is believed to be one of a country's main prospects for human development and international competitiveness (ITU, 2007).

The growth of internet access in nearly all nations has encouraged universal distance learning and resource sharing. For example, Education Investment Corporation (Educor) of South Africa through web based education, has registered over 300,000 students in 160 branches, leaving their market capitalisation at US $ 433 million and floating their shares on the Johannesburg stock exchange in 1997 (ITU, 1999). The internet has allowed interaction between businesses and consumers. Companies can market their products abroad easily. The use of internet encourages organizations to rework their messages and communicate to different customers around the world thereby respecting their diverse cultural differences (WITSA, 1998).

In general terms, the costs of doing business over the internet became considerably lower once a worldwide telecommunications infrastructure was put in place (WITSA, 1998). The literature has shown that the diffusion of the internet will promote the economic and human development level of the nations. The observation shows that the majority of the internet hosts are in developed countries where there existed adequate telecommunication infrastructure to form the backbone for the internet structure. This suggests that telecommunication infrastructure is one of the major factors driving the diffusion of the internet (ITU, 1999; ITU, 2002; ITU, 2007; World Bank Report, 2003). It is also expressed in the global diffusion of the internet (GDI) frame work developed by Wolcott, Press, McHenry, Goodman & Forster (2001) as telecommunication infrastructure and connectivity (Connectivity infrastructure and Geographical dispersion) was included in the six dimensions of assessing the level of Internet diffusion in a country. The framework has been used to analyse the internet diffusion in over 40 countries, including several African countries such South Africa, Kenya, Ghana and Nigeria. It is robust in making country level assessments of the internet as a cluster of technologies (*Figure 2.3)* and provides a broad overview of internet diffusion for comparison between countries (Wolcott et al., 2001).

The GDI framework consists of six dimensions which describe a measurable feature of presence of the internet in a country, as follows (Wolcott et al., 2001; Brown et al., 2007; Muganda, Bankole & Brown, 2008).

1. Connectivity Infrastructure-This dimension measures the state of telecommunications infrastructure that includes the physical robustness of the network in a country.
2. Pervasiveness- This is a measure of the number of internet users per capita.
3. Geographic Dispersion- This captures the level of telecommunications infrastructure distribution across the entire territory of a country.
4. Sectoral Absorption- This measures the level of internet adoption by organizations within the academic, health, public and commercial sectors in a country.
5. Organisational Infrastructure- This reflects the number of organizations that provide internet services.
6. Sophistication of Use- This assesses the level of adoption of internet applications based on the users and on what the internet services infrastructure is able to provide.

The six dimensions described above are assigned five ordinal values ranging from zero to four which represent non-existent to highly developed level respectively. These levels show the state of the internet in a country at a given point in time.

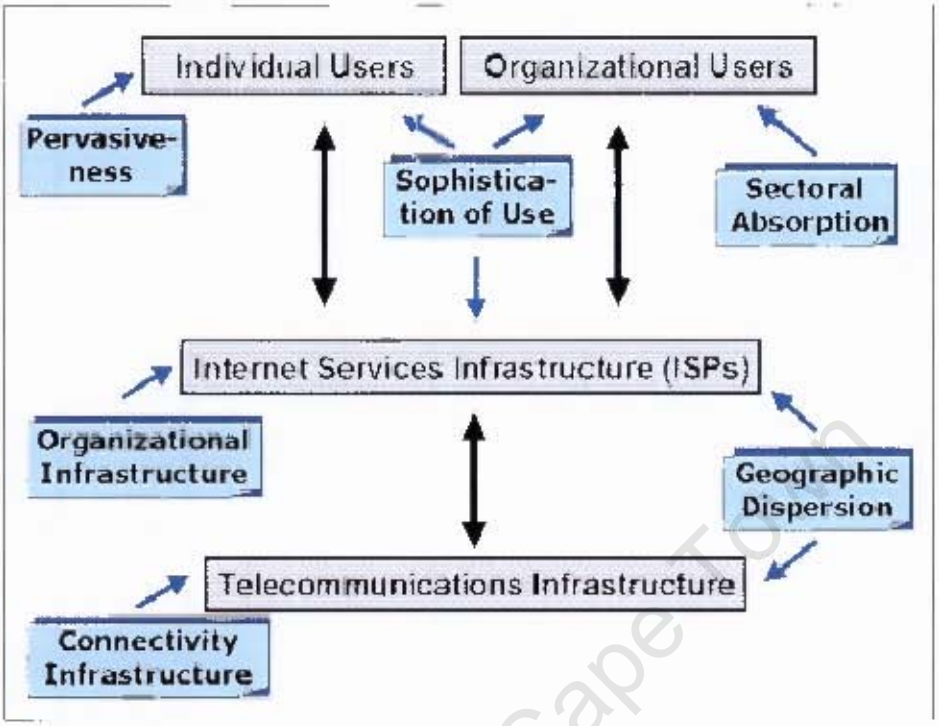


Figure 2.3: Constituents of the Internet Technology Cluster
Source: Wolcott et al., 2001.

2.3 Computing and Networks

This is a component of ICT comprised of computer systems hardware and software, peripherals and the network structure. At country and organizational levels, the impact of the computer-oriented environment cannot be over emphasised. The world is changing and the use of computers in everyday activities is a global trend. This concept is true in every activity particularly in education, government and communities (Bocij, Chaffey, Greasley & Hickie 2006).

The link between computers and other hardwire devices such as printers, scanners, speakers and storage devices can be referred to as a computer network. These links allow computer devices and others to be shared more cost effectively. Computer networks are based on local and wide area networks (Bocij et al., 2006).

The local area network (LAN) is structured within work a group for a single office whereas a wide area network (WAN) is constructed for national and international workgroup such as the internet.

Computer networks are providing organizations with a computer-based information system that improves their capability for response in a dynamic environment. Organizations and countries can operate effectively with the use of computers to provide better planning and, forecasting, and to diminish the effect of potential problems. Computer networks provide the interaction of data between people working in different departments of an organisation and in different organisations. It serves as a regular and reliable means of data transfer among people (Bocij et al., 2006).

The increased computerised systems and data transfer in the organizations has led to growing market for storage network in countries (Gibson & Meter, 2000). The area storage networks are technology that optimizes the processing and storage of data (Wang, 2006). A storage area network connects several network servers to a centralized group of disk storage to maximize the computing power and storage virtualization to all users. These reduce cost, perceived complexity and ensure responsiveness and accessibility of data (Wang, 2006).

In recent times, organizations have been developing a heterogeneous storage network system across several operating systems, database products and applications to ensure continuous access to the enterprise resource data. This has resulted in a change in organizational IT strategies by moving away from *in-house* IT systems to the use of package software (Holland, Light & Gibson, 1999).

Package software is licence software that is in a standardized package or electronic file (Jorgenson, 2001). Package software consists of two categories: Open Source Software (OSS) and Proprietary Software.

Open Source Software (OSS): The term open source software was invented in 1998 to describe a software package that is made freely available to all users (Ghosh, Glott, Krieger & Robles, 2002; Hippel & Krogh, 2003). OSS is software that is developed, tested and improved through collaboration.

The software has no licence fee and can be redistributed. Examples of open source software are the GNU/Linux computer operating systems. Apache sever software and the Perl programming language (Government OSS Strategy, 2003). Open source software offers a powerful way of generating knowledge and economic value. The non- proprietary status of OSS provides affordable IT solutions for individuals and organizations. OSS is useful in developing countries as a tool to leapfrog into the information age and create new markets and business opportunities (Government OSS Strategy, 2003).

Proprietary Software: This is the type of package software that is sold as a finished product and licensed to individuals or organizations for a fee (Bretthauer, 2001). Proprietary package software is developed by team of designers, programmers and quality assurance engineers. The software undergoes industrial design reviews and formal quality assurance procedures and requires technical support provided by the vendor (Boulanger, 2005).

The trend in the development of standardized packaged software has become a major sources of competitive advantage to speed up the demand for supply chain processes in an organization (Mashari, 2003 Cited in Gumaer, 1996). This demand led to the development of enterprise resource planning in information systems which provide cross- organization integration of data through embedded business processes (Esteves & Pastor, 2001). Enterprise Resource Planning (ERP) systems consist of software packages that include integrated business solutions for core processes such as human resources management, production planning and financing (Mashari, 2003 Cited in Gumaer, 1996). Most large organizations worldwide have adopted ERP software for their corporate activities to facilitate managerial control, decision making and reduce operational cost (Klaus, Rosemann & Gable, 2000).

2.4 ICT indicators

Indicator is an abbreviated language or value laden device used for assessment, monitoring and providing evaluation and feed back for specific programmes or initiatives (GISW, 2008). Indicator is designed based on its intended use and provide evidence of what is being valued. Indicator is an essential unit in policy making for measuring progress and results.

Organizations such as the ITU, the World Bank and the United Nation launched a partnership on measuring ICT for development at World Summit on the Information Society (WSIS) and United Nations Conference on Trade and Development (UNCTAD) in June 2004.

The partnership developed indicators which emphasize ICT in terms of the ICT sector and trade in ICT goods, use of ICT by individuals and households, use of ICT by businesses and ICT infrastructure access. The groups have come up with standardized ICT indicators in assessing the information society for all the countries. Table 2.4 listed most of the ICT indicators that have common indexes.

Table 2.1: ICT Indicators

ICT Indicator	ICT Index	Source	Website
Mobile Cellular Telephony Fixed Line Telephony Computer Penetration Internet Access and Host	Digital Opportunity Index (DOI)	ITU	www.itu.int/ict
Mobile Cellular Telephony Fixed Line Telephony Computer Penetration Internet Access and Host	Digital Access Index (DAI)	ITU	www.itu.int/ict
Mobile Cellular Telephony Fixed Line Telephony Computer Penetration Internet Access and Host	E-Readiness Index	UNPAN	
Mobile Cellular Telephony Fixed Line Telephony Computer Penetration Internet Access and Host	ICT Diffusion Index	UNCTAD	measuring-ict.unctad.org
Mobile Cellular Telephony Fixed Line Telephony Computer Penetration Internet Access and Host	ICT Index	World Bank	www.worldbank.org

2.5 ICT per Capita

ICT per capita is the total amount of money spent on ICT per person in a given country in a year. It is computed by dividing the total population into the total ICT spending for a given year (WITSA, 2008).

2.6 ICT Investments

The rapid increase in ICT deployment as an engine for social and economic development has led to growth in worldwide ICT market (ITU, 2008). The spending on information and communication technology is presently important elements of the world economy as it favours the improvement in global economy by easing the ups and downs of the economic cycles. Spending on ICT at individual level improves the quality of life through access to information and exchange of ideas in both developed and developing economies (ITU, 2007). While these increases in ICT investments are visible in all countries, the focus of ICT investment differs from country to country.

ICT investments are referred to as second-order investments (Servon, 2002; Morawczynski & Ngwenyama, 2007). Second –order investments are types of investments that are allocated to create opportunities for people to improve the conditions of poverty and marginalization while first- order investments are resources that are allocated towards the immediate needs of the individual such as provision of food, clothing, housing, education and health (Morawczynski & Ngwenyama, 2007).

ICT investments have been expressed in various categories according to many scholars and organizations. Samoilenko & Osei-Bryson (2008) refers to ICT investments as the total annual investments in telecommunication and human capital in the form of full-time telecommunication staff. ICT investments are categorised into four components according to Kaiser (2003) as (i) expenditure in physical ICT capital such as hardware, software and telecommunication equipment (ii) expenditure for ICT personnel such as workers and ICT professionals (iii) expenditure for non specified items.

ICT investments are also considered as computers, software, telecommunications equipment and semiconductor (chips) investments (Oulton, 2003). The International Telecommunication Union (ITU) also expressed investment in ICT as the total telecommunication spending while World Information Technology and Services Alliance (WITSA) describes ICT investment as the total value of information technology spending and telecommunication equipment and services. Information technology (IT) investment is the total annual spending on the combination of hardware for office machines, data processing equipment, data communication, software and services (WITSA, 2008).

Telecommunication investment is the total annual investment in telecommunication. It is referred to as the annual capital expenditure in telecommunication that includes fixed, mobile and other services (ITU, 2007). ICT investments are grouped into four facets according to WITSA: hardware, software, telecommunication investments and internal spending (WITSA, 2008).

2.7 Facets of ICT Investment

This study followed the comprehensive description of ICT investments by WITSA (2008) in order to have a deeper understanding of the various facets of ICT investments and as well as to be able to answer the research questions posed by this study. The four facets of ICT Investments are listed as follows:

2.7.1 Software Investment

Software spending is the total value of all the purchased software products including software packages, database systems, application tools, and utility software and programming tools (WITSA, 2008).

Software investments are growing rapidly and this is reflected in the large volume of software expenditure across the globe as many organizations and countries are investing strategically

in software assets to gain a competitive advantage in the market place (Withey, 1996; Jorgenson, 2001).

The global information age has enabled the incorporation of high speed and low cost information technology components that provide new functions and offer value creation in business processes. Software embodies these new value functions. For example, for the past few decades, India has remained as a major exporter of software in the international economy and the software industry remained a major export earner for the country (Arora & Athreye, 2002).

This is also evidenced when the world wide software expenditure was estimated to be more than US$ 800 billion annually (Boehm & Sullian, 2000). Software investments were classified into three different types- pre-packaged, customised and own-account software. Pre-packaged software is licensed software that is sold in standard packages or electronic files. Customised software is a specific application software that consist of analysis, programming and design for user customization while Own-account software is software that is sold for dedicated application (Jorgenson, 2001).

2.7.2 Hardware Investment

Hardware investment is the total computer hardware spending in a country .This includes purchased or leased computers, storage device, memory upgrades, printers, monitors, scanners, input-output devices, terminals, and other peripherals from external agents (Kim et al., 2008 ; WITSA, 2008). The investments in hardware and software are interwoven as hardware infrastructure in terms of computers, servers and networks permits the exploitation of software investments (Armour, 2001).

2.7.3 Internal spending

This aspect describes the amount of internal software customization, capital depreciation, human capital development and IT related internal spending such as outsource domestic and offshore IT consulting, computer systems integration, network

systems integration, web hosting, computer disaster recovery, office automation, facilities management, equipment maintenance and other expenses that cannot be attached to a vendor (WITSA, 2008; Kim et al., 2008).

2.7.4 Telecommunication Investment

Telecommunication Investment as described in 2.6 is the total value of voice and data communications services. Examples of telecommunication services are local and long distance wire- line telecommunication, wireless communication, paging, satellite communication, private line services and internet access. Examples of telecommunication equipment are wide area network (WAN) equipment, LAN equipment, modems, telephone handsets, multiplexers and telephone answering machine (WITSA, 2008).

Investments in telecommunications have brought together the expenditures by businesses, household, government and educational institutions on the public network equipment, private network and telecommunication services (ITU, 2007). The 1990s experienced a massive investment in the telecommunication sector with the opening of competitive markets in the sector (Bollou, 2008). Telecommunication investments remain the largest aspect of ICT investments (WITSA, 2008).

2.8 Human Development

2.8.1 Definition of Development and It's Concept

The concept of development is multifaceted, most definitions of development define it in terms of action plans, strategies, and programmes aimed at improving the condition of underdeveloped countries (Coetzee, Graaff, Hendricks & Wood, 2001). The underdeveloped countries are described poor, backward, traditional and rural in nature. These countries have high reproductive figures but lack savings capital, social distribution of benefits, political participation and sufficient educational training.

Development is seen as a favourable change from worse to better, simple to complex or growth in social change that will lead to progress in a country (Coetzee et al., 2001).

Roode, Pollock, Speight &Webber (2004) explained in broader terms the meaning of development as *"a multidimensional process involving major changes in the social structures, popular attitudes, and national institutions, as well as the acceleration of economic growth, the reduction of inequality, and the eradication of absolute poverty", pp. 2.* They explained that development is tied to improvement in a country.

There are several development theories (Madon, 2000); many early development theories in literature included modernization, dependency, welfarist, and feminist, sustainable, human centred and economic focus development on economic growth and material welfare., Economic development has conventionally been used as a measure of development in a country (Trusler, 2004). The discussions about development are centred on national income and standards of living of citizens. Since the 1950's, there has been a review by the UNDP of the use of only gross domestic product (GDP per capita) as a procurator of development.

In the late 1980's, the concept of development was expanded to include social factors and other aspects of human welfare such as education, health and political freedom as a view of development (Desai, 1991; Ngwenyama et al., 2006). Development in the African context was seen as being concerned with the improvement in the overall capabilities of the societies to solve the problems of the mass survival, indigenous entrepreneurship, international trade, and democratic self rule (Himmelstrand, 1994 pp. 3). It was also described as *"an inclusive process involving qualitative and structural change, resulting in the improvement of the quality of the community as a whole"* (Jayaweera, 1991 pp. 2-3 Cited in Coetzee et al., 2001).

Fielding (2002) explains development as the state of economic, education, health and democratic growth of a nation. Development is defined by much literature based on the notion that has been conceived by UNDP and how the concept has been understood.

2.8.2 Human Development

> *"Discussions on development are centred on economic growth, using variables such as per capita income growth. Of course these economic variables also generate some social benefits. But this view of development had been quite limited. While a country could perfectly well be considered highly developed, income might be concentrated in the hands of a few, and poverty worsening.... Speaking as President of Brazil, until today the country is plagued by a lot of problems—income concentration, poverty, and so on. If we do not adopt a development model that responds to the needs of the majority this development will not be long-lasting."*
>
> **FERNANDO HENRIQUE CARDOSO, FORMER PRESIDENT, BRAZIL.**

Human development is the process of enlarging people's choices as well as raising their levels of well-being (UNDP, 2003). Human development is a broader definition of human well being so as to lead to a long and healthy life, to acquire knowledge and to have access to the resources needed for a decent standard of living (UNDP, 2006). At all levels of development, the above three essential choices must be made accessible to people.

After many reviews about the concept of economic growth, it was noted that poverty still exists in the United States, United Kingdom and some developing economies in Latin America and South Asia irrespective of full employment and stabilized economic growth. This was also evident in Africa in the 1980s (Desai & Shah, 1988 Cited in Desai, 1991). Growth was found not to eradicate poverty and growth was contended to be less significant if it is uncongenial to removal of poverty (Desai, 1991). The Kuznets curve proved the narrow emphasis of GDP as a measure of development: the Atkinson's articles of the 1970s and Sen.'s contributions on the measurement of poverty led to the theory of entitlements and notion of capabilities (Sen, 1981).

In 1979, UNICEF underlined child related measures such as infant mortality rates and weight at birth as part of development while Morris David, an economist, proposed a theory know as Physical Quality of Life Index (POLI) for measuring development. POLI is the combination of infant mortality, life expectancy and literacy (Desai, 1991; Moran, Wackernage, Kitzes, Goldfinger & Boutaud, 2008). The POLI theory is based on the assumption that the physical quality of life index can used to measure and implement programmes that will move the country along the development path (Barnett, 1988).

In 1987, the United Nations (UN) delegated a World Commission on Environment and Development which asserted the importance of human development that "extends to all the opportunity to fulfill their aspirations for a better life". There was a call for sustainable human development that would meet the needs of the present as well as future generations (Moran et al., 2008). The human development paradigm implies that using GDP per capita as a measure of human development is inadequate.

The concept of human development was established from these concerns. In recent times, the UN adopted a program known as Millennium Development Goals (MDG) to assess human development, and MDGs were used as the standard scale for human development. This includes eradication of poverty, gender equality, universal primary education, reduction of child mortality rates, improvement of maternal health, empowerment of women, the fight against major diseases such as HIV/AIDS, and malaria, promotion of sustainable environment and development of global partnerships for development. This agenda called on countries around the globe to incorporate the rationale of human development into their national policies. (Moran et al., 2008; Chacko, 2005).

The United Nations under the auspices of UNDP introduced a measure broader than economic development that can promote human fulfillment named the human development index (HDI) (Sun, 1993; Sagar & Najam, 1998). HDI serves as a measure to specify the improvement of development of a country. The HDI consists of three major dimensions of human development: standard of living (Gross domestic product (GDP per capita)), education (literacy rates and levels of education enrolment) and health and longevity (life expectancy at birth) (UNDP, 1990, 1991, 2006).

Human Development Index has been published annually since 1990 in the Human Development Report (HDR) for all countries.

2.8.3 Dimension of Human Development

The concept of human development is essential to this study. The dimensions of human development are used to contextualise the countries under investigation and explicate their level of development. The three dimensions are:

1. **Health**

Health can be referred to as the bio-physiological functioning of humans. It covers biological functioning at large. Health can be viewed from two perspectives : positive health and negative health. Positive health refers to overall health as measured by performance tests and by subjective reports about the feelings of health. Negative health is measured by the incidence and the severity of impairments and diseases such as cancer and, HIV/AIDS. It is observed that socioeconomic status is related to all health experience in a country.For example, people with more education or income live longer and experience fewer adverse health issues (Crimmins & Saito, 2001).

Health is measured by life expectancy at birth and referred to as the average number of years a person is expected to live from the time of his/her birth or the average age of individuals in a country (HDR, 2008 p 234-248). It is an alternative measure of the mortality experience of the population (Silcocks, Jenner & Reza, 2001). Life expectancy rate is a paramount indicator of the health of a nation and shows a population's ability to lead a healthy, long life. It can be measured as the total observed death rates in age groups.

Life expectancy can be high in a country even when the average health level of such a country is low. The citizen's health is measured by their longevity and can be estimated on the basis of civil registration. Life expectancy differs by socioeconomic status in many countries of the world; long living might not necessarily be healthy living (Veenhoven, 1996). 'Healthy life expectancy' is the life that is free from the limitation in normal activity caused by a physical or mental condition.

Healthy life expectancy can be determined by measuring an individual's usual activity in a year and inability or limitation to perform as usual or in other activities (Crimmins & Saito, 2001). An empirical study conducted by Barro and Sala-I-Martin in 1995 shows that a 13year increase in life expectancy raised the annual growth rate by 1.4 percentage points (De la Croix & Licandro, 1999).

The World Health Organization (WHO) assessment of healthy life expectancy in 1999 for 191 member countries showed that Japan had the highest average healthy life expectancy of 75-years at birth. The countries with the lowest healthy life expectancy are in sub-Saharan Africa due to HIV-AIDS prevalence with healthy life expectancy lower than 35 years (De la Croix & Licandro, 1999).

WHO recorded that years of healthy life lost due to disability represented about 18% of the total life expectancy in the bottom countries and 8% in the countries with the highest life expectancies. The findings also show that healthy life expectancy increases at a faster rate than total life expectancy across countries and the male to female gap is lower in healthy life expectancy than total life expectancy: where women live longer but spend their life with disability. An increase in health expenditure per capita increases healthy life expectancy (Mathers, Sandana, Salomon, Murray & Lopez., 2000).

2. Education

Education is referred to as the level of literacy of people in a society. It is also determined by the measure of enrolment in primary, secondary and tertiary institution.(Despotis, 2005a) Education is measured by the UNDP the as weighted average of the adult literacy rate (one-third) and combined primary, secondary, tertiary gross educational attainment ratios (two-thirds) (Despotis, 2005a).

Literacy can be described as an individual skill that tends to remain stable during adulthood (Wallendorf, 2001 pp505). An increase in the literacy level will help in the adoption of innovations and wellbeing of children. Research shows that literacy increases output growth and structural transformation (Gibson, 2001).

The human development index places high importance on a country's adult literacy rate based on these reasons. Literacy is referred to "*as a continuous, multidimensional indicator of proficiency in using written language, with its higher levels reflecting on ability to draw logical inferences and think critically*". (Wallendorf, 2001 pp 505).

Literacy has been expressed in two terms, basic literacy and functional literacy. Basic literacy is the separation of those who can read from those who cannot. Functional literacy is refers to the use of text and possession of decoding and reasoning skills. It is a level of ability to use the written information needed for functioning in the society.

Literacy in the United States is categorized into five levels. Level one refers to people that can read and write, they can identify key facts in newspaper prints or articles but cannot draft a letter or extract information to determine the difference between two items. Level two refers to people that can extract information to calculate the cost of purchase but cannot integrate fact from longer documents. Level three refers to people that can generate responses based on information provided in text and can calculate without being told the arithmetic operation to use. Level four refers to people with 4-year college degree and level five are people that can draw high level text based inferences and can generate new information and insight by combining text information with their knowledge (Wallendorf, 2001.)

3. Standard of living

Standard of living can be described as equal distribution of income among the citizens of a nation. (UNDP, 2003). It is measured by adjusted GDP per capita in US dollars based on the Purchasing Power Parity Exchange (PPP USD). The UNDP instituted a measure known as the Gini coefficient to check the level of income inequality in a society. This varies from a value of one for total inequality and zero for total equality (Brown et al., 2007).

2.8.4 Human Development Index (HDI)

The human development index is a summary measure of human development. It measures a country's economic and social well being.

HDI is a composite index of three equally weighted indices: the gross domestic product (GDP) index, the life expectancy index and educational attainment index.

HDI is calculated by average achievements in three basic dimensions of human development:

• A long and healthy life, as measured by life expectancy at birth.

• Knowledge, as measured by the adult literacy rate (with two-thirds weight) and the combined primary, secondary and tertiary gross enrolment ratio (with one-third weight).

• A decent standard of living, as measured by GDP per capita, purchasing power parity in dollars (PPP US$) of the countries adjusted to its average global value (y*).

By employing the Atkinson formulation for the utility of income W(y):

$$W(y) = \left(\frac{1}{1-\varepsilon}\right) y^{1-\varepsilon}$$

Where 1-ε is the elasticity of the utility of income.

The HDI for country i =

$$\text{HDI}i = 1/3 \sum_{j=1}^{3} \left(\frac{Xij - \min Fj}{\max Fj - \min Fj}\right)$$

Where *Xij* = the value of component *j, min Fj and max Fj are minimum and maximum values fixed for the indicators.*

It can also be expressed as

HDI= 1/3(life expectancy index) +1/3(education index) +1/3(GDP index) (UNDP, 2003; Noorbakhsh, 1998).

2.8.5 Components of HDI

a) Life Expectancy Index (LEI)

Life Expectancy Index (LEI) : The life expectancy index measure the relative achievement of a country in life expectancy at birth. It was calculated using life expectancy at birth and the minimum and maximum value set.

