

Will M-Commerce Bridge the Global Digital Divide?

Abstract

Capabilities of accessing, delivering, and exchanging information in digital forms vary greatly across the rich and the poor countries. In the low-income countries, high costs of information and communication technology (ICT), supply constraints, lack of relevant skills, unavailability of required content on the Internet, unfavorable geographic structures, and other similar factors are responsible for the lack of access to digital information. This paper argues that the characteristics of mobile technologies and emergence of mobile commerce (m-commerce) offer the prospects of bridging the global digital divide if proper policies are put in place at various levels in the public and private sectors.

Capabilities of accessing, delivering, and exchanging information in digital forms vary greatly across the rich and the poor nations [4]. This “global digital divide” is the outcome of the complex interactions between information and communication technologies (ICT) and various factors in the environment (Figure 1). The disparity between developing and advanced nations in terms of their ICT infrastructure is attracting the attention of academicians and policymakers [27, 36]. This paper explores the potential role of mobile technologies in bridging the global digital divide.

It is often argued that the introduction of a modern telecommunications network may allow developing nations to leapfrog ahead of their advanced counterparts and help to close the digital divide [1, 18]. While the fixed line networks are exhibiting impressive growth rates in the developing world, the strongest trend in the world in general and developing countries in particular has been in the explosion of mobile telecommunications. Table 1 provides some indicators of the global disparities as well as of growth trends in fixed and mobile ICT infrastructure. As can be seen, the growth rate of mobile telephony in the low-income countries is almost twice that in the high-income

countries. It should be noted that until a few years ago, mobile phones actually widened the gap between the developed and developing countries as they were diffusing more rapidly in high-income countries [36]. Furthermore, there is evidence of leapfrogging – the percentage of mobile phones that are digital is the highest in the poorest nations.

Box 1: Technology Developers and Service Providers Focusing on Developing Countries

- Nokia has invested more than \$1 billion in China. China is Nokia's second largest source of sales revenue in the world. Nokia has over 5000 employees in China working in its eight joint ventures and in a wholly owned manufacturing plant and an R&D center.
- WorldTel is an investment venture launched by the International Telecommunication Union (ITU) and organized according to business principles. WorldTel helps businesses identify and execute profitable telecommunications investment opportunities in developing countries. Leading handset makers and service providers such as AT&T, Cable and Wireless, NEC, and Nokia have expressed interest in WorldTel, which expects to realize real rates of return on equity of 25 percent or more [10].
- In October 2000, Hewlett-Packard launched World e-Inclusion, a business initiative with a social mission of bringing the benefits of technology to the four billion people in the developing world with very low incomes. As an example, HP Labs India was launched in April 2001 to generate innovations targeted at the world's emerging economies by studying the confluence of relevant social, cultural, economic and technological drivers of and barriers to ICT adoption. The labs focus on economically and culturally appropriate technologies, language localization, and connectivity solutions.
- Millicom International Cellular (MIC) is a major developer and operator of cellular phone systems throughout the world, especially in developing countries. MIC has interests in 34 cellular operations in 21 countries in Latin America, Africa, Asia and Russia and covers a population of over 584 million. The number of subscribers of MIC grew by 63% to about 3.1million in 2000. During 1995-2000, the compound annual growth rate of MIC subscribers was 80%. MIC's total revenue in 2000 amounted to \$571million with an operating profit of \$229 million. The revenue of MIC Latin America, which accounts for MIC's 56% of subscribers, grew by 31% to \$314 million in 2000 [20].

Along with the growth of mobile telecommunications, “mobile commerce” or m-commerce is gaining popularity. M-commerce refers to any monetary transaction conducted via a mobile telecommunications network [21] and such transactions are not necessarily Internet based [28]. Estimates suggest that by 2005, Internet access through wireless devices will outstrip personal computer access [36] and more than 25 % of e-commerce will take place over handheld sets [29].

The rapid expansion of mobile networks in low-income countries and the associated emergence of m-commerce has brought a ray of hope that the global digital divide could be bridged in some cases with the help of mobile technologies. Some companies are beginning to incorporate truly global visions in their strategic plans (see Box 1).

