

# Digital Age: Technology Progress in Developing Countries

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## Abstract

Developing nations have developed technology rapidly in recent years. These nations are integrating various forms of technology, such as computers, radios, cellular phones, televisions, newspapers, and the internet into their daily lives. This research argues that technological growth in developing nations results from a mutually dependent process: technology use spurs understanding, which in turn spurs greater use. Using a multi-method approach of observation, trend analysis and case studies, this research breaks its argument into three main parts: 1) understanding the technological challenges in developing countries; 2) implications on how technology affects education, infrastructure, healthcare, and social and economic development; and 3) status of technological advancement and the accelerating growth and developmental rates of the developing countries. The evidence presented in this research also supports the contention that developing countries' lack of access to technology and other infrastructure has contributed to their lag behind the new technology development.

**Keywords:** developing countries, digital age, technology changes and its impact.

## 1. INTRODUCTION

Over the past decades, technology has contributed immensely to the development of various nations. The role of a technologically educated population in promoting social and economic development has long been recognized. The complex relationship between the economy, society, the environment, and technological knowledge requires a multi-disciplinary approach to develop technology and calls for skilled communication to be able to address technological issues. Yet, it is the

weakness of developing countries to make technology a veritable part of their daily lives that belies their continued underdevelopment. For a variety of reasons, developing nations are addressing the acquisition of scientific and technological knowledge. They must now refocus their initiatives with a strategy that begins with the popularization of science and its application to development in concrete and deliberate terms. In today's society, businesses and people are connecting to one another through the innovations in technology at rapid speeds. Technology advancements have allowed

for the distribution of information through many modes of mass communication such as computers, telephones, television, radio, and newspapers in several developing countries.

The increasing acquisition of accessible technology has served as a major avenue for advancements in developing nations in recent years; hence, the need to study and analyze the influence of technology on development in developing nations has become very important. An understanding of technology is a prerequisite for making wise choices in the acquisition and utilization of knowledge resources, which are to be fully deployed towards human development and welfare. Attempts to bring the benefits of technology to developing countries require a certain threshold of capacity to understand technology and its implications, and to recognize the daily opportunities to make technology work for people. This research seeks to answer: (a) how technological capabilities of developing nations have contributed to technological advancement, and (b) how technology advancements affect developing countries at the social and economic levels. The research hypothesizes that historically poor infrastructure in developing countries has contributed to their lag in technological advancement. It examines various forms of technological trends in developing nations. The major concepts, technological challenges and technological advancements discussed in this research deal with the underlying question of how advancing technologies challenge and affect developing nations' developmental structure.

Technology is important in developing nations for several key reasons. First, technology can be used through commerce to generate money and capital income. Secondly, updated technology improves the quality of life of the inhabitants of a nation, whether it is from new medical operating or hygiene equipment such as septic tanks. Lastly, technology allows for easier communication, for example, through computers and production of goods using new machinery. While these benefits of technology are all important, many experts would argue that technology is most important to a developing country because it raises income and capital, which allows a nation to better the general good of its citizens, including updating hospital equipment and enabling other resources such as running water and electricity. The term developing nation is generally used to describe a

nation with a low level of material well-being. Since no single definition of the term "developed nation" is recognized internationally, the levels of development may vary widely within so-called developing nations. Some developing nations have high average standards of living.

Nations whose economies are more advanced than others, but which have not yet fully demonstrated the signs of a developed country, are categorized under the term newly industrialized countries. The digital age is an idea that the current age will be characterized by the ability of individuals to transfer information freely, and to have instant access to knowledge that would have been difficult or impossible to find previously. The idea carries the ramifications of a shift from traditional industry that the industrial revolution brought, through industrialization, to an economy based on the manipulation of information. The digital age was developed as a result of capitalizing on computer microminiaturization advances, with a transition extending from the advent of the personal computer in the late 1970s to the internet reaching a critical mass in the early 1990s, and the adoption of such technology by the public since 1990. The digital age has played an important part in shaping modern society through rapid global communications and networking.

New opportunities are arising to make a new focus on developing nations compelling. For example, new information and communication technologies are facilitating the participation of more people in global knowledge dissemination and in providing access to the poor. There has always been a lag in technology advancements in developing nations; however, there is no doubt that some of these countries have surely made tremendous progress in the technology sector. Technology may be defined as the usage and knowledge of tools, techniques, crafts, systems or methods of organization in order to solve a problem or to serve some purpose. Technology can be viewed as an activity that forms or changes culture. It applies math, science, and the arts to benefit life. Information technology has unleashed a tidal wave of technological innovation in the collecting, storing, processing, transmission, and presentation of information; this has not only transformed the information technology sector itself into a highly dynamic and expanding field of activity, it has also widened the development gap between nations. The rapid growth and

unprecedented influence of new technologies, especially the information and communication technologies, including the Internet, is raising global awareness to the power of technology as a whole. Developing countries have to invest in these technologies or risk further widening the gap between themselves and developed nations. This realization should bring technology development and the strategies for making them work in developing nations, to the top of their agenda.

Major obstacles of general advancement in technology among developing nations are the lack of appropriate products, capital, education, language barriers, human resources, and social and administrative structures; without these, technology cannot be utilized. In developing nations, technology products are often not designed to meet the needs of the poor or those in remote areas because these groups face such constraints access to electricity. Affordability has also been an issue for these nations. Roughly half the world lives on less than four dollars a day. Many potential users are too poor to afford any form of access to technology. In many developing nations where there is physical access to technology, many people do not have the technical skills needed to benefit from it. Poor literacy in developing nations presents a language challenge because many of those who can read know only a local language, while the internet and other forms of information technology are dominated by English-language content. As in many sectors, the migration of skilled Information Communication Technology (ICT) professionals from developing to developed nations contributes to a lack of human resources to support advanced technology improvements. The survival and growth of developing nations in an increasingly turbulent environment would depend upon their ability to effectively utilize technology to narrow the gap between the developing and developed world. The emergence of the information revolution has changed the global economy by affecting the relationship of markets, products, competition and trade (UNIDO and WBCSD, 2002).