Life Expectancy Index = (Life Expectancy at Birth-minimum value)/ (Maximum value - minimum value)

The maximum and minimum values are 85 years and 25 years respectively (UNDP, 2008).

b) Education Index (EDI)

This is measured as adult literacy rate and combined primary, secondary and tertiary gross enrolment ratio. It was calculated using adult literacy rate and the minimum and maximum values specified (where maximum value is 100 and minimum value is 0). Education Index (EDI) = (Adult literacy Rate - minimum value) / (maximum value - minimum value)

Where the maximum value is 100 and the minimum value is 0 (UNDP, 2008).

c) Gross Domestic Product Index (GDPI)

This is measured as Gross Domestic Product. It was calculated using Adjusted GDP per Capita Index (APPPI) = [Log (Real GDP per Capita) - Log

(Minimum value)] / [(Log (maximum value)-(minimum value)]

Where:

Real GDP = GDP

Real GDP per Capita = Real GDP/Population

GDP = Gross Domestic Product (UNDP, 2008).

Note: Adjusted and logarithm income is used because it does not require unlimited income to achieve a respectable level of human development.

Dimension Index (DI): This is the minimum and maximum value set (also referred to as goalpost) chosen for each of the three indicators (Table 2.4). It is used to express performance in each dimension as a value of 0 and 1 by applying the following formula

DI= actual value-minimum value/maximum value-minimum value.

Table 2.2 shows HDI components and goalpost values according to HDR.

Table 2.2: HDI goalpost values

Indicators	Minimum Value	Maximum Value
Life expectancy at birth (years)	25	85
Adult literacy rate (%)	0	100
Combined gross enrolment ratio (%)	0	100
GDP per capita (PPP US$)	100	40000

Source: UNDP, 2007_2008

2.8.6 The HDI Calculation

This section provides the illustration of how HDI was computed . The researcher used the data value for Japan (one of the countries in this study).

The three indices- life expectancy index, education index and GDP index were first computed as follows:

1. Calculating the life expectancy index

Life expectancy index for Japan = life expectancy rate of 82.3 years in 2005

Life expectancy index = (82.3-25/85-25) = 0.955

2. Calculating the education index

Education index for Japan = Adult literacy ra te of 99.0% in 2005 and combined gross enrolment 85.9 in the school year 2005.

Education index =

Adult literacy index = (99.0-0/100-0) = 0.99

Gross enrolment index = (85.9-0/100-0)=0.859

Education index= 2/3(Adult literacy index) + 1/3 (Gross enrolment index)

Education index= 2/3(0.99) +1/3(0.859) =0.946

3. Calculating the GDP index

GDP index for Japan= GDP per capita index of $31,267 (PPP US$) in 2005.

GDP index = log (31,267)-log (100)/log (40,000)-log (100) = 0.959.

4. Calculating the human development index (HDI)

HDI for Japan = 1/3 (life expectancy index) + 1/3 (education index) +1/3 (GDP index)

HDI for Japan = 1/3 (0.955) +1/3(0.946) + 1/3(0.959) = 0.953.

2.8.7 HDI Ranking

The human development ranking is used to indicate the score limit value across countries. The HDI value ranges between 0 and 1, based on this value human development is grouped into three: High, medium and low human development (See HDI Table in Appendix).

High human development: These are the countries that are in range value of 0.800 and 1

Mid human development: These are the countries that are in the range of 0.790 and 0.500.

Low human development: These are the countries that are between 0.4900 and 0.

Where the indicators of a country are high, the HDI value will also be high. Within the parameter mentioned above, as the value of HDI increases, the better the country's achievement in basic standards of living will be (Moran et al., 2008).

2.9 ICT Investments Impacts on Human Development

The past years have witnessed the growth of investments in ICT in many countries as a catalyst for development,even though, most of the developing nations are characterized by a very poor state of ICT infrastructure. Their lack of this basic infrastructure has a deterrent effect on their development (Mbarika, 2002).

In Africa, several countries have carried out various policies and invested huge amounts of money into their ICT sectors (Bollou & Ngwenyama, 2008). International organizations such as ITU, World Bank and IMF, among others, have also indicated ICT investment a potential tool for development in poor nations while there have also been protest from some quarters that such nations should center their limited resources on basic amenities like building schools and making provision for basic health, electricity and clean water (Ngwenyama et al., 2006; Morawczynski & Ngwenyama, 2007).

The impact of ICT investments on human development has been receiving attention among policy makers, ICT practitioners and government as a result of convergence in IT, growing proliferation of the Internet, and worldwide telecommunications technologies (UNDP, 2003).

In 2001, UNDP organized a conference on ICT and development attended by more than hundred participants and thirty three speakers from over 25 countries across the globe to share their experiences and knowledge in the use of ICT for development. The conference addressed the need for policy makers to evaluate the impact of ICT investments in their various countries (Nepal & Upadhaya, 2002).

An ITU (2006) report indicated that little research has been carried out to assess the impact of ICT investments in countries. The organization advised the policy makers and stakeholders to evaluate their ICT sector so as to amend policies (Bollou & Ngwenyama, 2008; Bollou, 2006).

There have been several studies on the impact of ICT investments on economic growth in both developed and developing nations but there existed limited study on ICT and human development (Bollou & Ngwenyama, 2008; Morawczynski & Ngwenyama, 2007; Akpan, 2002; Avgerou, 1998; Mbarika, Kah, Musa, Meso & Warren, 2003; Mwesige, 2004).

Most literature discussed ICT impacts relative to economy or health. For example, Jalava & Pohjola, 2002, Van Ark, Melka, Mulder, Timmer & Ypma, 2002, Daveri, 2002 & Stiroh, 2000 studies have shown that an increase in ICT investment would result to improvement in the general economy.

ICT investments have been shown not to influence economic development alone but for the general welfare of human being (Ngwenyama et al., 2006). The Table 2.3 below provides the summary of some of the research conducted on ICT investments in both developed and developing countries of the world.

Table 2.3: ICT Investment Summary

No.	Title, Author & Year	Objective	Country	Research Method/Approach	Data Collection	Data Analysis
1.	Are ICT Investments Paying Off in Africa? An Analysis of Total Factor Productivity in Six West African Countries from 1995-2002 Bollou, F & Ngwenyama, O, (2008)	Analyzing productivity growth of ICT Sectors.	Benin, Burkina Faso, Cameroon, Cote d'Ivoire, Mali and Senegal	Positivist	Quantitative Data	Data Envelopment Analysis (DEA) and Ordinary Regression Analysis
2.	ICT Infrastructure Expansion in Sub-Saharan Africa: An analysis of Six West African Countries from 1995-2002 Bollou, F. (2006)	Empirical Report of ICT Expansion in sub-Saharan Africa.	Benin, Burkina Faso, Cameroon, Cote d'Ivoire, Mali and Senegal	Positivist	Quantitative Data	Data Envelopment Analysis (DEA).

No.	Title, Author & Year	Objective	Country	Research Method/Approach	Data Collection	Data Analysis
3	Egypt and ICTs: How ICTs bring national initiatives, global organizations and local companies together. El Sayed, H. & Westrup, C. (2002)	To show how ICTs have been linked to social and economic development	Egypt	Interpretive, Inductive	Web sites, Interviews, Document and Reports	
4	Making Sense of the Relationship between ICT and Economic Development Gillis, B., Mitchell, M. (2005)	To show challenges faced in attributing ICT with development	United States	Interpretive, Inductive	Documents	
5	Investment in ICT and its payoff in Malaysia. Kuppusanmy, M., & Santhapparay, S. (2005)	To show the impact of ICT Investments and its payoff	Malaysia	Positivist	Quantitative Data	Statistical Econometrics

No.	Title, Author & Year	Objective,	Country	Research Method/Approach	Data Collection	Data Analysis
7.	Unraveling the impacts of Investments in ICTs, education and health on development: An analysis of archival data of five West African countries Morawczynski, O. & Ngwenyama, O. (2007)	To show the impact of investments in ICT, Education and Health on Human development.	Benin, Burkina Faso, Cameroon,Cote d'Ivoire, Mali and Senegal	Positivist	Quantitative Data	Multivariate Regression Analysis Splines.
8	Is there a relationship between ICT, Health, Education and Development? An empirical analysis of five West African countries Ngwenyama., Ando-Baidoo, Bollou, F.& Morawczynski, O	To show the relationship between ICT, Health and Education on Human development	Benin, Burkina Faso, Cameroon,Cote d'Ivoire, Mali and Senegal	Positivist,	Quantitative Data	Ordinary Regression Analysis.

No.	Title, Author & Year	Objective	Country	Research Method/Approach	Data Collection	Data Analysis
9	Telecommunication Investments in Economically Developing Countries Negash, S. & Patala L. (2006)	Outline best practices to help improve e-government project success rates	Economically developing countries- Gambia, China, Gabon, Latvia, Costa Rica Jamaica and United States	To analyze the type of Telecommunication Investments economically developing countries should used to spur economic activities.	Quantitative Data	Statistical Analysis (Graph &Chart)
10	Characteristics & Impact of ICT Investments: perceptions among managers Vehovar, V. & Lesjak, D. (2007)	To study the impact of ICT Investments as perceived by ICT managers	Italy, Hungary, Austria and Croatia.	Positivist	Interview and Quantitative data	Descriptive statistics,
11	ICT and economic development in Taiwan. Wang, E. (1999)	To show the Impact of ICT on Economic Development	Taiwan	Positivist	Quantitative Data	Multiple regressions

No.	Title, Author & Year	Objective	Country	Research Method/Approach	Data Collection	Data Analysis
12	Impact of ICT on Organization in Tunisia Ziade, J. & Kuofie, M.H.S. (2006)	Explore the relationship between institutional arrangement, organizational forms, information technologies and the outcomes	Tunisia.	Positivist	Survey	Descriptive statistics, Pearson correlation, linear regression
13	Understanding the International ICT and Development Discourse: Assumptions and Implications Wilson, E. (2006)	To show the impact of ICT on development.	United States	Case Study	Interviews	

No.	Title, Author & Year	Objective	Country	Research Method/Approach	Data Collection	Data Analysis
14	Innovation and Investment: Information and Communication and Technologies and Millennium Development Goals Gilhooly, D. (2005)		African countries	Qualitative	Past research and related documents	Content Analysis
15	ICT Investment and Economic Growth in the 1990s: Is the United States a Unique Case? Colecchia, A. & Schreyer, P. (2002).	Contribution of ICT to output growth	OECD Countries	Positivist	Quantitative	Statistical Econometrics

As indicated in Table 2.3 above, the study on the impact of ICT capability and ICT investment on economic development in Taiwan was assessed based on the GDP level (Wang, 1999).

The Tunisia article on the impact of ICT was limited to organizations and company process (Ziadi & Kuofie, 2006). Mitchell & Gillis (2005) in their study illustrated a model to depict ICT and development; the model indicated ICT investment, community members and public policy but does not establish the concept of investment in ICT on human development but rather on deployment of ICT infrastructures.

The study conducted in Mozambique established the impact of ICT investments on the health sector; the research presented the appropriation of ICT at district and provincial level and the effect on the health sector. The main finding in the study shows the positive impact of ICT investment in improving health but does not give a holistic view on human development.

The comparative study conducted in United States and nine OECD countries shows the contribution of ICT to economic growth (Colecchia, & Schreyer, 2002; Kuppusamy & Santhapparaj 2005). The relationship between ICTs and poverty was analyzed in a study conducted in sub-Saharan Africa; the article recommends adequate investments in ICT the sector (Pigato, 2001).

The relationships between ICT investment and economic growth in Malaysia were also examined. The overall study showed the long-run and short run elasticity effect on GDP and the results demonstrated that ICT investments caused economic growth in Malaysia (Kuppusamy & Santhappaj 2005). The article also mentioned some of the studies that have contributed immensely to literature in the study of ICT and economic development as follows:
Lichtenberg 1995, Brynjolffson & Hitt, 1995, Lehr & Lichtenberg 1999 and Loveman, 1994 demonstrated that ICT investments have higher returns compared with non ICT investments in developing countries. Lau & Tokutsu (1992) demonstrated that ICT investments impact on economic growth in United States.

The contribution of computer investments to the growth in the economy of Finland revealed a strong influence on the real output growth (Niininen, 1998). The impact of ICT investments on productivity in Singapore revealed a positive effect on the productivity gain (Poh, 2001). The contribution of ICT investment to economic growth in the UK was investigated in 2001. The study showed that ICT improved the labour productivity (Oulton, 2001). This was also showcased in the study conducted on ICT and productivity in Korea (Kim, 2003).

Furthermore, characteristics and impacts of ICT investments were researched based on ICT managers' perspectives and the outcome revealed that the relative position of ICT investments satisfaction is high (Vehovar & Lesjak 2007).
The research on ICT and development in South Africa focuses on the impact of ICTs on democracy and concludes that ICT is a valuable agent in democracy development (Fleming, 2002). All these studies provide a narrow view of development.

More recently, there have been articles on ICT investments in African nations. For example, the positive impact of complementary investments in ICT, education and health on human development in some countries in West Africa was demonstrated (Ngwenyama et al., 2006) and was also supported by Morawczynski & Ngwenyama (2007).
Bollou (2006) showed that ICT investments in five West African countries have improved performances in growth and their ICT sector (Bollou &Ngwenyama, 2008).

The literature shows that ICT has been used widely to aid economic development and has had a huge impact in all facets of life (Manalo & Camacho, 2007). The application of ICT enables worldwide access to information and encourages collaboration between people across different continent. ICT creates employment opportunities as well as skills transfer for efficiency in business and politics. ICT's contribution to overall economic growth might be limited in some developing countries because of their small ICT investment .Yet opportunities still exist when appropriate policies such as creation of business climate that attracts investment, and the creation of domestic demand through network exploitation and spill over. The Table 2.4 below highlights the specific studies that are important to this study and the findings

Table 2.4: Specific Research and Findings.

Title, Author and Year	Findings
Are ICT Investments Paying Off in Africa? An Analysis of Total Factor Productivity in Six West African Countries from 1995-2002. Bollou, F & Ngwenyama, O. (2008)	The study revealed that ICT improves total factor productivity in six African countries
Defferential effects of IT Investments: Complementarity and the Effect of GDP Level. Kim, Y.J., Kang, H., Sanders, G.L., & Lee, S.T. (2008).	The research indicates the importance of IT in improving the gross domestic products of countries (GDP) .
Investments in ICT and its payoff in Malaysisa. Kuppusanmy, M., & Santhapparay, S. (2005)	The research shows that ICT investments is paying –off on economic development
Unravelling the Impacts of Investments in ICTs, Education and Health on Development: An Analysis of Archival Data of Five West African Countries. Morawczynski,O.& Ngwenyama, O. (2007)	Complementary investment in ICT, Education and Health sectors will improve the level of development
Is there a Relationship between ICT, Health, Education and Development? An Empirical Analysis of Five West African Countries. Ngwenyama, Ando-Baidoo, Bollou, F & Morawczyski, O. (2007).	The research indicate the relationship between ICT, Health and Education in improving the level of development.
An Exploration of the Effect of the Interaction between ICT and Labor Force on Economic Growth in Transition Economies. Samoilenko, S. & Osei-Bryson, K. (2008).	The research shows that complementary investments is one of the prerequisites for the translation of ICT into macroeconomic outcomes.
ICT Investments and Economic Growth in 1990s: Is the United States a Unique Case?. Colecchia, A.& Schreyer, P. (2002).	The study reveals that ICT is con tributing to economic growth in the US and nine other OECD countries.

In the study of ICT and development, several approaches have been employed by practitioners to evaluate the contribution of ICT investments. These include: growth accounting, sectoral contribution analysis and cross country regression analysis.

Growth Accounting: This is the measure of factors of production such as stocks of physical capital, human capital and labour. Physical capital is the term used to define the number of non-human assets such as roads or factories measured in constant dollar value. Human capital is the average year of schooling and labour is the total number of individual within the working age. Total Factor Productivity is the actual output growth minus the growth rates of capital and labour stocks weighted by their contribution to the output. It is the measure of the efficiency with which capital and labour are combined to produce output (Haacker & Morsink, 2002; Samoilenko & Osei-Bryson, 2008).

Sectoral Contribution: This refers to the sector that produces and uses ICT. The employment levels, capital allocation and the contribution to the GDP are considered in this type of analysis. The analysis helps to describe ICT producers and users' countries' economic growth and how the ICT producing sector facilitates the spread of ICT within their respective countries (Haacker & Morsink, 2002).

Regression Analysis: This method is used to determine the interdependency of ICT variables on the economic growth. The correlation of ICT related factors such as ICT investments, level of education, and growth in total factor productivity offers variables that determine whether there is gro wth or not. Many studies have used various regression analyses to evaluate ICT impact on economic development. For example, Haacker and Morsink (2002) use cross-section and panel regression to understand variations in growth of TFP and ICT activities in different countries. This study also employs dynamic model panel regression to determine the impact of ICT on human development. The policy makers can take the result of this analysis into account to make policy decisions (Zhen-Wei Qiang et al., 2004).

2.8 General Research Model

The few existing studies about ICT and human development have drawn the conclusion that ICT is contributing significantly to human development (Morawczynski & Ngwenyama, 2007; Ngwenyama et al., 2006) while some scholars have argued that human development improves the level of ICT investments. They explained that the higher the human development status of a country, the more such a country increases their ICT spending for economic and social transformations (Brown & Brown, 2008; Avgerou, 1998).

However, the notion on which the two impact each other is inconclusive. This research focuses on some of the salient points of this discourse in an attempt to clarify the issue. The general questions noted are:

- What are the impacts of the four aspects of ICT Investments on the standard of living?
- What are the impacts of the four aspects of ICT Investments on education?
- What are the impacts of four aspects of ICT Investments on health?
- What are the interaction effects of four aspects of ICT Investments on three key components of human development?

The analysis of the impact of ICT Investments on the three components of human development will provide a deeper understanding.

The general research model of ICT and human development is illustrated in Figure 2.4.

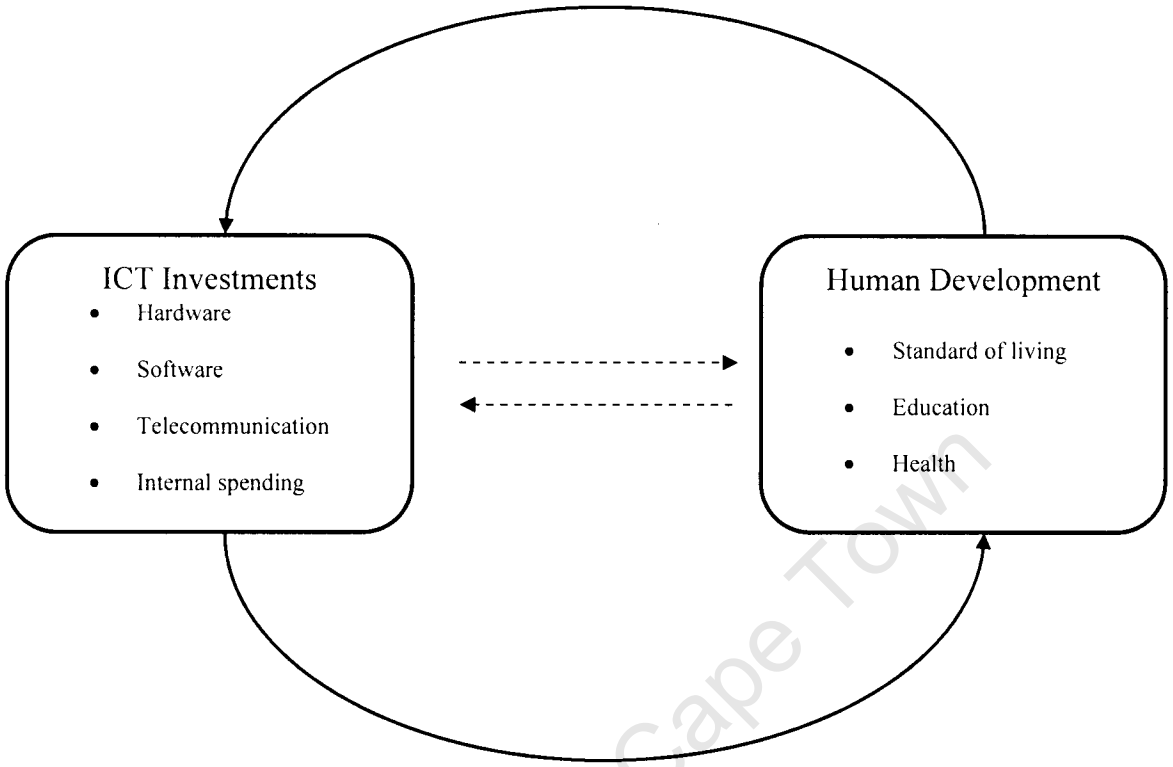


Figure 2.4: General Model for ICT Investments and Human Development

2.9 Measurement Model

Morawczynski & Ngwenyama (2007) conducted a study to "unravel the impact of investment in ICT, education and health on development in West Africa." The research covers similar aspect to this study. The Morawczynski & Ngwenyama (2007) study considered the impact of ICT, education and health on human development. The human development was expressed in terms of GDP level, literacy rates and schools enrolment and life expectancy rates. Given the Kim et al. (2008) and Morawczynski & Ngwenyama (2007), this researcher investigates the impact of ICT on human development and the interaction of the three facets of ICT investments on the components of human development. The interaction effect was introduced into the model because the deployment of each aspect of ICT needs to be accompanied by complementary investments in order for ICT investments to manifest on the development (Kim et al., 2008; Samoilenko & Osei-Bryson, 2008).

This research is expressed in two areas:

(a.) Validating the Kim et al. (2008) model and the Morawczynski & Ngwenyama (2007) concept of human development.

(b.) The introduction of telecommunication investment variable into the model.

The Kim et al. (2008) measurement model is shown in italics and the Morawczynski & Ngwenyama (2007) concept is shown in black. The extensions are based on the information about ICT found during the literature review process.

The Kim at al. (2008) model is expressed as:

*Impact of IT on GDP level: Gross Domestic Product = Software Investment (SI) + Hardware Investment (HI) + Internal IT Spending (IS) + (SI *IS) + (HI*IS) + (SI*HI)*

The Morawczynski &Ngwenyama (2007) study expressed human development as

- **The impact on GDP per capita.**
- **The impact on literacy rates and enrolments.**
- **The impact on life expectancy rates.**

The model is the following: Impact of ICT investment on human development (using the three components) (Ngwenyama et al., 2006)

1. The impact on Gross Domestic Product = Software Investment (SI) + Hardware Investment (HI) + Telecommunication Investment (TI) + Internal Spending (IS) + (SI*IS) + (HI*IS) + (TI*IS) + (SI*HI).
2. The impact on Literacy Rates = Software Investment (SI) + Hardware Investment (HI) + Telecommunication Investment (TI) + Internal Spending (IS) + (SI*IS) + (HI*IS) + (TI*IS) + (SI*HI).
3. The impact on Life Expectancy Rates = Software Investment (SI) + Hardware Investment (HI) + Telecommunication Investment (TI) + Internal Spending (IS) + (SI*IS) + (HI*IS) + (TI*IS) + (SI*HI).

2.10 Summary and Conclusion

This chapter provided an overview of the impact of ICT and their relation to the human evelopment. The review has shown that most developed countries have used ICT investments to foster development and ICT has been found to clearly show development in nations in human actions such as education, governance, health, human right and economic growth (Nngwenyama et al., 2006; Bolou, 2006; Wilson, 2006; Mansell, 1999).

From the literature review, none of the studies considered ICT investments in a holistic way on human development in both developed and developing nations and none of them showed clearly how ICT investments trends impact changes in development. This research is an attempt to fill this gap so as to provide a holistic interpretation of the impact of ICT investments on human development as indicated by the International Telecommunication Union (ITU, 2006).

From an African literature perspective, data availability has been a major problem hindering the estimation of ICT investments impacts. Most of the studies focused on some selected countries in West Africa. This study offers the most recent and appropriate set of analysis of ICT investments on human development.

CHAPTER 3

3 Methodology

3.1 Introduction

This chapter discusses the overall approach to the research process; the theoretical underpinning, the method of data collection and procedures for data analysis.

3.2 Research Problem and Paradigm

A clear research problem is important in determining the appropriate research paradigm on which a study should be based. The research paradigm has great importance in the methodology adopted. It highlights the principle and method of the research (Oates, 2006; Hussey & Hussey, 1997). This study investigates the impact of ICT investments on human development in high, medium and low income countries while the research paradigm adopted is *positivistic and quantitative.*

The researcher employed this approach based on the following notions:

- The positivistic and quantitative approach allows for the collection of highly precise and specific numerical data from a wider population for analysis (Collins & Hussey, 2003).

- The literature review revealed that there are very few studies conducted in this area and these few studies adopted positivistic and quantitative approach (Kim et al., 2008; Ngwenyama et al., 2006; Morawczynski & Ngwenyama, 2007). This study followed the same pattern.

- The research employs the positivistic approach, which is one of the three research paradigms described to be pertinent in the field of information systems (Orlikowski & Baroundi, 1991).

3.3 Research Approach

The research approach used in this study is *exploratory*. Exploratory research is conducted on the basis of a few earlier studies to which we can refer for information on the issue (Mbarika, Okoli, Byrd & Pratim, 2005). Prior research has indicated a relationship between ICT investment and human development. However, this study extends the line of inquiry to examine the aspects of ICT investment which have differential roles in the impact of ICT investment on the components of human development.

3.4 Research Time Frame

The study employs a longitudinal country level panel data set. The data set of 51 largest ICT market countries around the world were collected (WITSA, 1998) from 1994-2003. Longitudinal study involves the continuous investigation of a problem over a certain period of time (Collins & Hussey, 2003).

A panel study is the process of observing the same subject at multiple times or in different time periods (Neuman, 1994).The idea is to examine the change process of this research within its social, economic and political context so as to reveal the stability of the phenomenon under study and suggest an explanation of the process of change and the pattern of their emergent (McGiven, 2006).