Barriers to Internet Adoption

Depending upon the information to be accessed, delivered or exchanged, several means of communications can be employed, either singly or in some combination. These include fixed voice networks, fixed data networks (connected to personal computers), mobile voice networks, and mobile data networks. Although Internet – mainly via a fixed telecommunications network – is increasing exponentially, a large majority of population in the low-income countries is deprived of its benefits. The adoption of Internet via fixed telecommunications network in low-income countries is hindered by several factors. First, a large majority of potential users in developing countries cannot afford a telephone line, a personal computer, and the telephone and Internet services provider (ISP) access charges.

Figure 1 here

Second, even if consumers are willing to pay for the connection of a telephone line, there is a big gap between demand and supply in many developing countries. High import taxes on ICT products, monopoly in telecommunications sector, and unfavorable

geographical structures such as rugged mountains, wet and swampy ground, and deserts are responsible for the higher prices and low supply of ICT in these countries (Figure 1).

Table 1: Indicators Related to the Access to Information and Communications Technologies (ICTs)

<i>ICT-related Indicator</i>	<i>Income Category of Country</i>			
	<i>Low Income</i>	<i>Lower Middle Income</i>	<i>Upper Middle Income</i>	<i>High Income</i>
Per capita GNP (US\$), 1999	410	1200	4900	25730
Number of Internet hosts (per 10,000 people), January 2000	0.37	2.83	35.88	777.22
Telephone main lines, per 1000 people, 1998	23	90	176	567
Telephone main lines growth rate (APGR, 1995-98)	17.1	16.3	10.8	3.1
Mobile telephones, per 1000 people, 1998	2	18	76	265
Mobile telephones growth rate (APGR, 1995-98)	116.6	76.3	77.4	47.1
Percentage of mobile phones which are digital (1998)	82.9	60.5	44.3	72.7
Personal computers per 1000 people, 1998	3.2	13.6	53.1	311.2
Electric power consumption per capita, KWH, 1997	357	1042	2434	8238
Adult illiteracy rate (%), 1998				
▪ Males	30	10	9	-
▪ Females	49	23	11	-

Source: [14, 15, 34]

A third problem is related to the lack of skill. A majority of potential users in developing countries lack English language and computer skills – prerequisites to the use of Internet. For instance, a survey of 2.5 million Web pages in 1998 found that about 85 percent of the text was in English [26]. This proportion decreased to about 80 percent in 1999 and is estimated to reduce to 50 percent by 2003 [24]. Although a shift of Internet content to non-English languages is under way [23], some knowledge of English is still necessary to use the Internet as the bulk of software used in the Internet is in English [12] and most of the human-computer interfaces favor English language users [9].

A fourth problem is related to the lack of relevant content. Although there are an estimated 4 billion Web pages in existence with a daily addition of about 7 million new pages [25] and an annual growth rate of about 100 percent [22], the content remains largely geared to the needs of advanced nations.

Mobile communications and mobile commerce could help to close the gap if mobile sets are cheaper, the variable cost is reasonable, and yet able to serve the information needs of the potential users. Whether, and the extent to which, m-commerce will narrow or widen the global digital divide depends upon its capability to overcome the barriers to information access in low-income countries.

Barriers to Internet: Specifics

Table 2 describes several barriers to Internet adoption for a large proportion of potential users in developing countries. First, rugged mountains, jungles, deserts and wet and swampy grounds, characterize the geographical structures of many developing countries. Compounded by low population densities and low incomes, it is too costly as well as time consuming to install fixed telecommunications networks in such places.

