The Potential for Development of Information and Communication Technologies Within the Least Developed Countries.

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A Thesis

in

The Department

of

Geography

Presented in Partial Fulfilment of the Requirements
for the Degree of Master of Arts at
Concordia University
Montreal, Quebec, Canada

February, 1999

0-612-47739-8

ABSTRACT

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The study is an examination of the potential for the least developed countries of the world to develop information and communication technologies (ICTs) in aid of their social and economic development. It is felt that without the new technologies of information and communication these poorest countries will experience an ever widening of the development gaps that presently separate them from the more developed nations. This study focuses on four necessary criteria, or ingredients for the development of ICTs: the ability to fund ICTs, the presence of telecommunications infrastructures, the level of electrical generating capacity, and the capacity to provide trained scientists and technicians to develop, utilize and maintain ICTs. Individual measures for each of these criteria are developed, and these are used in combination to measure the relative ICT development potential within each of the 172 countries included in this study. The examination of any heterogeneity within the least developed countries with regards to this potential is an important part of this research. The specific implications of the findings for the 45 least developed countries which are included in this study are also discussed, as well as possible measures to increase ICT development potential therein. Finally, suggestions are made as to the need for further research in this area.

Acknowledgments.

There are a number of people without whose assistance this thesis would not have been completed. In particular, I would like to thank Professor Catherine Moore for her dedication to the completion of this research, not only over the past year, but especially during the last weeks of its completion. In addition, I extend thanks to Professors Brian Slack and Patricia Thornton who also gave a great deal of their own time during the final stages. There are also many people within the Department of Geography at Concordia University whose continued support was invaluable in completing my degree. And finally, I would like to thank my family and friends for persevering through many years of study, the culmination of which is this thesis.

Thank you all.

John Buskard

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Chapter 1

Introduction

> Every human society, from the most primitive to the most advanced, depends on some form of telecommunications network. It will be virtually impossible for any group of people to define their collective identities or make decisions about their common and binding interests, without communications. Communication networks make society a reality. It [sic] makes it possible for people to cooperate, to produce and exchange commodities, to share ideas and information and to assist one another in times of need. (Alabi, 1996)

The speed and scope of human communication have been rapidly increasing over recent decades. This has transformed the way the basic patterns of human communication are occurring. As a result of these changing patterns, new opportunities for economic growth and development have emerged, opportunities that are literally revolutionizing economic and social relationships around the globe. These new information and communication technologies (ICTs), of which the computer is the most easily identifiable technology, present both the developed and the developing regions of the world with opportunities to create new business opportunities and to carve out new economic relationships, both within the global economy and between the many countries that trade bilaterally. Along with these new business and economic relationships will necessarily come profound changes within societies themselves as they become increasingly linked to a world community where distances are measured in terms of kilobytes per second and bandwidth, not in the traditional spatial terms of kilometres or miles. This is an increasingly interconnected world where the periphery is characterized by the lack of access to information and communications, not by geographical location or natural resource endowments.

The developed regions and countries of the world have already begun to exploit these new economic relationships, and with their substantial human, technical and financial resources they are in an advantageous position to do so. But what of the developing world? Will the future information society create a new classification of underdevelopment? Will information poverty be added to the gaps that already separate the poorest nations of the world from the richest? Will "technological apartheid" create a new underclass within the developing world? These are important considerations for policy makers at all scales, from the regional to the national to the local, as they struggle with the problems of social and economic development. As we enter the next century it is increasingly important that we do not leave the developing world by the side of the road on the emerging 'Information Highway'. If this is allowed to happen, it will only increase the social and economic disparities that persist between the developed and the developing regions of the world.

1.1 Terminology

1.1.1 ICTs and Telecommunications

When these new technologies are discussed, the terms information and communication technologies and telecommunications are often used interchangeably. In reality they are very separate entities, and in fact, the development and operation of ICTs are dependent largely on the availability of reliable and sound telecommunications infrastructures.

ICTs are identified with the wide range of communications technologies that are largely separate from other systems. These technologies include computers, satellites, and "add-ons" to older media forms by means of video and audio cassette recorders, video and audio disc machines, as well as the extensive range of telecommunications technologies that integrate larger, more sophisticated connections, such as computer and telephone, telephone and video, satellite and computer (Hanna, 1981; ITU, 1984; Hanson and Narula, 1990). Broadly defined, ICTs encompass all technological systems that gather, process, transfer, or store information (Boulton, 1994). This definition builds on an earlier one developed by the UN, which defines information technology as a large collection of records in machine readable form, which, unlike files, are not constructed for a single purpose, but may be used for diverse purposes, and this information is available to a large number of users, who may be quite remote and who may use terminals connected through communications links to a set of computer programs for such activities as querying the data base, retrieving information, or printing reports (UNDESA, 1971).

In contrast, telecommunications involve all types of communication systems in which electronic or electromagnetic signals are used to transmit information between or among points. Transmission media include radio, light or waves in other portions of the electromagnetic spectrum, such as cable, satellite, microwave or any other medium (Riverson, 1993). The International Telecommunications Union (ITU, 1984) more broadly defines telecommunications as including broadcasting and associated media services, and focuses on telephone type services as perhaps the best measure of telecommunications potential. The voice telephone is still the dominant element in telecommunications worldwide (Boulton, 1994) and thus, without extensive and reliable telephone infrastructure sound telecommunications is difficult, if not impossible, to achieve.

Although not synonymous, the relationship between ICTs and telecommunications is a strong one. Information is of limited utility unless there is a way of sharing it. Computers, and other information technologies, are the main tools used to collect, store, and analyse data, and thus, are responsible for adding a great deal of value to information. Telecommunication media are the means by which we can communicate and share this value added information once processed by computers. The development of these two technologies goes hand in hand, telecommunications can be thought of as the backbone upon which sharing of information depends, and thus, ICT development depends on the concurrent development of telecommunications infrastructures. We can summarize by saying that ICTs, as the basic means by which information is processed and used, relies heavily on telecommunications to transmit and share this information.

1.1.2 Development and Underdevelopment

The term development is one whose use has increased dramatically over the past decades, and one which is meant to describe the social and economic state of particular societies, and the process of change experienced by them. However, it is a term for which a clear definition is not readily available. In the strictest sense, development is defined as:

> The achievement of state of development which would enable individuals to make their own histories and geographies under conditions of their own choosing. The process of development is the means by which such conditions of human existence might be achieved. They, in turn, would necessarily involve

> people in a productive, crisis free and non-exploitative set of relations with nature and in the struggle to remove oppression and exploitation from the relations between themselves. (Johnston, 1986; 103)

By this definition no society has achieved development. A more practical definition of development would be one based on measurable socio-economic indicators, such as those employed by the World Bank in its annual *World Development Report*. These reports compare relative levels of development using statistical measures about socio-economic phenomenon including production, consumption and investment, demand, industrialization, energy consumption and supply, trade, capital flows, population growth, fertility, the labour force, urbanization, life expectancy, health, education and income distribution. However, while such characteristics are clearly important components of development, it should be noted that the use of such indicators to measure a state of development has been criticized for only providing the surface appearance of what is a very dynamic process, one which is tied to both historical circumstances and the socially specific processes which are unique to each separate nation (Johnston, 1986). Therefore, in using such measures it must be recognized that comparisons between countries are sometimes difficult and in some cases unreliable. Despite these drawbacks, since the end of World War II, these are the type of indicators most commonly employed to describe and compare levels of development.

In every sense of the word development has come to mean a move towards 'modernization', primarily fashioned after the Western experience with the social and, perhaps most importantly, economic transformations associated with the rise of the capitalist market system and industrialisation (Krieger, 1993). For the purposes of this research a similar understanding of development will be used, one which views the continued social progress, along with the integration of all nations of the world into the modern global economic system, as the main goals of development.

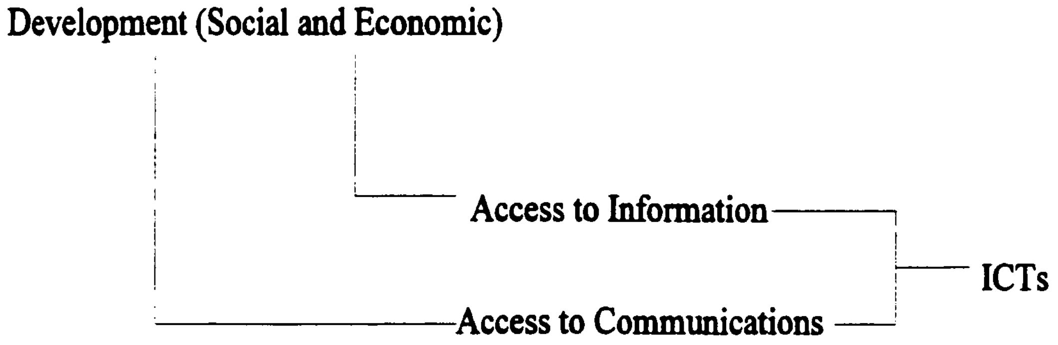
Underdevelopment, on the other hand, can be strictly defined as "a barrier to or subversion of development and a consequently distorted, limited and increasingly marginal state of human being or process of becoming" (Johnston, 1986; 503). Underdevelopment is, therefore, the term used to describe the poorest and most marginalised nations of the world. As a process underdevelopment has been closely associated with Dependency Theory: which ascribes the underdevelopment of many nations to the dependencies created by the disintegration of formally viable societies as a result of their contact with a powerful, external social influence (Johnston, 1986). While a complete understanding of underdevelopment necessitates a much broader discussion of such theories, a discussion of Dependency Theory is far beyond the scope of this research. Therefore, for the purposes of this paper underdevelopment is understood to be the general lack of modern social and economic conditions within the developing world which are themselves a result of massive inequalities in the distribution of the conditions likely to promote development (Johnston, 1996). These conditions are characterised by the types of social and economic indicators which are used by the World Bank to measure development, and which are listed in the discussion above.

1.2 ICTs and Development

The process of assisting the greater economic and social development of the underdeveloped regions is greatly enhanced through the adoption of ICTs and their integration into an overall progress plan. As one author puts it:

> ... the capacity to acquire and communicate knowledge is the foundation of development. If development depends on empowering people and communities to take control of their own lives, access to information becomes an essential component for progress. (Pruett, 1998)

The World Bank also argues that 'knowledge for development' is crucial for the future prospects of developing countries, and that the capacities of these countries to apply the growing stock of global 'electronic' knowledge will be increasingly important (Mansell and Wehn, 1998). Ensuring that the underdeveloped regions are capable of dealing with some of the most pressing social development issues, including healthcare, education and environmental sustainability, can be greatly enhanced with the employment of ICTs. But perhaps even more important from a tangible perspective is the impact that the adoption of ICTs can have on economic development. Again, as Pruett (1998) notes "there is growing agreement that developing communications capacities is essential for the economic survival of all developing countries." From this it follows that both social and economic development rely, to some degree, on access to knowledge or information and access to the means to communicate and share that information. In other words they rely on information and communication technologies.



Economic considerations are particularly important as countries search for ways to close the development gaps that have come to separate the rich developed countries from the relatively poor underdeveloped nations. There are many people who fear that the development gaps that already divide the world will increase with the advent of new technologies and the creation of new ways to generate wealth through the use and dissemination of information. As Cane (1992; 1721) states "an important question for policy makers dealing with developing countries, therefore, centres on strategies for information technology that might reduce the [development] gap - or at least prevent it from widening further." Mansell and Wehn (1998; 1) go further in stating that "there is a very high risk that these technologies and services [ICTs] will deepen the disadvantages of those without the skills and capabilities to make the investments required for building innovative knowledge societies." And finally, there are those who feel even more strongly about the threat of this new technology and believe that "the information highway could herald a new wave of colonization, with the highway as the medium of colonization and its globally networked systems and services providers as the agents" (Menzies, 1996; 72). These fears would seem to indicate that the role of ICTs in development, and their possible role in continuing the processes of underdevelopment, need to be explored in more detail in an effort to prevent the worst of these predictions from coming true.

The recognition that impacts of ICTs can be both positive and negative, is not a recent one, and it has been widely acknowledged that any future development projects will have to include a consideration of these new technologies. Even so, there is evidence that the their role is not well understood, especially for certain nations within the global village. The UN Commission on Science and Technology for Development (UNCSTD) provides some indication of these gaps in the research:

> Although the technological revolution in information technology and telecommunications has aroused much interest ... little is known about the obstacles to accessing information technology and the diffusion and use of information technologies in developing countries, particularly the low-income economies. These issues, especially the impediments to the diffusion of information technology, need to be better understood. (UNCSTD, 1995; 9)

Thus, it is apparent that there is a need for further exploration into the prospect for, and impediments to, the diffusion of ICTs, especially within the poorest or least developed countries. Mansell and Wehn (1998; 2) argue that "the least developed countries face a high risk of exclusion because they are less well-endowed with the human, physical, and financial resources needed to build capabilities and a widely accessible information infrastructure". While they do not specify what 'human, physical and financial resources' create hurdles to ICT adoption within any country, but particularly within the developing world, others have identified four important constraints to ICT development: they are: i) the ability to fund ICT development (financial resources); ii) the provision of telecommunications (physical resources); iii) the availability of electrical infrastructures for ICT (physical resources); and iv) the capacity to provide educated and skilled technicians and scientists for ICT development and maintenance (human resources).

With respect to these measures, some developing countries appear to be more constrained than others. In particular, those countries defined as the least developed countries (LDCs)[1] would seem, at first glance, to be the most restricted by these factors. For instance, with an average of less than 400$ annual GNP per capita the 48 countries defined as LDCs appear to lack the financial resources needed for adopting ICTs. They also appear to share a paucity of key physical resources when we consider that of the 48 countries worldwide with poor telecommunications development - which can be classified as less than one main telephone line per 100 inhabitants (teledensity) - only 11 are not classified as LDCs. And finally, the LDCs seem to lack the human resources, and together they average less than 51% adult literacy. Such statistics would seem to indicate that the LDCs will share a universally low potential for ICT adoption. If this were indeed true it would add credibility to the traditional methods of examining development issues, methods which often group the poorest nations of the world together as a homogeneous unit. However, there are indications, as the UNCSTD points out above, that there exists a need to better understand the situation within LDCs. Such an understanding is hard to achieve, however, unless we can discover and highlight differences which might exist within this group of countries. Thus, the focus of this research is the four criteria or constraints outlined above in an effort to better understand the impediments to ICT adoption, and to examine whether or not the LDCs should be treated as a homogeneous group, one which can be categorized as sharing, without exception, the lowest potential for the adoption of ICTs.

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1 For a complete discussion of the definition of LDCs see Chapter 3.

1.3 This Study

The first step in this research is to examine the potential for ICT development within all of the countries of the world, but particularly the poorest nations. This potential will be examined using a matrix which employs the values for the four variables outlined above, for the individual nations, each of which having been categorised as high, medium or low. On the basis of this matrix the development potential for ICTs will be discussed. The ability to fund ICTs will be measured by comparing levels of GNP per capita, infrastructural development will be assessed using both teledensity and electrical generating capacity figures, and the potential to provide qualified and educated technicians and scientists will be developed using adult literacy rates. From this will emerge a clearer picture of the global distribution of countries according to their overall potential for developing ICTs, as well as identifying the specific constraints that operate within each nation. This information can then be used to assist each nation as it tries to mitigate the constraints that hinder their ICT development. If the LDCs are a homogeneous group then all the LDCs will score consistently low within this matrix.

The second stage of this research is to examine the potential for leapfrogging over stages in ICT development. As technology continues to evolve, two of the constraints around which this research is centred - teledensity and electrical generating capacity - may prove to be less constraining on ICT development than they are at present. All nations, and the developing countries in particular, should benefit from new breakthroughs in wireless communications and small scale renewable energy production, and these breakthroughs may entirely eliminate teledensity and electrical generation as prerequisites for ICT development, thus making ICTs more accessible to even the poorest nations. As Pruett (1998) states "those countries with poorly developed telecommunications infrastructures could even gain a long-term advantage...they have the opportunity to leapfrog old technologies and install high quality and comparatively low cost and high capacity digital technologies..." In essence, the developing countries will be able to bypass the necessity of using of the older ICTs based on telephone lines and large scale energy production, and develop state of the art ICT infrastructures, based on wireless communications and small scale energy production.

However, the dearth of educated technicians and scientists, as well as the inability to fund ICTs, will continue to hinder the development of these technologies. Moreover, the importance of these two may even be magnified as these new breakthroughs in infrastructure take hold within the developing world and reduce the importance of the other two prerequisites. Education, in particular, is an important determinant of the ability of countries to leapfrog over stages of ICT development. While many nations may benefit from new advances in the technologies of the ICTs, they cannot forgo the need for highly educated operators and maintenance persons. With this in mind the measures of educational attainment and funding potential will be used to examine the degree of diversity which exists among the LDCs, and the existence of groups of countries which have a similar potential to capitalize on the leapfrogging possibilities. It is expected that despite the possibility of leapfrogging, the LDCs will all share a low potential for ICT adoption because they lack the human and financial resources to do so. When we account for the potential to leapfrog can all the LDCs be considered as a homogeneous group with the same potential for developing ICTs?