3.5 Research Method

The research method used in this study is quantitative. The data were collected from a case study of a large sample of countries and are presented in numbers, tables and charts for the analysis. The "*case study*" is used to express an extensive examination of one or more phenomenon for a certain period of time (Chen, & Hirschheim, 2004; Hussey, & Hussey, 1997).

Quantitative method is concerned with the use of statistical concepts for the analysis. In qualitative method, small sample size is obtained from interview and observation and the analysis are expressed in words or pictures (McGivern, 2006) which involves the use of several techniques such as grounded theory, ethnography, life history and conversational analysis (Neuman, 1994).

3.6 Research Approach to Theory

The underpinning approach to theory for this study is partly deductive and partly inductive. Firstly, this study employs a partially deductive approach as the literature review shows that there is a logical relationship among ICT investments and human development as indicated in Figure 2.4. This research examines the impact of four aspects of ICT investments on the three components of human development.

Secondly, the research proceeds to the inductive approach by developing theoretical propositions that allow for theory-creation through the interpretation of results from empirical findings. Iivari and Huisman (2007), show that the empirical quantitative research method is appropriate for exploratory-theory building research.

3.7 Data Sample, Variables and Population

The research samplings were drawn from a data set of 51 countries of the world population with 4500 data points from the years 1994-2003. The countries were heterogeneous (different geographic, economic and political backgrounds) but there existed some commonality in them in that they represent the countries with the largest ICT markets in the world (WITSA, 1998). The samplings were selected as a unit of analysis with much precision and without bias as resources allowed.

A variable is an attribute of the entity that is chosen as a unit of analysis. A variable can change or take more than one value either across the entity or within the same entity over time. Variables are classified into two types : *qualitative and quantitative.* The qualitative variable is a non numeric attribute of an object such as colour or gender while quantitative variable is a numerical attribute of an object such as age or income. The quantitative data is categorised into *independent and dependent variables.* The independent variable is the type of variable that can be manipulated to predict the values of the dependent variable.
The dependent variable is the type of variable whose values are predicted by the independent variable (Tabachnick & Fidell, 2007).

In order to assess the effect of ICT investment on human development, the following sample variables were introduced in the study.

- ICT investments-: the four aspects of ICT investment are: hardware investment, software investment, telecommunication investment and internal spending.
- Human development index-: the three key components of human development are: literacy rates, life expectancy rates and GDP per capita rates.

For the purpose of this research, the *independent variables* are ICT investment and the four facets of ICT investment and the *dependent variables* are the three components of human development.

3.8 Method of Data Collection

The data used in this study were collected from three different sources-: the ITU, the UN and the WITSA databases. The databases are a rich source of secondary data that provide detailed current and historic information about the actual phenomena.

The ITU data base provides statistical data for the telecommunication sector for all countries. The United Nation provides social, economic and demography indices for all countries. The WITSA provides the data about Information and Communication Technology (ICT) for all countries around the world based on research of International Data Corporation (IDC). This research employs country –level panel data set from 1994 to 2003.The study analyses the impacts of ICT investment and the complementary effect of four facets of ICT on human development for selected countries available from the WITSA database. The four areas of ICT investment used are: hardware, software, telecommunication and internal spending while gross domestic product level, literacy rate and life expectancy are required key components of human development.

The 51 countries included in this study are: Argentina, Australia, Austria, Belgium, Brazil, Bulgaria, Canada, Chile, Colombia, Czech Republic, Denmark, Egypt, Finland, France, Germany, Greece, Hong Kong, Hungary, India, Indonesia, Ireland, Israel, Italy, Japan,

Korea, Malaysia, Mexico, Netherland (Holland), New Zealand , Norway, Philippines, Poland, Portugal, China, Romania, Russia, Saudi Arabia, Singapore, Slovakia, Slovenia, South Africa, Spain, Sweden, Switzerland , Taiwan, Thailand, Turkey, United Kingdom, United States, Venezuela and Vietnam .

These countries were selected based on their ICT market value and relative importance in terms of their ICT spending. Two methods of analysis, namely regression (dynamic panel model) and trend analysis were used in the study. These methods can be used to investigate the impact of ICT investment for other countries that are not included in this study.

3.9 Background of the Countries

The countries in this study were grouped as high income, mid income and low income countries based on GDP per capita in 1994-2003. These countries were selected and grouped based on GDP per capita because the countries represent the ICT industry's largest country markets around the world (WITSA, 2002) and their relative importance in terms of ICT investment was considered. These serve as a meaningful analysis of impact of ICT spending.

The first 17 countries above the two-third percentile, were defined as high income countries and the second 17 countries, between the two third and one- third percentiles were defined as mid- income countries while the last 17 countries, below one- third percentile, were defined as low-income countries.

The high income countries in this study have a population range between 4.1(Ireland) and 299.8(United States) million with 60-100 % of urban population, an average literacy rate and schools enrolment of 90.0 % and life expectancy level of 79.7% .

The mid income countries have a population range of 2.0 (Slovenia) to 22.2(Taiwan) million with 40-92% of people living in urban area, average literacy rate and schools enrolment of 95.7% and 76.9% level of life expectancy.

The low income countries have a population range of 5.4(Slovakia) million to 1313.0(China) million with 26-94% of urban population, average literacy rate and schools enrolment of 89.8% and life expectancy level of 70.1% .

Table 3.2: Demographic Data for the Countries

Countries	Population (millions)	% Living in Urban Area	Land Area (sq. k.m)	Life Expectancy	GDP per capita US $	Literacy Rate%	HDI 2005	HDI Rank
High Income countries								
Japan	127.9	65.8	377'835	82.3	31,267	99.0	0.95	8
Swiss	7.4	75.2	41'287	81.3	35,633	99.0	0.96	7
Norway	4.6	77.4	323'895	79.8	41,420	99.0	0.97	2
Denmark	5.4	85.6	43'075	77.9	33,973	99.0	0.95	14
US	299.8	80.8	9'363'132	77.9	41,890	99.0	0.95	12
Sweden	9.0	84.2	449'790	80.5	32,525	99.0	0.96	6
Germany	82.7	75.2	43'075	79.1	29,461	99.0	0.94	22
Austria	8.3	66.0	83'853	79.4	33,700	99.0	0.95	15
Singapore	4.3	100.0	616	79.4	29,663	99.0	0.92	25
Netherlands	16.3	80.2	41'160	79.2	32,684	99.0	0.95	9
Belgium	10.4	97.2	30'567	78.8	32,119	99.0	0.95	17
France	61.0	76.7	543'965	80.2	30,386	99.0	0.95	10
Hong Kong	7.1	100.0	1'062	81.9	31,833	99.0	0.94	21
Finland	5.2	61.1	377'032	78.9	32,453	99.0	0.95	11
UK	60.2	89.7	244'754	79.0	33,238	99.0	0.95	16
Ireland	4.1	60.5	68'895	78.4	38,505	99.0	0.96	5
Canada	32.3	80.1	9'922'387	80.3	33,375	99.0	0.96	4
Mid income Countries								
Australia	20.3	88.2	7'682'300	80.9	31,794	99.0	0.96	3
Italy	58.6	67.6	301'245	80.3	28,529	98.4	0.94	20
Israel	6.7	91.6	20'770	80.3	25,864	97.1	0.93	23
New Zealand	4.1	86.2	268'704	79.8	24,996	99.0	0.94	19

Countries	Population (millions)	% Living in Urban Area	Land Area (Sq. km)	Life Expectancy	GDP per capita US $	Literacy Rate %	HDI 2005	HDI Rank
Spain	43.4	76.7	504'879	80.5	27,169	99	0.95	13
Taiwan	22.2	40.4	9'597'000	72.5	6,757	90.9	0.78	81
Greece	11.1	59	131'986	78.9	23,381	96	0.93	24
Portugal	10.5	57.6	91'631	77.7	20,410	93.8	0.9	29
Korea	47.9	83.1	98'447	77.9	22,029	99	0.92	26
Slovenia	2	51	20'251	77.4	22,273	99.7	0.92	27
Argentina	38.7	90.1	2'777'815	74.8	14,280	97.2	0.87	38
Saudi	23.6	81	2'400'900	72.2	15,711	82.9	0.81	61
Czech	10.2	73.5	78'834	75.9	20,538	99	0.89	32
Mexico	104.3	76	1'972'546	75.6	10,751	91.6	0.83	52
Hungary	10.1	66.3	93'032	72.9	17,887	99.4	0.87	36
Chile	16.3	87.6	751'626	78.3	12,027	95.7	0.87	40
Brazil	186.8	84.2	8'511'965	71.7	8,402	88.6	0.8	70
Low income countries								
Malaysia	25.7	67.3	332'967	73.3	10,882	88.7	0.81	63
Venezuela	26.7	93.4	912'047	73.2	6,632	93.0	0.79	74
Poland	38.2	62.1	312'683	75.2	13,847	99.8	0.87	37
Slovakia	5.4	56.2	49'036	74.2	15,871	99.0	0.86	42
South Africa	47.9	59.3	1'184'827	50.8	11,110	82.4	0.67	121
Turkey	73.0	67.3	779'452	71.4	8,407	87.4	0.78	84
Egypt	72.8	42.8	1'000'250	70.7	4,337	71.4	0.71	112
Colombia	44.9	72.7	1'138'914	72.3	7,304	92.8	0.79	75
Thailand	63.0	32.3	514'000	69.6	8,677	92.6	0.78	78
Russia	144.0	73.0	17'078'005	65.0	10,845	99.4	0.80	67
Romania	21.6	53.7	237'500	71.9	9,060	97.3	0.81	60
Bulgaria	7.7	70.0	110'912	72.7	9,032	98.2	0.82	53
Philippines	84.6	62.7	300'000	71.0	5,137	92.6	0.77	90
Indonesia	226.1	48.1	1'919'443	69.7	3,843	90.4	0.73	107
China	1313.0	40.4	9'597'000	72.5	6,757	90.9	0.78	81
India	1134.4	28.7	3'166'828	63.7	3,452	61.0	0.62	128
Vietnam	85.0	26.4	329'566	73.7	3,071	90.3	0.73	105

Source: ITU and UN Database (HDR, 2007_2008pp227-246)

3.10 Dynamic Fixed Effect Panel Model

In this research project, Kim et al.'s (2008 p511) study that "models the differential effects of IT investments: how the three aspects of IT investments : hardware, software and internal spending affects GDP in terms of complementarity and GDP level by using dynamic fixed effect panel model regression analysis" was adopted.

The Kim et al. (2008) study was conducted in the United States with the same data used in this thesis. The aim of this research is to investigate the impact of ICT investments on the three key components of human development: GDP, literacy rates and life expectancy. The dynamic fixed effect panel model has become popular with the increased availability of cross country data sets that span 10 years or more.

The dynamic fixed effect panel model is very important where there exists limited time series data for each country that might lead to insufficient power of tests of hypotheses. The model will impose some homogeneity conditions upon the parameter across the countries which affords additional power and allow for the detection of relationship that is not different from the individual time series (Bond, 2002).

The panel model allows control for the country specific time invariant characteristics by the use of country specific fixed effects which are not possible in cross section or single time series (Bond & Arellano, 1991).

In many statistical models such as regression spline, the dynamic aspect of data is ignored. This can lead to the loss of important information and result in misspecification biases in the estimation. Also model panel includes lagged dependent variables in the model which control large omitted variables (Weinhold,1999). Panel data analysis is an important tool for empirical research in social and biological sciences.

The literature revealed that "*an index of over 800 scholarly and trade journals in business, economics and ABI/INFORM provides references to 192 articles that include the phrase panel data in their title or abstract over 1997-98*" also refers to about 646 articles (Frees, Young & Luo, 2001 p25). The concept of panel data allows a regression analysis where a cross section of the observational units or individual is selected and a dependent variable and independent variables are then observed for each unit. The observational units are then followed over time and this allow for dynamic study of the problem (Hsiao, 2003).

The panel data techniques have been used widely in many areas such as firm level, international comparison at country level and at state level (Frees et al., 2001). The panel data is used at state or country level to draw inferences for the assessment of the effect that one or more independent variables (explanatory) have on a dependent variable (response), controlling for other independent variables. It has been used to examine the impact of increase investment in human capital on economic growth (Agiomirgianakis, Asteriou & Monastriotis, 2002).

The model can also be employed for forecasting in planning purposes. Forecasting is the prediction of an unknown random variable and the unknown variable is a value of the dependent variable (Frees et al., 2001). Free et al. (2001) stated some of the advantages of the panel data model as follows:

- It allows for a change in the response over time in terms of change of co-variates for the subject which differentiate dynamic relation from static comparisons
- It allows for individual variation unlike cross sectional study where individual variation is a component of a disturbance term that cannot be separately identified. This led to heterogeneity.

3.10.1 Dynamic Model Equation

The dynamic fixed effect panel model adopted as in Holtz-Eakin, and Rosen (1988) is expressed as follows:

The equation of the model =

$$y_{it} = \alpha_1 + \sum_{m=1}^{M} a_m y_{i,t-m} + \sum_{n=1}^{N} b_n x_{i,t-n} + \mu_i + u_{it} \quad \text{.....(1)}$$

Where y is the dependent variable (GDP, literacy rates, life expectancy simultaneously) and x is a set of explanatory variables (software investment, hardware investment, telecommunication investment and internal spending). These variables are log- transformed. The subscript denotes country i=. (i=1,....., N) in period t = (t=1,.....,T).

While μ_i = unobservable country specific fixed effect country heterogeneity, u_{it}= the error term that is assumed to be independently and identically distributed with zero mean and constant variance,σ^2.

The dynamic model is very good for this study because it specifies the causal direction among the variables (Kim et al., 2008).

Considering a simple ordinary least square of *y* and *x* without the introduction of lag terms shows the *correlation* but the cause and direction of causality can be argued. Based on the Granger (1969) study, the variable *x* is considered not to Granger-cause the variable *y if all the coefficients of lagged x are not significantly different from zero i.e. if knowing the history of x improves the prediction of y when the history of y is given.* Then it is assumed *"x Granger-causes y"*

Omitting individual effects might lead to biased and inconsistent estimates; therefore the fixed effects μ_i were eliminated through first difference transformation. Also, the first differencing is capable of alleviating spurious regression problems of possibly non-stationary variables (Granger & Newbold, 1974 Cited in Kim et al., 2008).

$$\Delta y_{it} = \sum_{m=1}^{M} a_j \Delta y_{it-m} + \sum_{n=1}^{N} b_j \Delta x_{it-n} + \Delta u_{it} \quad \text{..... (2)}$$

The equation (2) introduced the problem of endogenerity, where the new error term $u_{it} - u_{it-1}$ becomes a moving average of order one i.e. (MA (1)) and was correlated with regressors Δy_{it-m} . The twice lagged level variables of (y_{it-2}, x_{it-2}) and differenced x's (Δx_{it}) were introduced as instrumental variables according to Anderson-Hsiao (1982). The generalized method of moments (GMM) was introduced to provide consistency and eliminate biasness (Arellano & Bond, 1991 Cited in Kim et al., 2008).

3.11 Conclusion

This chapter provided an overview of the research paradigms in the information system and followed a theoretically valid method. It addresses the entire acceptable concept for the implementation of ICT and human development both in the IS field and in other social sciences study. The methods presented in this thesis allow comparison with the Kim et al. (2008) and the Morawczynski and Ngwenyama (2007) studies and consequently, shows how this phenomenon can be addressed in many other future IS studies.

CHAPTER 4

4 Trend Analysis

4.1 Introduction

This chapter describes the trend analysis used for data analysis in this study. The chapter is structured so that Section 4.2 presents the trend analysis of ICT investments and human development of the countries under study.

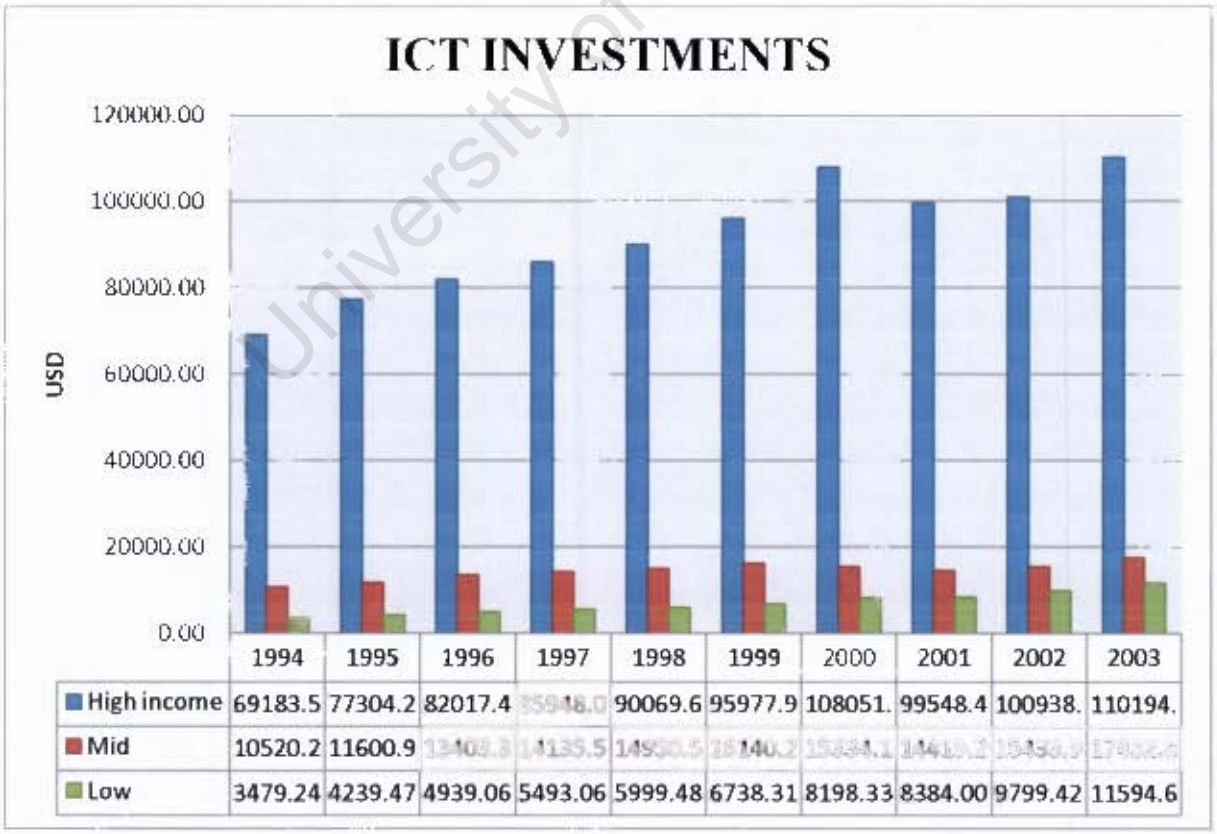
4.2 Trend Analysis of ICT Investments

In this section, the ICT investment was analysed using trend analysis. The attempt is to collect and compare the investment in ICT around the world and to spot a pattern or trend and the possible causes.

The data used for this study were drawn from three sources (ITU, WITSA and UN) and covers the period of 1994 to 2003. The ten year period experienced the rapid increase in ICT investment worldwide as well as many changes in the telecommunication sector, especially in African countries (Bollou, 2006). For example, Asia/Pacific, Latin America and Eastern Europe demonstrated the fastest growing ICT investment market with average annual growth rate of 14.5%, 13.6%, and 9.5% respectively during 1992-1997 and worldwide ICT investment was growing at over 27% faster than the worldwide GDP (WITSA, 1998).

As stated in section 3.9, the researcher classified the 51 countries that served as samples into high income, mid income and low income countries according to their GDP per capita during 1994-2003.

As observed in Figure 4.1, there are clear patterns that ICT investment in high income countries increased at a rapid rate from 1994 until 2000 (Colecchia & Schreyer). This was as a result of growth in *internet use* and the *dot- com boom* that led to increases in ICT investment such as the employment of IT executives to manage the emerging technology (Ward, 2006). ICT investment fell significantly in 2001 showing a 7% rate difference with the 2000 value (WITSA, 2002, Ward, 2006). The decline in ICT investment in 2001 was the aftermath of "*millennium bug*" due to over investment in ICT leading up to the year 2000 (Wallis, 2006). This also affected the mid income countries between 2000 and 2001. The Y2K compliant factor affected individuals, organizations and countries to reduce investment in ICT (Wallis, 2006).The decrease in investment in 2001 coupled with slow growth in 2002 led to a 4.1% compound annual growth rate in spending between 1999 and 2003 (WITSA, 2004) Despite the millennium factor and slow growth, the investment in high income and mid income countries increased at an 8.0% compound annual growth rate in 2003 (WITSA, 2004).



	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
High income	69183.5	77304.2	82017.4		90069.6	95977.9	108051.	99548.4	100938.	110194.
Mid	10520.2	11600.9		14135.5		140.2				
Low	3479.24	4239.47	4939.06	5493.06	5999.48	6738.31	8198.33	8384.00	9799.42	11594.6

Figure 4.1: ICT Investments in High, Mid and Low Income Countries.

In low income countries, the observation that stands out from the analysis is a rise in general trends of investment from 1994 till 2003. The investments in low income countries increase steadily every year till 2003. This finding is validated in the study of Bollou, 2006 that the period of 1995 to 2002 had seen the highest investment in the ICT sector especially in African countries. The literature also reveals a series of beneficial effects of this investment on the economies of the world (Colecchia, & Schreyer, 2002).

The increase in ICT spending from 1994- 2001 led to the creation of new companies in high income and mid income countries., For example, a net increase of 90,000 companies in the United States, Canada, Australia, the United Kingdom, Italy, the Netherlands and Sweden. United States alone accounted for more than average 7,200 new tax-paying ICT companies (WITSA, 2002). This is also evidenced according to Manalo & Camacho (2007), in that an increase in ICT investment strengthens the ICT sector in countries and hence poses greater advantage over countries with weak ICT structures. It has also been observed that the dismal performance of the Japanese economy in the 1990s and early 2000s was as a result of insufficient ICT investment (Nishimura & Shirai, 2003).

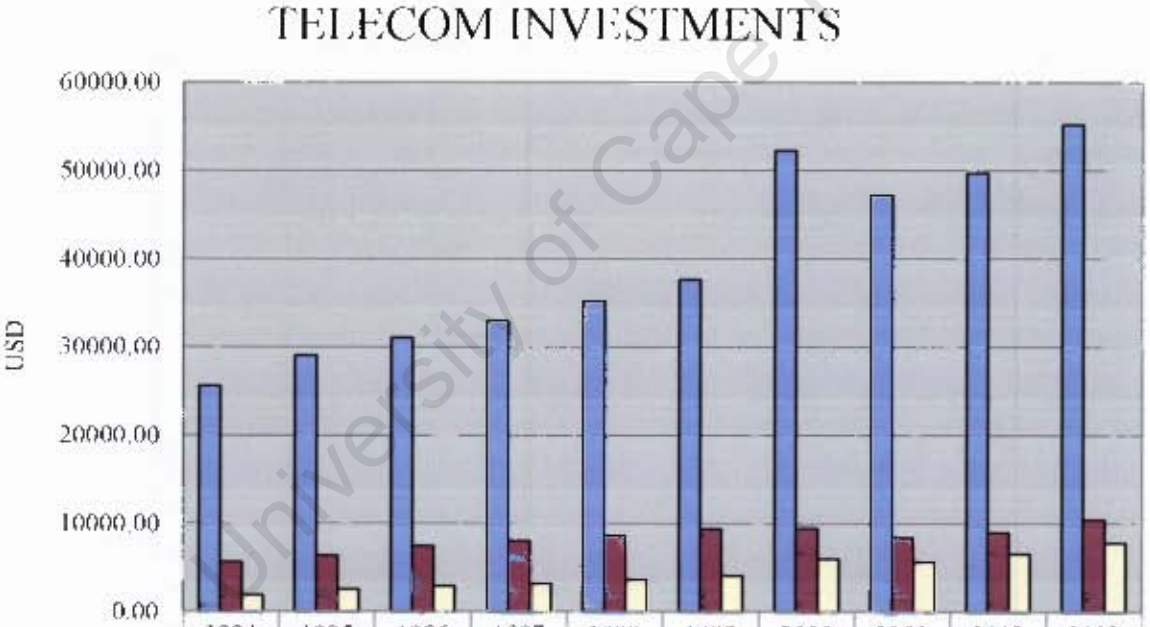
The global economic trends show that ICT investment is associated with productivity although the increase often lags by some years (Wang, 1999). Yet, ICT investment improves the quality of life through the access to information and the exchange of ideas in both developed and developing economies (Colecchia, & Schreyer, 2002). The four aspects of ICT investment are explained in the following section.

4.2.1 Telecommunication Investments

With regard to telecommunication investment, the Figure 4.2 shows different variation in investments. The countries' investment varies more widely. The high income countries' investments increased steadily from 1994 until 1999, it then skyrocketed in 2000, decreased in 2001 then rose consistently till 2003. The mid income and low income countries' investment also increased constantly from 1994 till 2001 while when there was a slight slowdown and then it continued to rise until 2003.

The clear drop in investment between 2001 among high income, mid income and low income countries was the effect of Y2K and dot. com crash (Wallis, 2006; Cooper, K. Ajay, Igor, P. Ajay, Raghavendra, 2005). There was a decrease in investment in internet and information technology sectors during the period (Goldfarb, Kirsch & Miller, 2007).

Telecommunication services and equipment still remained the largest share of the total global ICT investment with about 55% and more than 50 million individuals added to the global communication network every year due to investment in telecommunication infrastructures (WITSA, 1998). For example, more than 118 million computers are installed in homes and colleges worldwide in 1998 (WITSA, 1998).



	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
High income	25614.8	29033.5	31043.7	32980.1	35223.1	37646.7	52316.4	47228.9	49719.9	55223.7
Mid	5583.18	6331.06	7461.59	7985.53	8636.06	9362.56	9396.21	8365.18	8966.90	10468.4
Low	1854.06	2504.53	2904.71	3195.41	3595.71	4050.37	5938.22	5710.26	6587.86	7791.43

Figure 4.2: Telecommunication Investments in High, Mid and Low Income Countries

The three regions countries evaluated in this study show an annual double growth computer installation base rate (WITSA, 1998). The global reduction in computer prices improved the growth of ICT from business medium to home market (WITSA, 2002).
Traditionally, personal computers (PCs) were installed at home for entertainment but in recent times, the internet has expanded the concept of the home –PC entertainment model. The PC connected to the internet is useful to access information and to, share ideas with people around the world (WITSA, 1998; ITU, 1999). Computer simulations and, educational software serves as classroom enhancement for students.(WITSA, 1998) PC penetration at home improves personal productivity, work at home, home banking, home shopping and thereby adds values and time to people's lives (ITU, 1999).