To understand and answer this research problem, a multi-method approach is used to observe and analyze the information that is currently available on technology trends in developing countries. Two of the principal sources are the World Bank's annual publication on different sectors in developing countries and

the International Telecommunication Union (ITU) for telecommunication statistics for developing countries. A trend analysis was conducted to examine the selected developing nations' technology usage over the past few years.

This methodology is based on the premise that developing nations' rapid adaptation to technology is due to their focus on technological capability. The message of this research is that developing nations are headed in the right direction to improve the challenges that have hindered technological advancements. This research will be beneficial because it will shed some light on the potentials of developing nations in developing technologically.

## 2. LITERATURE REVIEW

Many authors invest their knowledge and research on analyzing the political and economic history of developing countries. What many fail to realize is that as our world is becoming smaller via technology, it is important to understand the role of technological advances in developing nations and its adaptation to new technologies. This is important because the introduction of advanced information technology will help many aspects of society in the developing world.

The level of development of technological capabilities in developing nations is very weak. Most people in developing countries have to earn their living using only their labor, with basic tools and equipment, little education and training, weak access to financial services, and poor infrastructure. As a result, productivity is low and there is widespread underemployment. This is a basic cause of persistent and extreme mass poverty in developing nations. As a result, the development of productive capacities, including technological learning and innovation, are hindered.

The World Bank report entitled *Building Knowledge Economies: Advanced Strategies for Development*, (Aubert et al., 2007) states that knowledge and innovation have played a crucial role in development from the beginnings of human history. But with globalization and the technological revolution of the last few decades, knowledge has clearly become the key driver of competitiveness and is now profoundly reshaping the patterns of the world's economic growth and activity. Developing nations should,

therefore, think with some urgency about their future in technology.

To developing nations, the developed world, which has thrived over the course of the last two decades, serves as a role model in terms of setting goals for technological achievements. The problem is that over the past two decades, regions such as Latin America and Africa have made little progress with respect to technological advancements and achievements. Some experts believe reasons for stalling progress in these regions can be attributed to "important parts of society that resist change;" others believe that the stalling of progress has little to do with social resistance and is heavily a result of lack of knowledge in the fields of science and technology. Education and technology go hand and hand; education is a driver for technology which in turn can be used to further education. The educational benefits that technology offers developing countries are vast. Computers facilitate distance learning and can also serve as a library and a laboratory. Educational levels are low in developing countries, which is a significant barrier to the development and diffusion of technology in these countries. According to a study by UNESCO Institute for Statistics (UNESCO, 2008), only 71% of the population in developing nations was considered to be literate in the year 2002; when broken down geographically, 79.7% of the Asian population and only 61% of African population were reported as literate. Figure 1 (Appendix) shows a comparison of adult literacy rates worldwide.

One can establish a clear relation between educational levels and the different phases of technological progress. As shown in Figure 2 (Appendix) there is a positive correlation in the increasing trends of the literacy rate in selected developing nations and their increasing usage of technology. As the literacy rate increased about 1.2% each year, the overall technology usage in the selected developing countries also increased at about 1.5% each year.

Literacy in technology can be defined as a broader set of text and technological skills that include the ability to access, analyze, evaluate, communicate and use information to solve problems and create new knowledge. Technology can support the development of youth and adult literacy and non-formal education in several different ways. ICT can serve as a set of potential delivery and

instructional tools that can be used to help people acquire the skills associated with traditional notions of literacy. Computer-assisted tutorials and other traditional technology-supported resources, such as radio and television, can make education more accessible and help adults improve their ability to decode and comprehend prose text, thus increasing their literacy, employability, and their continued use of literacy skills to become lifelong learners. ICT is not just a means for delivering literacy skills but is an integral part of an information-literate society and knowledge economy. Individual participation requires the skills needed to use technology as a means to access, disseminate and create new information and knowledge products for the benefit of the individual and society. But the use of these information resources also requires basic text literacy.

According to UNESCO, one in five adults are still illiterate and about two-thirds of them are women; 67.4 million children do not attend school. Compared to only a 1.4% illiteracy rate in developed nations, 27% of the total population of developing and underdeveloped nations is illiterate (see Table 1 in Appendix). Regionally, the selected developing nations in Africa have the lowest literacy rate (76.25%), along with the selected developing countries in Asia, which have an 85.54% literacy rate. The region with the highest literacy rate is the selected developing countries in Europe, with 99.1%. Literacy rates have increased proportionally across all regions since 2000, according to such estimates. Africa experienced a 10% increase in literacy rates, 14.1% in Asia. Overall, developing nations increased literacy rates by 6.6% between 2000 and 2007. However, in some of these regions the increases in literacy rates do not keep pace with population growth (e.g., Asia) with the actual number of illiterate citizens having increased in the past decade. An early contact with technology in primary schools can build the technological foundation necessary for future technological skills needed to support the continued technology of developing countries.

Literacy has often been seen as not only a 'good thing' in and of itself, but as also having a variety of by-products of great social and economic importance, such as improved health, lowered fertility, increased income, and so forth. Figure 3 and Figure 4 (Appendix) show the components of human development indicator

(HDI) and HDI for selected developing countries. The education component of the HDI is now measured by mean of years of schooling for adults aged 25 years and expected years of schooling for children of school going age. The life expectancy at birth component of the HDI is calculated using a minimum value of 20 years and maximum value of 83.2 years. For the wealth component, the goalpost for minimum income is \$163 (PPP) and the maximum is \$108,211 (PPP), both observed minimum observed during the same time series. The decent standard of living component is measured by GNI per capita (PPP US\$) instead of GDP per capita (PPP US\$).