Conclusion

The development of new information and communication technologies has the potential to raise the status of the least developed regions of the world. However, it is also possible that there will be negative consequences for some countries as a result of the ever broadening application of ICTs. In some cases, their introduction may only serve to widen the social and economic gaps that separate the rich from the poor as some countries become further isolated from the world economic system. Those countries who lack the human, physical and financial resources to develop ICTs are the most at risk from such exclusions. The developing countries in general, and the LDCs in particular, would appear, at first glance, to be the most lacking in such resources.

There are clearly defined constraints to the adoption of ICTs, and not all countries share the same potential to take advantage of these emerging technologies. Some may indeed not benefit at all, becoming further marginalised and underdeveloped as a result of the 'information age'. This research is designed to examine these issues more closely, especially in relation to the poorest countries of the world. It will examine the specific constraints to the adoption of ICTs, discuss any variability that might exist, and highlight the prospects for ICT adoption within those countries identified as least developed.

Chapter 2

Review of the Literature

As we enter the next phase of human development, a phase some refer to as the "Third Wave" (Toffler, 1980), the important role that information and communications technologies will play in development cannot be overstated. Even if considered solely from an economic perspective, the role of ICTs in the emerging world economy could be paramount. For the developing world the diffusion of ICTs may represent a unique opportunity to gain some of the development ground they have lost over the past two centuries and to close, at least partially, the development gap that separates the rich nations from the poor. Conversely, some believe that while new developments in ICTs hold the promise of assisting the developing regions, it is also possible that the new technologies may provide yet another occasion for the least developed countries to be left behind as the rest of the world benefits from a new technological revolution (Pierce and Jequier, 1983; Forester, 1985; Lamb, 1986; Balla and Jequier, 1988; Antonelli, 1991; Cane, 1992; Bande, 1995; Menzies, 1996; Roche and Blaine, 1996). What happens will largely depend on the ability of developing countries to cultivate the necessary infrastructures for the development and utilization of ICTs.

The recognition of the importance of ICTs in future economic and social development is not a recent revelation. As early as 1971, when computers were in their infancy, the United Nations Department of Economic and Social Affairs (UNDESA) recognized the importance of computers, and other information technologies, in aiding in the development process.

> During the Second UN Development Decade [1970s], the developing countries will need to call more fully on relevant technology to accelerate their development; computer technology is one important element in determining the rate of technological change. (UNDESA, 1971; 2)

While UNDESA also recognized that computer technology, by itself, is not a panacea for the problems of the developing world, it was expected that these regions would increasingly be able to utilize ICTs to improve their economic and social status. More recently, one author has noted that information technologies and institutions are central to contemporary world politics and economics (Mowlanda, 1996), while another argues that if trade is the lifeblood of an economy, then ICTs should be regarded as the nervous system upon which this trade flows (Riverson, 1993). Investment in ICTs is one of the causes or contributing factors to development, as is investment in education or public health (Pierce and Jequier, 1983). There is widespread agreement in the literature on ICTs that information will play an increasingly important role in the future social and economic development of all nations. This is not to say that we will develop economies based solely on exchanges of information. Rather, as Rada (1985) notes, the empirical evidence shows that more information is going into production and services. While information and knowledge are difficult to quantify or claim ownership of, they are necessary for the acquisition and use of the technologies that are changing the way economies operate (Antonelli, 1991). As such, the developing countries must necessarily invest in ICTs, else the already large gap that separates them from the developed nations will only grow larger as the LDCs' relative lack of technological development becomes a source of disadvantage (Kaji, 1996).

There is every indication, however, that this gap has already begun to widen. The

UN has stated:

> We are profoundly concerned at the deepening maldistribution of access, resources and opportunities in the information and communication field. The information and technology gap and related inequities between industrialized and developing nations are widening: a new type of poverty - information poverty - looms. Most developing countries, especially the least developed countries, are not sharing in the communication revolution . . . (ITU, 1996).

Addressing these growing inequities is, therefore, a priority for the UN and its member states.

2.1 Economic Development

Within the literature on ICTs and development the strongest arguments for the implementation of ICTs are economic ones. The benefits of ICTs, like many new technologies, are felt throughout an economy, resulting in many spin-offs or multiplier effects, which can in turn aid the development process. Moreover, it is generally accepted that an accessible telecommunications capability is a prerequisite for national economic growth and, therefore, investment in the telecommunications infrastructure is paramount in any society (Boulton, 1994; Alabi, 1996).

For instance, ICTs represent the most cost effective way for people and businesses to communicate. Up to half of managers' time is spent in and traveling to meetings, but less than 70% of meeting time is likely to be productive (Forge, 1995). Recent developments in ICTs, such as teleconferencing and telecommuting, have reduced the need for some business travel, thereby decreasing the time lost to these managers (Brem, 1989; Hudson, 1996). The World Bank estimates that by the year 2004 about 20% of workers within developing countries will telecommute (Smith, 1996). In addition, communication both within and between organizations is improved with increased use of

ICTs, leading to greater efficiencies within many organizations (Boulton, 1994). The increased speed of modern computer-assisted communication is one of the primary factors in improving efficiency, as measured by a decrease in the ratio of output to costs for many products (Hudson, 1996). Also, as the efficiency of communications systems is increased the inputs of crucial yet costly materials, such as energy, can be substantially reduced while maintaining a given level of communication, both within the organization or business itself and with its outside suppliers (Saunders, *et al.*, 1983; Goldemburg, 1987; Boulton, 1994; Hudson, 1996). Finally, all sectors of the economy can more freely interact using ICTs, leading to greater efficiencies in commerce (information exchange) and industry (production of goods) (Saunders, *et al.*, 1983; Boulton, 1994).

It is not only industrial development that is an important beneficiary of better communication, but the agricultural sector within many developing countries also stands to gain a great deal. Given the rural nature of the developing world populations, the agricultural sector often plays an important part in the economic development process (Hudson, 1996). Yet, as Munyua (1998) has found "the lack of reliable and comprehensive information is considered one of the major hindrances to agricultural development." Moreover, information is essential in facilitating agricultural and rural development, and is vital in bringing about social and economic change. Munyua believes that by allowing female farmers within developing countries better access to information on all aspects of agricultural production, processing, marketing, decision making processes, resource bases, and trade laws, ICTs can greatly improve the agricultural system within these regions. The result of these developments is not only increased economic growth and the possible alleviation of rural poverty, but can more generally improve the overall quality of life.

These are all-important considerations as we search for new ways to assist the underdeveloped economies of the world's poorest regions. However, it is important to note, as some authors do, that it is difficult to quantify precisely the economic benefits of improved communications (Saunders, *et al.*, 1983; Hobday, 1990). Still, as one unpublished OECD report has stated, there is a direct relationship between growth in telephone line density (a measure of telecommunications infrastructure) and economic growth (Holderness, 1996). Other researchers, most notably Bande (1995), have suggested that there is a direct and measurable correlation between telephone penetration and GDP. Bande calculates that a single pole line can add 3700$ (US) to GDP within a developed country. The experience of the newly industrializing countries (NICs) shows that the growth of ICT infrastructure and industrial growth are interrelated (Rahim, 1993). Finally, recent studies have shown that the ratio of benefits to costs of telecommunications usage range from 5:1 to more than 100:1 (Hudson, 1996). As Brem (1989) points out, the key to understanding this relationship is to appreciate the potential for multiplier or spin-off effects resulting from increased telecommunications. Still, as Saunders, *et al.* (1983) point out, the quantitative analyses are, in most instances, not definitive and decisions need to be made on more qualitative grounds (Hobday, 1990).

While the specific economic benefits may be difficult to measure, there seems to be widespread agreement that there are economic benefits to the development of ICTs, and that these benefits can, under the right circumstances, aid in the economic growth of developing countries (Brem, 1989).

2.2 Social Development

The benefits of ICTs extend far beyond economic growth, they can provide important assistance to both social and political development (Alvarez and Calas, 1996).

One of the qualitative criteria upon which ICTs may be rationalized is that ICTs improve the social development in many poorer countries, places where communication, for a variety of practical reasons, has traditionally been difficult. The International Telecommunications Union (ITU) noted, as early as 1984, that communications infrastructure was an essential element in economic and social development in all countries (ITU, 1984). Moreover, the ability to communicate defines social reality, it influences the organization of work, the character of technology, the curriculum of the educational system, both formal and informal, and the use of free time - in essence, the basic social arrangements of living (Boulton, 1994). More generally, increased communication, and more specifically telecommuting, can reduce the need for people to travel into work. This has positive implications for the amount of government revenue spent on public works like public transit or road and rail infrastructures, thus allowing the diversion of such savings to improving welfare conditions. In addition, ICTs can reduce the need for centralized employment in urban areas allowing the decentralization of industries to rural areas, and thereby reducing rural to urban migration[1] (Hudson, 1996). All of these developments will reduce the need for expensive fuel imports and lead to

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[1] Some of the most serious environmental, social and political problems many developing countries face are associated with the mass migration of people from the rural to the urban areas.

reductions in overall energy consumption (Boulton, 1994), as well as alleviating the congestion and pollution which often result from commuting inefficiencies. Again, as a result of these savings many developing countries may have more currency to spend on alleviating some of the important and pressing social problems which, to a large degree, derive from their relative poverty and negative trade balances (Forge, 1995).

However, the claims of improved social development must be viewed with some degree of scepticism. The problems that plague the less developed regions of the world are inherently tied to long standing historical relations with the rest of the world, and in many instances the present inequities have their roots in the international political and economic systems, far beyond the control on any one nation. Thus, these problems will not be solved overnight, nor unilaterally. Examples of improved social conditions resulting from extensive information and communication infrastructures are hard to find. For example, rural to urban migration has continued in the more developed regions of the world despite the fact that these regions are among the most "connected" places on earth. Therefore, any ICT developments must be in the context of an overall development plan, one which has specific programs and policies to deal with the development issues discussed above, and which incorporates ICTs as tools within that development plan.

In summary, both economic and social considerations are important to the future development of the least developed regions of the world, and both of these can benefit greatly from increased utilization of ICTs (Parapak, 1993). As Munyua (1996) states:

> ICTs have changed lives, education, training and delivery of services in the more wealthy nations and in the research sectors of some less developed nations. In South Africa, ICTs have also been used in rural communities. In these countries, ICTs have created employment, led to the development of telecommunication

and networking opportunities in rural areas and acted as delivery vehicles for distance training and education.

2.3 Development Tool or Panacea?

As alluded to above, some caution must be exercised when discussing the overall implications of ICTs for development. While an important contributor to the development of the world's poorest regions, ICTs are not, as many have noted, a panacea for all the current development issues (Mansell and Wehn, 1998). There are three general issues which stand out as inhibiting the ability of ICTs to solve all development issues. First, some argue that when only 14% of a population has access to electricity and only 4 of every thousand have a telephone, it might be naive to think that tools like the Internet are going to have a large impact on the quality of life. Moreover, focusing on ICTs ignores the fact that other priorities such as hygiene, sanitation, or safe drinking water are of more critical importance for many developing countries. And finally, the focus on ICTs as a development tool also ignores the fact that within the developing world most advanced technology is urban-based and concentrated in the hands of the wealthiest segments of the population (The Internet and Poverty, 1998).

Despite these cautions, substantial evidence exists to show that the new ICTs are transforming some sectors of some developing countries. Certain firms have dramatically improved their competitiveness, some developing countries have improved their export strengths in the ICT sector, and some governments within the developing world are providing services to their citizens more efficiently using ICTs (Mansell, and Wehn, 1998). However, there are some concerns about the potential of this transformation. For instance, there exist gender biases in these new technologies, as well as disadvantages for the largely rural populations of many developing nations, some of which have already been mentioned. These new technologies do not create the transformations in societies themselves; they are designed and implemented by people in their social, economic and technological contexts. If national goals are consistent with development goals, countries can gain advantages from ICTs and avoid the risks of exclusion and marginalization, but this requires national ICT strategies that build upon the strengths of each country (Mansell and Wehn, 1998).

Despite these reservations, many studies have shown that the benefits of telecommunications development outweigh the costs involved (International Commission for the Study of Communication Problems,1980; Saunders, *et al.*, 1983; Hudson, 1984; ITU, 1984; ITU, 1986). If these studies are reliable, and if they are equally true for ICTs as they are for telecommunications, then the capacity to acquire and communicate knowledge is the foundation of development, despite the constraints listed above. Moreover, there is growing consensus that developing information and communications capacity is essential for the economic and social survival of all developing countries. Where there is significant disagreement is in the specific strategies to aid this development (The Internet and Poverty, 1998).

2.4 Lessening the Development Gap

While the increased use of ICTs promises to herald a new age of development for many countries, the prospects are not equally promising for all regions of the world. Many have argued that ICTs may, in fact, widen the gap that already separates the low income and high income countries (Forester, 1985; "Information Technology: A South

Special Report", 1986; Holderness, 1996; Menzies, 1996; Sardar, 1996). Menzies (1996) goes so far as to suggest that the Information Highway could herald in a new wave of colonization, with the highway as the medium of colonization and its globally networked systems and service providers as the agents. Ziauddin Sardar (1996) echoes this view, stating in a recent interview that "the Internet will be a weapon of economic power and knowledge".

2.4.1 The Division of labor

While these positions represent an extreme view, it is clear that those who are already on the periphery of development are going to find it increasingly difficult to compete in a world where competitive production will be largely dependent on inputs of highly valued information, not on the provision of low cost labor. Until very recently the poorest countries of the world were able to compete internationally, albeit not equally, due largely to the relatively low cost of labor in many developing countries. Tapscott and Capston (1993) state that information has become a capital good, similar in value to labor, materials and financial resources. As such, it can often displace labor as robots and other machinery use computer information to mechanize many of the production processes formally carried out by humans. In the process these information driven technologies may create a new advantage for the industrialized countries of the North. The international division of labor is changing as the conventional pattern of exploiting low wage countries for wage differentials is no longer necessary because ICTs make it possible to tap skills wherever they are located (Jussawala, 1993). As the ICT revolution takes further hold, this comparative advantage may erode further, perhaps plunging the developing countries even more deeply into the global periphery (Rada, 1982;1985; Kaplinski, 1984; Alvarez and Calas, 1996; Roche and Blaine, 1996).

2.4.2 Relocation of Industries

As the amount of labor that goes into production is reduced and the cost of production drops, there are likely to be increased incentives to relocate production back to the industrialized countries where it can be located close to both suppliers and the market being served (Chossudovsky, 1997). While research indicates that this relocation back to the industrialized north has not taken place on a massive scale, Sirimanne (1996) notes that attracting industry to the LDCs in the future will rely not only on relatively low cost human resources, but also on a highly developed technological infrastructure, of which ICTs will be an important part. Similarly, the UN argues that "the low wages will undoubtably continue to be an asset, but no longer a panacea" (UNIDO, 1989;14). Others likewise doubt the continued power of low cost labor. Drucker (1994; 62) has noted: "Developing countries can no longer expect to base their development on their comparative labor advantage - that is, on cheap industrial labor. The comparative advantage that now counts is the application of knowledge." LDCs may no longer be able to rely on having the lowest prices for labor as a means of assuring economic competition (Lopez and Vilaseca, 1996; Chossudovsky, 1997).

2.4.3 A New Comparative Advantage

A new comparative advantage in international trade is emerging from the accessibility to information, and the ability to increase this accessibility will sharpen the competitive edge of developing countries (Jussawala, 1993). The extent to which developing countries can develop their own ICTs and employ them to provide new services and create new markets will dictate how far on the periphery they reside in the new information oriented world.

2.5 Constraints to ICT Development

2.5.1 The Challenge of Funding

The most formidable challenge to ICT development involves the cost of building and maintaining the infrastructures needed to support ICTs (Roche and Blaine,1996). However, with their low GDPs, crippling debt, and pressing needs for healthcare, education, food, and water, many LDCs do not have the money to develop, independently, the infrastructures upon which ICTs depend. Two of the most important are telecommunications and electrical generation capacity (Sirimanne, 1997). In light of this LDCs will increasingly need to rely on outside sources of funding for the development of ICTs. As Lopez and Vilaseca (1996) note, funding the infrastructure of ICTs is the biggest challenge for LDCs. This echoes the findings of many others (ITU, 1984; Hudson and York, 1988; Brem, 1989; Bennett, 1993; Bande, 1995; Mody *et al.*, 1995; Roche and Blaine, 1996).

Bande (1995) discusses four methods of funding telecommunications in developing countries: i) self financing; ii) bank loans; iii) multilateral lending institutions; and iv) foreign direct investment (FDI). Bande deals mainly with the funding of telecommunications infrastructure, but the problems and prospects of funding ICTs are largely the same, and thus, we can use telecommunications funding as a basis of a broader discussion of ICT funding.