Second, setup costs as a proportion of per capita incomes are much higher in developing countries than they are in advanced countries. Fixed telecommunications networks require infrastructures to support cables, wires, poles and ducts. Operation and maintenance costs are also significant proportion of the total costs. Furthermore, these costs increase with the increase in the distance to be served. In addition, Internet services providers (ISPs) from developing countries have to pay for the full cost of leased lines to Internet backbones in the U.S., which adds to the already high costs of providing Internet services. The problem is compounded by the lack of intra-regional infrastructure in

developing countries – even Internet communications with neighboring countries often need to be routed through the U.S. or other industrialized countries [27]. Also because of the long distances and unpaved roads, repairing rural telephone lines is relatively costly [31]. Since all these costs are transferred to the end-users, Internet access in developing countries often proves to be a very costly proposition.

Third, even if the consumers are willing to pay, existing telecommunications networks in developing countries are insufficient to meet the demand. For example, there were about 43 million people on registered waiting lists for telephone connection in developing countries in 1996 [12]. The average waiting period is longer than 10 years in some countries such as Russia and Moldavia [30].

Fourth, only individuals with a regular income, a bank account, and a permanent address are qualified for a telephone line in many developing countries. As a large proportion of rural people in developing countries lack one or more of these requirements, they are less likely to be qualified for the service. Furthermore, wired networks must be planned from the beginning to meet predicted long-term demand. The suppliers have to adjust the price to meet the demand uncertainty, which pushes up the price of telecommunications services further.

Fifth, Internet lacks the content required by the potential users in developing countries. Carter and Grieco[4] argue that to date, Internet content is driven by the goals of maximizing shareholder value or reducing public expenditures. Since providing content to low-income users increases public expenditure and is less likely to contribute to “shareholder value”, such content does not get developed. As a result, the information required by potential users in developing countries is not easily available on the Internet.

Sixth, electricity is a basic requirement to access Internet using personal computer and fixed telephone lines. Poor people are often located far from power grids and thus lack electricity connection.

Table 2: Several Types of Barriers to Internet Adoption

Type	Barrier
Geographic	<ul style="list-style-type: none"> ▪ Rugged mountains, jungles, deserts, wet and swampy ground compounded by low population density make too costly as well as time consuming to construct wire line networks in developing countries.
Cost	<ul style="list-style-type: none"> ▪ Infrastructures needed to support a cable network, wires, poles and ducts and operation and maintenance costs of fixed telecommunications services higher. The setup costs as a proportion of per capita incomes are much higher in developing countries. ▪ The cost increases with the increase in the distance to be served.
Supply constraint	<ul style="list-style-type: none"> ▪ Demand is much higher than supply of telephone services in many developing countries.
Payment/Pricing mechanism	<ul style="list-style-type: none"> ▪ Wired networks must be planned from the beginning to meet predicted long-term demand ▪ Requirement to have regular income, a bank account and a permanent address to be qualified for telephone ownership.
Unavailability content	<ul style="list-style-type: none"> ▪ Contents on the Internet lack focus on the information requirement of low-income communities.
Electricity	<ul style="list-style-type: none"> ▪ Only a small proportion of households in developing countries have electricity connection.
Skill required	<ul style="list-style-type: none"> ▪ Many people in developing countries cannot read and write and lack language and computer skills.
Bandwidth and speed	<ul style="list-style-type: none"> ▪ Low bandwidth of Internet connection in developing countries.
Proneness to vandalism and natural disaster	<ul style="list-style-type: none"> ▪ Fixed telecommunication networks are prone to vandalism, theft and natural disaster.

Seventh, Internet use requires literacy and basic ICT knowledge at a minimum. Internet adoption in low-income countries is hindered by poor awareness and knowledge of technology related products, lower literacy rates and lack of computer and language skills.

Eighth, Most developing countries, especially those with large populations, have Internet connection with very low bandwidth. Arunachalan [3], for instance, argues that low bandwidth in developing countries is one of the major obstacles for scientists in the developing countries to contribute as “equal partners in the worldwide enterprise of knowledge production and dissemination”.

Ninth, fixed telephone lines are prone to vandalism. In the civil unrest of Nepal in 1990, for instance, protestors destroyed thousands of telephone lines. In developing countries, copper wire used in fixed telephone is a lucrative target for thieves, which results in frequent breakdowns of the network [30].