A nation's human development indicator is closely related to its improved measures in the technology sectors. A brief synopsis which explains technology improvements drives health and economic factors as follows:

- (a) Health: As the life expectancy and technology usage are positively correlated overall, the life expectancy in the nations with the lowest technology usage rates is actually only half that of the most developed nations. As people in developing nations have access to different technologies such as computers, radios and televisions, fertility planning, care/nutrition, and health education will positively increase due to the availability of information to make more knowledgeable decisions. Technology may have independent effects on the healthcare, but the requisite longitudinal studies have yet to be carried out.
- (b) Economic: There is a widespread belief that technological advancements in developing nations and economic well-being go hand in hand. This is apparent in Figure 5 (Appendix), which shows a plot of Gross National Product (GNP) per capita against technology usages rates in developing nations. The trends illustrate the importance of long-term investments in technology because of its promising impact on economic status.

The Division for Africa, Least Developed Countries and Special Programmes (ALDC, 2007) considered the importance of technological progress for economic growth and sustainable human development in the Least Developed Countries. ALDC provides information which enhances the capability to use and improve technologies in developing

countries, as well as strategies for improvement through which appropriate new technologies are used to deliver new or enhanced products to the market. Their research identifies the appropriate international support measures necessary to enable technological progress.

ALDC discusses five key topics that enable technological progress:

- a) technological change increases the productivity of land, labor and capital, reducing the cost of production and improving the quality of output;
- b) technological learning is critical for technological change, as technological learning is defined as the development of capabilities to use and improve technologies;
- c) the level of development of technological capabilities in developing nations is very weak;
- d) successful developing nations' adoption of policies to promote technological learning and innovation is geared towards achieving technological catch-up; and
- e) official development assistance to promote technological learning and innovation in developing countries.

Developing nations often lack basic infrastructure and funding. Poor nations cannot afford basic infrastructures such as roadways, water lines, electricity or telephone lines. According to a United Nations Human Development Report (2008), electric power generation and grid delivery were still unavailable to over one third of the world's population, despite the fact that they were first developed in 1831. These statistics are even bleaker for Sub-Saharan Africa where only 8% of the rural populace has access to electricity.

Capability and availability of technology in developing nations are key factors to their advancement. Whether it is the cost of infrastructure, geographical separation, or its unskilled population, the lack of technological knowledge and access has made technology progress difficult in these nations. While technology factors result in overall affluent people living in urban areas, the diffusion of technology to a nation's rural population takes a much longer time.

The United Nations Industrial Development Organization and World Business Council for Sustainable Development (UNIDO and WBCSD,

2002) conducted a research project consisting of ten case studies. The cases all look at strengthening the developing nations' capacity for sustainable development. Topics included in the case studies are distribution of technology, technical progress, technology cooperation, capacity building and financing technology development. These case studies are significant to this study because they highlight the important role technical progress has on the progress of developing nations.

Research and development is considered to be the core of technological capability building. It is clear that developing countries need to boost their research and development capacity; however, this is easier said than done without increasing financial and human resources, as well as the fundamentally important existence of demand for research and development results. Research and Development cooperation activities can, however, serve as important means to upgrade the research systems in developing countries. As seen in Table 2 (Appendix), a positive correlation of research and development is the percentage of GDP in the selected developing nations with scientific and technical journals and articles. Nations that have published more articles and journals have higher percentages of expenditures for research and development. This conclusion is not observed for all the selected countries. For example, Croatia and Pakistan have high GDP percentage but low published articles and journals.

Experts say the international community seems to be more successful at subsidizing the purchase of technology than at supporting research and development or manufacturing capabilities in developing countries. However it is R&D and manufacturing that will allow these countries to create a knowledgeable and skilled workforce that can continue the progress to new levels of technological achievement. Presently it is extremely hard to track exactly how much funding foreign governments are contributing to research and development. For example, it is easy to find out how much a donor may spend to promote technology, but it is much harder to determine how much of it goes to new research.

### **3. STATISTICS AND ANALYSIS**

The World Bank's annual publication on Social, Economic and Technology indicators shows increasing trends in social and economic sectors

as technology trends increase in developing countries. These statistics provide groundwork for understanding and comparing the rates at which developing countries have progressed technologically, and the effect of this progress on the social, economic, and political fabrics of the societies. The statistics show initiative towards understanding the growing impact on information technology.

Information Communication Technology indicators, published by ITU World Telecommunication, illustrate upward trends in telecommunication sectors among developing countries over the past few years. These illustrations provide a snapshot of what information and communication technology looked like over the past years.

Location seems to play a determining role in technological distribution. Figure 6, Figure 7 and Figure 8 (Appendix), show a global comparison of fixed telephone lines, internet users, and mobile cellular subscriptions respectively, categorized by region. These statistics of all developing countries in the categorized regions indicate that Asia and Africa lag behind the rest of the world average with the penetration of information and communication technologies, and some lie further behind than others.

The one area of information technology that is perhaps having the largest impact within developing countries is cellular phone technology. The incredible growth that cellular technology has experienced can be credited to the wire-free mobility that the technology offers. There are currently more mobile cellular subscriptions than any other form of information technology. The actual number of cellular phone users is questionable in developing countries because cellular phones may be shared between families and communities, which, in turn services a larger population. The impact of this technology in developing countries is astounding. The fastest growth in the mobile cellular subscription is currently being experienced in developing nations which currently account for roughly two-thirds of the mobile phone usage. In the past five years, mobile cellular subscription in Asia has tripled. Figure 9 (Appendix) shows the growth rate of mobile cellular subscribers in selected developing countries. The figure shows the growth among developing countries in recent years.