Self-financing involves the use of a country's own domestic or foreign earnings to invest in the development of ICTs. Kaplinski (1990) argues that because these capital-intensive technologies are generally imported they may actually worsen the savings and foreign exchange problems faced by the developing countries. Many economies of the developing world rely largely on the earnings from export crops or natural resources for the income needed to import foreign manufactured products, such as ICTs. This has traditionally resulted in a deficit between the income earned by low value export crops and resource exportation, and the expenses incurred when importing high value manufactured products. This deficit has been financed in the past by borrowing from agencies like the World Bank, resulting in rising foreign debts and debt payments. The expensive nature of ICTs may worsen these balance of payments deficits, resulting in further indebtedness for many LDCs. In describing the situation in Nigeria, Alabi (1996) writes "given the capital intensive nature of the industry and the enormity of the shortfall in Nigeria there is no doubt that the development of telecommunications [and ICTs] services in Nigeria is too heavy a burden to be borne by Government alone." This situation is perhaps not unique to Nigeria, but describes a trend found throughout the developing world. Given these realities, it is unlikely that self-financing of ICTs will be an option for most developing countries.

The second and third options suggested by Bande, bank loans and the help of multilateral lending institutions, represent similar sources of income, and thus, can be dealt with together for the purposes of this discussion. Two problems with these sources have been identified. The first, and most obvious, drawback is that any loan would worsen the already serious balance of trade problems within the developing world, by creating more debt for these countries to repay (Kaplinski, 1990). Second, the World Bank, most often the principal multilateral lender to the developing world, has traditionally given very little assistance to developing countries for telecommunications development. Between 1960 and 1982 less than 3% of total bank lending to developing countries provided by the World Bank and its affiliate, the International Development Agency (IDA), was for telecommunications development (Saunders, *et al.*, 1983). Between 1983 and 1993 the approximate 621 million (US$) lent from all multilateral sources for telecommunications development in LDCs represents only 12% of the total multilateral loans for telecommunications development. Moreover, 90% of this went to African LDCs, and four countries - Tanzania, Uganda, Ethiopia and Angola - received more than half of the total funds (ITU, 1995). Thus, there has been a general lack of investment from these multilateral sources for telecommunications development, and furthermore, there is a great discrepancy between the assistance that individual LDCs receive. This under funding is partially explained by the fact that in the past the World Bank has tried to limit its involvement in the telecommunications sector to that of lender of last resort. It becomes directly involved in the sector only when acceptable financial and technical assistance is not available from other sources, or when a lack of investment and organizational or management inefficiencies in the sector become a significant bottleneck to the general economic and social development of a country (Saunders, *et al.*, 1983; Hudson, 1996). The International Commission for the Study of Communication Problems (1980), commonly referred to as The McBride Report, believes that many lending agencies, like the World Bank, have been reluctant to fund ICTs because they perceive that: i) the benefits of such investment tend to favor urban elites and not the whole population; ii) most LDCs have not formulated communications policies, and thus, needs are not well known; iii) international agencies lack experience in the field; and iv) the results of projects undertaken are too difficult to evaluate. Whatever the reason, Roche and Blaine (1996) make it clear that there is a paucity of development assistance for telecommunications and therefore, alternative sources of funding, i.e. other than banks or multilateral lending agencies, will be required. A final problem with these sources of funding, according to Bande (1995), is that these funds are often tied to specific purchases from specific suppliers and are seldom matched to the specific needs of individual recipient countries.

Bande suggests foreign direct investment (FDI) as a means to raise the capital necessary for telecommunications and ICT development. He argues that FDI allows developing countries to improve their telephone and electricity infrastructures quickly while saving valuable currency and allowing governments to balance their budget deficits or to provide other basic needs. Another advantage is that in such arrangements foreign investors, who obviously have a large and direct stake in the success of the enterprise, will often transfer technology and management skills to allow the host country to run their ICTs more efficiently.

This method of funding is not without drawbacks. FDI can overlook local investors, and thus, the opportunities for local ICT manufacturers and suppliers may be limited by outside competition. This is especially problematic for countries with small and fledgling ICT companies. FDI often engenders the loss of control over the development and management of such strategic national assets as telecommunications and power generation (Bande, 1995). It frequently introduces free-market speculation into essential national infrastructures, creating considerable instability for institutions which have traditionally enjoyed the protection from competition that is afforded government owned monopolies. This occurs largely because the introduction of FDI entails some degree of liberalization or deregulation (Saunders *et al*, 1983; Cane, 1992). As Brem (1989) points out, this may not be popular with many governments. Roche and Blaine (1996) suggest there are four ways that FDI can damage the economy of the host or recipient country. First, large capital flows can put upward pressure on the recipient's exchange rate, precipitating a drop in demand for exports and a rise in the demand for imports, all at the expense of GDP. Second, FDI may increase the price of local financial assets, making it harder for the poor to buy goods and services. Third, balance of payment problems may be incurred, because of interest payments, royalties and other fees paid to the parent firm, as well as the repatriation of foreign capital to the lender's country. Four, the recipient might become too reliant on FDI and, therefore, vulnerable to its sudden withdrawal. Added to these is the concern that deregulation of, and FDI in, essential infrastructures will only exacerbate the economic and social disparities which already exist between the rural and the urban regions within the developing world (Brem, 1989). This may occur because the focus of profit making corporations will largely be in the urban markets where population densities and individual incomes are highest.

However, there is evidence which suggests that these drawbacks will more than likely be compensated by the increased productivity and revenue, as well as savings in foreign exchange created by improved ICTs within the developing world. Again, the experience with telecommunications provides some valuable insight.

> Although telecommunications entities in developing countries generally do not directly generate enough foreign exchange to support very rapid expansion problems, certainly considerable foreign exchange savings are generated in other sectors as a result of expanded or improved telecommunications investment (Saunders, *et al.*, 1983; 26).

Pierce and Jequier (1983) demonstrate a multiplier effect in the entire economy as a result of telephone investments, and show that telecommunications development can also directly improve the livelihood of users and communities, especially those in rural areas. The authors cite a study of the Philippines, which showed that the benefit from telecommunications development can expect to be 44 times the cost to users. It is expected that the development of ICTs will render similar results. Finally, investments in telecommunications, and by inference ICTs, entail very significant economic and social benefits, benefitting not only the earning potential of many poorer countries, but also helping them improve the provision of education, healthcare, and employment opportunities, while most noticeably contributing to identifiable increases in GNP, especially in countries and regions with the lowest incomes (Brem, 1989; Riverson, 1993). Uimonen provides an indication of how ICT can improve the provision of healthcare within the poorest countries.

> In the health sector, telemedicine provides a number of advantages for doctors and other medical staff. In the Third World in particular, it is often difficult to have access to appropriate expertise for an accurate diagnosis and the treatment of illnesses. This is particularly true in rural and remote areas, but in many cases in urban areas as well. Computerized networks facilitate access to accurate and up to date information, enable long-distance training and consultation, and improve the administration of the health sector. On-line initiatives addressing

> health and medicine promote networking among hospitals and health professionals worldwide, and provide updates on current medical research (Uimonen, 1998).

Similarly, ICTs can improve education by enabling the application of alternative teaching methods through virtual classrooms and long-distance education, thus allowing more people to receive education.

However, when it comes to funding, the reality is that developing countries have limited alternatives to finance the capital intensive ICTs. Many believe that FDI is the front runner as a source of this funding.

> Developing countries have looked to privatization as the means for bringing significant hard currency into their weak economies while at the same time establishing a technological platform on which to build a telecommunications infrastructure which will support economic development efforts. Privatization has been particularly significant and visible in the telecommunications industry. Many countries have begun to privatize selected segments or even all of their telecommunications infrastructure.... Investors are attracted to telecommunications due to its prominent role in our global information society.... This approach has been a radical change for governments or natural monopolies which are witnessing a loss of full control within this industry sector (Lopez and Vilaseca, 1996; 70).

In order to balance some of the negative aspects of FDI mentioned above, Bande (1995) suggests the following: i) rather than simply selling off telecommunications, countries should establish joint ventures with sources of FDI; ii) there should be limits set to the degree to which any one firm may monopolize an industry; and iii) these countries should establish a clear regulatory authority. India is one example of a developing country which has had a great deal of success in attracting and controlling FDI to develop their national ICT infrastructures. In this case the Indian government forced foreign companies into partnerships with local firms (Lamb, 1986).

Telecommunication investments have traditionally proved to be profitable in many countries, with returns as high as 10-20% (Brem, 1989). Thus, even though many investors find the developing world a risky place to invest, attracting FDI for telecommunication should be made easier, by the possibility of such returns. In order to make attracting FDI even easier, developing countries must ensure a climate which is receptive to foreign investment, and one in which there is a certain amount of stability in the regulations of government. As Petrazzini (1995) has discovered, the privatization of state owned enterprises (SOE) enjoys a higher success rate when there is a great deal of governmental autonomy and a concentration of power within the central government. In this way investors are assured, that even if they enter into limited partnerships with these governments, there will be a large degree of stability, and thus a certain security in their investment.

2.5.2 The Need for Infrastructure

Riverson (1993) defines infrastructure broadly as the subordinate parts, installations, or establishments that may form the basis of an enterprise. While telecommunications infrastructure is a requirement for ICTs, telecommunications itself has requirements. Mowlanda (1996) identifies three: i) reliable and universal electrical supply; ii) interference free telephone lines; and iii) reliable maintenance services. These requirements are reiterated by other authors, most notably Sirimanne (1996;7), who writes "local infrastructure is crucial - telecom facilities (phone, fax, etc.) and above all, uninterrupted electricity." Others also point to the need for reliable energy for development, not only the development of ICTs, but for development in the broader sense (Hall *et al.*, 1982; Goldemburg, 1987; Cane, 1992; Munasinghe, 1994; Eberhard and Van

Horen, 1995). In addition to the provision of reliable energy, Roche and Blaine (1996) add that the number of telephone lines (i.e. teledensity) is of critical importance, because these two together constitute the backbone of ICT infrastructure.

In terms of teledensity the least developed parts of the world fall far behind even the most isolated peripheral regions of the developed world, and this is one of the largest hurdles preventing the development of ICTs such as the Internet (The Internet and Poverty, 1998). Seventy-five percent of the world's telephones are installed in just 8 industrialized countries; some 80% of the world's population have no access to telephones at all; fewer than 2% of people in China and India have phone lines; and Africa, with 12% of the world's population, has only 1.8% of the world's telephone lines (Telecommunications: Development and the Market..., 1997).[1]

In most developing countries reliable electrical capacity is equally lacking, creating a further hurdle to the development of ICTs (UNESCO, 1996b). As Iyang (1996) notes, the main barrier for e-mail communication in many African countries is the lack of reliable phone lines and electricity, both of which are often out of order for days on end, and even when telephone lines and electrical systems are working, poor telephone connections and power surges can dash attempts at communicating through telematics. In the developing world where the population is largely rural (Hudson, 1996), most people have not benefitted from modern commercial energy sources which are concentrated in

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These figures hide the discrepancies between the rural and urban areas in most developing countries which only reinforces the peripheral nature of many regions within the developing world when it comes to ICT infrastructure; see also: Alvarez and Calas, 1996.

urban centres. Instead they rely on the many forms of biomass for the majority of their energy needs (Goldemburg, 1987). This type of energy is not well suited to the needs of highly sophisticated computer technology, and thus, commercial electrical energy production capacity remains a hurdle to the development of telecommunications and, ultimately, ICT (The Internet and Poverty, 1998).

2.5.3 Lack of Education and the "Brain Drain" Phenomenon

Yet another constraint is the lack of well educated and trained technicians and scientists within the LDCs to develop and maintain costly and sophisticated ICT and telecommunication equipment. Bennett (1993), and others, point out that one of the main constraints on the use of ICTs in the developing world is the lack of trained computer staff (The Internet and Poverty, 1998). This is partly explained by the fact that more than half of the population of low income countries have no access to secondary level education which cripples the potential advantages that these young and adaptable populations should have (The Internet and Poverty, 1998).

In addition, countries in the early stages of ICT development are often hampered further by the loss of highly skilled workers to developed countries abroad ("brain drain") (Hudson, 1996). Initially these people often seek their education abroad, and then when attempts to find well paying positions back home fail, return to the developed country to find work. The result is a loss of talent in the home country, which only exacerbates the discrepancies between the rich and the poor. Brain drain is not a recent phenomenon. For instance, in 1970 for every three engineers who graduated from US schools a fourth was provided by immigration - of whom 10% came from India, 25% came from other countries of the Far East, and 40% came from Western Europe (UNDESA,1971). A more recent survey shows the same trend, approximately 6,000 Indians, highly qualified in information technologies, emigrate to the United States alone every year (Holderness, 1995; 8). They are attracted not only for financial remuneration, but jobs abroad allow them the opportunity to work with technology which is unavailable in their home countries.

But this need not continue to be the case. Indeed, one of the primary potential benefits of ICT is that it makes education of the highest caliber available anywhere in the world. Studies have demonstrated that if this technology is made available to teachers and pupils, it will be used extensively, even in rural areas (The Internet and Poverty, 1998). Moreover, the development of state-of-the-art ICTs within LDCs will ensure that these trained technicians will have access to the newest technology, and thus the need to emigrate is reduced (Holderness, 1996). Still, it is imperative that the countries of the developing world make education and training a priority for their development plans. As Brem (1989) notes, no significant telecommunication [and ICT] project can be mounted without a parallel training component. From this it follows that the less developed the educational system is within any given developing country, the greater the constraints will be on providing trained technicians for development in general, and the development of ICTs in particular.

In summary, the literature identifies four main constraints on the potential to develop, utilize and maintain ICTs. They are: i) the ability to fund ICT development; ii) the provision of telecommunications; iii) the availability of electrical infrastructures for

ICTs; and iv) the capacity to train educated and skilled technicians and scientists for ICT development and maintenance. The degree to which any country can provide these requirements will largely determine their potential to adopt and benefit from ICTs.

2.6 Reasons for Optimism

The constraints discussed above do indeed present barriers for developing countries to overcome as they attempt to develop their own ICT systems. For many countries, these obstacles may indeed be insurmountable. But there is reason to be optimistic about the potential of many developing countries to close the technology gap in the years to come. Ironically, this ability to catch up is a direct result of the fact that these countries are, in fact, what the World Bank calls "late starters" in telecommunications [and ICT] development (Telecommunications: Development and the Market: The Promises and the Problems, 1997). Many argue that the lateness of technological development means that the developing countries enjoy the advantage of being able to leapfrog over early stages of ICT development (Soete, 1985; Bhalla and Jequier, 1988; Hobday, 1990; Antonelli,1991). In addition, because the price of many of the necessary technologies, infrastructures and telecommunications continue to fall, these late starters can build and operate their systems for significantly less monetary investment than the developed world initially paid to develop and operate theirs (Jequier, 1977; UNESCO, 1996b). Finally, because the search for new markets has recently brought many multinational corporations (MNCs) to the developing countries, there exists a potential for the LDCs to negotiate the best prices for the products and services provided by telecommunications suppliers.

2.6.1 Leapfrogging

Elkington and Shopley (1988), paint a positive picture of the future for the developing countries. They, and others (Lamb, 1986; Antonelli, 1991; Forge, 1995; Jussawala, 1995), see new developments in ICTs as a means of helping developing countries close the gap between MDCs and LDCs. This is partly due to the potential for LDCs to "leapfrog" over stages of ICT development, and in some special cases even surpass the industrialized world in some forms of ICT technology and infrastructure because they are not held back by the inertia of 'old' technology or infrastructures.

However, several authors disagree with the potential for leapfrogging. One of the less strident positions is held by Hanson and Narula (1990), who characterize this notion as optimistic, yet naive. They are doubtful about the willingness of manufacturers, most of whom are based in the developed nations, to provide the most advanced technologies to LDCs. They wonder if these countries will not simply get stuck with the developed countries' older "hand-me-down" technology. Stronger opposition comes from Pavitt (1984), who believes leapfrogging ignores the cumulative and complex nature of technological advances. In other words, he believes that changes occur gradually, usually as improvements to older technologies, and that this allows governments to simply upgrade their older technologies in order to keep them current, rather than discarding them and leapfrogging to newer systems.

Despite this opposition, the more positive aspects of leapfrogging have been widely addressed in the literature. One of the earliest discussions of the leapfrogging potential was by the United Nations, although the discussion there centered mainly on the adoption of new computer technology, in general, for development, and did not deal specifically with the use of ICTs (UNDESA, 1971). Soete (1985) is also one of the earlier proponents of the leapfrogging possibility for the development of ICTs. Although his work uses examples from newly industrializing countries (NICs), he does devote some time to a general discussion of technological leapfrogging and the advantages afforded all developing countries as they exploit the intense competition that exists for third world markets. Hobday (1990) expands on this argument, noting that leapfrogging will allow many LDCs to use newer technology, especially in the area of telecommunications switching, that MDCs, which have massive amounts already invested in older technology, will be much slower to adopt. The ICT technology of the 1960s and 1970s was electro-mechanical, whereas the new telecommunications equipment is based on fully electronic switching. This radical change in the switching technology means that the MDCs are left operating the older, and increasingly obsolete, technology. Hobday (1990; 71) goes on to point out that "the opportunity for leapfrogging inferior and obsolete technologies and moving directly to ICT infrastructure, therefore presents itself to the LDCs, but not generally to the developed countries". Antonelli (1991) concurs, noting that these late investors can catch up or even leapfrog over the investments made by MDCs during the 1960s and 70s, investments which now leave them with generally obsolete technology. Bhalla and Jequier (1988; 282) also recognize the potential.