In the United States, the PCs proliferation has encouraged the work-at home scenario. This allows employers to minimise cost by creating contract hours and work-at-home options. Also employees are able to reduce day-care and commuting costs (WITSA, 1998).

Internet growth is increasing at an alarming rate; the internet host has been increasing twenty fold since 1994 providing access to information for rich and poor nations as well as individuals (WITSA, 1998; ITU, 1999). The internet and affordable computing services have bridged the digital divide that hindered ICT development (Hoffman & Novak, 1998; Graham, 2002). The World Wide Web (WWW) phenomenon has largely affected ICT spending-: over 320 million people were able to access the WWW in 2002 and WWW devices increased to 515 million (WITSA, 2002).

As indicated above, telecommunication investment is visible in all countries but vary from region to region. Countries like China and Brazil (mid and low income countries) were ranked among the 10 predominant ICT markets around the world in 1997 (WITSA, 1998). The observation reveals that the high income countries (advanced market) are currently focusing on maintaining their existing telecommunication infrastructures while the mid and low income countries (emerging market) are concentrating on building basic telecommunication and computer infrastructure (WITSA, 1998). The emerging economies now see telecommunication as a primary tool to enhance the economy and broaden people's horizons (Waverman, Meschi & Fuss, 2005).

Telecommunication is presently the backbone of ICT and all other investments such as hardware and software will lag behind until telecommunication infrastructure is put in place. The mid and low income countries have been investing heavily in the ICT backbone (Jussawalla, 1999; Garbacz & Thompson, 2007), while the high income countries are investing more in related software needed to access the telecommunication structure. (WITSA, 1998). This has been attracted ICT vendors to migrate toward mid and low income countries (WITSA, 1998). The world telecommunication market is huge and booming at present-: the provision of telecommunication infrastructure for the information age is exciting.

4.2.2 Software Investments

Software investment increased in high, mid and low income countries from 1994 till 2003. This pattern shows that there was consistent spending on software in all the three levels of the countries and it was not affected by the economic situation (Li & Gao, 2003)

This country level observation provides a clear picture of the trend, that spending in software markets continues to grow rapidly around the world result in a high demand for employees such as software developers, engineers and programmers (Arora & Athreye, 2002).
The high income countries are presently focusing on the maintaining their existing infrastructure by investing in new software (WITSA, 2002). The Organization for Economic Development (OECD) approximated that there are 600,000 unfilled IT software jobs worldwide (WITSA, 2002).

The demand is very high for IT professionals and the shortage of these skills in developed and developing countries is posing a threat to the growth of the software industry (Barr & Tessler, 1998; Cappelli, 2000). The second observation from Figure 4.3 is the exception to the trend of high income countries between 1999 and 2000, which shows about a 70% increase in 2000 as compared to 1999 (WITSA, 1998).

This is accounted for by the impact of the millennium. The high income countries invested heavily in purchasing new updated software and hardware (Wallis, 2006).

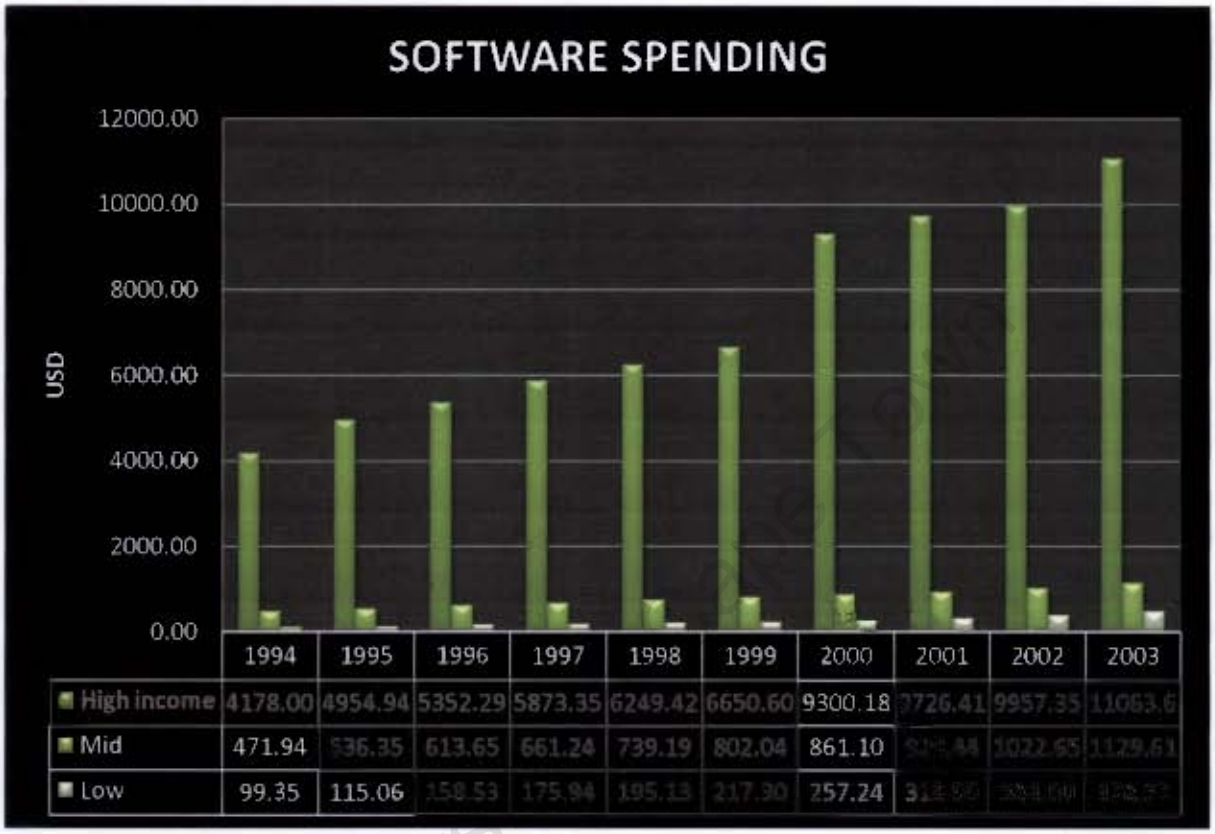


Figure 4.3: Software Investments in High, Mid and Low Income Countries.

4.2.3 *Hardware Investments*

The hardware investment in mid and low income countries increased steadily between 1994 and 2003. In high income countries, the investment increased up till 2000 then started to decrease as countries started focusing on maintaining the existing structure after the year 2000 (WITSA, 2002). Hardware spending growth increased in mid and low income countries at an impressive rate of 9.8% due to constant migration of ICT vendors (WITSA, 1998) and the demand of international organizations such as ITU, IMF and World Bank to increase ICT investment in these countries (Ngwenyama et al., 2006). The demand for networking equipment remains another key driver of hardware growth (Gibson & Meter, 2000. The networking environment created an opportunity for the vendors to have impact on the future of the ICT industry in mid and low income countries (WITSA, 1998).

The general observation shows that there was a continuous rise in hardware spending among the high, mid and low income countries from 1994 till 2000.

The decrease in the trend in the year 2000 was due to infrastructure failure as a result of the Y2K bug and dot com crash effect (Cette, Mairesse & Kocoglu, 2002).

For example, the London Stock Exchange experienced a system crash in April 2000 which affected their online trading and capital gain (Williams, 2001).

In mid and low income countries, limited financial resources have been a hindrance to the society's ability to make the full scale investments required to catch up with high income countries (WITSA, 1998; Ngwenyama et al., 2006) *(Figure 4.4)*.

An important factor to be mentioned is that as the mid and low incomes countries continue to increase their hardware investments', reaping the benefit of such investments requires planning and careful decision making within the context of ICT investment and development policy. Hardware investments comprise 18% of the world market and remain one of the fastest growing at investments 9.8% in 1997 (WITSA, 1998).

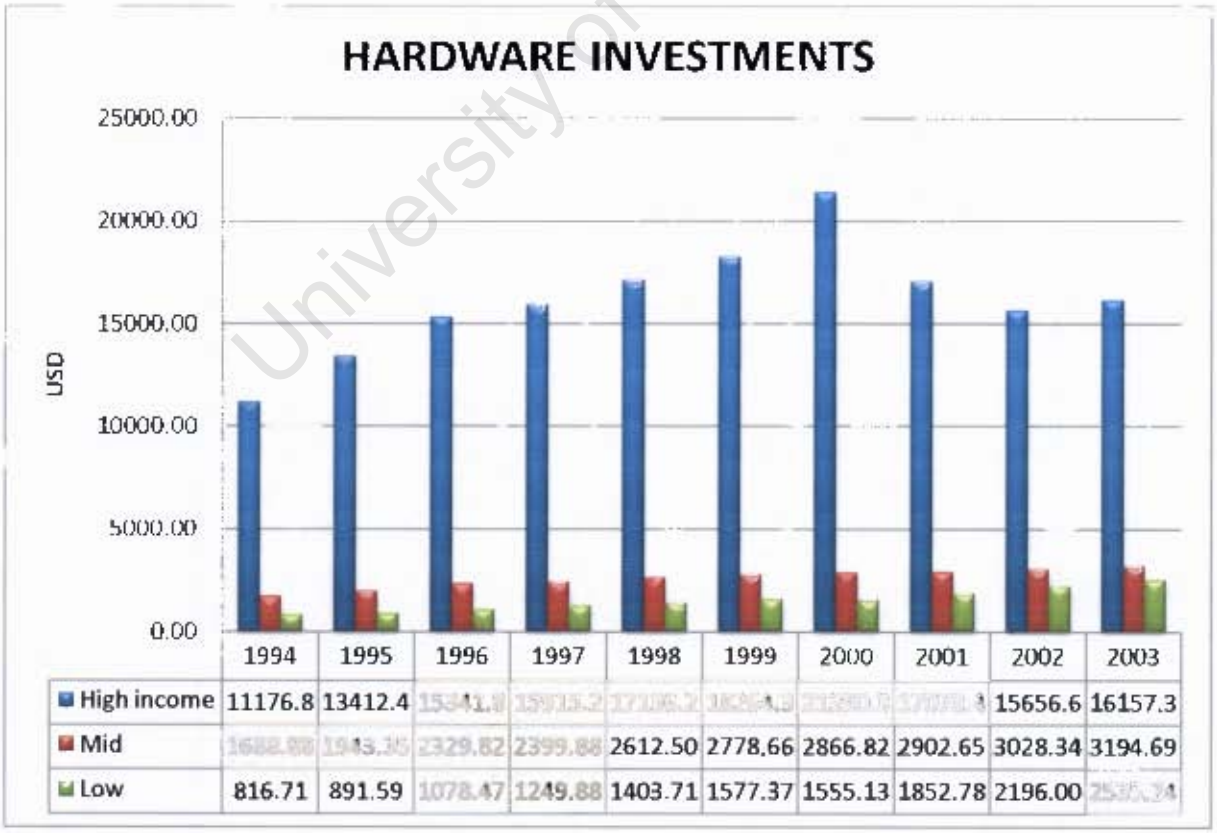


Figure 4.4: Hardware Investments in High, Mid and Low Income Countries

4.2.4 Internal Spending

The levels of internal spending vary considerably among high, mid and low income countries. There is a more significant difference in comparison with the other categories of investments.

The high and low income countries show an increase in internal spending from 1994 till 2000, when they slow down drastically, and then continue to increase in 2003.This occurrence in both high income and low income countries arises for different reasons. The proportion of internal spending in high income countries represents human capital development such as paying of salaries to the individuals installing and maintaining networks and developing the software.

The increase in demand for IS professionals led to increase in salary demanded and the cost of employing an IS professional rose sharply between the period of 2000 and 2003 that many Organizations sourced for alternative solution providers to perform the function of IS department through outsourcing (WITSA,

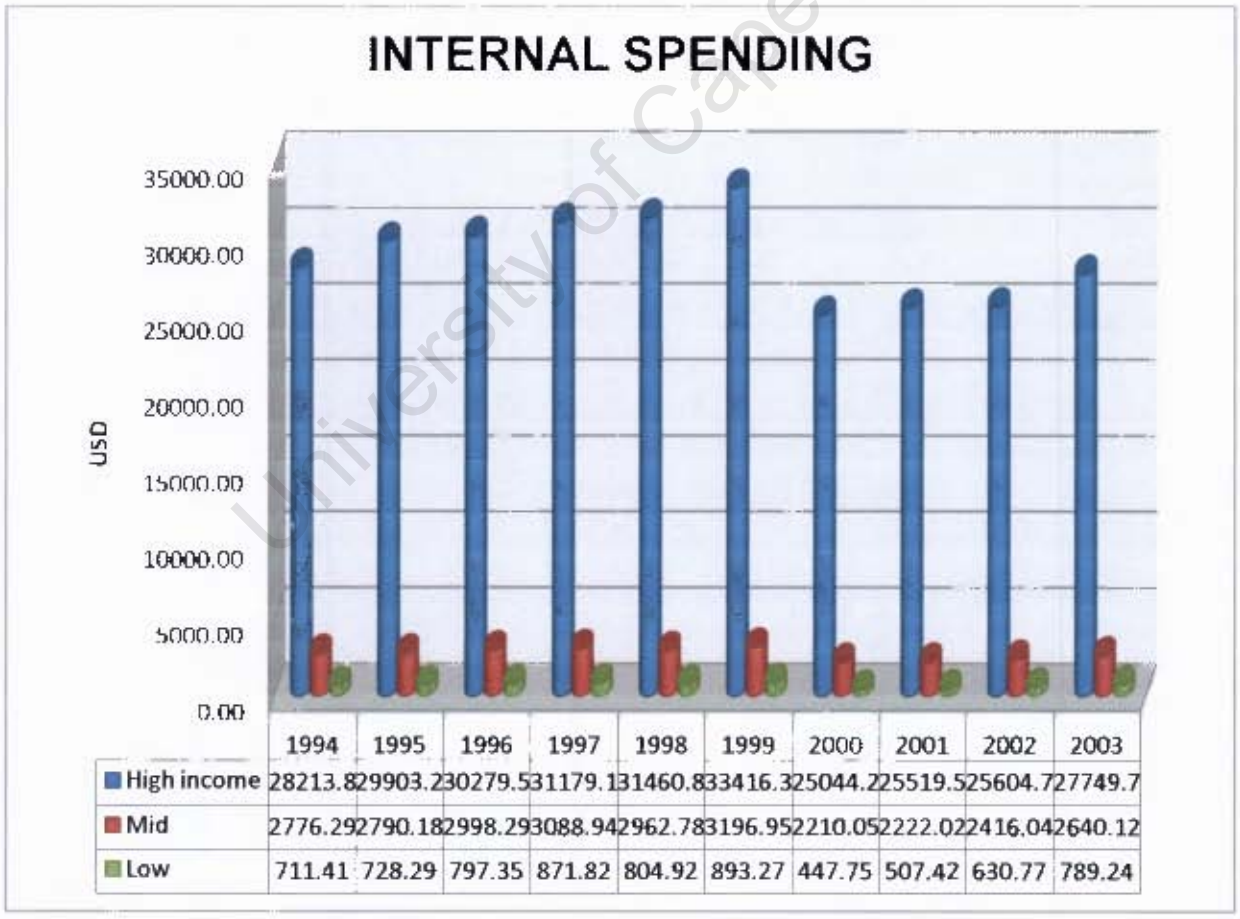
In high income countries, more and more organizations are hiring outside firms and contractors to manage their ICT sector without incurring the additional expense of employing them directly. For example, in the United States, internal spending declined by about one percent within this period (WITSA, 1998). In low income countries, the decrease in internal spending was caused by rapid investment in other segments such as hardware, software and telecommunication in 2000. This increase in investment in other segments of ICT led to a shortage of IS professionals and many of the ICT projects in low income countries were outsourced during the period.

The exceptional case is the mid income countries, the internal spending remained stable even though it declined slightly in 2000; most notably in Taiwan and Korea. The two countries were able to increase their spending on human capital development in response to the increase in other segments (WITSA, 1998). This shows that countries have dissimilar capabilities to utilizing resources and knowledge accumulated through ICT investment (Kim et al., 2008).

The observation also revealed that most of the IS professionals in high income countries are moving towards mid and low income countries as the countries are offering better salaries to IS professionals than high income countries.

This is evidenced in the studies of Kim et al. (2008) and Tom Lee, Gholami & Tong (2005) that high income countries need to invest more in acquiring expertise to improve the level of utilization of their heavily equipped hardware.

The mid and low income countries continue to grow capital development and infrastructures so corporate outsourcing is less on the agenda of these countries until basic infrastructures are in place (WITSA, 1998).



	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
High income	28213.82	29903.23	30279.53	31179.13	31460.83	33416.32	25044.22	25519.52	25604.72	27749.7
Mid	2776.29	2790.18	2998.29	3088.94	2962.78	3196.95	2210.05	2222.02	2416.04	2640.12
Low	711.41	728.29	797.35	871.82	804.92	893.27	447.75	507.42	630.77	789.24

Figure 4.5: Internal Spending in High, Mid and Low Income Countries.

4.3 Trend Analysis of Human Development

This section explains the trend of human development using the human development index data from 1994 to 2003. The trends were analysed with regard to ICT investment.

The average human development indices were computed for high, mid and low income countries as shown in Figure 4.6. The human development index in high income countries does not follow a particular pattern. The high income countries' values are in the upper range of human development. The human development index remained constant at the value of 0.93 from 1994 until 1996, then slowed slightly to the value of 0.91 between 1997 and 1998 and then continued to rise till 2003 at the value of 0.94. When compared with the growth in ICT investment, it was discovered that as the ICT investment increased from the year 2003, the level of human development also increased.

The mid income and low income countries followed a similar pattern, human development index trend in mid income countries showing a constant value of 0.87 between 1994 and 1996 where there was a slow down to the value of 0.83 from 1997 to 1998 and then a rise as ICT investment increased till 2003. In low income countries, human development rose with some ups and downs at a value of 0.72, 0.74, 0.72, 0.73 and 0.73 for the years 1994, 1995, 1996, 1997 and 1998 respectively. The notable trend similar to high and low income is the change in the human development value to 0.74 in low income countries as the ICT investment increases from year 2001 up till 2003.

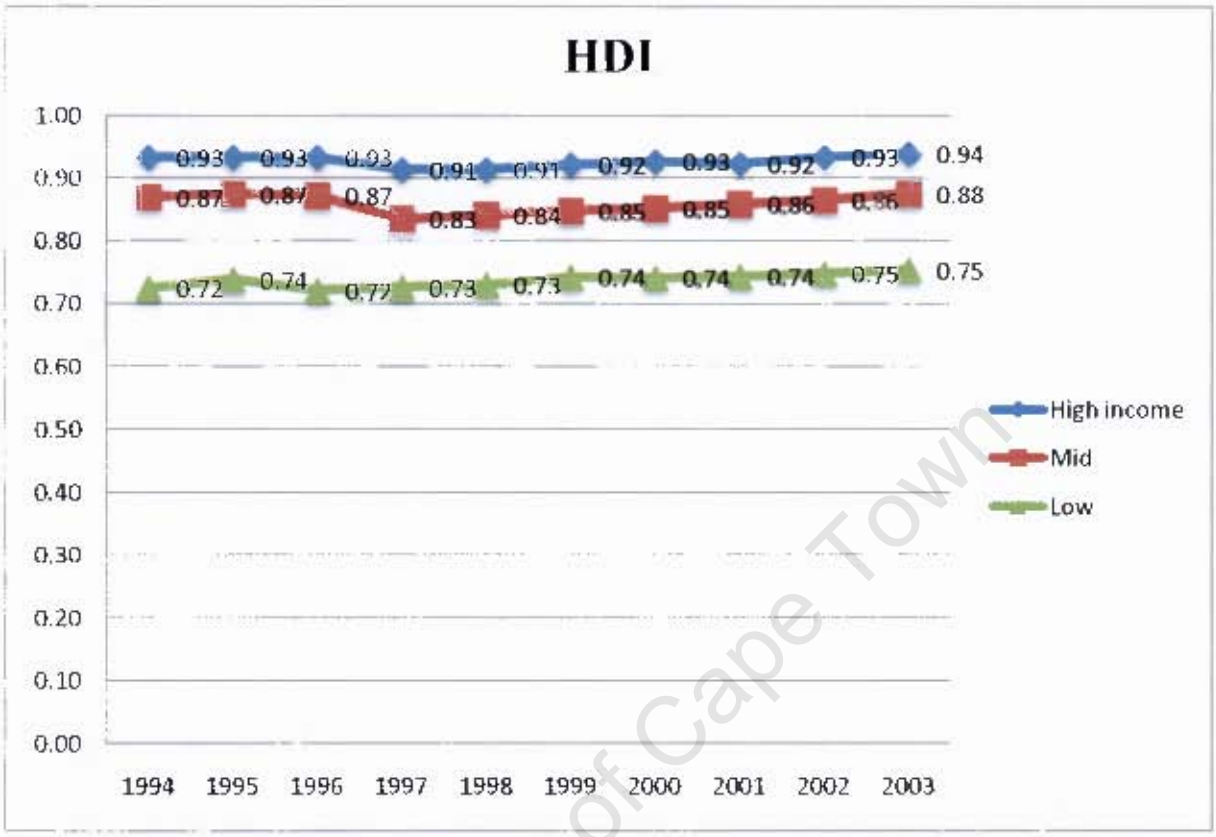


Figure 4.6: Human Development Index in High, Mid and Low Income Countries

4.3.1 Gross Domestic Index (GDPI)

The high income countries GDPI value remains constant at 0.99 in 1994 up till 1996.Then in 1997 and 1998; there is a significant drop in GDPI value from 0.99 to 0.91, followed by a steady rise from 1999 to the value of 0.95 in 2003.

In mid income countries, the GDPI rose in 1994 from the value of 0.93 to 0.94 in 1995, then slowed significantly between 1997 and 1998 to the value of 0.79 and 0.80 respectively, then increased till 2003. In low income countries, GDPI also increased steadily from 1994 till 2003. The year 1997 and 1998 in low income countries followed a similar trend with high and mid income countries as there was a drop in GDPI value due to a global economic recession (WITSA, 1998; ITU, 2007).

Despite the economic recession in 1997 and 1998, ICT investment is observed to be contributing to GDP in terms of a moderating influence during the adverse economic conditions (WITSA, 1998). ICT investment reveals resilience in both good and bad economic situations (WITSA, 2002). This shows that ICT investment fluctuates with the GDP without being sacrificed as GDP declines. The notable observation is that nations continue to invest in ICT during both economic recession and economic expansion (WITSA, 1998). The Figure 4.7 shows GDPI in high, mid and low income countries.

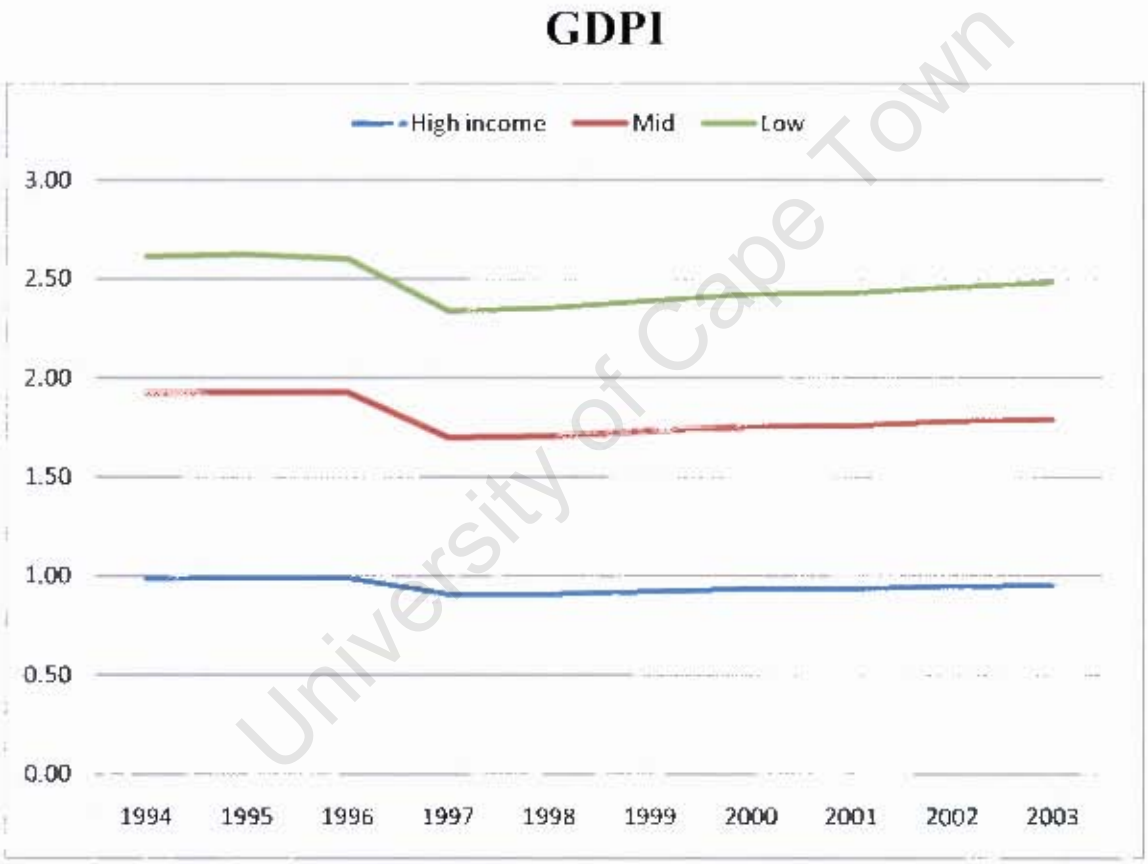


Figure 4.7: GDP Index in High, Mid and Low Income Countries.