Relative Effectiveness of Mobile Networks in Overcoming the Barriers

A comparison of fixed voice network, fixed PC-based data network, and mobile network to overcome different types of barriers listed above is presented in table 3.

Mobile networks are the most effective alternatives for communication in places with unfavorable geographic structures such as rugged mountains, wet and swampy ground, deserts, etc.

Since there is no need to dig trenches for cables, installation costs are likely to be lower for mobile phones. Furthermore, wireless systems are distance insensitive [5], which means that a subscriber 100 meters away can be served at the same cost as a subscriber 20 kilometers away. The cost of cabling a fixed network, on the other hand, rises rapidly in proportion to the distance from the local exchange. The payback period for the investment in mobile networks is likely to be relatively shorter and they can break even with a much smaller number of subscribers. In Venezuela, for instance, profits began to roll in only three years after the startup of the mobile services [17].

Competition in the telecommunications sector and rapid development in technology have reduced steeply the fixed as well as variable costs of using mobile phones. A study by Yankee Group found that worldwide wireless prices fell by an average of 38 % between the fourth quarter of 1996 and the first quarter of 1999 [30]. In China, for example, connection fees as well as handset prices have halved during 1997-99 [30]. Furthermore the new-generation mobile sets are hybrids between a laptop computer and a mobile phone. Third generation cell phones are putting a phone, a computer, the Internet and a credit card together. Costs of such mobile sets are likely to be lower than that of personal computers.

Mobile phones are also closing the gap between demand and supply. In the 1990s, for instance, the number of mobile phones worldwide grew by 50 % annually compared to less than 10 % for fixed connections and the proportion of mobile phones increased from 1 out of 50 phone connections in 1990 to 1 out of 3 in 1999 [37]. ITU [15] forecasts that by 2009 there will be more cellular subscribers than fixed line subscribers. While mobile phones are supplementing fixed telephones in higher income countries, they are acting as substitutes for fixed telephones in lower income countries [13]. Mobile networks are growing much faster than fixed networks in low-income countries (table 1). Moreover, the proportion of mobile phones that are digital is higher in low-income countries than in middle- and high-income countries. In some low-income countries such as Cambodia and Venezuela, mobile phones already outnumber the fixed phones [36]. Likewise, in Venezuela the waiting time for fixed phone lines was about five years and people were willing to pay the equivalent of 10 times the minimum wage to get a telephone line [17]. It is now possible to sign a contract for a mobile phone and start

using it immediately. Another important benefit of the wireless network is its scalability. It can be deployed gradually as new customers are added simply by adding antennae where necessary.

Table 3: A Comparison of Fixed and Mobile Networks along Several Dimensions

Barrier to Adoption	Effectiveness in Overcoming the Barrier		
	Fixed voice network	Fixed network connected to PC	Mobile network
Geographic	Not very effective	Not very effective	Very effective
Fixed Cost	Not very effective	Not at all effective	Very effective
Variable cost - Now	Very effective	Not very effective	Not very effective
Variable cost - Future	Very effective	Very effective	Very effective
Supply constraint	Not very effective	Not very effective	Very effective
Payment/Pricing mechanism	Not very effective	Not very effective	Very effective
Unavailability of content	Not very effective	Very effective	Very effective
Requirement of electricity	Not very effective	Not very effective	Very effective
Skill required	Very effective	Not very effective	Very effective
Bandwidth and speed	Very effective	Very effective	Not very effective
Proneness to vandalism and natural disaster	Not very effective	Not very effective	Very effective

Wireless companies are better at tailoring their products and pricing to different segments of the market than their fixed-line competitors. Wireless companies are selling a range of services, from pagers to pre-paid cards. Pre-payment has been one of the major attractions of cellular telephones for consumers as well as sellers. For instance, in 2000, pre-paid subscribers of Millicom International, a cellular company with investments in 34 cellular companies in developing countries, increased by 70% with an increase of 79% in prepaid minutes [20]. The proportions of MIC's prepaid subscribers are as high as 56% in