> ...and the less developed the network, the easier such technological leapfrogging can be; new networks are much easier to design and operate when they are not subject to the constraints of linking up with existing facilities that are technologically obsolete, poorly maintained, and inadequately planned.

However, as Hobday (1990) warns, we must be careful in generalizing about the possibilities for leapfrogging entire generations of telecommunications technology; the potential for leapfrogging is greater in the area of ICT infrastructure, as opposed to leapfrogging over stages in the manufacturing of ICT equipment itself (e.g. computers). Rather than leapfrogging, firms, industries, organizations and governments tend to learn their way through the manufacturing and technological development of modern telecommunications systems, thus allowing themselves the chance to learn from the mistakes made by others. The message for LDCs is that they should expect to benefit from infrastructural leapfrogging (electrical generation, switching systems, telephone systems, etc.), while relying on current manufacturers and suppliers for the provision of the higher technology components, such as the computers themselves.

2.6.2 Negotiating Prices

Late starters also benefit from reduced prices as well as intense competition for developing markets, which has created a buyer's market for the technology. Both of these put LDCs in a more advantageous position as they seek partners for ICT development (Jequier, 1977; Bhalla and Jequier, 1988; Hobday, 1990; Antonelli, 1991; Smith, 1996). However, Wilson (1992) cautions that developing countries must use this bargaining power to ensure that the developed countries and MNCs do not simply dump their old, obsolete technology, but that they provide the newest, most efficient technology available. In addition, they can use this bargaining power to establish equitable partnerships with MNCs that would preserve and enhance their ability to develop their own control and expertise in ICTs, as India has (Lamb, 1986).

Antonelli (1991) argues that the diffusion of telecommunications (and by extension ICTs) is more likely in countries with a i) high growth in demand for communications, in other words, where there exists a strong expansion potential for telecommunications lines; ii) low telecommunications density and few networks - these are areas where there are less 'sunk' costs in obsolete technologies; and iii) high investment potential in telecommunication - again, areas where there is little telecommunications development. He also notes that countries with smaller economies and those who enjoy high levels of international trade and FDI will experience the strongest opportunities for catching up and experiencing the fastest diffusion of ICTs. While these are not characteristics shared by all developing countries they certainly do describe the developing world more than they do the industrialized countries. One might conclude that the developing world should experience the greatest diffusion of ICTs in the coming decades.

Conclusion

The literature demonstrates the crucial role that information technology may play in the future development of the developing world. This is one area where there seems to be widespread consensus within the literature. This role is not restricted to economic development, rather, there is strong evidence to suggest that social developments will also be fostered by the adoption of new ICTs. Even though it is difficult to measure these developments in quantitative terms, there is ample agreement that adopting new ICTs will have largely positive effects.

It is when we examine the prospects that these technologies hold for ushering a new age development in LDCs that we encounter the first real divisions within the literature. One extreme views this technological revolution as a new form of "technological apartheid", while the other side sees the possibilities for lessening the development gap. However, many agree that there is emerging a new comparative economic advantage, based on knowledge, where it was once based on surplus labor and lower wages. This new comparative advantage makes it imperative that developing countries adopt new information technologies so they can avoid the "technological apartheid" against which some authors have warned.

The adoption of these new technologies for development will be constrained by many barriers. Four constraints, are discussed widely within the literature: i) the problems of funding ICTs; ii) telecommunication infrastructural needs; iii) the ability to provide electricity for ICTs; and, iv) the lack of higher level education and training within the developing world. These constraints have been discussed in the literature only at a very general level, however. When applied they tend to focus on all the developing countries as a group. This fails to recognize the individual needs and levels of development within the least developed of the developing countries. The literature largely ignores the fact that the least developed countries possess even fewer of the necessary ingredients for the development of ICTs than do the other developing, or peripheral, countries. What is largely absent from the literature is a discussion of the potential for the development of ICTs within the poorest and least developed countries and regions of the world. As the UN Commission on Science and Technology for Development (UNCSTD) has observed:

> Although the technological revolution in information technology and telecommunications has aroused much interest among policy-makers, the

> business sector, the media and the academic world in the industrialized countries, little is known about the obstacles to accessing information technology and the diffusion and use of information technologies in developing countries, particularly the low-income economies. These issues, especially the impediments to the diffusion of information technology, need to be better understood (Mansell and Wehn, 1998; 6).

It is these least developed countries which are the most at risk of being left behind as the information highway is built. Allowing this to happen would only exacerbate already serious economic, social, and even environmental problems within these countries. There is a need to explore the constraints to the development of ICTs which are discussed in the literature, in terms of how they relate to particular LDCs. The degree to which each LDC country can overcome these constraints will dictate how well they develop their own ICT systems, and thus, how well they integrate within the new emerging global economy. This study is intended to examine the constraints to ICT development identified within the literature, with a focus on how these constraints affect ICT potentials within the LDCs. It will examine the specific constraints to the adoption of ICTs, discuss any variability that might exist between the LDCs, and highlight the prospects for the adoption of ICTs within those countries identified as least developed.

Chapter 3

Methodology for Measuring ICT Development Potential

Four primary requirements for ICT development, which are lacking in numerous countries, but particularly within the poorest countries of the world are examined here: i) the ability to fund ICT development (income); ii) the potential for communications, both nationally and internationally (telecommunications development); iii) the ability to provide reliable electrical power for ICTs (electrical generating capacity); and iv) the technical and scientific ability to develop, utilize and maintain ICTs (levels of educational attainment) (UNDESA, 1971; Elkington and Shopley, 1988; Cane, 1992; Bennett, 1993; Mowlanda, 1993; Holderness, 1996; Hudson, 1996; Inyang, 1996; LaRovere, 1996; Lopez and Vilaseca, 1996; Mowlanda, 1996; Roche and Blaine, 1996; The Internet and Poverty, 1998).

The aim of this chapter is: i) to present the indicators used within this study to represent the four primary criteria for ICT development; ii) to describe the data set utilized; iv) to establish the methodology behind the creation of an ICT Development Potential Matrix; and iv) to introduce the LDCs, which are the focus of this research. The matrix is the specific tool used to examine the potential for ICT development throughout all of the 172 countries represented within this study.

3.1 Establishing the Indicators of ICT Development Potential

3.1.1 Income

One of the primary impediments to the development of many infrastructures and technologies within the developing world is the overall lack of revenues for investment.

A measure of a country's wealth, therefore, is an appropriate variable to include in this study, because it should have a direct impact on the ability to pay for the infrastructural needs of ICTs. The specific measure used is GNP per capita, for the year 1993. This is a standard measure of wealth used by many development agencies, and as such, there exist clear guidelines for the establishment of high, medium and low classes, the creation of which are an important consideration for the ICT development potential matrix (see discussion below). The source of these data is the World Data on CD ROM, from the International Bank for Reconstruction and Development/The World Bank 1995 (International Bank for Reconstruction and Development/The World Bank, 1995).

GNP per capita is, however, not the best measure for comparing wealth among countries, because it has not been adjusted to reflect the local cost of living for individuals. The UNDP, in creating its Human Development Index, employs a more refined measure: GDP per Capita measured in Purchasing Power Parity (PPP). In many ways this is a superior measure, and it allows for a more reliable comparison between countries because of the adjustment made for the local purchasing power. Unfortunately, it is difficult to break this measure down into high, medium and low categories. Nothing exists within the literature to indicate how these divisions should be made for GDP per capita, and since the value of each dollar is relative to the cost of living within each individual country these classifications would be virtually impossible to create without the type of extensive economic analysis that is beyond the scope of this research. Therefore, rather than use arbitrary income divisions for this study, GNP per capita is the variable chosen to measure income, at least partly because there are clearly established criteria for the high, medium and low class thresholds (UNDP, 1996).

3.1.2 Telecommunications Development

Teledensity is cited within the literature as one of the best indicators of telecommunications potential (ITU, 1995). Adequate and reliable telecommunications infrastructure is key to the development of ICT. Computers, as the backbone of ICT, need a way of communicating with each other, if they are to share the information they have processed. Moreover, this infrastructure for telecommunications is more broadly dispersed and developed than other forms of ICT, such as personal computers (Mansell and Wehn, 1998). Finally, teledensity is a measure which is available for virtually all countries and it is the most widely used tool for measuring communications potential. While new forms of communication (wireless cellular and digital communications technology) have begun to take hold around the globe the developing countries of the world still rely heavily on the older forms of wired telecommunications.

Teledensity, for the year 1993, has been chosen as the measure of the existing potential for communication and information sharing. Teledensity is defined as the number of main telephone lines per 100 inhabitants, and is the standard for measuring telecommunications development used by such agencies as the UN's International Telecommunications Union. The source of these data is the International Telecommunications Union's Yearbook, 1993 (ITU, 1993).

3.1.3 Electrical Generating Capacity

As with teledensity, the capacity to provide a reliable and constant flow of electricity is a key requirement for telecommunications and for ICT development

(Sirimanne, 1997). The UN Energy Statistics Yearbook (1994) distinguishes between self-produced electricity and the generation of electricity for public consumption. Self-production includes undertakings which, in addition to their main activities, produce electrical energy intended, in whole or in part, to meet their own needs. Self production is an important part of energy generation within the poorest countries, especially for the rural populations of those countries. The major form of self produced energy is biomass, such as wood, animal waste, and crop residue. However, these are not appropriate forms of energy for most forms of ICT because they do not provide a constant and reliable flow of power, and they are often subject to surges and reductions in the amount of energy provided. Therefore, public forms of energy are deemed to be the most relevant for this study.

Public energy comprises the undertakings whose essential purpose is the production, transmission and distribution of electrical energy. These may be private companies, co-operative organizations, local or regional authorities, nationalized undertakings, and/or governmental organizations.

While electrical capacity can be measured in many ways (total electrical production, production per capita, total consumption, consumption per capita, etc.) the net installed capacity of electrical generating plants of all types (thermal, hydro, coal, nuclear, etc.), for the year 1993, has been chosen as the measure for this study. The net installed electrical generating capacity provides a more accurate measure of the potential to provide electricity for ICTs than do other measures which have been more traditionally employed. The source of these data is the UN Energy Statistics Yearbook, 1994 (UN, 1994).

In order to standardize this measure to match measures of teledensity and literacy, the net installed capacity per 100 inhabitants has been calculated, measured in 000s kilowatt hours (kWh). The source of population data is the World Data on CD ROM, from the International Bank for Reconstruction and Development/The World Bank, 1995 (International Bank for Reconstruction and Development/The World Bank, 1995).

3.1.4 Levels of Educational Attainment

ICTs require a well educated pool of technicians and scientists to develop, utilize and maintain them. The adult literacy rate, for the year 1994, measured as a percentage of the adult population, has been chosen as the best measure of the ability to provide these scientists and technicians. Mansell and Wehn (1998) argue that literacy is the first indicator of the attainment of the skill levels needed to use ICTs productively. Moreover, the UN states that literacy is a good measure of educational achievement in developing regions, and for young people it is a better measure of education than other measures such as gross enrolment ratios (UNESCO, 1998). Finally, since literacy is a universal and common measure of development, one which is calculated for almost every country in the world, its use maximized the number of countries included within the study. There were three sources used for literacy data; UNDP Human Development Index, 1996 (UNDP, 1996); International Marketing Data and Statistics, 1997 (International Marketing Data and Statistics, 1997); European Marketing Data and Statistics, 1998 (European Marketing Data and Statistics, 1998).

3.2 The Size of the Sample.

All countries of the world were considered for inclusion in this study. However, countries were excluded in cases where complete data for all variables were not available. This resulted in a total of 172 countries for this study. The majority of the sources of data for each of the variables are UN agencies responsible for the various sectors of development.

In order to include as many countries as possible more than one source was used to provide data for some variables, most noticeably literacy, which utilizes three different sources. GNP per capita figures for some individual countries were grouped together by the World Bank, the originating source of the GNP data. GNP figures for France were combined with those of Monaco, Italy's GNP was consolidated with San Marino's, and Switzerland's GNP was merged with Liechtenstein's. Because these data could not be reliably separated it was also necessary to combine the teledensity, net installed electrical generating capacity and literacy figures for these countries in a similar manner.

The choice of year used in this study was largely based on the year for which all data were available. The most complete information on literacy was available for 1994, while in the cases of GNP per capita, teledensity and electrical generating capacity, 1993 was the year for which the most recent and complete data were available. Despite the use of two different years, rates of literacy are not deemed to have changed substantially enough in one year to impact significantly on the results of this study.

3.3 The ICT Development Potential Matrix

It was originally intended that an ICT development potential index be created and used as the tool to make comparisons between countries, and to examine the specific situation of ICT development within the LDCs. And while such an index would be relatively simple to create, utilizing the four criteria discussed above, it was also clear that testing the validity of the index would be extremely difficult, if not impossible. In order to assess the accuracy of such an index a measure of ICT development would have to be found, and then each country's index score could be evaluated by comparing the index's predicted level of ICT development against that actual measure. Unfortunately, there exist very little data on ICT development for the time frame of this research. Any data that do exist are for a limited number of countries, and the majority of these are developed ones. Such data or measures would include the number of personal computers per capita, the number of Internet hosts per capita, the number of Internet domains per capita, or any other reasonable measure of ICT development. These data were not available for use in this research, and thus, in order to express ICT development potential this study has created and employed an ICT development potential matrix. This tool allows an analysis and comparison of ICT development potential among countries, but does not present a method for validating this potential or for measuring the accuracy of the matrix as a predictive tool. As more research is done in this area it is expected the necessary data for creating and testing an index will be collected.

The first step in creating an ICT development potential matrix was the selection of three categories representing high, medium and low values for each of the four variables employed. For all but the net installed electrical generating capacity the literature provides indicators to aid in the establishment of thresholds for each of the three categories. The second step was to locate each country in the matrix within the specific cell appropriate to its scores on the four criteria.

3.4 Establishing Thresholds

3.4.1 GNP

Within the literature there exist clear indicators which can be employed to create the thresholds for the three income divisions. These are established by the UN in their Human Development Report (UNDP, 1996). According to this source a low income nation is any country with a yearly GNP per capita of less than $725.00 (US), medium income is $725.00-$8,995.00, and high income is above $8,955.00.

It is important to recognize that a measure of income is an important component in the UN's general categorization of development, especially in the definition of LDCs (see the definition of LDCs provided below). Because this study also uses a measure of income, the classification of ICT development potential that results is expected to reflect similar categorizations as those created by the UN for development in general.

3.4.2 Teledensity

For teledensity the ITU and the UN provide thresholds for the establishment of high, medium, and low categories. The UN sets a minimum level of teledensity for telecommunications development at 1.0 main telephone line per 100 inhabitants (Alabi, 1996). This is also the figure used as a minimum threshold for telecommunications development by the ITU (1998). Therefore, this figure has been used as the upper limit of the low teledensity category. The ITU (1998) also states that a teledensity of 50 reflects a high level of telecommunications development. Thus, the lower limit of the high category has been set at a teledensity of 50. The limits for the medium category are, therefore, teledensity figures between 1 and 50.

3.4.3 Net Installed Electrical Generating Capacity per 100 Inhabitants

Measuring net installed electrical generating capacity per 100 inhabitants is not a standard measure, and, therefore, nothing exists within the literature to assist in defining boundaries for high, medium and low categories. However, there is a strong relationship between economic development (measured by GNP per capita) and net installed electrical generating capacity. Using the actual data for GNP per capita and net installed electrical generating capacity per 100 inhabitants which were employed in this research, the correlation coefficient for these two variables was found to be 0.76. This is considered to indicate a strong degree of correlation. Thus, it was possible to extrapolate from GNP figures to establish the upper limit of the low category and the lower limit of the high category of electrical generating capacity. In order to do this all 172 countries and their absolute figures for both GNP per capita and net installed electrical generating capacity per 100 inhabitants were ranked, in ascending order, based on the values for GNP per capita. Using the actual values of net installed electrical generating capacity for countries near each of two thresholds used to define income categories (the lower threshold being $725.00 and the upper threshold being $8995.00) it is possible to estimate thresholds for electrical generating capacity. The results indicate that the lower threshold is 75 000 kWh per 100 inhabitants and the upper threshold is 180 000 kWh per 100 inhabitants.

Summary of Thresholds used for creating the ICT Development Potential Matrix				
	GNP per capita (US $)	Teledensity	Net Installed Electrical Generating Capacity per 100 Inhabitants	Adult Literacy %
Low	less than 725$	less than 1	less than 75 000 kWh	less than 50
Medium	725$ - 8,995$	1 - 50	75 000 - 180 000 kWh	50 - 70
High	greater than 8,995$	greater than 50	greater than 180 000 kWh	greater than 70

Table 1

3.4.4 Literacy

UNESCO provides clear and reliable indicators to establish the thresholds for adult literacy. It considers literacy rates above 70% to be indicative of a country which has generally reached full literacy or has the capacity for progress towards self-sustained full literacy. The upper threshold for literacy for this study is, therefore, set at 70%. Rates between 50% and 70% are considered transitional (medium literacy). Those below 50% are considered low, since at this stage the adult illiterates outnumber the adult literates (UNESCO, 1995).