4.3.2 Literacy Rate Index

The trend analysis shows that literacy rates and schools enrolment increased steadily across high income, mid and low income countries from 1994 till 2003 *(Figure 4.8)*. When compared with the ICT investment trend, the analysis shows that literacy rates and school enrolments grow as ICT investment increases.

Though the growth in literacy rates and schools enrolment is not in the same proportion as ICT spending, but there existed the contribution of ICT investment to the literacy rates and schools enrolment (Human technology, 2005).

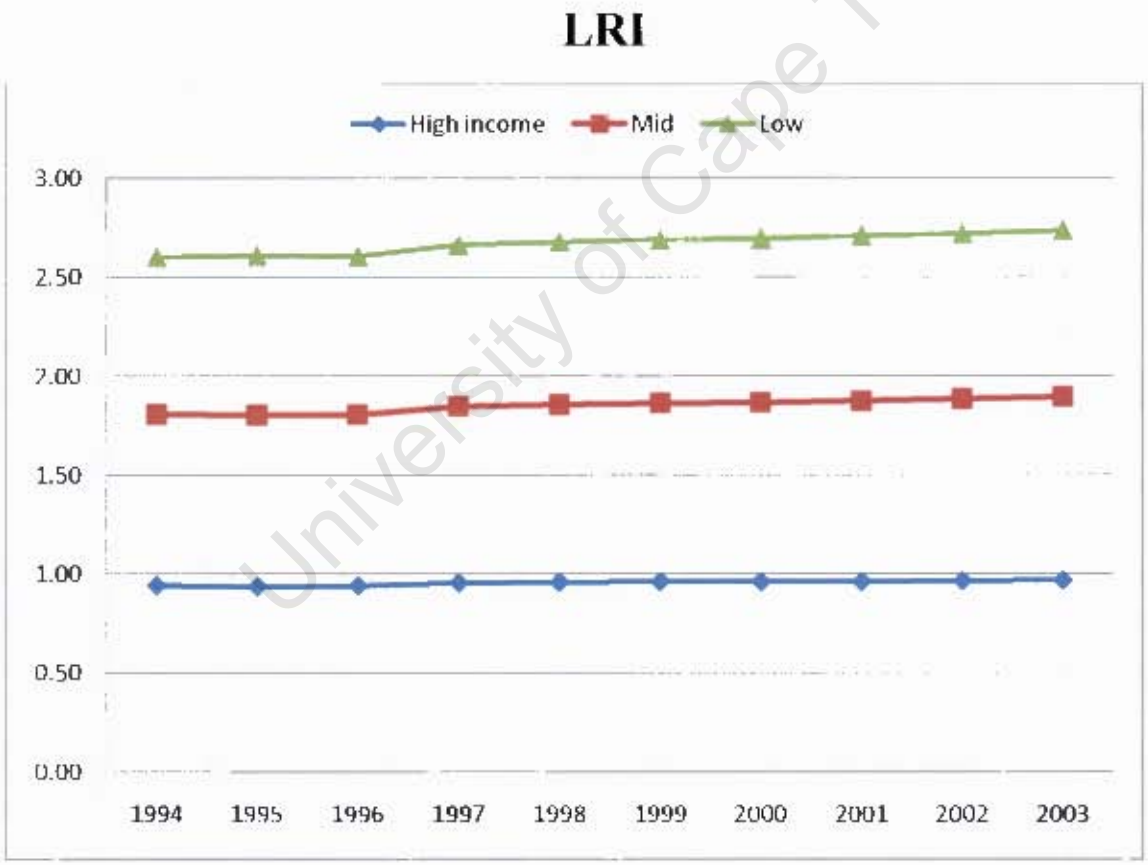


Figure 4.8: Literacy Index in High, Mid and Low Income Countries.

4.3.3 Life Expectancy Index

The life expectancy index in high income countries remained constant at a value of 0.88 from 1994 till 2000 *(Figure 4.9)*, when the value increases slightly to 0.90 by 2003. This shows that the level of life expectancy remain at the average rate of 88- 90% in high income countries between 1994 and 2003.

In mid income countries, the life expectancy rose steadily from the value of 0.81 to 0.86 between 1994 and 2003. It shows an average increase of 81-86% in life expectancy.

In low income countries, the life expectancy also increased slowly from 0.71 in 1994 to 0.74 in 2003. This indicates 71-74% increase in life the expectancy rate. When these trends were compared with ICT investment, it shows an increase in ICT spending has contributed to life expectancy.

Figure 4.9: Life Expectancy Index in High, Mid and Low Income Countries.

CHAPTER 5

5 Regression Analysis

5.1 Introduction

This chapter presents the empirical analysis known as the dynamic model panel and the estimated application. The chapter is structured as follows: Section 5.2 presents the impact of four facets of ICT investments on standards of living. Section 5.3 discusses the impact of four facets of ICT investments on education, followed by section 5.4, which discusses the impact of ICT investments on health, while section 5.5 concludes the chapter.

5.2 Regression Analysis

The data was analysed using E-views (version 6) software. For all the variables (both dependent and independent), averages indices were calculated. The four aspects of ICT investment (independent variables) were introduced into the software regarding each component of human development (dependent variables). This study considered 10% p value and the impact of the **co-efficient at >1%.** This study investigates all the significantly **positive independent variables** while all the significant negative variables were eliminated since they contribute only to the sustainability of the dependent variables. This is an attempt to have an understanding of the variables that have a positive impact on the dependent variables. Table 5.1 shows the average descriptive statistics of the data and results are reported in Table 5.2-5.7.

5.2.1 Descriptive Statistics of the Data

Table 5.1: Descriptive Statistics of the Data

(a) High income countries	HWS	SWS	HELCS	IS	GDPI	EDI	LEI
Japan	55152.307	11700.047	159807.25	93384.988	0.944	0.932	0.926
Swiss	4290.268	1970.756	7754.074	6610.367	0.954	0.932	0.898
Norway	1716.38	762.633	3825.27	2807.21	0.968	0.98	0.891
Denmark	2126.184	904.856	3980.04	3905.19	0.954	0.973	0.852
US	129014.28	69557.095	310107.27	230173.33	0.975	0.971	0.862
Sweden	3672.715	1393.555	6727.64	6998.582	0.934	0.972	0.903
Germany	22808.212	10579.196	49371.702	38048.277	0.939	0.951	0.875
Austria	1969.08	930.8546	4912.184	3342.52	0.946	0.956	0.877
Singapore	1585.836	505.8131	4281.15	1040.246	0.938	0.866	0.875
Holland	4647.937	2958.69	11151.079	8207.85	0.945	0.975	0.887
Belgium	2423.27	1401.099	6300.168	4584.053	0.945	0.978	0.881
France	13380.19	7249.476	33010.174	35941.056	0.937	0.965	0.896
Hongkong	1727.31	285.7478	8528.498	1089.627	0.939	0.843	0.906
Finland	1578.389	643.442	3789.528	2113.4	0.936	0.987	0.87
UK	19334.159	9917.379	39920.471	35256.119	0.935	0.978	0.883
Ireland	806.528	263.165	2781.829	814.76	0.955	0.957	0.861
Canada	8439.227	3596.662	17804.795	15913.81	0.95	0.983	0.91
Countries average	16152.487	7330.6157	39603.125	28837.14	0.9467059	0.9528824	0.8854706
(b) Mid income countries	HWS	SWS	HELCS	IS	GDPI	EDI	LEI
Australia	5478.434	2174.303	15441.424	7518.41	0.93605	0.969	0.897
Italy	7815.304	3899.193	26001.734	12983.45	0.91365	0.928	0.889
Israel	1114.911	461.074	3837.277	1442.87	0.90355	0.912	0.889
New Zealand	786.927	453.3055	3542.512	1274.706	0.9224	0.975	0.874
Spain	3935.802	1492.224	13679.496	4760.85	0.91855	0.961	0.898
Taiwan	2463.257	453.536	9609.908	1202.745	0.6986	0.787	0.752
Greece	605.4722	191.934	3748.47	600.9514	0.89845	0.927	0.887
Portugal	833.128	264.36	3240.36	744.455	0.8846	0.922	0.842
Korea	8225.934	824.052	18292.79	3528.031	0.8807	0.949	0.812
Slovenia	202.6836	55.8615	317.8208	139.228	0.87985	0.927	0.839
Argetina	1456.896	357.443	6691.452	1262.226	0.8566	0.924	0.805
Saudi	697.99	146.809	2929.288	806.651	0.7637	0.674	0.774
Czech	777.9935	248.788	1955.261	936.354	0.8621	0.903	0.817
Mexico	2638.559	470.317	10352.706	2478.916	0.8134	0.835	0.796
Hungary	538.218	221.898	1404.33	578.703	0.8394	0.916	0.761
Chile	523.058	102.114	2556.518	596.062	0.8526	0.892	0.843
Brazil	5672.96	1387.037	16745.105	5558.226	0.7732	0.834	0.708
Countries average	2574.5604	776.72053	8255.6736	2730.1667	0.8586706	0.8961765	0.8284118

Lower income countries	HWS	SWS	TELCS	IS	GDPI	EDI	LEI
Malaysia	1238.041	306.172	3485.676	750.106	0.7974	0.795	0.786
Venezuela	571.821	125.448	2340.93	607.8	0.8004	0.84	0.789
Poland	1303.62	318.21	2768.3	896.21	0.83715	0.935	0.795
Slovakia	224.209	69.47	544.649	167.1044	0.8453	0.906	0.792
South Africa	1708.049	670.973	5154.083	2367.55	0.69465	0.842	0.506
Turkey	929.72	189.8	6829.984	414.39	0.7266	0.77	0.736
Egypt	199.138	73.53	756.072	196.745	0.6315	0.601	0.696
Colombia	703.87	121.98	4217.23	848.55	0.7778	0.854	0.757
Thailand	966.693	224.281	2782.7	538.03	0.78375	0.837	0.74
Russia	2534.17	313.674	5369.428	1605.689	0.7782	0.928	0.684
Romania	167.2	30.464	505.772	66.149	0.7792	0.873	0.7522
Bulgaria	109.541	19.281	258.528	42.75	0.7825	0.896	0.764
Philippines	578.58	102.084	1964.66	352.125	0.7273	0.899	0.729
Indonesia	888.988	117.471	3680.853	249.29	0.6804	0.786	0.673
China	11106.237	1071.97	24930.52	1454.485	0.6986	0.787	0.752
India	2138.765	293.006	8264.266	1565.12	0.5389	0.558	0.618
Vietnam	398.054	26.668	1171.696	87.7345	0.6471	0.821	0.713
Countries average	1515.688	239.55776	4413.2557	718.22517	0.7368676	0.8192941	0.7224824

KEY

IS: *Internal Spending*

HWS: *Hardware Investments*

SWS: *Software Investments*

TELCS: *Telecommunication Investments*

EDI: *Education Index*

LEI: *Life Expectancy Index*

GDPI: *Gross Domestic Product Index*

5.3 Findings of Impact and Interaction on the Standard of Living

The results of the **positive** impact and interaction between software, hardware, telecommunication investment with internal spending on the standard of living are presented in Tables 5.2 and 5.3

The four variables were introduced to show their effect on country level GDP.

a. High income countries

In high income countries, when the four variables were included without interaction terms, only telecommunication investment influenced GDP growth. It shows 1% increase in telecommunication investment growth would lead to 0.12% change in the standard of living which is significant at $p<0.1$*(Table 5.2).*

In Table 5.3, the interaction terms were introduced for high income countries. The interaction effect between telecommunication investment and internal spending remain significant at 0.047% change in standard of living. The hardware investment and internal spending also became significant at $p<0.01$ *with* 0.038% change in standard of living.

b. Mid income countries

In mid income countries, the telecommunication investment is statistically significant at $p<0.01$.The analysis shows that 1% increase in telecommunication investment in mid income countries would yield 0.09% change in the standard of living, while the hardware investment also turns out to have a significant positive impact on the standard of living (*Table 5.2).* The results of interaction also show that telecommunication and hardware investments are significantly positive. The interaction between an increase in telecommunication investment and internal spending also has a positive effect on the standard of living.

c. Low income countries

In low income countries, 1% increase in telecommunication investment would cause 0.077% change in the standard of living while hardware investment is also significant (*Table 5.2).*

The regression with the interaction terms between software and hardware is statistically significant at $p<0.01$. This shows that in low income countries the proportional increase in hardware and software investment will positively impact on the standard of living.

Table 5.2: The Impact of Four ICT Investments on the Standard of Living

(1a) High income countries	Coefficient	SE	t-Statistic	Probability
ΔGDP (-1)	-0.536028	0.063527	-8.43777	0.0000
Δ Internal Spending (-1)	-0.000134	0.004016	0.033484	0.9733
Δ Hardware (-1)	0.025778	0.009781	-2.635613	0.0094
Δ Software (-1)	0.01164	0.009134	1.274319	0.2047
Δ Telecoms (-1)	0.120273	0.06919	1.738289	0.0844
(1b) Mid income countries	**Coefficient**	**SE**	**t-Statistic**	**Probability**
ΔGDP (-1)	-0.55305	0.057197	-9.669282	0.0000
Δ Internal Spending (-1)	-0.153175	0.032926	-4.652029	0.0000
Δ Hardware (-1)	0.075962	0.027592	2.753068	0.0067
Δ Software (-1)	-0.151624	0.029081	-5.213844	0.0000
Δ Telecoms (-1)	0.094758	0.011894	7.966551	0.0000
(1c) Low income countries	**Coefficient**	**SE**	**t-Statistic**	**Probability**
ΔGDP (-1)	-0.539598	0.06838	-7.891100	0.0000
Δ Internal Spending (-1)	-0.004483	0.019588	0.22888	0.8193
Δ Hardware (-1)	0.051197	0.026968	1.898414	0.0598
Δ Software (-1)	0.017211	0.019959	0.86233	0.3900
Δ Telecoms (-1)	0.077396	0.020507	-3.774103	0.0002

Table 5.3: The Interaction Effect of Four ICT Investments on the Standard of Living

(1a) High income Countries	Coefficient	SE	t-Statistic	Probability
ΔGDP (-1)	-0.551315	0.064712	8.519547	0.0000
Δ Internal Spending (-1)	-0.008880	0.007992	1.111111	0.2686
Δ Hardware (-1)	-0.025200	0.009561	-2.635667	0.0094
Δ Software (-1)	0.002688	0.009740	0.275947	0.7830
Δ Telecoms (-1)	0.289321	0.077248	3.745360	0.0003
Δ Telecoms (-1) x Δ Internal Spending (-1)	0.056197	0.031602	-1.777826	0.0777
Δ Software (-1) x Δ Internal Spending (-1)	-0.013456	0.004636	-2.902546	0.0043
Δ Software (-1) x Δ hardware(-1)	-0.024049	0.005067	-4.746369	0.0000
Δ Hardware (-1) x Δ Internal Spending (-1)	0.038277	0.006537	5.855932	0.0000
(1b) Mid income Countries	**Coefficient**	**SE**	**t-Statistic**	**Probability**
ΔGDP (-1)	-0.612803	0.065096	-9.413878	0.0000
Δ Internal Spending (-1)	-0.234754	0.056831	-4.130712	0.0001
Δ Hardware (-1)	0.121483	0.043752	2.776596	0.0063
Δ Software (-1)	-0.145047	0.048203	-3.009111	0.0031
Δ Telecoms (-1)	0.090731	0.026611	3.409471	0.0009
Δ Telecoms (-1) x Δ Internal Spending (-1)	0.047719	0.019498	2.447353	0.0157
Δ Software (-1) x Δ Internal Spending (-1)	0.123923	0.049144	-2.521613	0.0129
Δ Software (-1) x Δ hardware(-1)	-0.008425	0.035116	-0.239911	0.8108
Δ Hardware (-1) x Δ Internal Spending (-1)	0.022423	0.033275	0.673866	0.5016
(1c) Low income Countries	**Coefficient**	**SE**	**t-Statistic**	**Probability**
ΔGDP (-1)	0.479211	0.061848	-7.748147	0.0000
Δ Internal Spending (-1)	-0.032342	0.016344	-1.978808	0.0499
Δ Hardware (-1)	0.220009	0.033184	6.630045	0.0000
Δ Software (-1)	-0.062577	0.021153	-2.958359	0.0037
Δ Telecoms (-1)	0.144092	0.024104	-5.977934	0.0000
Δ Telecoms (-1) x Δ Internal Spending (-1)	0.125510	0.014999	8.367924	0.0000
Δ Software (-1) x Δ Internal Spending (-1)	-0.012132	0.013926	-0.871226	0.3852
Δ Software (-1) x Δ hardware(-1)	0.063221	0.012068	-5.238933	0.0000
Δ Hardware (-1) x Δ Internal Spending (-1)	-0.056715	0.016298	-3.479809	0.0007

5.4 Finding of Impact and Interaction on Education

The results of the **positive** impact and interaction of the four aspects of ICT investments on education are presented in Table 5.4 and 5.5 respectively.

a. High income countries

In high income countries, the analysis shows a significant impact of hardware investment on education. 1% increase in hardware investment would result in 0.0007% in education while an increase in telecommunication investment and internal spending are significant but not contributing to the sector as the coefficient are negative at 0.0003%. The education sector has attained a peak where the increase in telecommunication and internal spending are for the sustainability of the sector. The interaction effect between an incr ease in hardware and software are positively significant at $P<0.1$. The analysis revealed that 1% increase in investment in hardware and software would lead to 0.0095% growth. This shows that an increase in hardware and software investment would promote the level of education.

b. Mid income countries

Hardware, software and telecommunication investment are significant for education. 1% increase in hardware, software and telecommunication investment would lead to 0.022%, 0.024% and 0.005% growth in the education sector (*Table 5.4).* The introduction of interaction terms between software and internal spending also shows a significant effect on education at 0.04% growth (*Table 5.5).*

c. Low income countries

In low income countries, an increase in telecommunication investment and internal spending has a significant impact on education.1% increase in telecommunication and internal spending would yield 0.009% and 0.013% growth in education respectively. The interaction terms between telecommunication investment and internal spending became significant at $p<0.01$.1% increase in interaction terms between telecommunication investment and internal spending would lead to 0.020% growth in education. Software investment and internal spending are also significant at $p < 0.1$ with 0.009% growth at 1% increase in investment. Hardware and software are also significant at $p< 0.1$ with 0.004% growth at 1% in investment (*Table 5.5*).

This shows that telecommunication and software investment have a higher impact on education when there are adequate investments in human capital development(internal spending).

Table 5.4: The Impact of Four ICT Investments on Education

(2a) High income countries	Coefficient	SE	t-Statistic	Probability
Δ literacy rates (-1)	-0.009995	0.095912	-0.104206	0.9172
Δ Internal Spending (-1)	-0.000317	0.000159	-1.991582	0.0484
Δ Hardware (-1)	0.0007	0.000266	2.632077	0.0095
Δ Software (-1)	0.000061	0.000134	0.453581	0.6509
Δ Telecoms (-1)	-0.003647	0.001634	-2.231615	0.0273
(2b) Mid income countries	Coefficient	SE	t-Statistic	Probability
Δ literacy rates (-1)	-0.488995	0.066264	-7.379516	0.0000
Δ Internal Spending (-1)	0.00831	0.005913	-1.405479	0.1622
Δ Hardware (-1)	0.022662	0.00469	4.831925	0.0000
Δ Software (-1)	0.024542	0.006446	3.807137	0.0002
Δ Telecoms (-1)	0.005896	0.003514	1.677835	0.0957
(2c) Low income countries	Coefficient	SE	t-Statistic	Probability
Δ literacy rates(-1)	0.147278	0.081182	-1.814172	0.0719
Δ Internal Spending (-1)	0.01306	0.004206	3.104534	0.0023
Δ Hardware (-1)	0.001537	0.005131	0.299605	0.7649
Δ Software (-1)	-0.006932	0.005293	-1.309707	0.1925
Δ Telecoms (-1)	0.00917	0.003832	-2.392898	0.0181

Table 5.5: The Interaction Effect of Four ICT investments on Education

(2a) High income Countries	Coefficient	SE	t-Statistic	Probability
Δ literacy rates (-1)	-0.087677	0.063306	-1.384973	0.1684
Δ Internal Spending (-1)	0.001061	0.000250	-4.234211	0.0000
Δ Hardware (-1)	0.001667	0.000333	5.009439	0.0000
Δ Software (-1)	0.001263	0.000264	4.783651	0.0000
Δ Telecoms (-1)	-0.018173	0.002025	-8.974911	0.0000
Δ Telecoms (-1) x Δ Internal Spending (-1)	0.007044	0.000782	9.012478	0.0000
Δ Software (-1) x Δ Internal Spending (-1)	1.432306	0.000123	0.011651	0.9907
Δ Software (-1) x Δ hardware(-1)	0.000955	0.000159	6.013498	0.0000
Δ Hardware (-1) x Δ Internal Spending (-1)	-0.000126	0.000145	-0.866238	0.3879
(2b) Mid income Countries	Coefficient	SE	t-Statistic	Probability
Δ literacy rates (-1)	-0.509430	0.070796	-7.195791	0.0000
Δ Internal Spending (-1)	0.014009	0.012320	1.137061	0.2576
Δ Hardware (-1)	0.007247	0.010830	0.669191	0.5046
Δ Software (-1)	-0.015853	0.008395	-1.888453	0.0612
Δ Telecoms (-1)	-0.013326	0.007750	-1.719448	0.0879
Δ Telecoms (-1) x Δ Internal Spending (-1)	-0.002848	0.005297	-0.537719	0.5917
Δ Software (-1) x Δ Internal Spending (-1)	0.040298	0.011001	3.662966	0.0004
Δ Software (-1) x Δ hardware(-1)	0.008440	0.009610	-0.878176	0.3815
Δ Hardware (-1) x Δ Internal Spending (-1)	0.027240	0.008404	3.241553	0.0015
(2b) low income Countries	Coefficient	SE	t-Statistic	Probability
Δ literacy rates (-1)	-0.155095	0.061374	-2.527040	0.0127
Δ Internal Spending (-1)	0.016040	0.003004	5.339179	0.0000
Δ Hardware (-1)	0.035592	0.005431	6.553897	0.0000
Δ Software (-1)	-0.032695	0.004293	-7.615747	0.0000
Δ Telecoms (-1)	-0.026354	0.003410	-7.729025	0.0000
Δ Telecoms (-1) x Δ Internal Spending (-1)	0.020900	0.002774	7.534194	0.0000
Δ Software (-1) x Δ Internal Spending (-1)	0.009269	0.003105	2.985106	0.0034
Δ Software (-1) x Δ hardware(-1)	0.004932	0.002643	1.866349	0.0642
Δ Hardware (-1) x Δ Internal Spending (-1)	-0.025635	0.004305	-5.955081	0.0000

5.4 Finding of Impact and Interaction on the Health

The analysis of the **positive** impact and interaction among the four aspects of ICT investment on health are presented in Table 5.6 and 5.7

a. High income countries

In high income countries, increased investment in all the four aspects of ICT is not significant to growth in the heath sector. This shows that high income countries don't necessarily have to increase their spending on all the variables in order to promote growth in their health sector.

b. Mid income countries

In mid income countries, an increase in internal spending such as human capital development is significant to health. 1% increase in internal spending would lead to 0.0288% growth in the health sector *(Table 5.6).* Hardware, software and telecommunication investment also contribute significantly to the health sector but show negative co-efficients at 0.012%, 0.014% and 0.0009% respectively. This means an increase in investment in these segments does not raise the healthy living standard.

c. Low income countries

In low income countries, the results are different. Internal spending and hardware show a significant impact on health growth *(Table 5.6).* 1% increase in internal spending and hardware would result to 0.010% and 0.004% growth in education. When the variables were included in the interaction terms, the interaction between telecommunication and internal spending shows a highly positive significant impact on health at $p<0.1$. 1% increase in interaction terms between telecommunication and internal spending would lead to 0.007% growth in the health sector. Software and hardware are also highly significant at 0.006% growth *(Table 5.7).* Interestingly, hardware shows a positive significant effect in interaction terms. This shows that hardware would be significant when interacted with other variables as complementary investment. The analysis shows that telecommunication investment with adequate internal spending has a significant effect on the health sector. Also, proportional investment in hardware and software investments would lead to growth in the health sector.