In contrast to the rapid expansion that mobile cellular subscription has experienced, fixed telephone lines have experienced little growth over the past few years, due largely to the increased availability of mobile networks. Figure 10 (Appendix) shows fixed telephone lines statistics in selected developing countries. As the figure indicates, South America and Africa show a very slight increase, while the selected developing countries in Europe experience a decline in fixed telephone lines. There is noticeable growth of fixed telephone lines in the developing countries in Asia of roughly 69.7% compared to all other developing countries. The slight growth rate of fixed telephone lines is a prime example of historic technology that is being surpassed by newer, more flexible, forms of technology. Given the preceding data, it appears that the selected developing countries are taking advantage of cheaper and more robust technologies.

In most of the developing countries selected for comparison, the number of Internet users has seen an increasingly upward trend as shown in Figure 11 (Appendix). As the development of the Internet progresses, some of the selected developing countries in Europe, South America and Africa registered phenomenal growth in the estimated internet users.

This can be traced to some deliberate actions and strategies undertaken by the respective countries towards increased access and deployment of internet services. Even though the trends in Figure 11 (Appendix) indicate increasing growth for the selected developing countries, according to experts many developing countries still lack an adequate fixed telephone line infrastructure; yet, recent statistics indicate that developing countries have twice as many internet users as they have PCs. This ratio is inversely related to per capita income, with four times as many internet users than PCs in the Middle East, North Africa, and South Asia (World Bank, 2008).

Strategic actions by developing countries regarding technology can transform the conditions under which technology achievement occurs. Sound economic and regulatory framework, transparency and infrastructure stability can make developing countries more attractive for both the private and public sectors of technology. Other methods of improving technological capability in developing include:

- Strengthening scientific and technological education at all levels
- Establishing a system for the popularization of technology
- Providing incentives for the encouragement of young scientists
- Promoting the publication of scientific books, and science & technology journals and newsletters
- Encouraging the private sector to participate in popularization activities

#### 4. CONCLUSIONS

The importance of technology as a driver for social, economic, and educational advancement has been well documented in recent years. Technology has become integrated into the daily activities of millions of people throughout the world's most industrialized nations, yet millions of people still have never heard a dial tone. In developing nations where food, clean water, and adequate health care are in short supply, the benefits that technology can provide have not been fully realized.

Developing nations may feel threatened by the equitable social and economic development of their society's consequent to problems of poverty, unsustainable patterns of consumption and production, and profligate utilization of their natural resources. As discussed above, knowledge and its application in technology have always been key components of development for all countries. The generation and application of technology and technological interchange, sharing and networking have become increasingly vital for economic and social development. Developing societies still sorely lack the capacity to fully participate in the building of a knowledge community, and this at a moment when the digital divide also accentuates disparities in development, excluding entire nations from the potential benefits of new opportunities. Thus an authentic global network is not yet a reality for many. The speed of modern technological progress poses new sets of challenges. The information and communication revolution offers new and effective means of exchanging science knowledge and advancing education and research, which promote the economic and social development of all people. The analysis also shows that in most cases the technology has positive effects on education, infrastructure, healthcare, social and economic development, as well as positive growth and developmental rates.

The adoption of technology by developing nations has shown that older technologies are being replaced, and in some circumstances bypassed entirely, by new technologies such as cellular phones. In less than three decades, cell phones have connected more individuals than fixed line telephony had throughout the preceding century. Computers and the Internet are having a direct impact on the lives of people worldwide. Several obstacles that must be overcome before the benefits of technology will truly be realized by developing nations, however. A majority of developing nations lack the infrastructure necessary to support reliable data technology. As developing countries continue to focus on their technological capability and access by enhancing their research and development in the technology sector, progress in the digital age looks bright.

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## Appendix

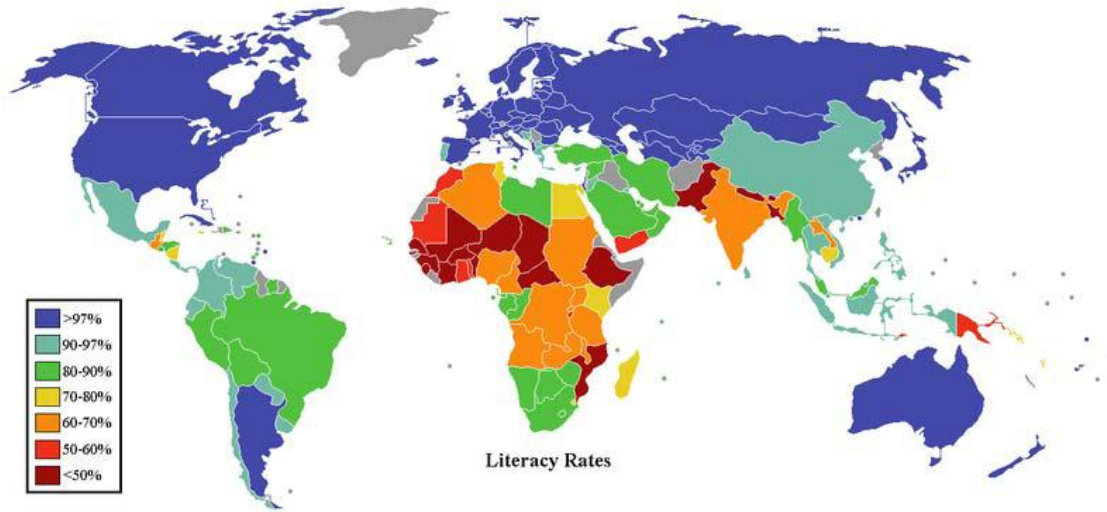


Figure 1. Global Literacy Rates  
Source: UNESCO Institute for Statistics (2008)