As with income measures, literacy is one of the UN's criteria for establishing development levels and thus, the results of this study are expected to mirror those results to a degree. Yet, as with income, literacy is only one of many variables used in either classification system, and using literacy as our surrogate measure for levels of educational attainment does not, therefore, compromise the validity of the ICT development potential matrix.

The ICT Development Potential Matrix

<table>
<tr><th></th><th></th><th colspan="3">Lit H</th><th colspan="3">Lit M</th><th colspan="3">Lit L</th></tr>
<tr><th></th><th></th><th>GNP H</th><th>GNP M</th><th>GNP L</th><th>GNP H</th><th>GNP M</th><th>GNP L</th><th>GNP H</th><th>GNP M</th><th>GNP L</th></tr>
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<tr><td>ELEC L</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
</table>

Table 2

3.5 Creating the ICT Development Potential Matrix

The ICT development potential matrix is a two headed, two dimensional matrix which creates separate classes for each of the possible combinations of the high, medium, and low categories for each of the four variables. The variables of GNP per capita and literacy occupy the top horizontal axis, while teledensity and net installed electrical generating capacity, the two infrastructural measures, occupy the left vertical axis. Together these four variables and 3 classes create 81 cells (see Table 2).

3.6 Defining the LDCs

The primary focus of this study is a discussion of the future prospects for ICT development of those countries identified as the least developed of the developing countries. The definition of LDCs is one of the focuses of the UN Conference on Trade and Development (UNCTAD). The list of LDCs is reviewed once every three years, the latest review having been carried out in 1997. At that time there were 48 countries identified as LDCs, 45 of which are included in this study (see Table 3). The following criteria, established by the UNCTAD in 1994, are used in defining LDCs:

- **Population less than 75 Million**
It was decided that from 1991 population size will explicitly be taken into account, and countries larger than 75 million inhabitants should not be considered for inclusion in the list of LDCs. In the last two decades, it has only been implicit that LDC classification was meant to designate countries with small economies.

- **Per capita GDP less than US$ 700 (average 1990-92)**
The relative level of poverty may be measured by per capita income.

- **Augmented physical quality of life index (APQLI) less than 47**
This index comprises four indicators: life expectancy at birth, per capita calorie supply, school enrolment ratio, and adult literacy rate.

- **Economic diversification index (EDI) less than 26**
This index comprises the share of manufacturing in GDP, the share of employment in industry, per capita electricity consumption, and export concentration ratio.
(ITU, 1995; 37)

Least Developed Countries as of 1997	
Afghanistan	Madagascar
Angola	Malawi
Bangladesh	Maldives
Benin	Mali
Bhutan	Mauritania
Burkina Faso	Mozambique
Burundi	Myanmar
Cambodia	Nepal
Cape Verde	Niger
Central African Republic	Rwanda
Chad	Sao Tome and Principe
Comoros	Sierra Leone
Democratic Republic of the Congo	Solomon Islands
Djibouti	Somalia
Equatorial Guinea	Sudan
Eritrea	Togo
Ethiopia	Tuvalu
Gambia	Uganda
Guinea	United Republic of Tanzania
Guinea-Bissau	Vanuatu
Haiti	Western Samoa
Kiribati	Yemen
Laos People's Democratic Republic	Zambia
Lesotho	
Liberia	

Source: UNCTAD, 1997
Note: Those countries underlined were not included in the present study due to missing values for some variables used to measure ICT development potential.

Table 3

3.7 Limitations of the Research Methodology

While the research methodologies outlined above will be sufficient to achieve the research goals, they are not without limitations. One limitation is created by the use of some of the specific variables employed to measure ICT potential. For instance, the income and literacy measures used here are the same as those included in the UNCTAD classification of LDCs and, therefore, could be expected to affect ICT potential classifications established in this study. Therefore, we could reasonably expect that a matrix based on similar criteria would show similar results. However, these two variables are combined with many others to measure levels of development, and as such the impact of any one of them is diminished. Furthermore, the fact that this study uses some similar criteria and obtains similar conclusions may not in fact invalidate the results, but rather, demonstrate that new classifications of development are required. Perhaps components of ICT potential should be incorpcrated within the traditional measures of development, and thus, they could reflect the increasing importance of ICTs in defining development levels.

A second limitation of this study has to do with the choice of variables. Again, as discussed above, the use of GNP per capita to measure income or wealth is possibly not the best choice, especially given the existence of more refined measures like GDP per capita measured in PPP. However, these other measures are difficult to use for this particular study due to a lack of clear criteria with which to define income categories. In addition, while the literature clearly indicates the importance of literacy as a measure of both the capacity to use many forms of ICT and overall levels of educational attainment, a measure such as the number of scientists and technicians per capita might have been more appropriate for this specific study. While such measures do exist, the extent of their coverage is limited, especially for many of the least developed countries, thereby excluding many countries from this study.

Third, there are limitations to the methodology employed to create the matrix class divisions for electrical generating capacity, those which were employed are admittedly estimates. This is partly the result of using net installed electrical generating capacity per 100 inhabitants, which is not a standard measure. Still, it was felt that for this research this particular variable was superior to the others more traditionally employed, and thus, it was used despite this shortcoming. As will be discussed in Chapter 4 this defect is further mitigated by the decreasing role that present forms of electrical generation will play in determining future ICT potential.

There is also the more general limitation of basing the conclusions made within this study on the ICT development potential matrix itself. The position of countries within this matrix is largely relative, and somewhat generalized. There is nothing to indicate that all forms of ICT are beyond the reach of even those countries located in the lowest right cell of the matrix, but rather, that compared with the others they have the lowest potential for ICTs. Moreover, because this matrix only uses four variables to measure this potential, it ignores the fact that many other factors affect the development of ICTs. Some of these contributing factors have been referred to in Chapter 2. This matrix provides a partial picture of ICT potential, but its use as predictive tool is partly diminished by these limitations.

Finally, the approach taken with this study is largely global in nature, and does not focus on particular regions within the developing world. By including 172 countries within the study there is a risk that regional peculiarities will go unrecognized. There may be regional components of this analysis which should be explored, such as the development of ICTs in Africa.

Conclusion

While the LDCs are diverse, they share many similar characteristics, one of the most obvious being that they are the least advanced in terms of general levels of social and economic development. The classification system used by UNCTAD reflects this. The aim of this study is to determine whether or not all the 45 LDCs included in this study will also share the characteristic of low ICT development potential. To determine this four sets of data, for 172 countries, have been collected, and a two headed, two dimensional matrix is employed to analyze the potential for ICT development within each country individually. If they are indeed a homogeneous group, all the LDCs will score consistently low within this matrix, occupying the extreme lower right cell.

Chapter 4

Results and Discussion

While the literature suggests that the potential exists for ICTs to benefit the developing world, many of the LDCs may not presently possess the requirements to develop, utilize and maintain these new technologies. The purpose of this study is to examine how the lack of financial, physical, and human resources affects the potential for ICT development in the LDCs, and to discover whether or not this group of countries is homogenous with respect to this potential. Based on the measure of the four important prerequisites discussed in the preceding chapter, an ICT Development Potential Matrix is developed.

4.1 The ICT Development Potential Matrix

The four indicators of ICT development potential used in this study (GNP per capita, teledensity, electrical generating capacity, literacy) have been categorized into high, medium and low classes so that countries can be grouped together based on their relative ability to develop their own ICTs. Such groupings facilitate the discovery of patterns in ICT development potential. The absolute values for each of these variables, for each of the 172 countries in the study, are presented in Appendix 1. The ICT Development Potential Matrix has 81 cells allowing for all possible combinations of the four variables. The matrix is provided in Table 4.

Each country has a value for each of the four variables, and these absolute values result in a classification of high, medium or low for each of the variables. Thus, each country occupies one cell within the matrix which reflects the combination of these classifications for that country. The matrix can be used to provide a measure of a country's present potential for ICT development. The extreme lower right cell contains the countries with the lowest values for all four variables, and the extreme upper left cell holds the countries with the highest values for all four variables. The remaining countries are spread throughout the cells of the matrix. Each of the variables impacts, individually and in combination, on a country's present ability for ICT development and, therefore, the countries within the upper most left cell can be deduced to have the highest potential to develop ICTs, and conversely, those occupying the extreme lower right cell are expected to have the lowest potential for ICT development. It is expected that the countries of the developed world would score high in ICT potential while the LDCs would score consistently low in ICT development potential.

The ICT Development Potential Matrix

		LITERACY H			LITERACY M			LITERACY L		
		GNP H	GNP M	GNP L	GNP H	GNP M	GNP L	GNP H	GNP M	GNP L
TEL H	ELEC H	151, 153, 160, 164, 165, 166, 170, 171								
	ELEC M	157, 159, 169								
	ELEC L									
TEL M	ELEC H	150, 152, 156, 161, 163, 168	97,							
	ELEC M	143, 145, 147, 148, 149, 155, 158, 162, 167	53, 69, 78, 79, 80, 81, 93, 94, 98, 102, 118, 120, 126, 131, 133, 137, 140, 141, 146, 172	27, 41		134,				
	ELEC L	45, 154	**60**, 63, 64, 66, 68, **70**, 74, 83, 87, 89, 90, 92, 95, 96, 99, 100, 101, 104, 105, 106, 108, 111, 112, 113, 115, 116, 117, 119, 121, 122, 123, 124, 125, 127, 128, 129, 130, 132, 138, 139, 142, 144	39, 47, 51, 55, 59, 67, 71, 72, 86, **91**, 103, 135		**52**, **56**, **61**, 75, 76, 82, 107, 109, 110, 114,	40, **50**, 88,		84, **31**, 136	**14**, **17**, 58,
TEL L	ELEC H									
	ELEC M									
	ELEC L		**62**, 85	3, **18**, **22**, 30, 38, **48**, 77,		57,	**1**, **6**, **8**, **12**, **26**, **28**, 34, 35, **36**, **37**, 54, **65**,		**44**,	**2**, **4**, **5**, **7**, **9**, **10**, **11**, **13**, **15**, **16**, **19**, **20**, **21**, **23**, **24**, **25**, **29**, **32**, **33**, **42**, 43, 46, **49**,

Table 4

Notes:
i) Boldface indicates an LDC, as established by UNCTAD in 1994.
ii) Total number of countries = 172; Total number of LDCs = 45.
iii) Countries are listed in ascending order by GNP per capita value.

List of Countries used in Matrix

RWANDA	1
ETHIOPIA	2
ZAIRE	3
MALI	4
SIERRA LEONE	5
UNITED REP. TANZANIA	6
MADAGASCAR	7
MALAWI	8
BURUNDI	9
CHAD	10
NIGER	11
GUINEA-BISSAU	12
BURKINA FASO	13
YEMEN	14
AFGHANISTAN	15
HAITI	16
GAMBIA	17
ZAMBIA	18
MOZAMBIQUE	19
SOMALIA	20
LIBERIA	21
MYANMAR	22
SUDAN	23
CAMBODIA	24
GUINEA	25
TOGO	26
TAJIKISTAN	27
CENTRAL AFRICAN REP.	28
NEPAL	29
VIET NAM	30
DJIBOUTI	31
BHUTAN	32
BANGLADESH	33
INDIA	34
NIGERIA	35
COMOROS	36
UGANDA	37
KENYA	38
REPUBLIC OF MOLDOVA	39
NICARAGUA	40
GEORGIA	41
MAURITANIA	42
SENEGAL	43
ANGOLA	44
UNITED ARAB EMIRATES	45
COTE D'IVOIRE	46
AZERBAIJAN	47
EQUATORIAL GUINEA	48
BENIN	49
SAO TOME AND PRINCIPE	50
ARMENIA	51
CAPE VERDE	52
KYRGYZSTAN	53
GHANA	54
HONDURAS	55
SOLOMON ISLANDS	56
CAMEROON	57
PAKISTAN	58
ZIMBABWE	59
MALDIVES	60
VANUATU	61
CONGO	62
EL SALVADOR	63
UZBEKISTAN	64
LAOS, PEOPLES' DEM REP.	65
BOLIVIA	66
CHINA	67
PHILIPPINES	68
UKRAINE	69
WESTERN SAMOA	70
GUYANA	71
ALBANIA	72
PAPAU NEW GUINEA	73
CUBA	74
IRAQ	75
GUATEMALA	76
SRI LANKA	77
KAZAKSTAN	78
LATVIA	79
TURKMENISTAN	80
PARAGUAY	81
GABON	82
PERU	83
MOROCCO	84
INDONESIA	85
MONGOLIA	86
JAMAICA	87
EGYPT	88
DOMINICAN REPUBLIC	89
CROATIA	90
KIRIBATI	91
MACEDONIA	92
LITHUANIA	93
ROMANIA	94
JORDAN	95
SOUTH AFRICA	96
ESTONIA	97
BULGARIA	98
ECUADOR	99
SURINAME	100
BELARUS	101
RUSSIAN FEDERATION	102
LEBANON	103
POLAND	104
GRENADA	105
TURKEY	106
TUNISIA	107
BRAZIL	108
SYRIAN ARAB REP.	109
ALGERIA	110
BELIZE	111
ST. VINCENT-GRENADINES	112
FIJI	113
IRAN	114
COSTA RICA	115
PANAMA	116
COLOMBIA	117
LIBYAN ARAB JAMAH	118
SAINT LUCIA	119
SLOVAKIA	120
HUNGARY	121
URUGUAY	122
THAILAND	123
MEXICO	124
SEYCHELLES	125
VENEZUELA	126
MALAYSIA	127
ARGENTINA	128
ANTIGUA AND BARBUDA	129
DOMINICA	130
TRINIDAD AND TOBAGO	131
CHILE	132
CZECH REPUBLIC	133
SAUDI ARABIA	134
SAINT KITTS AND NEVIS	135
OMAN	136
SLOVENIA	137
KOREA, REPUBLIC OF	138
BARBADOS	139
GREECE	140
PORTUGAL	141
MALTA	142
CYPRUS	143
MAURITIUS	144
SPAIN	145
BAHRAIN	146
BAHAMAS	147
ISRAEL	148
IRELAND	149
NEW ZEALAND	150
FINLAND	151
QATAR	152
SWEDEN	153
UNITED KINGDOM	154
NETHERLANDS	155
AUSTRALIA	156
ITALY AND MARINO	157
GERMANY	158
FRANCE AND MONACO	159
ICELAND	160
AUSTRIA	161
BELGIUM	162
SINGAPORE	163
DENMARK	164
NORWAY	165
CANADA	166
JAPAN	167
KUWAIT	168
HONG KONG	169
SWITZERLAND AND LIECHTENSTEIN	170
UNITED STATES	171
BRUNEI DARUSSALAM	172

4.2 Distribution of Countries within the Matrix

4.2.1 The Developed Countries

The countries which score high in all four of the variables are those which are considered to be more developed. These include: Canada, Denmark, Finland, Iceland, Norway, Sweden, Switzerland and Liechtenstein, and the United States.

However, not all developed countries are located in the extreme upper left cell, and the results somewhat contradict our expectations that all of the developed countries should score high in all four variables. For example, there are three in the sample which score high in three of the variables, but exhibit only a medium capacity for electrical generation. They are France (including Monaco), Hong Kong[1], and Italy (including San Marino). There are many possible explanations for this distribution. For Hong Kong and France their figures for electrical generating capacity per 100 inhabitants - 173 300 kWh and 155 800 kWh respectively - are close to the upper threshold for the medium class, and thus, do not deviate significantly from other developed countries which are classified as high in this capacity. Italy has an electricity figure well below these (96 290 kWh), and is more difficult to account for. There are 3 developed countries (Australia, Austria, and New Zealand) which score high on three variables, but have only medium teledensity. Again, all three have teledensity values which are close to the threshold that separates medium and high categories, and do not, therefore, represent significant deviations from other developed countries. Finally, there are a number of countries

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1 Describing the future potential for Hong Kong becomes somewhat problematic, given the recent return of Hong Kong to China.

which score high in GNP per capita and literacy, but medium in the other two measures. The actual number of countries within this last grouping which would be considered developed is hard to discern, especially since some of them were previously members of the former Soviet Union and, therefore, defy easy classification. They probably reflect a more transitional category.

There are a few countries which are commonly considered to be developed, and which score lower in more of the variables than any of those already mentioned. Turkey, for instance, scores high in literacy, medium in GNP per capita, medium in teledensity and low in electrical generating capacity. The position of these countries, and those other developed countries which scored low in ICT potential and which were discussed above, would seem to indicate that the ICT development potential matrix does not precisely correlate with the criteria presently used to define levels of social and economic development.

In summary, despite some individual low rankings, none of the more developed countries scored outside of the high literacy category, and none scored lower than medium in the GNP per capita categories. High rates of literacy and high and medium incomes are associated with higher levels of development, in general. The literature on ICT development confirms that high levels in these two variables are also associated with high potentials for the development of ICTs (UNDESA, 1971; Elkington and Shopley, 1988; Cane, 1992; Bennett, 1993; Mowlanda, 1993; Holderness, 1996; Hudson, 1996; Inyang, 1996; LaRovere, 1996; Lopez and Vilaseca, 1996; Mowlanda, 1996; Roche and Blaine, 1996; Pruett, 1998). Teledensity and electrical generating capacity, while important, may have less of a crucial role in determining ICT development potential. This will be discussed below.