Table 5.6: The Impact of Four ICT Investments on Health

(3a) High income countries	Coefficient	SE	t-Statistic	Probability
Δ life expectancy (-1)	0.246078	0.082487	-2.983218	0.0034
Δ Internal Spending (-1)	-0.000621	0.000683	-0.909401	0.3648
Δ Hardware (-1)	-0.002006	0.001733	-1.157789	0.2490
Δ Software (-1)	0.001211	0.001244	0.973364	0.3321
Δ Telecoms (-1)	0.011253	0.00973	1.156554	0.2495
(3b)Mid income countries	**Coefficient**	**SE**	**t-Statistic**	**Probability**
Δ life expectancy (-1)	-0.738801	0.042295	-17.46793	0.0000
Δ Internal Spending (-1)	0.028826	0.009485	3.039321	0.0028
Δ Hardware (-1)	-0.012595	0.005082	-2.478386	0.0144
Δ Software (-1)	-0.014659	0.007526	-1.947788	0.0535
Δ Telecoms (-1)	-0.009605	0.00431	-2.228779	0.0275
(3c) Low income countries	**Coefficient**	**SE**	**t-Statistic**	**Probability**
Δ life expectancy (-1)	0.074813	0.067305	-1.111552	0.2683
Δ Internal Spending (-1)	0.010962	0.00132	8.301421	0.0000
Δ Hardware (-1)	0.004416	0.001573	2.807881	0.0057
Δ Software (-1)	-0.01336	0.00173	-7.723264	0.0000
Δ Telecoms (-1)	-0.005469	0.001271	-4.30122	0.0000

Table 5.7: The Interaction Effect of Four ICT investments on Health

(3a) High income Countries	Coefficient	SE	t-Statistic	Probability
Δ life expectancy (-1)	-0.262367	0.082365	-3.185427	0.0018
Δ Internal Spending (-1)	-0.000313	0.000686	-0.455880	0.6492
Δ Hardware (-1)	-0.000768	0.001721	-0.445966	0.6564
Δ Software (-1)	-0.000471	0.001339	-0.351384	0.7259
Δ Telecoms (-1)	0.013762	0.009985	1.378264	0.1705
Δ Telecoms (-1) x Δ Internal Spending (-1)	0.005026	0.005145	0.976912	0.3304
Δ Software (-1) x Δ Internal Spending (-1)	-0.001152	0.000465	-2.478742	0.0145
Δ Software (-1) x Δ hardware(-1)	0.000226	0.000458	0.493289	0.6226
Δ Hardware (-1) x Δ Internal Spending (-1)	0.000701	0.000950	0.738106	0.4618
(3b)Mid income Countries	Coefficient	SE	t-Statistic	Probability
Δ life expectancy (-1)	0.762132	0.043239	-17.62591	0.0000
Δ Internal Spending (-1)	0.093619	0.013700	6.833573	0.0000
Δ Hardware (-1)	0.032565	0.007204	-4.520395	0.0000
Δ Software (-1)	-0.025958	0.008128	-3.193606	0.0018
Δ Telecoms (-1)	-0.034335	0.005842	-5.877029	0.0000
Δ Telecoms (-1) x Δ Internal Spending (-1)	-0.013093	0.004664	-2.807183	0.0058
Δ Software (-1) x Δ Internal Spending (-1)	0.047302	0.007937	5.959953	0.0000
Δ Software (-1) x Δ hardware(-1)	-0.064048	0.010704	-5.983765	0.0000
Δ Hardware (-1) x Δ Internal Spending (-1)	0.032591	0.008866	3.675857	0.0003
(3b) Low income Countries	Coefficient	SE	t-Statistic	Probability
Δ life expectancy (-1)	0.031230	0.053064	0.588537	0.5572
Δ Internal Spending (-1)	0.008494	0.001185	7.167309	0.0000
Δ Hardware (-1)	0.014857	0.002140	6.943207	0.0000
Δ Software (-1)	-0.021337	0.001718	-12.41622	0.0000
Δ Telecoms (-1)	-0.006365	0.001425	-4.465928	0.0000
Δ Telecoms (-1) x Δ Internal Spending (-1)	0.007916	0.001006	7.865725	0.0000
Δ Software (-1) x Δ Internal Spending (-1)	-0.002324	0.001391	-1.671388	0.0970
Δ Software (-1) x Δ hardware(-1)	0.006941	0.001005	6.904953	0.0000
Δ Hardware (-1) x Δ Internal Spending (-1)	0.011680	0.001426	-8.189921	0.0000

5.5 Conclusion

The general results of the analysis reveal that the four aspects of ICT investment have differential impact on the three key components of human development. Each aspect of ICT investment contribution to human development varies according to different level, degree and from country to country but they show a significant contribution to human development.

CHAPTER 6

6 Results and Discussion

6.1 Introduction

In this chapter, the results reported in Chapter Five a re discussed. The support for the measurement model used in this study is provided and the brief findings are presented.

6.2 The Measurement Model

For the purpose of discussion, the measurement model used in this study is restated here as follows:

1. **The impact on Gross Domestic Product = Software Investment (SI) + Hardware Investment (HI) + Telecommunication Investment (TI) + Internal Spending (IS) + (SI*IS) + (HI*IS) + (TI*IS) + (SI*HI).**

2. **The impact on Literacy rates and enrolments = Software Investment (SI) + Hardware Investment (HI) + Telecommunication Investment (TI) + Internal Spending (IS) + (SI*IS) + (HI*IS) + (TI*IS) + (SI*HI).**

3. **The impact on Life expectancy rates = Software Investment (SI) + Hardware Investment (HI) + Telecommunication Investment (TI) + Internal Spending (IS) + (SI*IS) + (HI*IS) + (TI*IS) + (SI*HI).**

The use of the first model was provided by the Kim et al. (2008) study-: their analysis identifies the context in which the facets of IT investment and their interaction are effective. This study investigated ICT investment and telecommunication variable introduced into a Kim et al. (2008) model as an additional variable.

This model of Kim et al. (2008) is supported by Free et al. (2001) who indicated that the panel data is more effective at country level when one or more explanatory (independent) variables are observed to draw inference on the response (dependent) variable. The inclusion of literacy rates and life expectancy rates as dependent variables was adopted from the measure model of Morawczynski & Ngwenyama (2007) and served as an extension of the Kim et al. (2008) study.

6.3 Results of the Regression Analysis.

The dynamic fixed effect regression analysis was used to test the impact and interactive effect of four aspects of ICT investment on the three key components of human development.

The four aspects of ICT investment were considered as independent variables and the three components as dependent variables. The results of the positive **impact** of the four independent variables on the three components of dependent variables (Table 5.2, 5.4, 5.6) and **interaction terms** of telecommunications and internal spending, interaction of software and internal spending, interaction of software and hardware and interaction of hardware and internal spending on the three components of dependent variables (Table 5.3, 5.5, 5.7) are summarized in Table 6.1

Table 6.1: Results of the Regression Analysis

	Standard of living	Education	Health
	β	β	β
Internal Spending (-1)	HI:-0.00*; MI:-0.15; LI:-0.01	HI:-0.00; MI:-0.01; LI:0.01	HI:-0.00*; MI:0.03*; LI:0.01*
Hardware (-1)	HI:-0.03; MI:0.08**; LI:0.05**	HI:0.00**; MI:0.02*; LI:0.00	HI:-0.00; MI:-0.01; LI:0.00**
Software (-1)	HI:0.01; MI:-0.15; LI:0.02	HI:0.00; MI:0.03*; LI:-0.01	HI:0.00; MI:-0.02; LI:-0.01
Telecoms (-1)	HI:0.12*; MI:0.09*; LI:0.08*	HI:-0.00; MI:0.01**; LI:0.01**	HI:0.01; MI:-0.015; LI:-0.01
Telecoms (-1) x Internal Spending (-1)	HI:0.056; MI:0.05**; LI:0.13*	HI:-0.01; MI:-0.00; LI:0.02*	HI:-0.01; MI:-0.01; LI:0.01*
Software (-1) x Internal Spending (-1)	HI:-0.01; MI:-0.12; LI:0.01	HI:1.43; MI:0.04*; LI:0.001*	HI:-0.00; MI:0.05*; LI:0.00
Software (-1) x Hardware(-1)	HI:0.02; MI:-0.01; LI:0.06*	HI:0.00*; MI:0.01; LI:0.01**	HI:0.00; MI:-0.06; LI:0.01*
Hardware (-1) x Internal Spending (-1)	HI:0.04**; MI:0.02; LI:0.07	HI:-0.00; MI:-0.03; LI:0.03	HI:0.00; MI:0.03*; LI:-0.01

KEY

HI: High income countries
MI: Mid income countries
LI: Low income countries

P<0.01*
p<0.10**

In the next section, this study reported the findings of the results of the regression analysis in Table 6.1

6.4 Finding of Impact and Interaction on the Standard of Living (GDP)

Supporting previous research such as Bollou & Ngwenyama, 2008; Morawczynski & Ngwenyama, 2007; Akpan, 2002; Dewan & Kraemer 2000; Avgerou, 1998; Mbarika et al., 2005; Mwesige, 2004; Wang, 1999; Kim et al,. 2008; Ngwenyama et al., 2006; Colecchia & Schreyer, 2002; Kuppusamy & Santhapparaj, 2005 and many others, this study shows some contribution of ICT to economic growth.

Table 6.1 shows the result of the regression analysis and the specific findings that are important are reported. The telecommunication investment in particular is very important in all the countries (high, mid and low income countries at 0.12, 0.09 and 0.08% coefficients) for economic growth. The observation revealed that the level of telecommunication investment varies from country to country according to their level of utilization For example, 1% increase in telecommunication investment in high income countries would result in 0.12% change in the standard of living while in mid income countries, 1% increase in telecommunication investment would lead to 0.09% growth in the standard of living. Likewise, in low income countries, 1 % invested in telecommunication would cause 0.08% economic growth.

Deregulation in most mid and low income economies has shown the commitment of these nations to invest more in telecommunications. For example, in 1997, 94% of people living in Slovenia had telephone lines compared to 1992 when only 61% had. These changes have also occurred in Slovakia, Hungary, Colombia and Turkey (WITSA, 1998). In North America, internet hosting supported by telecommunication infrastructure grew at a considerable rate from less than a million in 1992 to over 16 million by 1997. This growth reflected the commercial importance of the internet and ICT capability to unleash many economic and social benefits in both developed and developing countries. The assumption of this study is that if the world's largest countries such as India, Indonesia and China, who together represent more than half of the world's population, should invest in t elecommunication infrastructures as low as 20%, there would be tremendous growth in these economies and,

most importantly, on the global economy as citizens of these states utilize the opportunities to reach their potentials.

The International Telecommunication Union (ITU) stated in their 2006 report that telecommunication and hardware are among the fastest growing segments of ICT investment worldwide. The analysis (both trend and regression) carried out in this study evidenced these. For example, hardware and telecommunication investment remains significant in high, low and mid income countries in this study. It is also stated that a well established hardware infrastructure will promote the utilization of software investments and lead to better national performance (Kim et al., 2008).

With careful examination of the results, telecommunications remain the backbone of ICT-: investments in other aspects such as hardware and software will lag behind until the backbone is in place.

The second specific observation concerns the low income countries. The results revealed that all four aspects of ICT investment are significant with 0.05%, 0.02%,0.13% growth in hardware, software, telecom and internal spending interaction. This indicates that low income countries need adequate investment in all areas of ICT to promote the economies of their countries. The proportional investment in hardware and software, telecommunication and internal spending are required for the positive influence on the standard of living.

6.5 Finding of Impact and Interaction on Education (Literacy rates and enrolments)

As expected, the educational sector in high income countries has reached a saturation level. The high income countries considered in this study accounted for most of the developed countries of the world. These countries, according to human development report, show an average literacy rate and schools enrolment of 99.9% in 2008. The results in Table 6.1 show that continuous spending in telecommunication and internal spending is significant to the educational sector but does not contribute to the growth in literacy and enrolments due to saturation since it shows a negative coefficient at 0.01%.

Complementary investments that aid growth in literacy and schools enrolment such as the provision of telecommunication networks and human capital are already in place in high income countries. Specifically, literacy and school enrolments in high income countries have reached the peak. The introduction of interaction terms between software and hardware is significant in these countries at 0.00% coefficient. This result can be explained by the fact that hardware and software are referred to as knowledge containing media that can facilitate the process of turning knowledge into action by aiding an individual's work (Dewan & Kraemer, 2000; Kim et al. 2008). This shows that investment in both aspects of ICT will promote the level of education.

In mid income countries, 1% investment in hardware, software and telecommunication would lead to 0.022%, 0.024% and 0.005% rise in literacy and enrolments. The interaction terms between software and internal spending also confirm a significant impact. This means internal spending is important to manage knowledge about computer resources, software applications in order to have a positive impact on education. Software investments allow individuals to utilize accumulated knowledge in the form of software packages in an effective manner which facilitates improvement in literacy and the schools enrolment level.

In low income countries, the four aspects of ICT investment show a significant contribution to the literacy rates and schools enrolment at 0.00%, 0.01%,0.01%,0.01% coefficients for hardware, software, telecommunications and internal spending respectively. Telecommunication, software and hardware investment will have a great impact on the education sector when adequate investments in human capital development are provided. For example, India is believed to be one of the fastest growing economies but over one third of the population still remains illiterate; UNICEF stated that 35% of the children in India have not been to secondary schools. In Africa, ICT investment has been shown to improve the level of education (Morawczynski & Ngwenyama (2007).

6.6 *Finding of Impact and Interaction on the Health* (Life Expectancy)

In high and mid income countries, the investments in all aspects of ICT are significant to the health sector as follows:

Software indicates the coefficients of 0.00% in high income countries and negative 0.02% in mid income countries.

Hardware shows the coefficients of negative 0.00% for high income countries and negative 0.001 for mid income countries

Telecoms shows the coefficients of negative 0.00% for high income countries and negative 0.001 for mid income countries

Internal Spending indicates the coefficients of negative 0.00% for high income countries and 0.01% for mid income countries.

The increase in these segments of investment would not lead to growth in life expectancy rates. The United Nations estimates show that most of the countries that represented high and mid income countries in this study have an average of 85% life expectancy rates.

Another interesting result is that 1% increase in only internal spending in mid income countries would lead to 0.0288% growth in the health sector while increases in other segments do not impact on health.

This indicates that a certain level of human capital development is still essential in mid income countries to attain optimally healthy living. The finding in low income countries differs from both high and mid income countries; there is high disparity in the impact of ICT between these countries.

The result in section 6.1 on low income countries indicates that telecommunication investment and adequate investments in the area of human capital development have a higher impact on health at coefficient of 0.01%. Moreover, the proportional investment in hardware and software would lead to growth in health sector at coefficient of 0.00%.

CHAPTER 7

7 Implication of Findings

7.1 Introduction

In this chapter, the implication of findings, the theory building process, limitations of the study and areas for future research are discussed.

7.2 Theory Building

Following the discussion in section 6.3, 6.4 and 6.5 and taking into account the fact that few studies exist in ICT and Human development, this study employs the exploratory, theory building process, even though this study is a quantitative research in terms of methodology. Iivari & Huisman (2007) confirm that a quantitative research is also useful in theory building. Based on the insight from the empirical analysis (*Table 6.1)* and the state of ICT around the world as shown in the trend analysis (*Figure 7-15*), this research proposes to develop theoretical propositions to explain further the impact of ICT investment on human development. Table 7.1 shows a summary of the regression analysis.

The table lists the highly significant and marginally significant coefficients identified as + for positive and – for negative when $p<0.01$ and (+) and (-) for marginally significant coefficients when $p<0.1$.

Table 7.1: Summary of the Regression Analysis

	Standard of living	Education	Health
Internal Spending (-1)		LI	MI (+) LI +
Hardware (-1)	MI (+) LI (+)	MI +	
Software (-1)	HI LI	MI +	
Telecoms (-1)	HI + MI + LI -	MI (+) LI (+)	
Telecoms (-1) x Internal Spending (-1)	HI (+) MI (+) LI +	LI +	LI +
Software (-1) x Internal Spending (-1)		MI (+) LI +	MI +
Software (-1) x Hardware(-1)	LI + HI	LI (+)	LI +
Hardware (-1) x Internal Spending (-1)	HI + MI		MI +

HI: High income countries
MI: Mid income countries
LI: Low income countries

P<0.01*
p<0.10"

7.3 *Theoretical Implications*

In an attempt to explain the findings in Table 7.1, the observation was presented based on the relationship of highly significant positive coefficients of the four aspects of ICT investment to the components of human development in high, mid and low income countries.

7.3.1 High Income Countries

Table 7.3 shows the highly significant aspects of ICT investment on each of the components of human development.

Table 7.2: Significance Level of ICT Investments in High Income Countries.

High Income countries	Standard of living	Education	Health
Internal Spending (-1)			
Hardware (-1)			
Software (-1)			
Telecoms (-1)	HI+		
Telecoms (-1) x Internal Spending (-1)			
Software (-1) x Internal Spending (-1)			
Software (-1) x Hardware(-1)			
Hardware (-1) x Internal Spending (-1)	HI+		

In Table 7.2, the striking observations are the columns of education and health, which were empty. All four aspects of ICT investment seem not to show any significance to education and health in the table. These show that high income countries have reached a state of saturation in their health and education sectors. The trend analysis performed in this study indicated that high income countries have 80- 90% education and health levels. This means any increase in investments in the four aspects of ICT investment to the education and health sectors in high income countries is for sustainability. These findings also show why most of the research on ICT in high income countries focus on the standard of living (GDP).

The other observations are that telecommunication investment shows a highly significant effect on the standard of living (GDP) while the interaction of hardware and internal spending are also highly significant. These reveal that telecommunication investment in high income countries raises the level of GDP thereby leading to an increase in the standard of living. Likewise, the interaction of hardware investment and internal spending shows that investment in hardware with adequate skills increases the country's performance.
This lead to the following propositions:

$P1_H$: Telecommunication Investment leads to increases in the standard of living in high income countries

$P2_H$: Interaction of Hardware and Internal Spending lead to increases in the standard of living in high income countries.

7.3.2 Mid Income Countries

Table 7.3 shows the significant level of ICT investments on the components of human development in mid income countries.

Table 7.3: Significance Level of ICT Investments in Mid Income Countries

Mid Income countries	Standard of living	Education	Health
Internal Spending (-1)			
Hardware (-1)		MI+	
Software (-1)		MI+	
Telecoms (-1)	MI+		
Telecoms (-1) x Internal Spending (-1)			
Software (-1) x Internal Spending (-1)			MI+
Software (-1) x Hardware(-1)			
Hardware (-1) x Internal Spending (-1)			MI+

From Table 7.3, the first observation is that telecommunication investment has a highly positive significant impact on the standard of living in mid income countries. This indicates that investments in telecommunication in mid income countries yields standard of living. Telecommunication investments has also been shown to promote social overhead capital and standard of living (GDP) in mid income countries (Waverman et al., 2005). Also hardware and software investments have a positive impact on the level of education. This can be explained by the fact that investment in hardware and software in mid income countries contribute to growth in education. It is known that software is a medium for transforming knowledge which can be carried out through hardware infrastructures such as computer systems (Kim et al., 2008). The utilization of hardware and software will produce higher returns in the standard of education.

The notable observation is in the health column is that-: both the interaction of software and internal spending as well as hardware and internal spending indicate a positive impact on the standard of healthy living. These show the importance of adequate training in terms of skills development in software and hardware. Research has also shown that skills development and human capital development, such as an increase in wages, will improve the health of people (Bloom & Canning, 2000). This leads to the following propositions:

$P1_M$: *Telecommunication investment leads to the increases in the standard of living in mid income countries*

$P2_M$: *Hardware and software investment leads to increases in the level of education in mid income countries.*

$P3_M$: *Interaction of hardware and internal spending lead to increases in healthy living in mid income countries.*

$P4_M$: *Interaction of software and internal spending lead to increases in healthy living in mid income countries.*

7.3.3 Low Income Countries

Table 7.4: Significance Level of ICT Investments in Low Income countries

Low Income countries	Standard of living	Education	Health
Internal Spending (-1)			LI:+
Hardware (-1)			
Software (-1)			
Telecoms (-1)	LI:-		
Telecoms (-1) x Internal Spending (-1)	LI:+	LI:+	LI:+
Software (-1) x Internal Spending (-1)		LI:+	
Software (-1) x Hardware(-1)	LI: +		LI:+
Hardware (-1) x Internal Spending (-1)			

In Table 7.4, the first observation is the positive impact of internal spending on health. This is an indication that internal spending in terms of skills development, adequate remunerations for skilled workers and human capital appreciation will lead to healthy living. The second observation reveals that telecommunications investment has a positive impact on the standard of living in low income countries. This means telecommunication infrastructures such as the provision of broadband access raises the living standard, especially in Africa. The third observation is the interaction of telecommunication and internal spending which shows a positive impact on the standard of living, education and health. This reveals that the provision of telecommunication infrastructures with adequate skills and training has impact on the three components of human development in low income countries. The fourth observation shows the positive impact of the interaction of software and internal spending on education. The investments in software coupled with adequate skills and training leads to higher returns in the level of education in low income countries. The fifth observation is the

interaction of software and hardware that shows a positive impact on the standard of living and health. This means proportional investments in hardware and software in low income countries increase the standard of living thereby influencing healthy lifestyles. This leads to the following propositions:

$P1_L$: *Internal Spending will increase healthy living in low income countries*

$P2_L$: *Telecommunication Investment leads to increases in the standard of living in low income countries.*

$P3_L$: *Interaction of Telecommunication and Internal Spending lead to increases in the standard of living, health and education in low income countries.*

$P4_L$: *Interaction of Software and Internal Spending leads to increases in the level of education in low income countries*

$P5_L$: *Interaction of Software and Hardware lead to increases in the standard of living and health in low income countries.*

7.4 General Theory Building

Information systems is a profession that has several constituents such as IS managers, executives and practitioners tasked with the purpose of improving the efficiency of an organization or country through furthering knowledge that enhances the productive application of information technology to human development and management (Hevner, March, Park & Ram, 2004). This encourages the IT artefacts to extend to human problem solving in society through the provision of intellectual theories regarding their impact, use and development. (Hevner et al., 2004). It has been observed that IS research constitutes the confluence of people, technology and society at large (Lee 1999; Davis & Olson 1985 Cited in Hevner et al., 2004). The generalization of IS theory to different settings is paramount to research as well as managing and solving problems that might occur in organizations and countries (Lee & Baskerville, 2003).

Conceptualized in this manner, a general theory was adopted from eleven propositions obtained from the three level of countries (high, mid and low income countries) based on *standard of living, education and health* to develop a theory that satisfies the requirements of

propositions and that can be implemented in all countries (Lee, 1991). This study deduced the general propositions from the three levels of countries (high, mid and low income) in an attempt to theorize IT artefacts as described by Orlikowski & Iacono (2000). The propositions were classified into *explanation and prediction* (EP) theory type according to taxonomy of theory types in IS research (Gregor, 2005). The propositions are presented in the Table 7.5.

Theorizing the impact of ICT investment on human development offers a new frame work for understanding the effect of ICT spending on human development. This provides a reference for new insights for other frameworks that constitute a paradigm shift (Stoker, 1998).

Table 7.5: Table of Propositions

Standard of living
P1: Telecommunication Investments lead to increases in standard of living in high, mid and low income countries
P2: Interaction of hardware and internal spending lead to increases in standard of living in high income countries
P3: Interaction of telecommunication and internal spending lead to increases in standard of living in low income countries
Education
P4: Hardware and Software Investment lead to increases in level of education in mid income countries
P5: Interaction of software and internal spending lead to increases in level of education in low income countries
P6: Interaction of telecommunication and internal spending lead to increases in level of education in low income countries
Health
P7: Interaction of hardware and internal spending lead to increases in healthy living in mid income countries
P8: Interaction of software and internal spending lead to increases in healthy living in mid income countries
P9: Internal spending lead to increases in health living in low income countries
P10:Interaction of telecommunication and internal spending lead to healthy living in low income countries
P11: Interaction of software and hardware lead to healthy living in low income countries

In proposition *P1*, telecommunication investment shows a positive impact and an increase in the standard of living in the three levels of countries. In high income countries, telecommunications have been shown to facilitate the improvement in the standard of living (Manalo & Camacho, 2007; Andova & Diaz-Serrano, 2007 Cited in Samoilenko & Osei-Bryson, 2008).

In mid income countries, telecommunications investment leads to a huge improvement in the standard of living. For example, Taiwan and South Korea have invested heavily in telecommunications-: Taiwan has liberalized its telecommunication sector and has remained the largest supplier of telecommunication products while South Korea has created Samsung CDMA for cellular telephones as a means of competing with GSM in Asia (Jussawalla, 1999; Wang, 1999). The two countries have used investments in telecommunications as an export earner to raise their standard of living.

In low income countries especially in Africa, telecommunication investment started in the early 1990s with the aim of bridging the digital divide and improving the standard of living for individuals in Africa. The introduction of broadband ac cess for internet and mobile telephone services in 1994 (the period of data collected for this study) and development of a fiber-optic backbone for Africa; an initiative of the New Partnership for Africa's Development (NEPAD) were based on the long term ability to help build wealth in African nations. The projects are a means of connecting all African countries to each other through submarine cables to reduce high cost and poor telecommunication infrastructure in Africa as most of calls from African countries are routed through Europe at an outrageous cost.

The living standard and economic growth in developing countries especially in Africa has been linked to the provision and use of telecommunication services (Garbacz & Thompson, 2007). Today the evidence is glaring:South Africa has the most sophisticated telecommunication infrastructures in Africa (Brown et al., 2007) while Nigeria remains outstanding in Africa in terms of m-commerce usage for economic development (Muganda et al., 2008). The investment in mobile phones and the accompanying infrastructure improves the standard of living in Africa as mobile phone penetration serves as a powerful device for economic growth (Waverman et al., 2005).

In China, telecommunication investment has helped the country to remain the world's second largest market for telecommunications equipment and services. These have boosted the economy and improved the standard of living. (Jussawalla, 1999).

The ITU report in 1998 according to Jussawalla (1999) stated that the NIEs and low income countries have a massive stake in the US$ 1.5 trillion IT industries that are in existence worldwide.

The proposition *P2,* the interaction of hardware and internal spending lead to a rise in the standard of living in high income countries. The high income countries are heavily equipped with computer hardware and equipment as a result of technological change and global economic competition. This is shown in the trend analysis conducted in this study. The advent of the internet also encouraged investment in hardware in high income countries. As a result, the demand for skilled professionals is required, especially IT workers. For example, the United States has been attracting a large number of highly skilled IT workers to create a balance in the labour market and raise the standard of living (OECD, 2002). This shows that investments in hardware and internal spending create a balance in the labour market that leads to improvement in the standard of living. Another example is the growing market for networked storage and the firm training of its use in developed countries has led to business opportunities for IT organizations and professionals which encourage growth in the economy and the standard of living (Gibson & Meter, 2000).

The proposition *P3,* the interaction of telecommunication investments and internal spending lead to increases in the standard of living in low income countries. In low income countries especially in Africa, investments in telecommunications have been linked to economic development. However, such investments require complementary investments in internal spending, in terms of skilled workforce, human capital development, and adequate remunerations for skilled workers and training. This shows that investments in telecommunication infrastructures and services still require internal spending to absorb and efficiently use the technology (Murshed, 2002). Odedra, Bennett, Goodman and Lawrie (1993) emphasized that African countries need IT skills for economic growth and better standards of living.

The proposition *P4,* hardware and software investment leads to increase in level of education. This shows that proportional investments in hardware and software in mid income countries lead to a rise in the literacy level. Software and hardware in terms of packaged software and computer systems serves as a means for information processing and knowledge transfer (Kim

et al., 2008). A typical case is Slovenia where the government introduced hardware and software computing for development in the education sector (Wechtersbach, 2007).