Russia, 33% in Asia and 26% in Latin America [20]. In Latin America, pre-paid mobile consumers do not need to worry about the arbitrary telephone bills whereas erroneous billing has been a major problem for fixed telephone consumers. Similarly, 70 % of new users in Thailand and 100 % in Malaysia were pre-paid users in 1999 [30]. A mobile handset may be more expensive than a fixed telephone set, but the cost of the handset and service connection fee added together is lower than the installation charge for a new fixed line in many developing countries. Even the issue of handset cost is being attacked. Motorola and other handset makers have developed “disposable” mobile phones. Just as “disposable” razors are often used as regular razors in developing nations, low-cost disposable handsets may become regular phones for the poor in developing nations.

Box 2: Some Examples of the Uses of Mobile phones in Developing Countries

- In Jamaica, tradesmen on bicycles are found speaking on mobile phones [33].
- In Johannesburg, South Africa, many homemade signs with mobile phone numbers can be found in the streets which offer basic services ranging from house painting to gardening [30].
- Farmers have benefited from mobile sets by eliminating or reducing the role of intermediaries in the value chain. Mobile phones have enabled Bangladeshi farmers to find the proper prices of rice and vegetable. Similarly, cocoa and coffee farmers of Cote d'Ivoire check current prices in London commodity markets using mobile phones [30]. A few years ago, they could only have found out about market trends by applying to an office in the capita city, and their deal-making was based on information from buyers, which is often unreliable [17].
- In Uganda, despite the limited bandwidth, GSM is being used to provide Internet. Even high frequency radio is used to provide email connectivity [9].
- Investors in Shanghai, China trade stocks over paging network as well as over fixed Internet. Average daily trading volume over the paging network managed by GW Trade is about 30 times as much as the average trading volume on stockstar.com, the largest and most popular Web based stock trading company [6].
- In Congo, some maize farmers give the mobile phones to their security guards. Such uses of mobile sets have proven to be an effective weapon against robbery, which has resulted in the increase in their yields. Similarly, taxis Uganda have been found to be more efficient because of the uses of mobile sets [17].

Mobile phones do not need electricity as solar power can be used to recharge mobile phones and also to connect to the Internet [11]. Also, batteries can provide supplemental power.

Mobile sets have lower social entry barriers than computer-based Internet [7] since the use of a mobile phone does not require sophisticated skills.

Wireless technology has helped overcome bandwidth as well as infrastructure problems in some developing countries. For instance, Latvia overcame poor telephone infrastructure by providing high-speed wireless Internet links to universities, schools, and government agencies [35]. The Latvian academic network (LATNET), started in 1993 with low cost 2 Mbps wireless LAN PC adapters for use in a citywide University network, is currently the most important part of the educational network, connecting more than two hundred sites including university departments, institutes, high schools, and government agencies [35].

Mobile phones are also ideal for countries with inadequate infrastructure or in cases where existing infrastructure has been damaged by war, civil unrest or natural disaster. For example, the infrastructures were severely damaged by war in Lebanon and Cambodia but they were able to deploy mobile phones very quickly [17]. Similarly, after the earthquake in Honduras in 1998, mobile base stations were deployed in a few days [30].

Mobile sets have some limitations as well. Wireless Application Protocol (WAP) based service does not allow access to non-compatible and non-portal websites. Since the screens are small and images are of poor quality, they cannot deliver much entertainment value. Furthermore, while free browsers, free email accounts, free web

sites and even free Internet services are available in fixed Internet, content in mobile Internet is not likely to be free. Another concern is related to security. When WAP was introduced in China in 2000, the response rate was low. One of the reasons for the low response was found to be the security concern [7]. If someone steals the mobile set, the thief can have access to important information such as credit card, personal contact detail, etc. Such limitations, however, are of little relevance to the majority of potential users in developing countries deprived of any form of ICT infrastructure at present.

Mobile networks are already serving a variety of information and communication, needs for the users in developing countries (Box 2).