4.2.2 The LDCs

As with the distribution of the developed countries, the matrix revealed both expected and unexpected results for the distribution of the 45 LDCs included in this study. First, as expected, all the countries which occupy the extreme lower right cell of the matrix are, with two exceptions, LDCs. They are: Afghanistan, Bangladesh, Benin, Bhutan, Burkina Faso, Burundi, Cambodia, Chad, Ethiopia, Guinea, Haiti, Liberia, Madagascar, Mali, Mauritania, Mozambique, Nepal, Niger, Sierra Leone, Somalia, and Sudan. The two anomalous countries occupying this cell are Cote D'Ivoire and Senegal, both of which, while developing countries, are not classified by the United Nations as LDCs. The 21 LDCs in this cell represent 46.7% of all the LDCs included in this study. These results would appear to corroborate the expected low potential for ICTs in developing countries generally, and the least developed countries in particular. However, there are a few LDCs which exhibit higher scores. As with the more developed countries, the LDCs show a degree of variability.

The higher scoring LDCs are spread throughout the matrix, with a relatively large grouping of 9 LDCs in the low GNP per capita, medium literacy, low teledensity and low electrical generating capacity categories. This group consists of: Central African Republic, Comoros, Guinea-Bissau, Laos People's Democratic Republic, Madagascar, Rwanda, Tanzania, Togo, and Uganda. The three other countries occupying this cell (Ghana, India, and Nigeria), are considered to be developing countries, not LDCs.

In terms of the four variables combined there are three LDCs which stand out as

Comparison of absolute values for three significant LDC outliers and the overall group of LDCs.

	GNP per capita	Teledensity	Electrical Generating Capacity	Literacy
Maldives	820.00 [Medium]	4.15 [Medium]	5.88 [Low]	93 [High]
Western Samoa	960.00 [Medium]	4.06 [Medium]	10.18 [Low]	98 [High]
Kiribati	710.00 [Low]	2.19 [Medium]	2.63 [Low]	95 [High]
All LDCs n=45	392.87 (271.02)	.80 (1.06)	4.42 (7.58)	50.35 (19.55)

Note: numbers in ( ) indicate Standard Deviation
[ ] indicate matrix classification

Table 5

having significantly greater ICT development potential than the others. The Maldives and Western Samoa score medium in GNP per capita, high in literacy, medium in teledensity, and low in electrical generating capacity, while Kiribati scored the same, with the exception of having a low GNP per capita classification. The absolute figures for these countries are compared with the averages for the entire group of LDCs in Table 5, and indicate that, with two exceptions for electrical generating capacity (Maldives and Kiribati), these three score significantly higher than the average LDC on each of the variables used in this study.

These outliers can be partly explained by a combination of factors, including their absolute locations and physical size, their political and economic affiliations, and their relatively small populations. Their small physical size and their relatively small populations result in denser settlement of these countries, making it less expensive for them to achieve higher levels of teledensity. While not considered high, the teledensities for these three are among the highest within the LDC group. In addition, their historical, political and economic affiliations with other, more developed countries, and with colonial powers - witnessed by their continued membership within the Commonwealth - are perhaps reasons for relatively higher levels of literacy within these LDCs. The combination of these factors, as manifested in their positions in the matrix, suggest that these three countries have potentials for ICT adoption that are significantly greater than the majority of the world's LDCs.

Beyond the countries specifically identified above there also exists a wide diversity in the values for the remaining LDCs. Because of this variability it is useful to look at how all the LDCs rank within each of the four variables separately, and to discuss the implications that arise.

4.2.2.1 Teledensity

No less than 115 of the 172 countries (66.9%) scored in the medium category for teledensity, and thus, the bulk of countries lie around the horizontal axis of the matrix. This is largely explained by the fact that the upper limit of the low teledensity category is set at 1 main line per 100 inhabitants. This is an extremely low figure, despite the fact that it is considered by the UN as a critical threshold for telecommunications development (Alabi, 1996). Notwithstanding this low threshold, the majority of LDCs - 35, or 77.8% - score in the low category for teledensity, and the remaining 10 (22.2%)

Teledensity Categories for the LDCs

	# of Countries	List of Countries
Medium Teledensity	10	Cape Verde, Djibouti, Gambia, Kiribati, Maldives, Sao Tome and Principe, Solomon Islands, Vanuatu, Western Samoa, and Yemen
Low Teledensity	35	Afghanistan, Angola, Bangladesh, Benin, Bhutan, Burkina Faso, Burundi, Cambodia, Central African Republic, Chad, Comoros, Congo, Equatorial Guinea, Ethiopia, Guinea, Guinea-Bissau, Haiti, Liberia, Madagascar, Malawi, Mali, Mauritania, Mozambique, Myanmar, Nepal, Niger, People's Democratic Republic of Laos, Rwanda, Sierra Leone, Somalia, Sudan, Togo, Uganda, United Republic of Tanzania, Zambia

Table 6

score in the medium category (see Table 6). However, these last 10 score close to the lower threshold which defines medium GNP, the highest of which is the Maldives with a teledensity of only 4.15. Still, even with these relatively low values a paucity of telephone main lines may not continue to hinder ICT development.

Teledensity has traditionally been used to demonstrate the potential of telecommunications within any country and is an important part of communications, even in the most developed and technologically advanced economies. However, the role of the terrestrial copper and fibre optic cables, which together carry the majority of modern telecommunications, will undoubtably decrease as recent developments in signal compression and digitization make wireless communication via cellular and satellite a realistic option for ICT purposes (Pruett, 1998). The radio signal, once the dominant form of mobile communications, has more recently been replaced by digital cellular networks and personal communications networks (PCNs), at least for local communication needs. More importantly for international communication is the use of satellite communications.

As Hudson (1996; 26) states: "while fiber-optic undersea cables are now carrying the majority of global voice and data traffic, the broad coverage area of satellites makes them ideal for other forms of communication, for example, point-to-multipoint data and video." As voice communication becomes increasingly digitized for use in computerized ICTs it too will benefit from the versatility of satellite communications links. The International Telecommunications Satellite Organization (Intelsat), established in 1964, now has 139 national members and remains a major communication link, especially in many of those developing countries without reliable terrestrial links. More recently, there has been an increase in the number of private international satellite systems, and these will continue to play an increasingly larger role in international communications, particularly within the developing world. Not only do these countries have strategic locations, they also have the least invested in traditional forms of communication and, therefore, the largest untapped communications markets. Developing countries with domestic satellite systems include Argentina, Brazil, China, India, Indonesia, Malaysia, Mexico, South Korea, and Thailand.

There is one important disadvantage to satellite communication, however. Due to the distance between terrestrial stations and the satellites, and between satellites themselves when used in combination, there is a time delay between transmission and reception (Hudson, 1996). Still, this may represent a significant problem only when used for traditional forms of voice communication, time delays may not have as great an impact on the transmission of data signals, which are perhaps the most important part of ICTs. These time delays may become less of a limitation even on voice communication as this, too, becomes increasingly digitized for transmission between computers and other communication technologies.

Due to their reliability, flexibility of capacity, and, perhaps most importantly, the ability to transmit from virtually any location without the need for extensive terrestrial networks, satellite communication is particularly useful for developing countries, especially those with largely rural and remote populations[1]. In fact, because the terrestrial wired communication systems are significantly less developed within the poorest countries of the world, there is much less uncertainty about the future role of satellites and wireless communications than there is within the industrialized world, where the highly developed wire systems makes the role of satellites much less evident (Hudson, 1996). It will be important that those countries that will develop communications systems in the future make full use of these emerging technologies in wireless communications. As the developing world benefits from these breakthroughs, low teledensity will become less of a limiting factor to ICT development, and moreover, those LDCs with even low teledensity values will have an increased ICT development

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As much as 80% of the population in the world's poorest countries live in rural areas (Hudson, 1996; 180).

potential.

4.2.2.2 Electrical Generating Capacity

Almost without exception the countries which exhibit high electrical generating capacity, as defined by this study, are considered more developed. Two notable exceptions are Kuwait and Qatar, two countries whose oil generation capacity and small size help explain these high electrical capacities. The other two exceptions, Estonia and Singapore are more difficult to account for.

The majority of the countries used in this study - 121, or 70.3% - are categorized as having low electrical generation capacity, and this number includes all 45 of the LDCs. This would seem to indicate a lower ICT development potential for the majority of the countries in this study, and for the entire group of LDCs. However, as with teledensity, recent technological developments mean that electrical generating capacity may not continue to hinder ICT development potential.

The need for large scale public electrical generation, the kind which has dominated the construction of power installations within much of the developing world for many years, will diminish as newer technologies provide small scale, affordable, and reliable energy at almost any scale. Solar power is one of the most promising of the breakthroughs in energy for ICTs. As the costs per watt of solar photovoltaics and the energy needs of modern communications technologies continue to decline, there will be less need to rely on traditional forms of electrical generation, most of which involved connection to a regional or national power grid. These power grids are very expensive to construct and maintain, and the priority within many developing nations has traditionally been towards the electrification of urban centres (Blackburn and Dowall, 1991). As a result dispersed rural populations often go without connections to regional or national power systems. This is reflected in the fact that 1 in 3 people globally lack access to electricity (UNDP, 1995).

Increasingly, satellite terminals will be solar powered, especially in the developing world, as the costs of solar energy are further reduced (Hudson, 1996). The research and development of these energy alternatives will continue with their increased use, and as a result their reliability, affordability and adaptability will also be enhanced. The potential to leapfrog over the need for large scale, centralized public energy for satellite communication can then equally be transferred to the other components of ICTs, even to the micro-computers. As a result, low levels of installed electrical generation capacity will become less of a limiting factor to ICT development. This can only increase the ICT development potential of all the LDCs sighted in this study.

4.2.2.3 GNP per Capita

Since a measure of economic capacity is one of the principle measures of development, it comes as no surprise that, almost without exception, those countries which score high on GNP per capita, as defined by this study, are considered developed countries. One notable exception is the United Arab Emirates. In this case, it is earnings from oil exportation which are at the root of this country's relative wealth. On other measures of ICT development potential the United Arab Emirates score noticeably lower.

A total of 28 of the 172 countries (16.3%) have a high GNP per capita. Eighty one (47.1%) have medium GNP per capita, and the majority of these are considered developing nations. Finally, 63 (36.6%) of the countries fall into the low GNP per capita category, again the majority of these are considered developing countries. Some, such as Georgia and Tajikistan, are not strictly defined as developing nations, but are identified in the low GNP per capita grouping. This last group of 63 countries includes all the LDCs except 8 which have a medium GNP per capita (see Table 7). However, as with the LDC outliers in teledensity, these 8 are not significantly wealthier than the rest of the LDCs. The highest income in this last group is enjoyed by Vanuatu ($1150.00), a figure which is at least partially explained by the fact that this country is a popular tourist destination.

The capacity to fund ICTs will continue to be a limiting factor to ICT development potential, and this has negative implications for the developing world in general, and for most of the LDCs in particular. All countries who wish to increase their use of ICTs will need capital to improve their infrastructures (telecommunications and electrical generation), and purchase, develop and maintain the ICTs. Within the LDCs,

GNP Categories for the LDCs.

	# of Countries	List of Countries
Medium GNP per capita	8 (17.8%)	Angola, Cape Verde, Congo, Djibouti, Maldives, Solomon Islands, Vanuatu, Western Samoa
Low GNP per capita	37 (82.2%)	Afghanistan, Bangladesh, Benin, Bhutan, Burkina Faso, Burundi, Cambodia, Central African Republic, Chad, Comoros, Equatorial Guinea, Ethiopia, Gambia, Guinea, Guinea-Bissau, Haiti, Kiribati, Liberia, Madagascar, Malawi, Mali, Mauritania, Mozambique, Myanmar, Nepal, Niger, Rwanda, Sao Tome and Principe, Sierra Leone, Somalia, Sudan, the People's Democratic Republic of Laos, Togo, Uganda, United Republic of Tanzania, Yemen, Zambia

Table 7

there is currently such a paucity of ICT development that a great deal of investment will be required to bring these countries up to even a minimal level of communications development readiness. For example, attaining a minimum teledensity level of 1 main telephone line per 100 inhabitants in a majority of the 48 LDCs by the year 2000 would require an investment of 9.44 billion (US$) (ITU, 1995). When we compare this amount to the total multi-lateral lending made to LDCs between 1983 and 1993 of 621 million (US$), it is apparent how daunting this task will be (ITU, 1995). Moreover, as we have discussed earlier, it is hard to justify the diversion of scarce government revenues towards ICTs when such priorities as public health, education, housing, and employment within the developing world are in such dire need of attention and investment. In short, a great deal of funding is required, and, based on their low GNP, many countries will have difficulty affording ICTs on their own.

Table 7 shows that the LDCs can be divided into two distinct groups: those with at least a possibility of self-financing for ICTs and those with no realistic hope of self-financing their ICT development at present or for the foreseeable future. The 8 LDCs with medium GNP per capita levels could perhaps be able to self-finance the purchase, development and maintenance of ICTs, while those 37 with low GNP per capita figures will most likely not be able to afford ICTs on their own. Despite the possibility of self-financing for the first group, in both cases it would be useful for the LDCs to explore the possibility of attracting other sources of funding for ICT development.

The Potential to Attract Investment for ICTs

As has traditionally been the case with telecommunications, funding and investment in ICTs within the developing world is lacking, regardless of the source or method (ITU, 1995; Hudson, 1996). There are several possible explanations for this, but two stand out as particularly relevant for the developing world.

Based on the experience of telecommunications, investments in ICTs are likely to be on a direct cost recovery basis, largely ignoring the indirect benefits of communication across the entire economy. Investment is more likely, then, in a region or country where revenues are anticipated to exceed costs. LDCs, with their poverty and large infrastructural requirements and dispersed rural populations, do not generally offer such guaranteed investment opportunities. Yet, according to some (Brem, 1989; Pierce and Jequier, 1983), the benefits across the entire economy should outweigh the costs of any telecommunications (or ICTs) investment. While a foreign investor might not be interested in the overall benefits of ICTs for development, they should be aware that by entering into partnerships with developing nations they could enjoy a healthy return on their ICT investment.

Second, it is often assumed by many governments and foreign investors alike that providing services like ICTs to rural areas will substantially exceed the revenues generated. This is perhaps one of the primary reasons why telecommunications and ICTs are lacking within much of the developing world, where the populations are largely rural. Again, this ignores the overall economic and social benefits of ICT development within rural areas. Moreover, as the costs of providing the necessary infrastructure for ICTs drop, and as the price of ICT components continue to decline, the investments required should also decrease, hopefully making them less risky and more profitable. As a consequence, medium levels of national income (GNP per capita) may become less of a hindrance to ICT development because internal revenues can be augmented by FDI. However, for the 37 LDCs with very low levels of income it is unlikely that any amount of FDI available to the LDCs would be sufficient. These will always find the self-financing of ICTs impossible, and perhaps even less encouraging, they will be unlikely to improve their situation through the substitution of FDI (see Table 7).

As was discussed in Chapter 2, perhaps the most realistic option for getting outside ICT investment within these economies is the attraction of FDI. However, the least developed of the developing countries are not attractive options for potential investors. In addition to high levels of poverty, investment in ICTs will also be discouraged by regulatory restrictions against foreign investment, a general lack of information for investors, government or bureaucratic control of state run monopolies in telecommunications and other important infrastructures, political instability, internal warfare[1] (ITU, 1995). When many of these problems combine, as they do in most LDCs, they create unhealthy investment climates for private sources of funding and investment. Still, from the perspective of the developing world, FDI is the preferred option, not least because it provides much needed equity and foreign technical and management expertise, all of which are absent from most developing countries.

Countries who seek outside funding for ICT development should be aware that,

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There are 14 LDCs which currently suffer from civil strife significant enough to deter economic growth and FDI. They are Afghanistan, Angola, Burundi, Cambodia, Ethiopia, Haiti, Liberia, Mozambique, Rwanda, Sierra Leone, Somalia, Sudan, Togo, Yemen (UNCTAD, 1996).

despite a poor internal climate for investment there are many strategies (Blackburn and Dowall, 1991; Bande, 1995; Hudson, 1996) which can attract or encourage FDI. Among these are:

- **Joint Ventures**: partnerships between foreign companies and the operators of communications services;
- **Revenue Sharing**: the foreign investors receive a share of revenues in return for investment;
- **Build Operate Transfer (BOT)**: a foreign investor builds and operates a facility for a set period of time to earn back their investment and then turns the facility over to the country's own carrier;
- **Combined Revenue Sharing and BOT**: similar to BOT except that it requires the immediate transfer of the communications facility to the national control but with a continued sharing of the revenue;
- **Debt Equity Swap**: the trading of unpaid national debt obligations for equity in communications industries;
- **Local Alliances**: agreements and partnerships between a country and an international manufacturer of ICTs to produce and sell ICTs within the host country.