The proposition *P5,* interaction of software and internal spending in low income countries lead to an increase in the level of education in low income countries. This means software investment and necessary skills in the utilization of its use lead to an increase in the standard of education. An initiative on free and open source software in Africa (FOSSFA) has been formed to promote the use of open source software as well as the provision of training and support in education (Fossfa, 2003).

The proposition *P6,* the interaction of telecommunications and internal spending lead to an increase in the level of education in low income countries. This means the provision of telecommunication infrastructures such as broadband internet access services with adequate skills for utilization and services lead to a rise in the level of education in low income countries. This is evident in Africa where several countries have used internet access and development of skills in telecommunication to improve the level of education. In Liberia, government invested in telecommunications and skills development to improve the level of education (Mangesi, 2007). In South Africa, the mobile telecommunication firm MTN has invested R15- million rand for skills development in tertiary institutions to raise the level of education in young people (Engineering News, 2009).

The propositions *P7,* the interaction of hardware and internal spending lead to improvement in healthy living standards in mid income countries. This explains that the interaction of internal spending with hardware in mid income countries leads to a rise in performance in the health sector that improves the standard of healthy living.

For example, i n Taiw an, the use of computer web-based learning has helped nurses to improve their practical nursing knowledge and skills thereby promoting community health, preventing diseases, and protecting the health of vulnerable populations which lead to increase in healthy living of the population (Yu & Yang, 2005). Also T. Lee, T. Lee and Lin (2005) shows that a computerized nursing care plan increase health living of population in Taiwan.

The proposition *P8,* the interaction of software and internal spending lead to improvements in healthy living standards in mid income countries. This shows that adequate training and skills in the use of software applications to diagnose health condition of individuals lead s to improvement in the performance of health workers which has the overall effect on the healthy living standard. For example, the use of software technologies among nurses in Taiwan for care planning and learning leads to improvement in their professional ability (Yu & Yang, 2005).

The proposition *P9,* internal spending leads to health living in low income countries. This proposition means that low income countries need a substantial level of skills development, human capital development in terms of remunerations and wages to raise the level of health in these countries. The study has shown a positive correlation between the level of income and health (Bloom & Canning, 2000). Internal spending in forms of human capital investments in Africa has been associated with a rise in healthy living (Schultz, 1999).

The proposition *P10,* interaction of telecommunication and internal spending lead to healthy living in low income countries. The investments in telecommunication, adequate training and skills utilization as mentioned in *P3 and P6 lead to healthy living in low income countries.* There has been a global health policy that gives attention to the role of technology and skill development for health (Yach, 1998). The utilization of telecommunications infrastructure has a long history in the health sector. Since early 1980s countries like South Africa, Namibia, and Venezuela have been using telecommunications infrastructure (telemedicine) for diagnosis, teaching and the transfer of health related data (Yach, 1998). Ajuwon (2006) has also shown that telecommunications and internet have a positive impact in health research and patient care in Nigeria. In India, the World Bank, the UNDP and the Department for International Department for International Development of the British Government (DIDIDBG) supported the use of VSAT/VHF and GIS based communications networks by skilled health workers in a disaster management project to improve the health of the people (WHO, 2001).

The proposition *P11,* the interaction of software and hardware leads to healthy living in low income countries. The use of health information technology has been projected to contest medical errors and shortfall in quality of health delivery (Mclnnes, Saltman, Kidd, 2006).

This means the interaction of software and hardware investment in the health sector such as provision of computers and clinical software packages for prescription, medication examination, generating medical data, performing of recall systems and writing of medical progress leads to improvement in the health sector and healthy living of individuals in low income countries.

In South Africa, computer hardware and software are used in geographical information systems to plan malaria control. (WHO, 2000). Also in the Northern Province of South Africa, the government has invested R130 million for integrating computerized health information systems in hospitals to improve the efficiency of health services (Herbst, Littlejohns, Rawlinson, Collinson & Wyatt, 1999). Another case in point occurred in India where government and Apple Computer Inc supported the use of personal digital assistants (PDA) by health workers to collect health care data for counselling, health programmes and immunization administering processes (WHO, 2001).

7.5 Practical Implications

In practical terms, the theories show that investment in the area of ICT has a great impact on the general well being of humans. The increase in the aspects of ICT investments would improve the standard of living, health and education. This helps to understand that each aspect of ICT investment differs and varies from country to country. Each country has different structures and capabilities for the accumulation and utilization of ICT investment and result might be different accordingly. These findings correspond to Kim et al., (2008) and Ngwenyama et al., (2006), whose studies stated that the country level of investment utilization depends on such country structure. The second point is that the telecommunication investment shows a strong impact on the standard of living in all countries.

This finding is strong since, telecommunications are the backbone of all ICT infrastructures. Countries need to pay attention to their telecommunication infrastructure so as to considerably raise a standard of living in all countries. The fourth point is that internal spending appears to contribute the most complementary investments in all the country levels. Internal spending and its interaction with other aspects of ICT lead to achievement in

the area of human capital appreciation so as to impact the level of human development in all countries. This is noted in Pinjala, Pintelon & Vereecke (2006) that highly skilled professionals are required in business market and development. Internal spending should be encouraged in all countries so as to improve the level of human development.

The fifth point is that hardware and software are vital for effective development in home, schools, organization and country at large. The deployment of hardware and software constitute skills and knowledge that would affect the way people do things at the country level thereby improving their development.

In summary, the propositions help to advise the policy makers and the ICT practitioners on the formulation of policies that country ICT investment varies and that each aspect also depends on the country level. The investments policies in high, mid and low countries should be different from each other based on their structure. It also shows that a telecommunication investment is paramount to all countries and should come first when a nation is considering investment in ICT.

ICT investment and economic development have been considered by many researchers. This study is among the few to approach ICT investments and human development. The research questions posed in this study investigate the impact of ICT investment on human development. This research explored further by finding the impact of the four aspects of ICT investment on the three key components of human development and their interaction in terms of complementarity. This study suggests a dynamic fixed effect model to examine the effect of the four aspects of ICT investments on the three components of human development. Consistent with the previous studies, ICT investment was found to contribute to the economic growth of nations. This thesis makes several contributions to the existing body of knowledge as follows:

This study was driven by a combination of the accepted measurement models of Kim et al. (2008) and Morawczynski & Ngwenyama (2007) that have been applied in the context of IT, economic growth and human development.

From the result of the analysis, this research demonstrated that the measurement model could be successfully used in the analysis of ICT investments on human development. Moreover, the findings answer the question whether ICT investment improves the level of human development in countries.

The analysis also infers that each of the four aspects of ICT investment has differential effects on the three components of human development and vary according to country. For example, telecommunication investments were found to contribute to the standard of living in all countries while the other aspects of ICT contribution differ according to country level. This finding is consistent with the contention of several studies such as Hoskisson, Eden, Lau & Wright (2000) and Samoilenko & Osei-Bryson, (2008) which stated that countries have dissimilar ICT investment utilization. The study also demonstrated the interaction effects among the four aspects of ICT investments on the components of human development and discovered that the complementary investments in ICT are contributing significantly to the growth of human development in all countries. This is also validated in Samoilenko & Osei-Bryson's (2008) study that complementary investments are prerequisites for the successful translation of investments in ICT.

Furthermore, this thesis corroborates the findings in the complementary effect of the four aspects of ICT investment with the previous studies regarding complementary factors in ICT investments and possible outcomes. The results show that the interaction effect of ICT investment on human development is not constant but varies considerably on which aspects of ICT investment are interacting with each other and the level of country (i.e. high ,mid and low income countries). Based on this notion, this study put investment in ICT into three categories according to the level of importance to human development in all countries, namely telecommunication investment, internal spending, hardware and software. Telecommunication investment and internal spending should first be considered when a country is attempting to invest in ICT, while the other aspects follow suit.

In view of the above, this research obtained new findings and presents theories that have immediate application to ICT investment and human development. The implication of these theories is that the data used are between 1994 and 2003.

When the results were compared with the current situation and researches on ICT and human development around the world, the observation revealed a valid outcome. This means these theories are applicable to the present situation and the next ten years.

7.6 Limitation of the Study

Despite the major contribution of this study, there exist some limitations. The researcher identified the quantity of data that spans ten years as a major limitation of this study.
The data used in this research were drawn from three notable sources-: the ITU, the UN and the WITSA databases. The data covers a period of ten years from 1994-2003. Even though the regression model employed in this research was used when there existed limited time series data for country observation to avoid insufficient power of tests of hypotheses (Frees et al., 2001). However, the wider data may offer richer insight, improve the validity of the findings and provide the broadest and most comprehensive view of the subject. However, this limitation is not peculiar to this study alone but is characteristic to the research in this area in general: the ten years period can be used for longitudinal analysis (Samoileko & Osei-Bryson, 2008; Hoskisson et al., 2000).

The second limitation is that this study used the same source of data employed in the previous study. This might reduce the generalization of the study. In future, data should be collected from other sources.

The limitation of the human development index as a measure of the level of literacy rates in developed countries shows that human development components might not be appropriate for this type of study. In general, the contributions provided in this study outweighed its various limitations.

7.7 Areas for Future Research

The impact of ICT on development is a broad area. ICT can be viewed from many perspectives; ICT is seen as a tool for development and, it can be referred to as an engine for economic growth. This research conceptualizes ICT investment as a medium for human development.

The study investigates the impact of four aspects of ICT investment on human development so as to gain a better understanding of the phenomenon. It is clear from the findings that each aspect of ICT has a differential effect on human and national development. The emerging questions during the process of this research are:

- How can we maximise the impact of ICT investment on the standard of living?
- How can low income countries improve to become mid income countries and mid income move to become high income countries in their level of development?
- How can current data produce the same theories that will be applicable to ICT and the three aspect of human development?

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Appendix

IMPACT OF FOUR ICT INVESTMENTS ON GDP (HIGH INCOME COUNTRIES)

Dependent Variable: D(LGDP)
Method: Panel EGLS (Cross-section SUR)
Date: 12/19/08 Time: 05:49
Sample: 1 170
Periods included: 15
Cross-sections included: 10
Total panel (balanced) observations: 150
Linear estimation after one-step weighting matrix

	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.005896	0.015477	-0.380951	0.7038
D(LGDP(-1))	-0.536028	0.063527	-8.437770	0.0000
D(LIS(-1))	-0.000134	0.004016	-0.033484	0.9733
D(LHWS(-1))	-0.025778	0.009781	-2.635613	0.0094
D(LSWS(-1))	0.011640	0.009134	1.274319	0.2047
D(LTELCS(-1))	0.120273	0.069190	1.738289	0.0844

Effects Specification

Cross-section fixed (dummy variables)

Weighted Statistics

R-squared	0.382558	Mean dependent var	-0.019831
Adjusted R-squared	0.318527	S.D. dependent var	1.225549
S.E. of regression	1.011739	Sum squared resid	138.1882
F-statistic	5.974583	Durbin-Watson stat	2.152384
Prob(F-statistic)	0.000000		

Unweighted Statistics

R-squared	0.334766	Mean dependent var	-0.004853
Sum squared resid	2.580330	Durbin-Watson stat	2.479715

IMPACT OF FOUR ICT INVESTMENTS ON GDP (MID INCOME COUNTRIES)

Dependent Variable: D(LGDP)
Method: Panel EGLS (Cross-section SUR)
Date: 12/19/08 Time: 06:56
Sample: 1 170
Periods included: 15
Cross-sections included: 10
Total panel (balanced) observations: 150
Linear estimation after one-step weighting matrix

	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.145427	0.053354	-2.725689	0.0073
D(LGDP(-1))	-0.553050	0.057197	-9.669282	0.0000
D(LIS(-1))	-0.153175	0.032926	-4.652029	0.0000
D(LSWS(-1))	-0.151624	0.029081	-5.213844	0.0000
D(LHWS(-1))	0.075962	0.027592	2.753068	0.0067
D(LTELCS(-1))	0.094758	0.011894	7.966551	0.0000

Effects Specification

Cross-section fixed (dummy variables)

Weighted Statistics

R-squared	0.592196	Mean dependent var	-0.038762
Adjusted R-squared	0.549906	S.D. dependent var	1.492404
S.E. of regression	0.997876	Sum squared resid	134.4271
F-statistic	14.00297	Durbin-Watson stat	2.319272
Prob(F-statistic)	0.000000		

Unweighted Statistics

R-squared	0.308561	Mean dependent var	-0.079979
Sum squared resid	104.5985	Durbin-Watson stat	2.516524

IMPACT OF FOUR ICT INVESTMENTS ON GDP (LOW INCOME COUNTRIES)

Dependent Variable: D(LGDP)
Method: Panel EGLS (Cross-section SUR)
Date: 12/19/08 Time: 07:09
Sample: 1 170
Periods included: 15
Cross-sections included: 10
Total panel (balanced) observations: 150
Linear estimation after one-step weighting matrix

	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.139241	0.050774	-2.742394	0.0069
D(LGDP(-1))	-0.539598	0.068380	-7.891106	0.0000
D(LIS(-1))	-0.004483	0.019588	-0.228880	0.8193
D(LHWS(-1))	0.051197	0.026968	1.898414	0.0598
D(LTELCS(-1))	0.077396	0.020507	-3.774153	0.0002
D(LSWS(-1))	0.017211	0.019959	0.862330	0.3900

Effects Specification

Cross-section fixed (dummy variables)

Weighted Statistics

R-squared	0.373954	Mean dependent var	0.001362
Adjusted R-squared	0.309031	S.D. dependent var	1.207074
S.E. of regression	0.988279	Sum squared resid	131.8538
F-statistic	5.759937	Durbin-Watson stat	2.083890
Prob(F-statistic)	0.000000		

Unweighted Statistics

R-squared	0.210087	Mean dependent var	-0.088609
Sum squared resid	88.18715	Durbin-Watson stat	2.302028

IMPACT OF FOUR ICT INVESTMENTS ON LITERACY RATES (HIGH INCOME COUNTRIES)

Dependent Variable: D(LALR)
Method: Panel EGLS (Cross-section SUR)
Date: 12/19/08 Time: 07:31
Sample: 1 170
Periods included: 15
Cross-sections included: 10
Total panel (balanced) observations: 150
Linear estimation after one-step weighting matrix

	Coefficient	Std. Error	t-Statistic	Prob.
C	0.000445	5.59E-05	7.952800	0.0000
D(LALR(-1))	-0.009995	0.095912	-0.104206	0.9172
D(LIS(-1))	-0.000317	0.000159	-1.991582	0.0484
D(LSWS(-1))	0.000061	0.000134	0.453581	0.6509
D(LHWS(-1))	0.000700	0.000266	2.632077	0.0095
D(LTELCS(-1))	-0.003647	0.001634	-2.231618	0.0273

Effects Specification

Cross-section fixed (dummy variables)

Weighted Statistics

R-squared	0.188650	Mean dependent var	0.098576
Adjusted R-squared	0.104510	S.D. dependent var	0.750334
S.E. of regression	0.714951	Sum squared resid	69.00586
F-statistic	2.242096	Durbin-Watson stat	2.215852
Prob(F-statistic)	0.009098		

Unweighted Statistics

R-squared	0.072067	Mean dependent var	0.000431
Sum squared resid	0.013963	Durbin-Watson stat	2.265761

IMPACT OF FOUR ICT INVESTMENTS ON LITERACY RATES (MID INCOME COUNTRIES)

Dependent Variable: D(LALR)
Method: Panel EGLS (Cross-section SUR)
Date: 12/19/08 Time: 07:44
Sample: 1 170
Periods included: 15
Cross-sections included: 10
Total panel (balanced) observations: 150
Linear estimation after one-step weighting matrix

	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.001533	0.002631	-0.582777	0.5610
D(LALR(-1))	-0.488995	0.066264	-7.379516	0.0000
D(LIS(-1))	-0.008310	0.005913	-1.405479	0.1622
D(LSWS(-1))	0.024542	0.006446	-3.807137	0.0002
D(LHWS(-1))	0.022662	0.004690	4.831925	0.0000
D(LTELCS(-1))	0.005896	0.003514	1.677835	0.0957

Effects Specification

Cross-section fixed (dummy variables)

Weighted Statistics

R-squared	0.406810	Mean dependent var	-0.009149
Adjusted R-squared	0.345294	S.D. dependent var	1.160687
S.E. of regression	0.919031	Sum squared resid	114.0233
F-statistic	6.613067	Durbin-Watson stat	2.176287
Prob(F-statistic)	0.000000		

Unweighted Statistics

R-squared	0.477395	Mean dependent var	0.000561
Sum squared resid	8.782598	Durbin-Watson stat	2.839363

IMPACT OF FOUR ICT INVESTMENTS ON LITERACY RATES (LOW INCOME COUNTRIES)

Dependent Variable: D(LALR)
Method: Panel EGLS (Cross-section SUR)
Date: 12/19/08 Time: 07:51
Sample: 1 170
Periods included: 15
Cross-sections included: 10
Total panel (balanced) observations: 150
Linear estimation after one-step weighting matrix

	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.000212	0.002737	-0.077289	0.9385
D(LALR(-1))	-0.147278	0.081182	-1.814172	0.0719
D(LIS(-1))	0.013060	0.004206	3.104834	0.0023
D(LSWS(-1))	-0.006932	0.005293	-1.309707	0.1925
D(LHWS(-1))	0.001537	0.005131	0.299605	0.7649
D(LTELCS(-1))	0.009170	0.003832	-2.392898	0.0181

Effects Specification

Cross-section fixed (dummy variables)

Weighted Statistics

R-squared	0.261829	Mean dependent var	-0.010411
Adjusted R-squared	0.185277	S.D. dependent var	1.144641
S.E. of regression	1.025888	Sum squared resid	142.0803
F-statistic	3.420309	Durbin-Watson stat	2.029002
Prob(F-statistic)	0.000094		

Unweighted Statistics

R-squared	0.094942	Mean dependent var	0.000199
Sum squared resid	1.134671	Durbin-Watson stat	1.818521

IMPACT OF FOUR ICT INVESTMENTS ON LIFE EXPECTANCY RATE (HIGH INCOME COUNTRIES)

Dependent Variable: D(LLEB)
Method: Panel EGLS (Cross-section SUR)
Date: 12/19/08 Time: 08:01
Sample: 1 170
Periods included: 15
Cross-sections included: 10
Total panel (balanced) observations: 150
Linear estimation after one-step weighting matrix

	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.000373	0.000483	-0.773256	0.4407
D(LLEB(-1))	-0.246078	0.082487	-2.983218	0.0034
D(LIS(-1))	-0.000621	0.000683	-0.909401	0.3648
D(LSWS(-1))	0.001211	0.001244	0.973364	0.3321
D(LHWS(-1))	-0.002006	0.001733	-1.157789	0.2490
D(LTELCS(-1))	0.011253	0.009730	1.156554	0.2495

Effects Specification

Cross-section fixed (dummy variables)

Weighted Statistics

R-squared	0.278959	Mean dependent var	0.108666
Adjusted R-squared	0.204184	S.D. dependent var	1.174752
S.E. of regression	1.050158	Sum squared resid	148.8822
F-statistic	3.730657	Durbin-Watson stat	2.045794
Prob(F-statistic)	0.000028		

Unweighted Statistics

R-squared	0.062096	Mean dependent var	-0.000140
Sum squared resid	0.019429	Durbin-Watson stat	1.969427

IMPACT OF FOUR ICT INVESTMENTS ON LIFE EXPECTANCY RATE (MID INCOME COUNTRIES)

Dependent Variable: D(LLEB)
Method: Panel EGLS (Cross-section SUR)
Date: 12/19/08 Time: 08:04
Sample: 1 170
Periods included: 15
Cross-sections included: 10
Total panel (balanced) observations: 150
Linear estimation after one-step weighting matrix

	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.003871	0.002138	-1.810074	0.0725
D(LLEB(-1))	-0.738801	0.042295	-17.46793	0.0000
D(LIS(-1))	0.028826	0.009485	3.039321	0.0028
D(LSWS(-1))	-0.014659	0.007526	-1.947788	0.0535
D(LHWS(-1))	-0.012595	0.005082	-2.478386	0.0144
D(LTELCS(-1))	-0.009605	0.004310	-2.228779	0.0275

Effects Specification

Cross-section fixed (dummy variables)

Weighted Statistics

R-squared	0.720591	Mean dependent var	-0.098648
Adjusted R-squared	0.691616	S.D. dependent var	1.887994
S.E. of regression	1.048813	Sum squared resid	148.5011
F-statistic	24.86881	Durbin-Watson stat	2.187706
Prob(F-statistic)	0.000000		

Unweighted Statistics

R-squared	0.551353	Mean dependent var	-0.003493
Sum squared resid	0.969900	Durbin-Watson stat	2.388219

IMPACT OF FOUR ICT INVESTMENTS ON LIFE EXPECTANCY RATES (LOW INCOME COUNTRIES)

Dependent Variable: D(LLEB)
Method: Panel EGLS (Cross-section SUR)
Date: 12/19/08 Time: 08:08
Sample: 1 170
Periods included: 15
Cross-sections included: 10
Total panel (balanced) observations: 150
Linear estimation after one-step weighting matrix

	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.001247	0.000977	-1.275985	0.2042
D(LLEB(-1))	-0.074813	0.067305	-1.111552	0.2683
D(LIS(-1))	0.010962	0.001320	8.301421	0.0000
D(LSWS(-1))	-0.013360	0.001730	-7.723264	0.0000
D(LHWS(-1))	0.004416	0.001573	2.807881	0.0057
D(LTELCS(-1))	-0.005469	0.001271	-4.301220	0.0000

Effects Specification

Cross-section fixed (dummy variables)

Weighted Statistics

R-squared	0.519941	Mean dependent var	0.071287
Adjusted R-squared	0.470157	S.D. dependent var	1.443686
S.E. of regression	1.028430	Sum squared resid	142.7852
F-statistic	10.44394	Durbin-Watson stat	2.163628
Prob(F-statistic)	0.000000		

Unweighted Statistics

R-squared	0.078785	Mean dependent var	-0.000289
Sum squared resid	0.241615	Durbin-Watson stat	1.647559

THE INTERACTION EFFECT OF FOUR ICT INVESTENTS ON GDP (HIGH INCOME COUNTRIES)

Dependent Variable: D(LGDP)
Method: Panel EGLS (Cross-section SUR)
Date: 12/19/08 Time: 11:18
Sample: 1 170
Periods included: 15
Cross-sections included: 10
Total panel (balanced) observations: 150
Linear estimation after one-step weighting matrix

	Coefficient	Std. Error	t-Statistic	Prob.
C	0.025769	0.022451	1.147802	0.2531
D(LGDP(-1))	-0.551315	0.064712	-8.519547	0.0000
D(LIS(-1))	-0.008880	0.007992	-1.111111	0.2686
D(LSWS(-1))	0.002688	0.009740	0.275947	0.7830
D(LHWS(-1))	-0.025200	0.009561	-2.635667	0.0094
D(LTELCS(-1))	0.289321	0.077248	3.745360	0.0003
D(LTELCS(-1))*D(LIS(-1))	0.056197	0.031602	-1.778267	0.0777
D(LSWS(-1))*D(LHWS(-1))	-0.024049	0.005067	-4.746369	0.0000
D(LSWS(-1))*D(LIS(-1))	-0.013456	0.004636	-2.902546	0.0043
D(LHWS(-1))*D(LIS(-1))	0.038277	0.006537	5.855932	0.0000

Effects Specification

Cross-section fixed (dummy variables)

Weighted Statistics

R-squared	0.498393	Mean dependent var	-0.025078
Adjusted R-squared	0.429470	S.D. dependent var	1.350121
S.E. of regression	1.019863	Sum squared resid	136.2557
F-statistic	7.231151	Durbin-Watson stat	2.310410
Prob(F-statistic)	0.000000		

Unweighted Statistics

R-squared	0.436805	Mean dependent var	-0.004853
Sum squared resid	2.184540	Durbin-Watson stat	2.407905

THE INTERACTION EFFECT OF FOUR ICT INVESTENTS ON GDP (MID INCOME COUNTRIES)

Dependent Variable: D(LGDP)
Method: Panel EGLS (Cross-section SUR)
Date: 12/19/08 Time: 11:25
Sample: 1 170
Periods included: 15
Cross-sections included: 10
Total panel (balanced) observations: 150
Linear estimation after one-step weighting matrix

	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.080365	0.063722	-1.261184	0.2095
D(LGDP(-1))	-0.612803	0.065096	-9.413878	0.0000
D(LIS(-1))	-0.234754	0.056831	-4.130712	0.0001
D(LSWS(-1))	-0.145047	0.048203	-3.009111	0.0031
D(LHWS(-1))	0.121483	0.043752	2.776596	0.0063
D(LTELCS(-1))	0.090731	0.026611	3.409471	0.0009
D(LTELCS(-1))*D(LIS(-1))	0.047719	0.019498	2.447353	0.0157
D(LSWS(-1))*D(LHWS(-1))	-0.008425	0.035116	-0.239911	0.8108
D(LSWS(-1))*D(LIS(-1))	-0.123923	0.049144	-2.521613	0.0129
D(LHWS(-1))*D(LIS(-1))	0.022423	0.033275	0.673866	0.5016

Effects Specification

Cross-section fixed (dummy variables)

Weighted Statistics

R-squared	0.581743	Mean dependent var	-0.019472
Adjusted R-squared	0.524272	S.D. dependent var	1.341213
S.E. of regression	0.921521	Sum squared resid	111.2454
F-statistic	10.12246	Durbin-Watson stat	2.302571
Prob(F-statistic)	0.000000		

Unweighted Statistics

R-squared	0.310579	Mean dependent var	-0.079979
Sum squared resid	104.2932	Durbin-Watson stat	2.434150

THE INTERACTION EFFECT OF FOUR ICT INVESTENTS ON GDP (LOW INCOME COUNTRIES)

Dependent Variable: D(LGDP)
Method: Panel EGLS (Cross-section SUR)
Date: 12/19/08 Time: 11:31
Sample: 1 170
Periods included: 15
Cross-sections included: 10
Total panel (balanced) observations: 150
Linear estimation after one-step weighting matrix