Policy Implications

Mobile communications have a number of implications for the handset manufacturers, mobile service providers, national governments as well as international agencies concerned with narrowing the global digital divide. The “divide” can be “narrowed” if multiple policy initiatives are undertaken to attack the main barriers: cost, lack of purchasing power, supply constraints and content (Figure 2).

Figure 2 here

Handset Manufactures and Service Providers

Among the several factors influencing the adoption of ICTs in low-income countries, affordability of mobile sets and services is the most important one. In the short run, providing handset and services at low price to potential users in low-income countries may result in low profit margin or even loss. The business models of ICT firms, however,

should consider the potential economies of scale when the number of adopters increases. Given that more than 80 % of the world population lacks telephone connection, even a small dollar margin multiplied by 3 or 4 billion becomes a huge amount. As Arthur [2] argues: “the Casino of Technology requires several things: excellent technology, the ability to hit the market at the right time, deep pockets, strategic pricing, and a willingness to sacrifice current profits for future advantage” (p. 108). Mobile technology is an excellent technology to serve the needs of potential users in low-income countries and now is probably the best time. The only things required for handset producers and service providers are: deep pockets, strategic pricing, and a willingness to sacrifice current profits for future advantage.

National Governments and International Agencies

Developments in mobile technologies are likely to allow developing countries to leapfrog ahead of their advanced counterparts if proper policies are put in place. The experience of countries that have opened their markets, such as Korea and Sri Lanka, indicates that competition among operators leads to lower prices [19, 36]. An effective way to attack two of the main barriers – high cost and supply constraint – is to open the market for competition. Merely opening the markets may not be enough to overcome these barriers. Governments in developing countries may also need to launch big projects or provide additional incentives to encourage ambitious private initiatives in mobile telecommunications.

Increase in mobile density should not be an end-goal in itself. Adoption of mobile phones should be evaluated in terms of the potential to improve the quality of lives of low-income people. National governments and international agencies should also help in

providing other related facilities to enable low-income people to use mobile sets effectively. Facilities provided to enable the use of mobile sets are likely to result in other shadow benefits. For instance, if loans are provided to buy small solar-power packs to recharge a mobile phone, it improves the quality of lives of rural people in a variety of ways. The solar power can be used to power radio, to keep vaccines cool in a community health clinic, etc. and people will be able to report diseases and order vaccines and other medicines [19]. Effectiveness of mobile sets can be increased further by identifying the information needs of low-income people and establishing several “information centers” to provide them with timely and relevant information.

Concluding Remarks

Mobile phones have the potential to reduce the global digital divide if appropriate policies are put in place at various levels. Availability, cost and pricing structure, and capability to satisfy information and communications needs are the main determinants of mobile telecom adoption in low-income countries. Whether and the extent to which mobile technologies can bridge the global digital divide, thus, depends upon the willingness of mobile set manufacturers and service providers to sacrifice current profit for future growth and initiatives of the national governments as well as international agencies.

References

1. Aggarwal, R. Technology and globalization as mutual reinforcers in business: Reorienting strategic thinking for the new millennium, *Management International Review*, 39, 2 (1999), 83-104.
2. Arthur, W.B. Increasing returns and new world of business. *Harvard Business Review*, (July/August, 1996) 101-108.