The first step in attracting FDI is to allow some privatization in communications and other infrastructural sectors of the economy. The methods outlined above all require some privatization in sectors of national economies that have traditionally been state run, and which often involve monopoly control. Privatization has been an important factor in the development of telecommunications worldwide (ITU, 1998), and there are indications that the developing countries should be successful in their attempts to privatize. One study has found that there is a better chance of success (in the privatization of state owned enterprises (SOEs)) when there is a great deal of state autonomy and a concentration of power in the central government (Petrazzini, 1995). Less fragmented control facilitates the transition from state owned and operated facilities to privately run enterprises, and makes the investment more attractive for the foreign firm. Many LDCs still exhibit these characteristics.

Sources of FDI use specific criteria to define lower risk investment opportunities. Again, the criteria used to define sound telecommunications investments can also be used to determine sound ICT investments (Lopez and Vilaseca, 1996). They include:

- ❑ **High population density** - means a larger initial and future potential consumer base;
- ❑ **High gross national product** - means potential industrial consumer base and existing sectors which have a need for advanced telecommunications [and ICTs];
- ❑ **Growing infrastructure** - increases the potential to maximize technical innovations;
- ❑ **Foreign Investment receptiveness** - laws and regulations regarding FDI which indicate government willingness to protect FDI;
- ❑ **Education** - means facilities necessary to support training for ICTs.

Since measures of income, infrastructural development, and educational levels are components of the ICT development potential matrix developed in this study, it can be deduced that many of the LDCs are unlikely to fulfill all, or even some, of these criteria. The potential to fulfill these is particularly low in those 21 LDCs that scored in the lowest right cell of the matrix.

Experience has shown that a low potential for attracting FDI can be partially offset in the developing world by strategic investments, and FDI has been attracted in many instances because the foreign investors were able to target more focused areas within the telecommunications sectors, such as cellular telephone service (Lopez and Vilaseca, 1996). The same method could be used to attract FDI to target sectors of ICT development, particularly within those countries which are in greater need of outside funding sources. Satellite communication systems and small scale energy facilities are just two emerging technologies that could offer attractive investment opportunities for those weary of the high risk of investing in the developing world, and in the LDCs in particular.

Even so, there is every indication that most LDCs have traditionally had a difficult time attracting foreign investment. While foreign investment within developing countries has risen markedly in the last few years, very little of it has been directed towards the least developed countries (UNCTAD, 1996). This is particularly true of investments in telecommunications (ITU, 1995). Moreover, even though there is a chance for focused investments, especially in remote communications and small scale energy production, the potential to attract investors for the majority of LDCs (even those with medium GNP per capita figures) is deterred by many other factors.

4.2.2.4 Adult Literacy

There is no substitution for skilled and trained technicians and scientists to develop, construct and maintain ICTs. Without indigenous expertise in these new technologies developing countries will not be able to take full advantage and control of new information technologies. The matrix demonstrates a wide variation in the levels of literacy within the LDCs. The majority of LDCs - 25, or 55.6% - score in the low literacy category. There are 13 (28.9%) LDCs in the medium group, and 7 (15.6%) in the high

Adult Literacy Categories for the LDCs

	# of Countries	List of Countries
High Literacy	7 (15.6%)	Congo, Equatorial Guinea, Kiribati, Maldives, Myanmar, Western Samoa, Zambia
Medium Literacy	13 (28.9%)	Cape Verde, Central African Republic, Comoros, Guinea, Guinea-Bissau, Malawi, People's Democratic Republic of Laos, Sao Tome and Principe Rwanda, Solomon Islands, Uganda, United Republic of Tanzania, Vanuatu
Low Literacy	25 (55.6%)	Afghanistan, Angola, Bangladesh, Benin, Bhutan, Burkina Faso, Burundi, Cambodia, Chad, Djibouti, Ethiopia, Gambia, Haiti, Liberia, Madagascar, Mali, Mauritania, Mozambique, Nepal, Niger, Sierra Leone, Somalia, Sudan, Togo, Yemen

Table 8

literacy group (see Table 8).

There is some discussion within the literature about the importance of educational attainment for the potential to develop and maintain autonomous ICTs. "It may be that the long-term deployment and exploitation of the Internet [and ICTs, in general] by developing countries will depend less on technology and costs and more on their capabilities to educate their young people" (Pruett, 1998). This supports the idea that teledensity and electrical generating capacity are of less, and perhaps decreasing importance, and that adult literacy (the surrogate for educational attainment utilized in this research) is of primary importance in determining the potential to develop ICTs. Even GNP per capita, while important, is not as important as literacy because of the potential availability of external funding. On this assumption Table 8 indicates that the majority of LDCs have a very low potential for the adoption of ICTs (low literacy), a few have a medium potential (medium literacy), and still fewer LDCs have a high potential to develop ICTs (high literacy).

There are ways to overcome low levels of educational attainment: the training of technicians and scientists overseas and the importation of trained personnel from other, more developed countries. Both of these solutions, however, have serious drawbacks. The first solution often results in the loss of well educated individuals to other countries where they can more readily utilize the skills they have developed abroad. The second solution can involve increased ICT procurement costs beyond those incurred in the importation of ICT equipment and technology. The increased costs of importing personnel, as well as the technology, can be an important consideration, especially when we compare the wage differentials between technicians and scientists in the industrialized countries with those in the developing world. Moreover, importing expertise can lead to dependency and the loss of national control over ICT development, both of which can have profound negative effects on the autonomous development and utilization of ICTs within the developing world. Thus, while it is possible for some LDCs to import expertise, it is something that should be avoided, as it negates many of the positive effects of ICT development and creates outside dependencies. Indeed, many would argue that such dependency is the root cause of underdevelopment. Thus, while in theory alternatives do exist to compensate for low rates of educational attainment, none of these comes without its own costs. As a precursor to ICT development cultivating indigenous expertise, most notably by raising levels of education, should be a priority for any country with less than a high rate of literacy.

4.3 Summary of Findings

To summarize, the ICT development potential matrix shows that there is a wide range of ICT development potential within the two groups at either end of the development scale: the most developed and the least developed countries. Contrary to expectations some developed countries scored much lower in our matrix, and conversely, some LDCs scored much higher in our matrix than their overall levels of development would suggest. Much of the literature on ICTs and development groups the LDCs together as all having the lowest potential for ICT development when compared to the rest of the developing world. The matrix does indicate that the majority of LDCs do, in fact, show the lowest potential for ICT development, but there are exceptions. In particular, there are three LDCs (Kiribati, Western Samoa, Maldives) which have a significantly greater potential for ICT development than do the majority of the LDCs. The matrix also shows a high degree of variability within the LDCs which is largely ignored within the literature.

By segregating out the four components, or variables, used in the matrix it is possible to see exactly what attributes account for this variability and the implications for the potential for ICT development. This has provided some interesting results. Two of the variables which influence ICT development potential - teledensity and electrical generating capacity - will most likely decrease in importance in the future. This would suggest that those LDCs which do not enjoy high levels of either factor can and should concentrate on alleviating the other hurdles to the adoption of ICTs which may exist.

GNP per capita figures demonstrate that some LDCs, those with medium GNP per capita, possess some potential for self-funding part or all of their ICT development, while those with low GNP per capita, the vast majority of the LDCS, have very little likelihood of self financing. The role of GNP is partially offset by the ever decreasing cost of ICTs and the fact that there are many creative ways of attracting and introducing FDI to develop ICTs. Even so, the fact that the majority of LDCs score very low overall in the matrix suggests that they will not be very successful, as has traditionally been the case, in attracting FDI. Therefore, for most of the LDCs low levels of income will continue to hinder ICT development.

Finally, literacy emerges as the predominant factor in determining ICT potential. Low levels of literacy, more than any other factor, will frustrate the majority of LDCs. The majority of LDCs have low and medium levels of literacy, which will significantly hinder ICT development. For these countries it is imperative that they improve levels of educational attainment as a precursor to ICT development.

The fact that literacy, and to a lesser degree GNP per capita, have surfaced as the two most important indicators of ICT development potential has important implications for the ability of LDCs to leapfrog over stages in ICT development.

4.4 Literacy, GNP per capita, and the Potential to Leapfrog

The literature suggests there is a possibility for certain countries which presently have low ICT development potential to leapfrog over stages of ICT development by benefitting from breakthroughs in the technologies of ICTs. The ability to leapfrog will increase their ICT development potential. Being late starters in developing their own information and communications networks, the less developed countries have a distinct advantage over the more developed regions of the world, regions which have more money invested in older communications technologies and infrastructures. For the purpose of this study, we are primarily interested in the potential to leapfrog over the need for main telephone lines (measured by teledensity) and large scale public electrical power generation (measured by net installed electrical generating capacity per 100 inhabitants), two important infrastructural requirements for ICTs.

This ability to leapfrog, however, is tied to the ability to afford ICTs (measured by GNP), and the technical and scientific expertise to develop, use and maintain them (measured by literacy). In the case where equally low values for each of these variables exists within one country it is literacy which is considered the primary constraint over GNP per capita levels, as is suggested in the previous section and within the literature (Pruett, 1998). The constraints on leapfrogging potential can be categorized into four groups:

- ❑ those countries who are hindered by both low literacy and low GNP per capita;
- ❑ those countries which are affected most by low rates of GNP per capita;
- ❑ those disadvantaged primarily by low rates of literacy;
- ❑ the countries which are constrained by neither a lack of GNP per capita nor low rates of literacy.

The categories are summarized in Table 9.

Using this information and the results of the ICT development potential matrix we can classify the LDCs based on the main constraint, or constraints, that affect their individual ability to leapfrog over stages of ICT development and thus take the analysis of ICT potential one step further. These are summarized in Table 10. The results

The Primary Constraints on Leapfrogging Potential.

	High Literacy	**Medium Literacy**	**Low Literacy**
High GNP	Neither Literacy nor GNP per capita	Literacy	Literacy
Medium GNP	GNP per capita	Literacy	Literacy
Low GNP	GNP per capita	GNP per capita	Both Literacy and GNP per capita

Table 9

demonstrate that a slight majority of LDCs - 23, or 51.1% - will be severely constrained in their attempts to leapfrog over stages in ICT development because they lack both income and educational levels. Slightly fewer - 17, or 37.8% - will only be obstructed by income, and a minority of LDCs - 7, or 11.1% - will be hindered by low levels of educational attainment. None of the LDCs will have unconstrained leapfrogging potential, and this supports the hypothesis that, while there is a diversity of ICT development potential within the LDCs, none of them will have unfettered access to ICT development.

The relationship between leapfrogging potential and the ICT development potential matrix needs to be made clearer. The ICT development potential matrix identifies the four constraints affecting ICT development potential. We can use the discussion above surrounding the constraints affecting leapfrogging potential to refine the findings of the matrix and focus our attention on the two variables which will continue to affect ICT potential whatever the future developments in the technologies used to support

ICTs (ie. satellite communication and small scale electrical generation). These more refined results support that hypothesis that, with few exceptions, most LDCs have significant constraints to leapfrogging potential, and thus, for ICT development potential in general. Perhaps more importantly, this examination highlights, once again, a degree of variability within the poorest countries, something which is often ignored within the literature.

This study tends to support those who question that the development of ICTs is a solution for the economic and social underdevelopment that exists in much of the world. Moreover, it tends to support those, such as Pierce and Jequier, 1983; Forester, 1985; Lamb, 1986; Balla and Jequier, 1988; Antonelli, 1991; Cane, 1992; Bande, 1995; Menzies, 1996; Roche and Blaine, 1996, who go so far as to suggest that the development of ICTs threatens to increase the development gap even further. The results of this

Constraints affecting the Leapfrogging Potential of the LDCs.

Constraint	# of Countries	List of Countries
Neither Literacy nor GNP per capita	0	
Literacy	5	Angola, Cape Verde, Djibouti, Solomon Islands, Vanuatu
GNP per capita	17	Central African Republic, Comoros, Congo, Equatorial Guinea, Guinea-Bissau, Kiribati, Malawi, Maldives, Myanmar, Peoples Democratic Republic of Laos, Rwanda, Sao Tome and Principe, Togo, Uganda, United Republic of Tanzania Western Samoa, Zambia
Both Literacy and GNP per capita	23	Afghanistan, Bangladesh, Benin, Bhutan, Burkina Faso, Burundi, Cambodia, Chad, Ethiopia, Gambia, Guinea, Haiti, Liberia, Madagascar, Mali, Mauritania, Mozambique,, Nepal, Niger, Sierra Leone, Somalia, Sudan, Yemen,

Table 10

analysis point to a weakness in the argument that technology in general, and ICTs in particular, is going to help the developing countries, and the LDCs in particular, elevate themselves from the low levels of economic and social development which persist. This discussion demonstrates that there are certain prerequisites that are largely not being met in the majority of LDCs. Although, not all LDCs share the same causes for the low potential for ICT development, and some variability does exist. Still, the apparent inadequacy of development of many of the necessary ingredients of ICTs may prevent the benefits of these technologies from reaching many of the poorest countries of the world.

Conclusion

The analysis presented in this study can be used to set priorities for the development of ICTs. By identifying the specific constraints affecting individual LDCs this information can be used to develop an overall development plan for the improved potential to develop ICTs for economic and social development within each individual country. However, ICTs are not a development panacea, and need to be integrated into a broader development plan for the developing countries. Only in such an environment can ICTs be used to improve economic and social conditions. Many international agencies have long recognized the importance of information and communication technologies, and the UN has made "ensuring universal access to basic information and communications for all" one of its primary objectives in an effort to ensure sustainable human development (ITU, 1998). The prognosis for many of the LDCs is not good, and the majority of them are in danger of being left behind as the information society progresses. Still, the situation is not hopeless, even for the least developed of them. The literature on ICTs and development does not deal with the potential for ICT development within the LDCs in the detailed way presented in this study. It is hoped that this analysis will fill this void and assist those least developed countries in their future economic and social development.

Chapter 5

General Conclusions and Suggestions for Further Research

This research has examined the criteria that affect the ability to develop ICTs in order to determine if, as the literature on development suggests, the least developed countries would demonstrate consistently low potentials for the development of ICTs. Findings have shown that not all LDCs show the lowest potential for ICTs. In fact, the ICT development potential matrix constructed for this purpose demonstrates that, with reference to the constraints to ICT development which were identified, there is indeed a great deal of variation within the potential of the LDC group to adopt ICTs. The fact that a majority of LDCs did indeed show the lowest ICT potential does not hide the fact that some heterogeneity does exist. This is a departure from traditional studies of development which often group the LDCs together. We can draw some useful conclusions from the results of this study.

First, with respect to the overall potential for ICT development based on the four criteria used in this study(funding ability, telecommunications infrastructure, electrical generating infrastructure, and education levels), the majority of LDCs show little potential for ICT development, and there are only a minority of LDCs which, at present, show any significant potential (see Table 4). With respect to a refined measure of ICT capacity using GNP and literacy, and based on the potential of countries to leapfrog older technologies, there are again a minority of LDCs with what could be considered a strong potential for adopting ICTs. The results indicate that none of the 45 LDCs included in this study will have unfettered access to ICTs. Twenty three will be constrained by both a lack of income and low levels of educational attainment, 17 will be primarily hindered by low levels of income, and 5 will be predominantly restricted by low levels of educational attainment (see Table 10). These two findings seem to provide at least general support to the notion that the LDCs have a low potential for adopting ICTs to aid in future development plans. Because most of the other countries which also demonstrate low potentials for ICT adoption are developing countries, we can expect that the developing world in general will have a more difficult time employing ICTs. However, we must be careful not to overgeneralize, because there exists a great degree of variability within the other developing countries as well.

Strong implications arise from the findings of this research for those agencies whose responsibility it is to aid the poorest countries of the world in closing the development gaps that separate the rich from the poor. In the introduction I alluded to the possibility of ICTs creating a new underclass within the global society: the information poor. While this research has failed to show that all the LDCs, without exception, have become members of such a group, it has demonstrated that a majority, along with many developing countries, could suffer such a fate. It is, therefore, imperative that aid agencies address some of the concerns that are identified within the literature and developed throughout this paper.

Chief among these is both the need to address the global inequities that exist in the distribution of wealth and the need to assist developing countries in elevating general levels of educational attainment. Both have been identified as important precursors to the development of ICTs. If ICTs come to play as paramount a role in future development as the literature appears to indicate, then addressing these two concerns becomes even more important. Addressing the needs for ICT infrastructures, such as telecommunications and electrical generation, has emerged from this research as less of an immediate concern. No one is naive enough to believe that addressing these issues is going to be easy, however, and the alleviation of these inequalities is something which has eluded development agencies for many decades. It is hoped that the findings of this study will add further strength to the conviction that the developing world in general, and the LDCs in particular, need assistance in closing the development gaps that persist, and that education and poverty alleviation are among the most compelling.