	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.116594	0.032350	-3.604078	0.0004
D(LGDP(-1))	-0.479211	0.061848	-7.748147	0.0000
D(LIS(-1))	-0.032342	0.016344	-1.978808	0.0499
D(LSWS(-1))	-0.062577	0.021153	-2.958359	0.0037
D(LHWS(-1))	0.220009	0.033184	6.630045	0.0000
D(LTELCS(-1))	0.144092	0.024104	-5.977934	0.0000
D(LTELCS(-1))*D(LIS(-1))	0.125510	0.014999	8.367924	0.0000
D(LSWS(-1))*D(LHWS(-1))	0.063221	0.012068	-5.238933	0.0000
D(LSWS(-1))*D(LIS(-1))	-0.012132	0.013926	-0.871226	0.3852
D(LHWS(-1))*D(LIS(-1))	-0.056715	0.016298	-3.479809	0.0007

Effects Specification

Cross-section fixed (dummy variables)

Weighted Statistics

R-squared	0.536510	Mean dependent var	0.010814
Adjusted R-squared	0.472825	S.D. dependent var	1.460545
S.E. of regression	1.031078	Sum squared resid	139.2690
F-statistic	8.424361	Durbin-Watson stat	2.115140
Prob(F-statistic)	0.000000		

Unweighted Statistics

R-squared	0.236568	Mean dependent var	-0.088609
Sum squared resid	85.23070	Durbin-Watson stat	2.439951

THE INTERACTION EFFECT OF FOUR ICT INVESTENTS ON LITERACY RATE. (HIGH INCOME COUNTRIES)

Dependent Variable: D(LALR)
Method: Panel EGLS (Cross-section SUR)
Date: 12/19/08 Time: 11:21
Sample: 1 170
Periods included: 15
Cross-sections included: 10
Total panel (balanced) observations: 150
Linear estimation after one-step weighting matrix

	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.000302	0.000261	-1.158076	0.2489
D(LALR(-1))	-0.087677	0.063306	-1.384973	0.1684
D(LIS(-1))	-0.001061	0.000250	-4.234211	0.0000
D(LSWS(-1))	0.001263	0.000264	4.783651	0.0000
D(LHWS(-1))	0.001667	0.000333	5.009439	0.0000
D(LTELCS(-1))	-0.018173	0.002025	-8.974911	0.0000
D(LTELCS(-1))*D(LIS(-1))	-0.007044	0.000782	-9.012478	0.0000
D(LSWS(-1))*D(LHWS(-1))	0.000955	0.000159	6.013498	0.0000
D(LSWS(-1))*D(LIS(-1))	1.432306	0.000123	0.011651	0.9907
D(LHWS(-1))*D(LIS(-1))	-0.000126	0.000145	-0.866238	0.3879

Effects Specification

Cross-section fixed (dummy variables)

Weighted Statistics

R-squared	0.612156	Mean dependent var	0.086296
Adjusted R-squared	0.558865	S.D. dependent var	1.299142
S.E. of regression	0.864778	Sum squared resid	97.96720
F-statistic	11.48693	Durbin-Watson stat	2.047750
Prob(F-statistic)	0.000000		

Unweighted Statistics

R-squared	0.114108	Mean dependent var	0.000431
Sum squared resid	0.013330	Durbin-Watson stat	2.131623

THE INTERACTION EFFECT OF FOUR ICT INVESTENTS ON LITERACY RATE. (MID INCOME COUNTRIES)

Dependent Variable: D(LALR)
Method: Panel EGLS (Cross-section SUR)
Date: 12/19/08 Time: 11:29
Sample: 1 170
Periods included: 15
Cross-sections included: 10
Total panel (balanced) observations: 150
Linear estimation after one-step weighting matrix

	Coefficient	Std. Error	t-Statistic	Prob.
C	0.008842	0.008432	1.048644	0.2963
D(LALR(-1))	-0.509430	0.070796	-7.195791	0.0000
D(LIS(-1))	0.014009	0.012320	1.137061	0.2576
D(LSWS(-1))	-0.015853	0.008395	-1.888453	0.0612
D(LHWS(-1))	0.007247	0.010830	0.669191	0.5046
D(LTELCS(-1))	-0.013326	0.007750	-1.719448	0.0879
D(LTELCS(-1))*D(LIS(-1))	-0.002848	0.005297	-0.537719	0.5917
D(LSWS(-1))*D(LHWS(-1))	-0.008440	0.009610	-0.878176	0.3815
D(LSWS(-1))*D(LIS(-1))	0.040298	0.011001	3.662966	0.0004
D(LHWS(-1))*D(LIS(-1))	-0.027240	0.008404	-3.241553	0.0015

Effects Specification

Cross-section fixed (dummy variables)

Weighted Statistics

R-squared	0.414122	Mean dependent var	0.010840
Adjusted R-squared	0.333620	S.D. dependent var	1.123674
S.E. of regression	0.917312	Sum squared resid	110.2314
F-statistic	5.144226	Durbin-Watson stat	2.091692
Prob(F-statistic)	0.000000		

Unweighted Statistics

R-squared	0.502850	Mean dependent var	0.000561
Sum squared resid	8.354820	Durbin-Watson stat	2.800197

THE INTERACTION EFFECT OF FOUR ICT INVESTENTS ON LITERACY RATE (LOW INCOME COUNTRIES)

Dependent Variable: D(LALR)
Method: Panel EGLS (Cross-section SUR)
Date: 12/19/08 Time: 11:32
Sample: 1 170
Periods included: 15
Cross-sections included: 10
Total panel (balanced) observations: 150
Linear estimation after one-step weighting matrix

	Coefficient	Std. Error	t-Statistic	Prob.
C	0.001927	0.002694	0.715248	0.4757
D(LALR(-1))	-0.155095	0.061374	-2.527040	0.0127
D(LIS(-1))	0.016040	0.003004	5.339179	0.0000
D(LSWS(-1))	-0.032695	0.004293	-7.615747	0.0000
D(LHWS(-1))	0.035592	0.005431	6.553897	0.0000
D(LTELCS(-1))	-0.026354	0.003410	-7.729025	0.0000
D(LTELCS(-1))*D(LIS(-1))	0.020900	0.002774	7.534194	0.0000
D(LSWS(-1))*D(LHWS(-1))	0.004932	0.002643	-1.866349	0.0642
D(LSWS(-1))*D(LIS(-1))	0.009269	0.003105	2.985106	0.0034
D(LHWS(-1))*D(LIS(-1))	-0.025635	0.004305	-5.955081	0.0000

Effects Specification

Cross-section fixed (dummy variables)

Weighted Statistics

R-squared	0.616390	Mean dependent var	-0.108937
Adjusted R-squared	0.563681	S.D. dependent var	1.575836
S.E. of regression	1.043101	Sum squared resid	142.5358
F-statistic	11.69405	Durbin-Watson stat	2.043063
Prob(F-statistic)	0.000000		

Unweighted Statistics

R-squared	0.120581	Mean dependent var	0.000199
Sum squared resid	1.102527	Durbin-Watson stat	1.800410

THE INTERACTION EFFECT OF FOUR ICT INVESTENTS ON LIFE EXPECTANCY (HIGH INCOME COUNTRIES)

Dependent Variable: D(LLEB)
Method: Panel EGLS (Cross-section SUR)
Date: 12/19/08 Time: 11:23
Sample: 1 170
Periods included: 15
Cross-sections included: 10
Total panel (balanced) observations: 150
Linear estimation after one-step weighting matrix

	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.000897	0.000751	-1.194441	0.2345
D(LLEB(-1))	-0.262367	0.082365	-3.185427	0.0018
D(LIS(-1))	-0.000313	0.000686	-0.455880	0.6492
D(LSWS(-1))	-0.000471	0.001339	-0.351384	0.7259
D(LHWS(-1))	-0.000768	0.001721	-0.445966	0.6564
D(LTELCS(-1))	0.013762	0.009985	1.378264	0.1705
D(LTELCS(-1))*D(LIS(-1))	0.005026	0.005145	0.976912	0.3304
D(LSWS(-1))*D(LHWS(-1))	0.000226	0.000458	0.493289	0.6226
D(LSWS(-1))*D(LIS(-1))	-0.001152	0.000465	-2.478742	0.0145
D(LHWS(-1))*D(LIS(-1))	0.000701	0.000950	0.738106	0.4618

Effects Specification

Cross-section fixed (dummy variables)

Weighted Statistics

R-squared	0.331765	Mean dependent var	0.111990
Adjusted R-squared	0.239946	S.D. dependent var	1.227005
S.E. of regression	1.052165	Sum squared resid	145.0237
F-statistic	3.613262	Durbin-Watson stat	2.032197
Prob(F-statistic)	0.000009		

Unweighted Statistics

R-squared	0.078222	Mean dependent var	-0.000140
Sum squared resid	0.019095	Durbin-Watson stat	1.983785

THE INTERACTION EFFECT OF FOUR ICT INVESTENTS ON LIFE EXPECTANCY (MID INCOME COUNTRIES)

Dependent Variable: D(LLEB)
Method: Panel EGLS (Cross-section SUR)
Date: 12/19/08 Time: 11:27
Sample: 1 170
Periods included: 15
Cross-sections included: 10
Total panel (balanced) observations: 150
Linear estimation after one-step weighting matrix

	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.004553	0.003100	-1.468821	0.1443
D(LLEB(-1))	-0.762132	0.043239	-17.62591	0.0000
D(LIS(-1))	0.093619	0.013700	6.833573	0.0000
D(LSWS(-1))	-0.025958	0.008128	-3.193606	0.0018
D(LHWS(-1))	-0.032565	0.007204	-4.520395	0.0000
D(LTELCS(-1))	-0.034335	0.005842	-5.877029	0.0000
D(LTELCS(-1))*D(LIS(-1))	-0.013093	0.004664	-2.807183	0.0058
D(LSWS(-1))*D(LHWS(-1))	-0.064048	0.010704	-5.983765	0.0000
D(LSWS(-1))*D(LIS(-1))	0.047302	0.007937	5.959953	0.0000
D(LHWS(-1))*D(LIS(-1))	0.032591	0.008866	3.675857	0.0003

Effects Specification

Cross-section fixed (dummy variables)

Weighted Statistics

R-squared	0.760762	Mean dependent var	-0.094348
Adjusted R-squared	0.727890	S.D. dependent var	2.002833
S.E. of regression	1.044847	Sum squared resid	143.0133
F-statistic	23.14291	Durbin-Watson stat	2.158847
Prob(F-statistic)	0.000000		

Unweighted Statistics

R-squared	0.575849	Mean dependent var	-0.003493
Sum squared resid	0.916943	Durbin-Watson stat	2.357634

THE INTERACTION EFFECT OF FOUR ICT INVESTENTS ON LIFE EXPECTANCY. (LOW INCOME COUNTRIES)

Dependent Variable: D(LLEB)
Method: Panel EGLS (Cross-section SUR)
Date: 12/19/08 Time: 11:33
Sample: 1 170
Periods included: 15
Cross-sections included: 10
Total panel (balanced) observations: 150
Linear estimation after one-step weighting matrix

	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.002560	0.001701	-1.504635	0.1348
D(LLEB(-1))	-0.031230	0.053064	-0.588537	0.5572
D(LIS(-1))	0.008494	0.001185	7.167309	0.0000
D(LSWS(-1))	-0.021337	0.001718	-12.41622	0.0000
D(LHWS(-1))	0.014857	0.002140	6.943207	0.0000
D(LTELCS(-1))	-0.006365	0.001425	-4.465928	0.0000
D(LTELCS(-1))*D(LIS(-1))	0.007916	0.001006	7.865725	0.0000
D(LSWS(-1))*D(LHWS(-1))	0.006941	0.001005	6.904953	0.0000
D(LSWS(-1))*D(LIS(-1))	-0.002324	0.001391	-1.671388	0.0970
D(LHWS(-1))*D(LIS(-1))	-0.011680	0.001426	-8.189921	0.0000

Effects Specification

Cross-section fixed (dummy variables)

Weighted Statistics

R-squared	0.687173	Mean dependent var	0.132925
Adjusted R-squared	0.644189	S.D. dependent var	1.738515
S.E. of regression	1.036765	Sum squared resid	140.8094
F-statistic	15.98676	Durbin-Watson stat	2.070285
Prob(F-statistic)	0.000000		

Unweighted Statistics

R-squared	0.100446	Mean dependent var	-0.000289
Sum squared resid	0.235934	Durbin-Watson stat	1.693869

HDI TRENDS OF 177 COUNTRIES FROM 1975-2005 (UNDP, 2008).

HDI Rank	Country	1975	1980	1985	1990	1995	2000	2005
	High Human Development							
1	Iceland	0.868	0.890	0.899	0.918	0.923	0.947	0.968
2	Norway	0.870	0.889	0.900	0.913	0.938	0.958	0.968
3	Australia	0.851	0.868	0.880	0.894	0.934	0.949	0.962
4	Canada	0.873	0.888	0.911	0.931	0.936	0.946	0.961
5	Ireland	0.823	0.835	0.851	0.875	0.898	0.931	0.959
6	Sweden	0.872	0.882	0.893	0.904	0.935	0.952	0.956
7	Switzerland	0.883	0.895	0.902	0.915	0.926	0.946	0.955
8	Japan	0.861	0.886	0.899	0.916	0.929	0.941	0.953
9	Netherlands	0.873	0.885	0.899	0.914	0.934	0.947	0.953
10	France	0.856	0.872	0.884	0.907	0.925	0.938	0.952
11	Finland	0.846	0.866	0.884	0.906	0.918	0.940	0.952
12	US	0.870	0.890	0.904	0.919	0.931	0.942	0.951
13	Spain	0.846	0.863	0.877	0.896	0.914	0.932	0.949
14	Denmark	0.875	0.883	0.890	0.898	0.916	0.935	0.949
15	Austria	0.848	0.862	0.876	0.899	0.918	0.938	0.948
16	UK	0.853	0.860	0.870	0.890	0.929	0.931	0.946
17	Belgium	0.852	0.869	0.883	0.903	0.931	0.943	0.946
18	Luxembourg	0.836	0.850	0.863	0.890	0.913	0.929	0.944
19	New Zealand	0.854	0.860	0.871	0.880	0.908	0.927	0.943
20	Italy	0.845	0.861	0.869	0.892	0.910	0.919	0.941
21	Hongkong	0.763	0.803	0.830	0.865	0.886	0.919	0.937
22	Germany		0.863	0.871	0.890	0.913	0.928	0.935
23	Israel	0.805	0.830	0.850	0.869	0.891	0.918	0.932
24	Greece	0.841	0.856	0.869	0.877	0.882	0.897	0.926
25	Singapore	0.729	0.762	0.789	0.827	0.865		0.922
26	Korea	0.713	0.747	0.785	0.825	0.861	0.892	0.921
27	Slovenia				0.851	0.857	0.891	0.917
28	Cyprus		0.809	0.828	0.851	0.870	0.893	0.903
29	Portugal	0.793	0.807	0.829	0.85	0.885	0.904	0.897
30	Brunei Darussalam							0.894
31	Barbados							0.892
32	Czech Republic				0.845	0.854	0.866	0.891
33	Kuwait	0.771	0.789	0.794		0.826	0.855	0.891
34	Malta	0.738	0.772	0.799	0.833	0.857	0.877	0.878
35	Qatar							0.875
36	Hungary	0.786	0.801	0.813	0.813	0.817	0.845	0.874
37	Poland				0.806	0.822	0.852	0.870
38	Argentina	0.790	0.804	0.811	0.813	0.836	0.862	0.869
39	United Arab Emirates	0.734	0.769	0.790	0.816	0.825	0.837	0.868
40	Chile	0.708	0.743	0.761	0.788	0.819	0.845	0.867
41	Bahrain		0.747	0.783	0.808	0.831	0.846	0.866
42	Slovakia							0.863
43	Lithuania			0.827	0.791	0.831		0.862
44	Estonia		0.811	0.820	0.813	0.792	0.829	0.860
45	Latvia		0.797	0.810	0.804	0.771	0.817	0.855

HDI Rank	Country	1975	1980	1985
46	Uruguay	0.762	0.782	0.787
47	Croatia			
48	Costa Rica	0.746	0.772	0.774
49	Bahamas		0.809	0.822
50	Seychelles			
51	Cuba			
52	Mexico	0.691	0.739	0.758
53	Bulgaria		0.771	0.792
46	Uruguay	0.762	0.782	0.787
47	Croatia			
48	Costa Rica	0.746	0.772	0.774
49	Bahamas		0.809	0.822
50	Seychelles			
51	Cuba			
52	Mexico	0.694	0.739	0.758
53	Bulgaria		0.771	0.792
54	Saint Kitts & Nevis			
55	Tonga			
56	Libyan Arab			
57	Antigua and Barbuda			
58	Oman	0.487	0.547	0.641
59	Trinidad and Tobago	0.756	0.784	0.782
60	Romania		0.786	0.792
61	Saudi Arabia	0.611	0.666	0.684
62	Panama	0.718	0.737	0.751
63	Malaysia	0.619	0.662	0.696
64	Belarus			
65	Mauritius			0.692
62	Panama	0.718	0.737	0.751
63	Malaysia	0.619	0.662	0.696
64	Belarus			
65	Mauritius		0.662	0.692
66	Bosnia and Herzegovina			
67	Russian Federation			
68	Albania		0.675	0.694
69	Macedonia			
70	Brazil	0.649	0.685	0.700

HDI Rank	Country	1975	1980	1985	1990	1995	2000	2005
	Medium Human Development							
71	Dominica							0.798
72	Saint Lucia							0.795
73	Kazakhstan				0.771	0.724	0.738	0.794
74	Venezuela	0.723	0.737	0.743	0.762	0.770	0.776	0.792
75	Colombia	0.663	0.694	0.709	0.729	0.753	0.772	0.791
76	Ukraine				0.809	0.756	0.761	0.788
77	Samoa			0.709	0.721	0.740	0.765	0.785
78	Thailand	0.615	0.654	0.679	0.712	0.745	0.761	0.781
79	Dominican Republic	0.628	0.660	0.684	0.697	0.723	0.757	0.779
80	Belize		0.712	0.718	0.750	0.777	0.795	0.778
81	China	0.530	0.559	0.595	0.634	0.691	0.732	0.777
82	Grenada							0.777
83	Armenia				0.737	0.701	0.738	0.775
84	Turkey	0.594	0.615	0.651	0.683	0.717	0.753	0.775
85	Suriname							0.774
82	Grenada							0.777
83	Armenia				0.737	0.701	0.738	0.775
84	Turkey	0.594	0.615	0.651	0.683	0.717	0.753	0.775
85	Suriname							0.774
86	Jordan		0.647	0.669	0.684	0.710	0.751	0.773
87	Peru	0.647	0.676	0.699	0.710	0.737	0.763	0.773
88	Lebanon				0.692	0.730	0.748	0.772
89	Ecuador	0.636	0.678	0.699	0.714	0.734	0.772	0.772
90	Philippines	0.655	0.688	0.692	0.721	0.739	0.758	0.771
91	Tunisia	0.519	0.575	0.626	0.662	0.702	0.741	0.766
92	Fiji	0.665	0.688	0.702		0.743	0.747	0.762
93	Saint Vincent/Grenadine							0.761
94	Iran	0.571	0.578	0.615	0.653	0.693	0.722	0.759
95	Paraguay	0.667	0.701	0.707	0.718	0.737	0.749	0.755
96	Georgia							0.754
97	Guyana	0.682	0.684	0.675	0.679	0.699	0.722	0.750
98	Azerbaijan							0.746
99	Sri Lanka	0.619	0.656	0.683	0.702	0.721	0.731	0.743
100	Maldives							0.741
101	Jamaica	0.686	0.689	0.690	0.713	0.728	0.744	0.736
102	Cape Verde			0.589	0.627	0.678	0.709	0.736
103	El Salvador	0.595	0.590	0.611	0.653	0.692	0.716	0.735
104	Algeria	0.511	0.562	0.613	0.652	0.672	0.702	0.733
105	Viet Nam			0.590	0.620	0.672	0.711	0.733
106	Palestinian Territories							0.731
107	Indonesia	0.471	0.533	0.585	0.626	0.670	0.692	0.728
108	Syrian Arab Republic	0.547	0.593	0.628	0.646	0.676	0.690	0.724
109	Turkmenistan							0.713
110	Nicaragua	0.583	0.593	0.601	0.610	0.637	0.671	0.710
111	Moldova		0.700	0.722	0.740	0.681	0.683	0.708
112	Egypt	0.434	0.482	0.532	0.575	0.613	0.659	0.708
113	Uzbekistan				0.704	0.683	0.691	0.702

HDI Rank	Country	1975	1980	1985	1990	1995	2000	2005
114	Mongolia			0.637	0.654	0.638	0.667	0.700
115	Honduras	0.528	0.578	0.611	0.634	0.653	0.668	0.700
116	Kyrgyzstan							0.696
117	Bolivia	0.519	0.553	0.580	0.606	0.639	0.677	0.695
118	Guatemala	0.514	0.550	0.566	0.592	0.626	0.667	0.689
119	Gabon							0.677
120	Vanuatu							0.674
121	South Africa	0.650	0.670	0.699	0.731	0.745	0.707	0.674
122	Tajikistan		0.705		0.703	0.638	0.640	0.673
123	Sao Tome/Principe							0.654
124	Botswana	0.509	0.571	0.624	0.674	0.658	0.631	0.654
125	Namibia					0.698	0.657	0.650
126	Morocco	0.435	0.483	0.519	0.551	0.581	0.613	0.646
127	Equatorial Guinea			0.484	0.505	0.529	0.606	0.642
128	India	0.419	0.450	0.487	0.521	0.551	0.578	0.619
129	Solomon Islands							0.602
130	Lao People's Rep			0.448	0.478	0.524	0.563	0.601
131	Cambodia					0.540	0.547	0.598
132	Myanmar							0.583
133	Bhutan							0.579
134	Comoros		0.483	0.500	0.506	0.521	0.540	0.561
135	Ghana	0.442	0.471	0.486	0.517	0.542	0.568	0.553
136	Pakistan	0.367	0.394	0.427	0.467	0.497	0.516	0.551
137	Mauritania	0.383	0.410	0.435	0.455	0.487	0.509	0.550
138	Lesotho	0.499	0.541	0.571	0.605	0.616	0.581	0.549
139	Congo	0.478	0.520	0.567	0.559	0.546	0.518	0.548
140	Bangladesh	0.347	0.365	0.392	0.422	0.453	0.511	0.547
141	Swaziland	0.527	0.561	0.588	0.633	0.641	0.592	0.547
142	Nepal	0.301	0.338	0.380	0.427	0.469	0.502	0.534
143	Madagascar	0.407	0.444	0.440	0.450	0.463	0.493	0.533
144	Cameroon	0.422	0.468	0.523	0.529	0.513	0.525	0.532
145	Papua New Guinea	0.431	0.462	0.481	0.495	0.532	0.544	0.530
146	Haiti		0.442	0.462	0.472	0.487		0.529
147	Sudan	0.354	0.381	0.400	0.429	0.463	0.491	0.526
148	Kenya	0.466	0.514	0.534	0.556	0.544	0.529	0.521
149	Djibouti				0.476	0.485	0.490	0.516
150	Timor-Leste							0.514

HDI Rank	Country	1975	1980	1985	1990	1995	2000	2005
151	Zimbabwe	0.550	0.579	0.645	0.654	0.613	0.541	0.513
152	Togo	0.423	0.473	0.469	0.496	0.514	0.521	0.512
153	Yemen				0.402	0.439	0.473	0.508
154	Uganda			0.420	0.434	0.433	0.480	0.505
155	Gambia				0.290	0.436	0.472	0.502
146	Haiti		0.442	0.462	0.472	0.487		0.529
147	Sudan	0.354	0.381	0.400	0.429	0.463	0.491	0.526
148	Kenya	0.466	0.514	0.534	0.556	0.544	0.529	0.521
149	Djibouti				0.476	0.485	0.490	0.516
150	Timor-Leste							0.514
151	Zimbabwe	0.550	0.579	0.645	0.654	0.613	0.541	0.513
152	Togo	0.423	0.473	0.469	0.496	0.514	0.521	0.512
153	Yemen				0.402	0.439	0.473	0.508
154	Uganda			0.420	0.434	0.433	0.480	0.505
155	Gambia				0.290	0.436	0.472	0.502
149	Djibouti				0.476	0.485	0.490	0.516
150	Timor-Leste							0.514
151	Zimbabwe	0.550	0.579	0.645	0.654	0.613	0.541	0.513
152	Togo	0.423	0.473	0.469	0.496	0.514	0.521	0.512
153	Yemen				0.402	0.439	0.473	0.508
154	Uganda			0.420	0.434	0.433	0.480	0.505
155	Gambia				0.290	0.436	0.472	0.502
	Low Human Development							
156	Senegal	0.342	0.367	0.401	0.428	0.449	0.473	0.499
157	Eritrea					0.435	0.459	0.483
158	Nigeria	0.321	0.378	0.391	0.411	0.432	0.445	0.470
160	Guinea							0.456
161	Rwanda	0.337	0.385	0.403	0.340	0.330	0.418	0.452
162	Angola							0.446
163	Benin	0.312	0.344	0.367	0.374	0.403	0.424	0.437
164	Malawi	0.330	0.355	0.370	0.388	0.444	0.431	0.437
165	Zambia	0.470	0.478	0.489	0.477	0.439	0.420	0.434
166	Côte d'Ivoire	0.419	0.448	0.453	0.450	0.436	0.432	0.432
167	Burundi	0.290	0.318	0.352	0.366	0.347	0.368	0.413
168	DRC	0.414	0.423	0.430	0.423	0.391	0.375	0.411
169	Ethiopia			0.311	0.332	0.347	0.379	0.406
170	Chad	0.296	0.298	0.342	0.364	0.377	0.397	0.388
171	Central African Rep	0.350	0.371	0.394	0.398	0.390	0.394	0.384
172	Mozambique		0.304	0.291	0.317	0.335	0.375	0.384
173	Mali	0.245	0.268	0.272	0.296	0.321	0.352	0.380
174	Niger	0.246	0.264	0.261	0.279	0.296	0.321	0.374
175	Guinea-Bissau	0.267	0.271	0.300	0.322	0.350	0.365	0.374
176	Burkina Faso	0.257	0.280	0.305	0.321	0.337	0.353	0.370
177	Sierra Leone							0.336