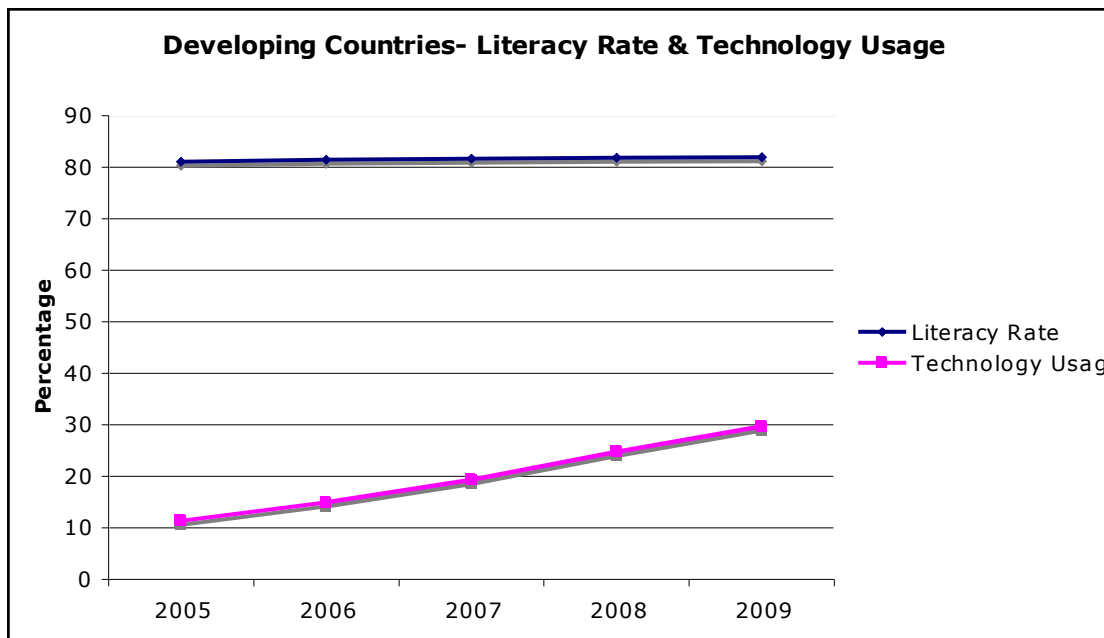


Figure 2. Selected Developing Countries Literacy Rate & Technology Usage  
Source: International Human Development Indicators/ Adult Literacy Rate & ITU World Telecommunication / ICT Indicators database

**Table 1. Literacy Rate in selected developing countries (2000 – 2007)**

	Literacy				Primary Education					
	Adult literacy rate, 2005 - 2008 (%)		Youth literacy rate, 2005 - 2008 (%)		Primary net enrollment rate 2000 - 2007 (%)		Survival rate to final grade of primary, 2000 - 2007 (%)		Primary level repeaters 2000 - 2007 (%)	
	Women	Men	Young women	Young men	Girls	Boys	Girls	Boys	Girls	Boys
Argentina	98	98	99	99	98	99	96	93	5	8
Brazil	90	90	99	97	95	93	84	76	20	20
Chile	99	99	99	99	94	95	98	98	2	3
Colombia	93	93	98	98	87	87	92	85	3	4
Croatia	98	100	100	100	90	91	100	100	~	~
Czech Republic	~	~	~	~	94	91	99	98	~	1
Egypt	58	75	82	88	94	98	96	94	2	4
Ethiopia	23	50	39	62	68	74	59	57	5	7
Hungary	99	99	99	98	86	87	98	98	2	2
India	51	75	74	88	87	90	65	66	3	3
Indonesia	89	95	96	97	93	97	81	78	3	4
Iran	77	87	96	97	100	91	87	88	1	3
Kenya	83	90	93	92	86	86	71	74	6	6
Malaysia	90	94	99	98	82	83	93	86	8	11
Morocco	44	69	68	85	86	91	76	79	10	14
Pakistan	40	67	59	79	57	73	72	68	5	6
Peru	85	95	97	98	97	95	90	90	8	8
Poland	99	100	100	100	96	95	~	~	~	1
Romania	97	98	98	97	94	94	95	95	1	2
South Africa	88	90	98	96	86	86	79	75	8	8
Thailand	92	96	98	98	94	94	~	~	6	12
Ukraine	100	100	100	100	89	89	99	97	~	~
Venezuela	95	95	99	98	92	92	100	95	4	6
Viet Nam	90	95	96	97	91	96	86	87	2	3

Source: Statistical Annex / Education: Literacy and primary education- Table 3

The HDI—three dimensions and four indicators

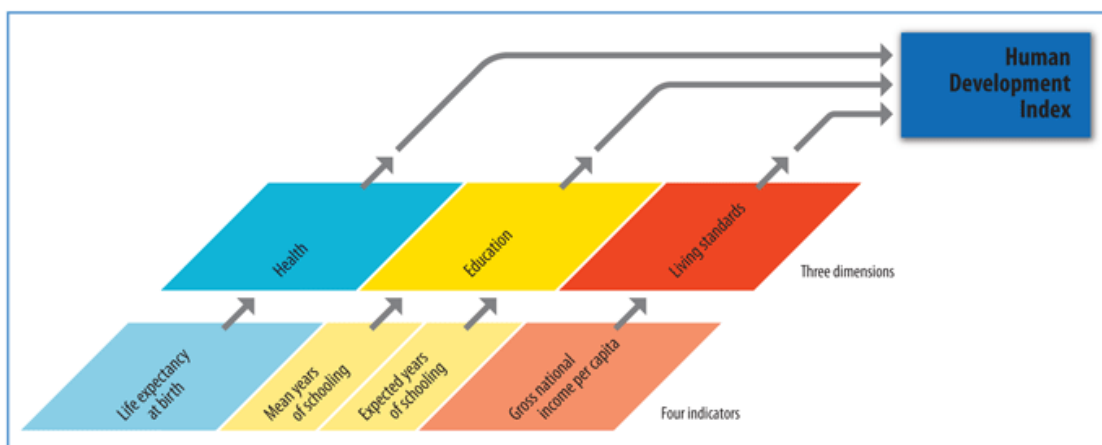


Figure 3. Components of Human Development Indicator (HDI)  
 Source: International Human Development Indicator