3. Arunachalam, S. Information technology: What does it mean for scientists and scholars in the developing world?, *Bulletin of the American Society for Information Science*, 25, 4 (1999), 21-24.
4. Carter, C. and Grieco M. New deals, no wheels: social exclusion, tele-options and electronic ontology. *Urban Studies*, 37, 10 (2000), 1735-1748.
5. Couesnongle, M. D. Technology solutions for the wireless local loop. *Telecommunications*, 30, 3 (2000), 49-51.
6. Ebusinessforum, GW Trade: Serving a High-tech Niche in China. March 23, 2000 <http://www.ebusinessforum.com>
7. Ebusinessforum China WAP technology gets a poor receptions. August 16, 2000 <http://www.ebusinessforum.com>
8. Ernberg, J. Universal access for rural development: from action to strategies, IRST International Conference on Rural Telecommunication, November 30 to Dec 2, Washington DC, 1998
9. Goodman, S.E., Press, L.I., Ruth, S.R. and Ruthowski, A.M. The global diffusion of the Internet: patterns and problems. *Communications of the ACM*, 37, 8 (1994), 27-31.
10. Garcia, D. L. and Gorenflo, N. R. Rural networking cooperatives: lessons for international development and aid Strategies, <http://www.fao.org/docrep/x0295e/x0295e21.htm> 2001
11. Hammond, Allen L. Digitally empowered development, *Foreign Affairs*, 80, 2 (2001), 96-106.
12. Hedley, R. A. The information age: apartheid, cultural imperialism, or global village?. *Social Science Computer Review*, 17, 1 (1999), 78-87.
13. ITU. *World Telecommunication Development Report 1996/97: Trade in Telecommunications*, International Telecommunications Union, 1997.
14. ITU. *World Telecommunication Development Report: Mobile Cellular World Telecommunication Indicators*, International Telecommunications Union, 1999.
15. ITU. *Digital Mobile Growth*, International Telecommunications Union, 2000.
16. Landers, P. G-8 creates 'Dot Force' to help poorer nations tap technology. *Wall Street Journal*, July 24th, 2000.
17. Lopez A. The south goes mobile. *The UNESCO Courier*, 53, 7/8, (Jul/Aug , 2000), 65-67.
18. McGrey, D. The silicon archipelago, *Daedalus*, 128, 2 (1999), 147-176.
19. Millicom International, *1998 Annual Report*, 1998 <http://www.millicom.com/investor/index.htm>
20. MIC. Millicom International Cellular S.A. Annual Reports and Accounts 2000 <http://www.millicom.com/investor/downloads/mic2001ra.pdf>

21. Muller-Veerse, F, Mobile Commerce Report, London: Durlacher, 1999
<http://www.durlacher.com/research/res-reports.asp>
22. Nielsen, J. Kill the 53-day Meme, <http://www.useit.com/alertbox/9509.html>
23. Nua Internet Surveys. The Global Internet Market, April 5th, 1999,
<http://www.nua.ie/surveys/trendmuncher/archives/1999/issue1.html>.
24. Nua Internet Surveys, Internationalization of the Web, May 29th, 1999.
25. Nua Internet Surveys, Number of Pages Online Tops 2.1 Billion, July 13th, 2000.
26. Nunberg, G. Will the Internet always speak English?. The American Prospect, March 27- April 10, 40-43 (2000).
27. Petrazzini, B and Kibati, M. The Internet in developing countries. Communications of the ACM, 42, 6 (1999), 31-36.
28. Rask, M. and Dholakia, N. Next to the Consumer's Heart and Wallet: Frameworks for Exploring the Emerging M-Commerce Arena, Paper Presented at the American Marketing Association's Winter Educators' Conference, 2001.
29. Shaffer, R. M-Commerce: online selling's wireless future. *Fortune*, July 10th, 2000.
30. The Economist, *Survey: Telecommunications*, October 9th, 1999.
31. The Economist, *Business: Wiring the wilderness*, Jun 10th, 2000.
32. The World Bank. *World Development Report: Entering the 21st Century*, 2000
<http://www.worldbank.org/wdr/2000/fullreport.html>
33. The World Bank, The Role of Science and Technology in Small and Medium Sized Enterprise Development, 2000
<http://www.worldbank.org/html/fpd/technet/gk-smes.htm>.
34. The World Bank. World Development Report 2000/2001: Attacking Poverty, 2000 <http://www.worldbank.org/poverty/wdrpoverty/report/index.htm>.
35. Tully, J and Riekstins A. License-free wireless Internet access technologies *Computer Networks*, 31, 21 (1999), 2205-2213.
36. UNDP. *Human Development Report 2000*, United Nations Development Program, New York, 2001 <http://www.undp.org/hdr2001/completnew.pdf>
37. Wellenius, B., Braga, C. A. P. and Qiang, C. Z. Investment and growth of the information infrastructure: summary results of a global survey. *Telecommunications Policy Online*, 24, 8/9 (2000).