For the individual countries themselves, there are also important lessons to be learned from this research. Perhaps most important, is the paramountcy that literacy plays in improving ICT development potential. Countries can use this research to establish their own priorities for ICT development. For the majority of LDCs, improving rates of literacy, as a precursor to ICT development, has been identified as a priority. No better example exists of a peripheral region's ability to capitalize on a highly literate population than that of Canada's own Province of New Brunswick. By taking advantage of a literate and bilingual population New Brunswick has been successful in becoming the "call centre capital of North America", and in so doing has transformed the economy of what many considered a chronic "have-not" province (Government of New Brunswick, 1998). As the Provincial Government advertises: "our workers are loyal, motivated, educated and bilingual... it's the key to Call Center Success. And, it's an ongoing challenge for the call center industry where traditional locations are virtually "tapped out""'(Government of New Brunswick, 1998). As the promotional material suggests, New Brunswick, as a "non-traditional" call centre location, offers the same services as may other locations with much lower labour costs. In a world of advanced communications, peripheral sites have actually come to hold an advantage, and as the economist Thomas Courchene recently noted, New Brunswick has become "a business solution rather than a location" (Reid, 1996; 31). Similarly, India has been very successful in not only developing its own indigenous software manufacturing industries, but has also created niche markets in information and communication services: both Swiss Air and British Airways have located parts of their accounting operations in Bombay. As this research suggests, providing a literate workforce is the first step for many LDCs as they attempt to develop similar possibilities.

The next priority for most LDCs, once the educational prerequisite has been established, is to improve their ability to fund ICTs, either through self-funding or through the creative use of FDI. As this research has shown, this requirement plays a subordinate role to literacy, but nonetheless proves a significant hurdle to the majority of LDCs. However, there is ample evidence within the literature that imaginative ways do exist to attract investment. Countries that lack internal sources of funding, as most LDCs do, should investigate some of these. In particular, the experience with telecommunications development has proven that privatization of ICT industries is key to attracting outside investment. Gambia provides an example of a LDC which has been successful in attracting outside sources of funding and in creating a profitable telecommunications industry. Through the development of the Gambia Telecommunications Company (GAMTEL), Gambia has used investment in telecommunications to restructure its national economy during a difficult period between 1980 and 1990 when agriculture declined from 48% of the national economy to just 29%. The telecommunications industry in Gambia has been one of the five fastest growing telecommunications industries over the past decade (ITU, 1995). Contributing to their success was the privatization of GAMTEL, a move that increased the ability to attract funds for investment (ITU, 1995).

5.1 Suggestions for Further Research

There is a need for further research into ICT development potential. For instance, as discussed in Chapter 3 there is a need to refine the discussion of ICT potential to include regional discussions. This is particularly important for Africa where a majority of the LDCs with the lowest potential for ICT development are located. Even more important is the need for specific, country by country comparisons which would bring out other important observations and patterns, as would a more in depth analysis of a single country. India, as a developing country which has experienced relative success in developing its own ICT industries, would provide a very good case study.

The traditional methods by which stages of economic and social maturation are measured also need to be revised to include some assessment of ICT development. Methodologically, more research is needed to refine both the measures used to assess the potential for ICT adoption, and the relative weight that ICTs have on social and economic development. What criteria are most important determinants of ICT potential? While these criteria have been partially explored within this research, it remains to be determined how strong an impact they, and ICTs themselves, have on development? This present study can assist in this process, but further research would greatly strengthen its utility.

The development of ICTs is a very dynamic process, and since the data for this research are 5 and 6 years old, we can assume that the levels of ICTs have increased during that time. This has occurred even within the poorest nations, despite their low potentials for ICT development, although as we might expect not to the same extent as elsewhere, particularly within the MDCs. It would be useful then to devise some measure of ICT development, utilizing perhaps the number of personal computers per capita, and to compare the expected results, based on the ICT development potential matrix, with the actual ICT development levels in 1999. This would perhaps provide some further insight into the relative importance of the specific criteria and measures employed within this paper to assess ICT development potential. Quantifying the impact of ICTs on overall development patterns would be much more difficult, but nonetheless worthwhile.

Conclusion

This study began with an examination of the assumption that all LDCs would share common characteristics, resulting in low potentials for ICT development, but it has been demonstrated that this is not the case. This study has identified priorities among the mechanisms for overcoming some of the limitations to the development of ICTs, and these can be used to establish priorities and specific strategies for increasing the capacity to adopt ICTs, especially within the poorest nations of the world. However, as the literature makes very clear, the development of ICTs is not a panacea for the ills of the developing world, and any such technology must be incorporated into an overall development scheme. It is expected that the research contained within this thesis, and the suggestions made for further study, will make a valuable contribution to assisting both development agencies and the developing countries themselves in augmenting the potential to adopt ICTs for improved social and economic development.

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Appendix 1 Absolute Values for Measuring ICT Development Potential.

COUNTRY	GNP PER CAPITA -1993	TELEDENSITY -1993	NET INSTALLED CAPACITY OF ELECTRICAL GENERATING PLANTS PER 100 INHABITANTS 000's kWh - 1993	ADULT LITERACY RATE % -1994
AFGHANISTAN	192.00	0.16	2.40	31.5
ANGOLA	827.00	0.52	4.48	42.5
BANGLADESH	220.00	0.23	2.26	37.3
BENIN	430.00	0.39	0.29	35.5
BHUTAN	170.00	0.24	44.38	41.1
BURKINA FASO	300.00	0.23	0.77	18.7
BURUNDI	180.00	0.26	0.71	34.6
CAMBODIA	84.00	0.06	0.36	35.0
CAPE VERDE	920.00	4.12	1.35	69.9
CENTRAL AFRICAN REP.	400.00	0.21	1.36	57.2
CHAD	210.00	0.08	0.48	47.0
COMOROS	570.00	0.66	0.85	56.7
CONGO	990.00	0.79	4.83	73.9
DJIBOUTI	780.00	1.31	15.26	45.0
EQUATORIAL GUINEA	420.00	0.35	1.32	77.8
ETHIOPIA	170.00	0.23	0.82	34.5
GAMBIA	350.00	1.58	2.59	37.2
GUINEA	500.00	0.18	4.16	34.8
GUINEA-BISSAU	240.00	0.83	0.97	53.9
HAITI	280.00	0.65	1.89	44.1
KIRIBATI	710.00	2.19	2.63	95.0
LAOS, PEOPLES' DEM REP.	280.00	0.19	5.56	55.8
LIBERIA	397.00	0.17	6.47	38.3
MADAGASCAR	240.00	0.25	1.48	45.8
MALAWI	200.00	0.36	1.62	55.8
MALDIVES	820.00	4.15	5.88	93.0
MALI	300.00	0.14	0.88	29.3
MAURITANIA	500.00	0.35	4.86	36.9
MOZAMBIQUE	90.00	0.40	14.41	39.5
MYANMAR	178.00	0.18	1.81	82.7
NEPAL	190.00	0.35	1.32	27.0
NIGER	270.00	0.13	0.74	13.1
RWANDA	210.00	0.17	0.44	59.2
WESTERN SAMOA	960.00	4.06	10.18	98.0
SAO TOME AND PRINCIPE	330.00	1.99	4.10	67.0
SIERRA LEONE	150.00	0.34	1.63	30.3
SOLOMON ISLANDS	740.00	1.51	2.26	62.0
SOMALIA	156.00	0.17	0.78	24.1
SUDAN	285.00	0.23	1.31	44.8

COUNTRY	GNP PER CAPITA	TELEDENSITY	NET INSTALLED CAPACITY OF ELECTRICAL GENERATING PLANTS PER 100 INHABITANTS	ADULT LITERACY RATE %
	-1993	-1993	000's kWh - 1993	-1994
TOGO	360.00	0.45	0.44	50.4
UGANDA	190.00	0.14	0.86	61.1
UNITED REP. TANZANIA	90.00	0.30	1.50	66.8
VANUATU	1150.00	2.55	5.59	64.0
YEMEN	280.00	1.32	5.65	41.1
ZAMBIA	370.00	0.87	24.84	76.6
ALBANIA	340.00	1.47	55.83	85.0
ALGERIA	1770.00	4.00	19.92	59.4
ANTIGUA AND BARBUDA	6540.00	32.02	38.46	96.0
ARGENTINA	7270.00	12.18	48.06	96.0
ARMENIA	670.00	16.72	74.46	98.8
AUSTRALIA	17490.00	48.36	202.60	99.0
AUSTRIA	23500.00	44.80	199.22	99.0
AZERBAIJAN	660.00	9.49	67.29	96.3
BAHAMAS	11420.00	30.58	129.19	98.1
BAHRAIN	8030.00	23.03	178.19	84.4
BARBADOS	6230.00	31.73	53.85	97.3
BELARUS	2850.00	17.81	68.91	97.9
BELGIUM	21650.00	43.74	132.62	99.0
BELIZE	2500.00	13.35	11.27	70.0
BOLIVIA	760.00	3.31	8.99	82.5
BRAZIL	3020.00	7.05	33.72	82.7
BRUNEI DARUSSALAM	7681.00	20.45	155.42	87.9
BULGARIA	1170.00	27.15	127.77	93.0
CAMEROON	820.00	0.42	4.82	62.1
CANADA	19960.00	57.29	362.22	99.0
CHILE	3170.00	11.01	27.79	95.0
CHINA	490.00	1.18	14.87	80.9
COLOMBIA	1390.00	11.28	27.47	91.1
COSTA RICA	2160.00	11.38	31.98	94.7
COTE d'IVOIRE	630.00	0.70	8.81	39.4
CROATIA	7059.00	21.31	68.41	97.0
CUBA	2458.00	3.18	29.27	95.4
CYPRUS	10380.00	42.60	90.53	94.0
CZECH REPUBLIC	2710.00	18.98	121.29	99.0
DENMARK	26580.00	58.96	197.04	99.0
DOMINICA	2720.00	19.57	11.27	94.0
DOMINICAN REPUBLIC	1230.00	7.26	12.55	81.5
ECUADOR	1200.00	5.45	20.90	89.6
EGYPT	660.00	4.20	20.94	50.4
EL SALVADOR	1320.00	3.14	12.94	70.9
ESTONIA	2720.00	23.57	210.57	99.0
FIJI	2180.00	7.10	22.31	91.3
FINLAND	19400.00	54.34	240.26	99.0
FRANCE AND MONACO	22490.00	80.50	173.30	99.0

COUNTRY	GNP PER CAPITA	TELEDENSITY	NET INSTALLED CAPACITY OF ELECTRICAL GENERATING PLANTS	ADULT LITERACY RATE %
			PER 100 INHABITANTS	
	-1993	-1993	000's kWh - 1993	-1994
GABON	4950.00	2.95	30.64	62.6
GEORGIA	580.00	10.48	80.32	94.9
GERMANY	23560.00	45.45	122.28	99.0
GHANA	430.00	0.30	1.07	63.4
GREECE	7480.00	45.84	83.16	96.7
GRENADA	2380.00	22.33	9.78	98.0
GUATEMALA	1100.00	2.30	6.64	55.7
GUYANA	430.00	5.00	6.37	97.9
HONDURAS	600.00	2.10	5.44	72.0
HONG KONG	19010.00	50.54	155.80	92.3
HUNGARY	3520.00	14.55	65.10	99.0
ICELAND	24900.00	55.23	396.49	99.0
INDIA	290.00	0.75	8.55	51.2
INDONESIA	750.00	0.91	6.36	83.2
IRAN	2230.00	5.61	28.38	68.6
IRAQ	2298.00	3.47	35.50	56.8
IRELAND	13010.00	32.87	108.44	99.0
ISRAEL	13920.00	37.23	80.47	95.0
ITALY AND MARINO	19840.00	51.50	96.29	98.1
JAMAICA	1400.00	9.34	19.50	84.4
JAPAN	31360.00	46.94	152.99	99.0
JORDAN	1300.00	6.94	21.22	85.5
KAZAKSTAN	1410.00	14.73	93.79	97.5
KENYA	260.00	0.76	3.11	77.0
KOREA, REPUBLIC OF	7660.00	37.87	62.66	97.9
KUWAIT	20270.00	25.03	391.40	77.8
KYRGYZSTAN	850.00	8.11	75.93	97.0
LATVIA	2310.00	26.81	77.44	99.0
LEBANON	553.00	12.96	29.57	92.0
LIBYAN ARAB JAMAH	4671.00	5.11	91.19	75.0
LITHUANIA	1340.00	22.90	146.77	98.4
MACEDONIA	820.00	14.80	66.80	94.0
MALAYSIA	3140.00	12.52	33.18	83.0
MALTA	7970.00	43.76	69.22	86.0
MAURITIUS	3040.00	9.81	28.69	82.4
MEXICO	3730.00	8.36	32.44	89.2
MONGOLIA	320.00	2.86	33.30	82.2
MOROCCO	1020.00	3.15	9.10	42.1
NETHERLANDS	20950.00	49.87	97.93	99.0
NEW ZEALAND	12600.00	46.04	215.63	99.0
NICARAGUA	340.00	1.57	9.77	65.3
NIGERIA	280.00	0.33	5.57	55.6
NORWAY	25960.00	54.17	566.92	99.0
OMAN	5320.00	7.43	70.99	35.0
PAKISTAN	440.00	1.31	8.62	37.1

COUNTRY	GNP PER CAPITA	TELEDENSITY	NET INSTALLED CAPACITY OF ELECTRICAL GENERATING PLANTS PER 100 INHABITANTS 000's kWh - 1993	ADULT LITERACY RATE %
	-1993	-1993		-1994
PANAMA	2600.00	10.29	36.37	90.5
PAPAU NEW GUINEA	1180.00	1.02	5.35	71.2
PARAGUAY	1510.00	3.12	138.86	91.9
PERU	1490.00	2.99	12.64	88.3
PHILIPPINES	850.00	1.29	10.69	94.4
POLAND	2250.00	11.49	69.88	89.0
PORTUGAL	8950.00	33.07	81.78	89.6
QATAR	15030.00	19.86	209.13	78.9
REPUBLIC OF MOLDOVA	1160.00	12.02	59.62	98.9
ROMANIA	1150.00	11.53	90.93	96.9
RUSSIAN FEDERATION	2330.00	15.83	135.01	98.7
SAINT KITTS AND NEVIS	440.00	30.58	26.19	90.0
SAINT LUCIA	3380.00	17.30	15.49	82.0
SAUDI ARABIA	7780.00	9.20	102.94	61.8
SENEGAL	720.00	0.81	2.86	32.1
SEYCHELLES	6280.00	16.14	38.89	88.0
SINGAPORE	20130.00	43.40	161.76	91.0
SLOVAKIA	1970.00	16.78	114.25	99.0
SLOVENIA	6310.00	25.94	119.06	96.0
SOUTH AFRICA	2910.00	9.23	63.01	81.4
SPAIN	13580.00	36.43	107.75	97.1
SRI LANKA	600.00	0.90	7.87	90.1
ST. VINCENT-GRENADINES	2120.00	15.00	12.73	82.0
SURINAME	1080.00	11.44	15.70	92.7
SWEDEN	24740.00	67.66	401.45	99.0
SWITZERLAND AND LIECHTENSTEIN	35750.00	61.80	220.49	99.0
SYRIAN ARAB REP.	967.00	4.13	23.36	69.8
TAJIKISTAN	410.00	4.50	77.04	96.7
THAILAND	2110.00	3.73	21.93	93.5
TRINIDAD AND TOBAGO	3830.00	15.28	86.07	97.9
TUNISIA	1740.00	4.92	15.76	65.2
TURKEY	2970.00	18.16	31.89	81.6
TURKMENISTAN	1380.00	7.13	100.23	97.7
UKRAINE	2210.00	14.98	97.06	98.8
UNITED ARAB EMIRATES	21420.00	45.72	33.53	78.6
UNITED KINGDOM	18050.00	46.00	11.03	99.0
UNITED STATES	24780.00	57.49	271.48	99.0
URUGUAY	3960.00	16.83	62.81	97.1
UZBEKISTAN	980.00	6.64	50.06	97.2
VENEZUELA	2840.00	10.06	84.04	91.0
VIET NAM	170.00	0.36	4.91	93.0
ZAIRE	238.00	0.09	5.20	76.4
ZIMBABWE	520.00	1.19	19.98	84.7

COUNTRY	GNP PER CAPITA	TELEDENSITY	NET INSTALLED CAPACITY OF ELECTRICAL GENERATING PLANTS	ADULT LITERACY RATE %
			PER 100 INHABITANTS	
	-1993	-1993	000's kWh - 1993	-1994
Maximum Value	35750	80.5	566.92	99
Minimum Value	84	0.06	0.29	13.1
Mean Values -				
45 LDCs	392.87	0.8	4.42	50.35
Remaining 127 Countries	6383.74	19.18	81.21	86.2
All 172 Countries	4816.36	14.37	61.12	76.79
Standard Deviation for				
all 172 Countries	7510.86	17.81	87.14	23.16

Note: Countries in bold indicate LDCs.

Glossary of Abbreviations

FDI	-	Foreign Direct Investment
GDP	-	Gross Domestic Product
GNP	-	Gross National Product
ICT	-	Information and Communication Technology
IDA	-	International Development Agency
ITU	-	International Telecommunications Union
LDC	-	Least Developed Country
MDC	-	Most Developed Country
MNC	-	Multi-National Corporation
NIC	-	Newly Industrializing Country
OECD	-	Organization for Economic Cooperation and Development
PCN	-	Personal Communication Networks
PCS	-	Personal Communication Systems
PPP	-	Purchasing Power Parity
SOE	-	State Owned Enterprise
UN	-	United Nations
UNCTAD	-	United Nations Conference on Trade and Development
UNDP	-	United Nations Development Program
UNESCO	-	United Nations Educational, Scientific and Cultural Organization
UNIDO	-	United Nations Industrial Development Organization