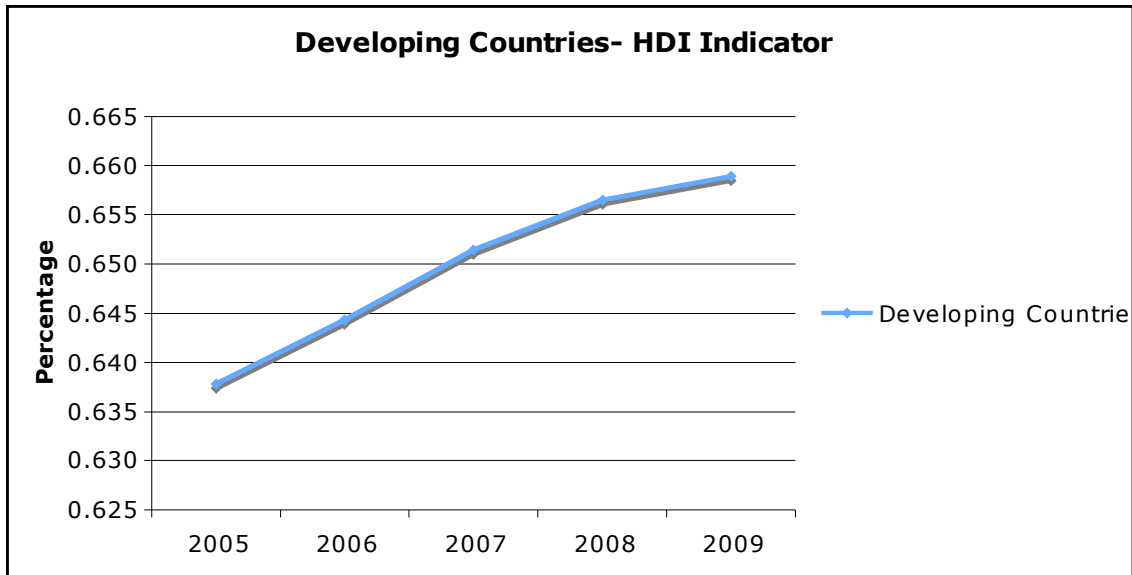


Figure 4. Human Development Indicator for selected developing countries  
Source: International Human Development Indicator

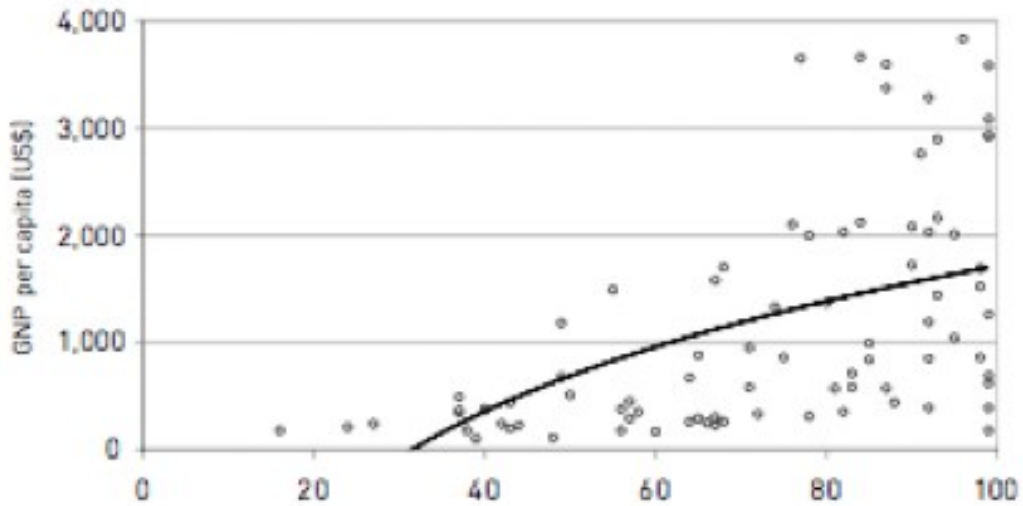


Figure 5. Technology Usage and GNP per capita  
Source: ITU World Telecommunication / ICT Indicators database & World Bank (2008)

**Table 2. Investment in R&D and publications**

<u>Country</u>	<u>Research and Development</u>		<u>Scientific and Technical Journals and Articles</u>
	Year	as % of GDP	#
<i>(Developing Countries)</i>			
Argentina	2007	0.51	3362
Brazil	2007	1.10	11885
Colombia	2007	0.16	489
Croatia	2007	0.81	1102
Czech Republic	2007	1.54	3689
Egypt	2007	0.23	1934
Ethiopia	2007	0.17	149
Hungary	2007	0.96	2452
India	2007	0.80	18194
Pakistan	2007	0.67	741
Poland	2007	0.57	7136
Romania	2007	0.53	1252
South Africa	2007	0.93	2805
Ukraine	2007	0.85	1847

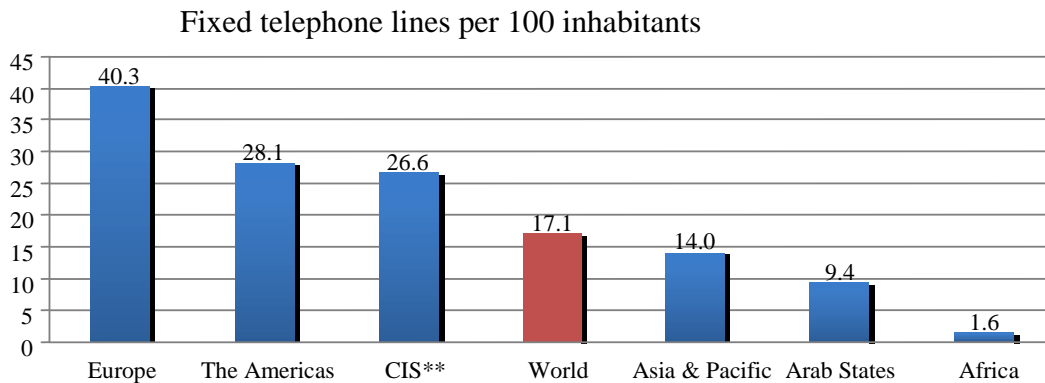


Figure 6. Global Fixed Telephone Lines per 100 inhabitants, 2005 - 2009  
 Source: ITU World Telecommunication /ICT Indicators database