Figure 1: Classification of and interrelationship among various barriers to ICT adoption in developing countries

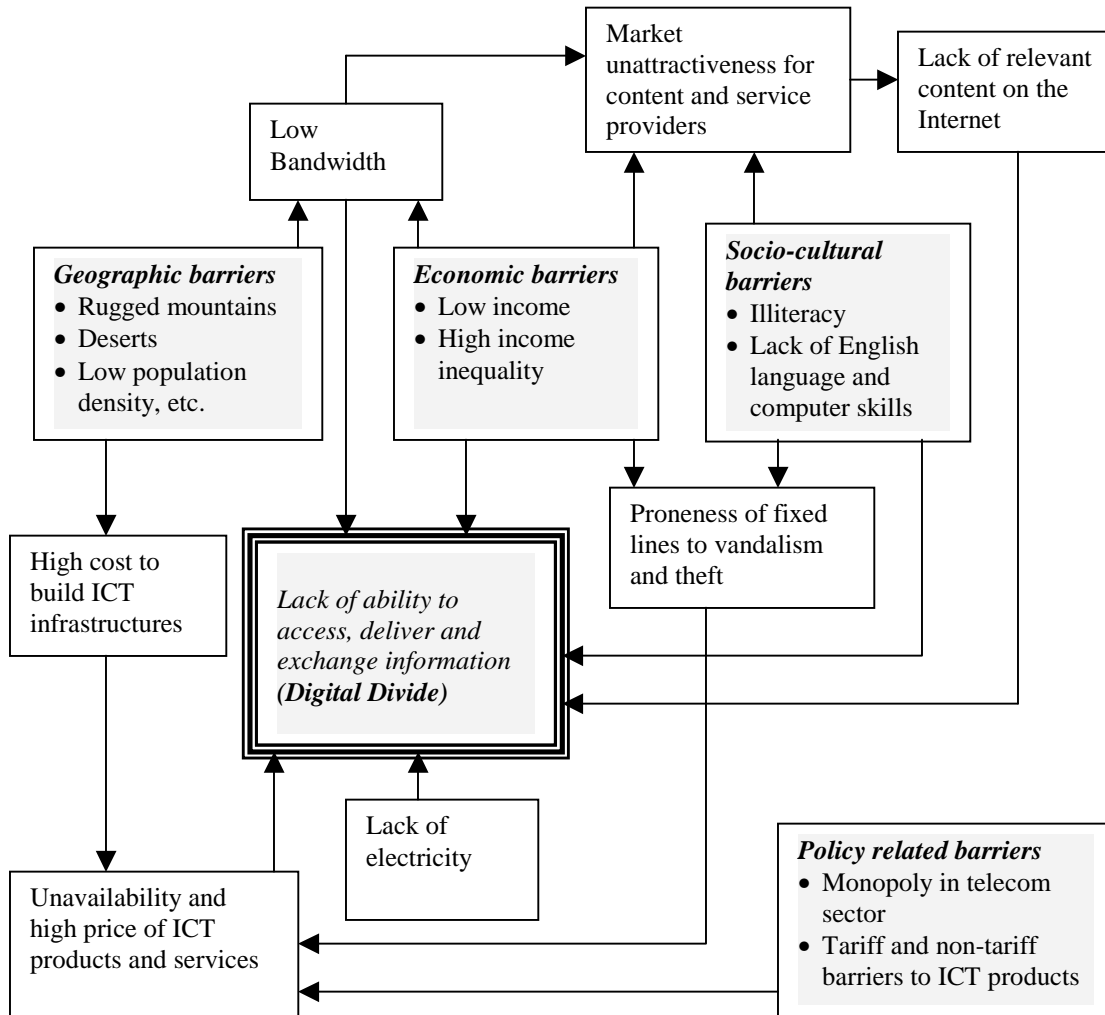


Figure 2: Policies at various levels to attack the barriers to ICT adoption in developing countries