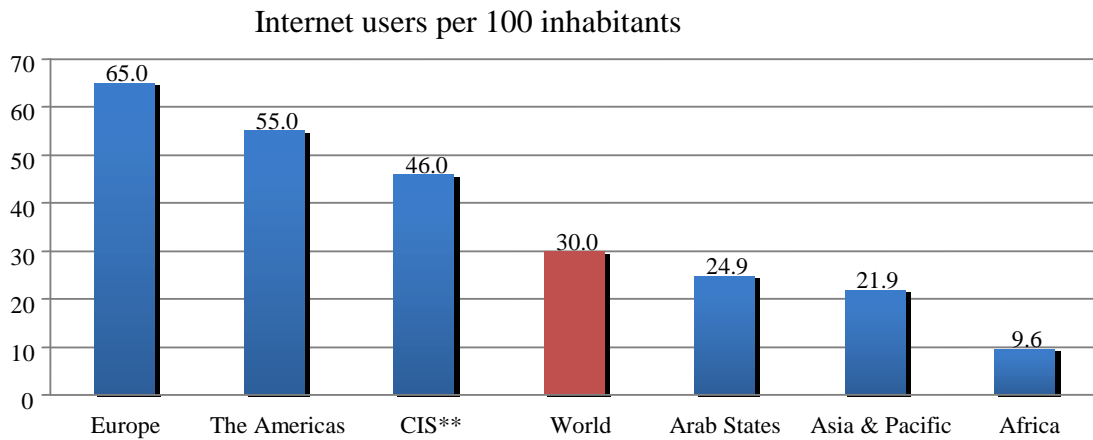


Figure 7. Global Internet Users per 100 inhabitants, 2005 - 2009  
Source: ITU World Telecommunication /ICT Indicators database

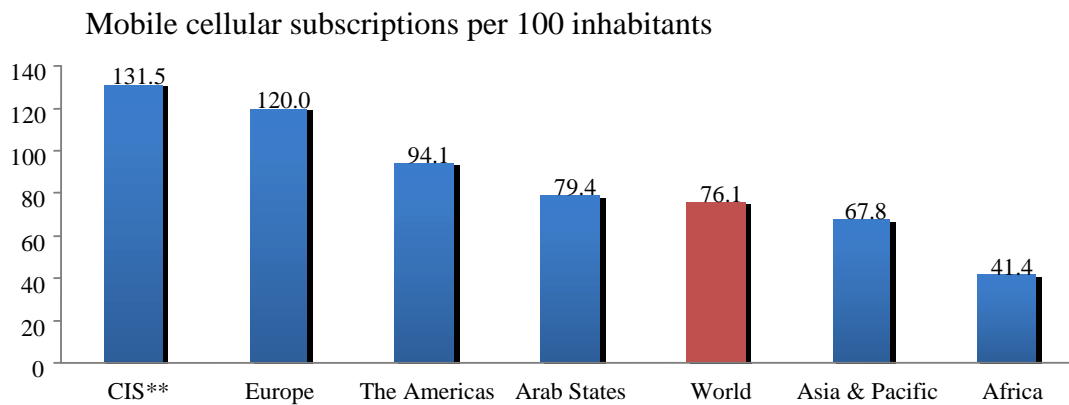


Figure 8. Global Mobile Cellular Subscriptions per 100 inhabitants, 2005 - 2009  
Source: ITU World Telecommunication /ICT Indicators database

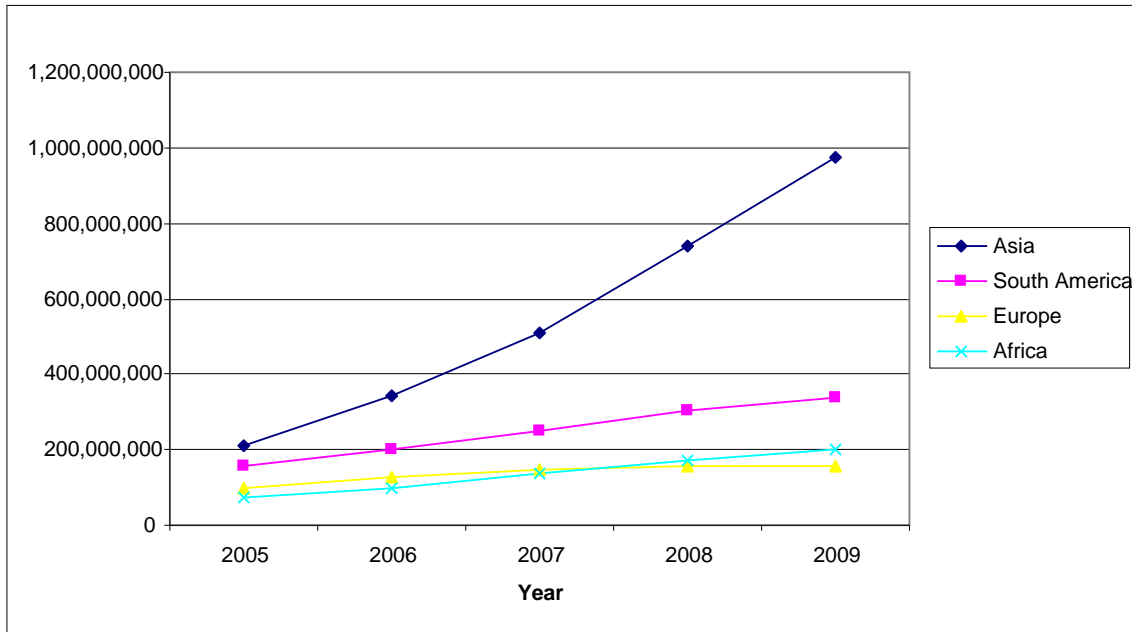


Figure 9. Mobile Cellular Subscriptions, 2005 - 2009

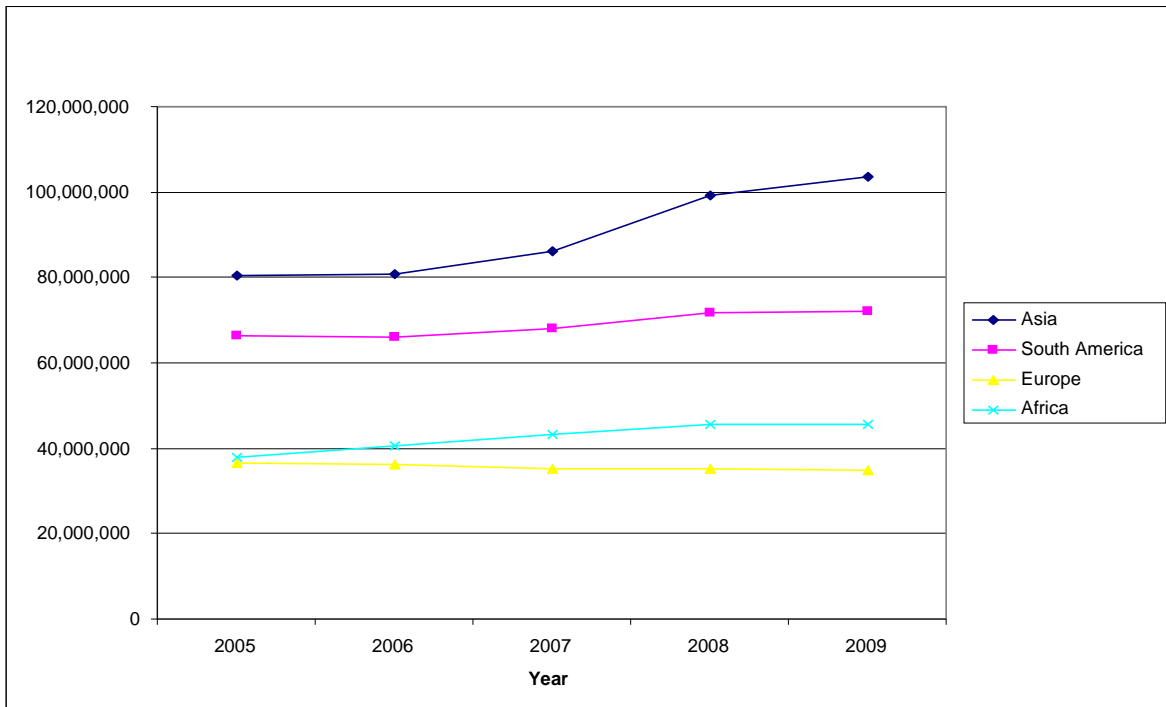


Figure 10. Fixed Telephone Lines, 2005- 2009

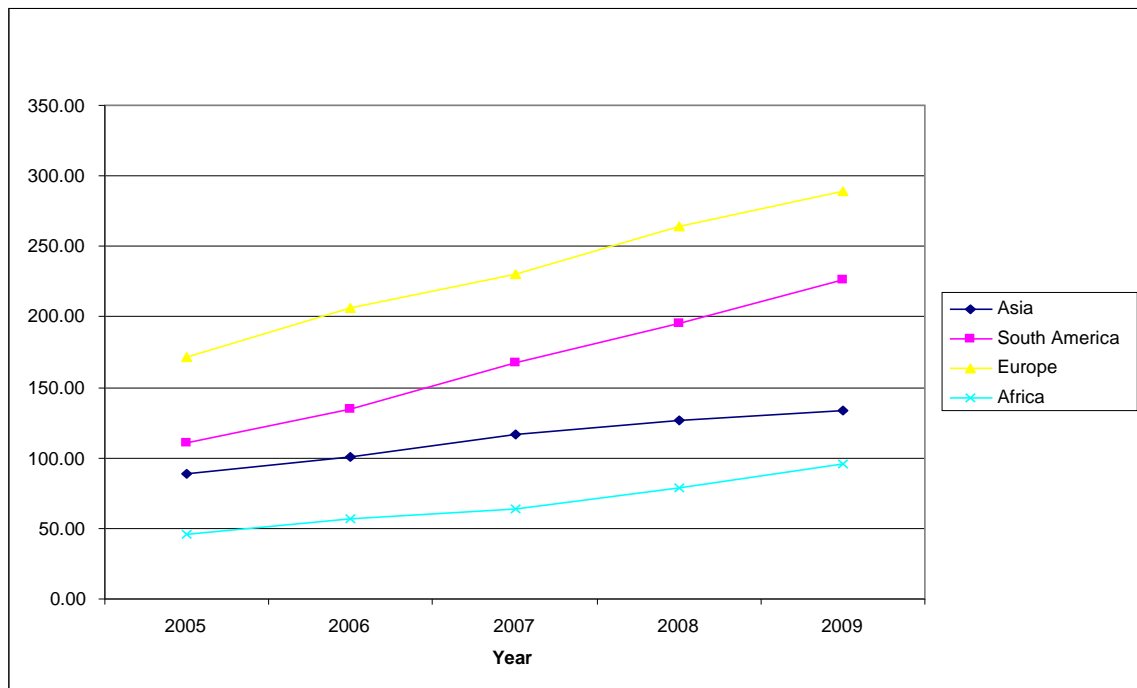


Figure 11. Estimated Internet User, 2005 - 2009