Chapter 2
Implications of the ICT Revolution

This chapter explores some of the ways ICT is likely to impact social and economic development and points to the strategic significance of ICT for enabling national development and poverty reduction strategies. ICT offers many promises and opportunities, even while posing serious risks and uncertainties. Its impact is likely to be pervasive. Countries must fashion their own responses. Ad hoc or passive postures are likely to lead to increasing digital and economic divides, marginalization of poor, and increasingly costly and burdensome government that erodes economic competiveness.

First, we are still in an early phase of a long-term technological wave and productivity revolution. Promising paradigm shifts within computing and communication point to a continuing dramatic decline in prices and increase in performance and intelligence of ICT systems. Moreover, long adjustment periods are needed for an economy to fully benefit from a revolutionary new technology. The ICT revolution and the accompanying socio-economic adjustments constitute a techno-economic paradigm shift with profound implications for the renewal of the productive and institutional structures in developed and developing countries alike.

Next, the pervasive and increasing impact of ICT is examined in a few areas related to public sector, community development, and poverty reduction. This impact covers organizations and markets, competitive strategies, innovation, financial services, employment, media and cultural development, regional and urban development, governance and participatory democracy, education, health, and poverty.

ICT's impact is accompanied by downside risks such as: wasting scarce development resources; exacerbating inequalities; reinforcing existing power distributions; and controlling, rather than empowering the individual. None of the promises or risks is predetermined by the technology; they are outcomes of complementary economic policies and socio-political choices. This argues for integrating the ICT agenda into the development and reform agendas in creative and dynamic ways.

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Early Phase of a Technological Revolution

Before assessing the revolutionary potential of information and communication technologies, we need to appreciate the phase we are in and the lead time needed for the full impact to be realized. The infancy and pace of the ICT revolution suggest that ICT is still undergoing revolutionary change and that many ICT tools have yet to diffuse to the majority of mankind. Technical advances in many ICT areas continue apace and could level or change the playing field for developing countries, provided policy and institutional changes are made to capitalize on these advances. These include mobile devices, wireless communications, open source software, low cost access devices, and the coming paradigm shift to utility computing. The recent explosive growth of mobile phones in developing countries opens up massive possibilities for delivering services to rural and remote areas of the world, as will be illustrated later.

A paradigm shift is underway to deliver Internet-based software service (cloud computing) and to have computing power made available as a utility (utility computing), much like electrical utilities (Carr, 2008). This shift will have profound impact on ICT investment and diffusion: reducing the cost of ICT ownership, emphasizing the importance of shared infrastructures and broadband communications to realize economies of scale, and accelerating the diffusion of ICT as a general-purpose technology.

Advances in Internet technology are likely to provide the interactivity and real-world awareness needed to support business-to-business transactions, even while demanding limited communication capacity (by optimizing use of bandwidth). It will exploit sensors and smart tagging and tracing technologies to enable manufacturers to track every product they make from inception to phase out, and thus help manufacturers optimize their sensor-enabled supply chain assets countrywide. The promise of next generation Internet is already being realized by early adopters in developing countries for logistics by companies such as Cemex in Mexico and for enhanced customer service by Carrier China (Colony et al., 2002).

Early Phase of a Productivity Revolution

Not only is the world at an early phase of a sustained technological change, but also it is in an early phase of realizing the productivity gains from those ICTs already available. In assessing the productivity impact of ICT, it is important to take account of the fact that long adjustment periods are needed for an economy to fully benefit from a revolutionary new technology.

It is instructive to understand the dynamics of the productivity surge of the 1920s arising from electrification and draw lessons for the anticipated lead time for economy-wide productivity surges from ICT (David, 1990, 2000). In the case of the electric dynamo, the great productivity gains came not from the fact that electrical engines were faster and stronger than steam engines, but that they facilitated more

efficient organization of work. It took decades for factories to be reorganized and for the full gains to be realized, but there were overall surge in productivity growth once a certain critical mass was reached. There are parallels between the interconnection of electric motors through grids—and the associated transformation in manufacturing practices—and the interconnection of computers via communication networks. The Internet, diffusing much faster in the United States than electricity did during 1880s–1920s, is a major step in this interconnection throughout local and global economies.

The ongoing technological revolution is so profound and pervasive that it challenges many traditional economic concepts that are rooted in incremental thinking. The transformative role of ICT has been difficult to capture in national statistics due to several kinds of measurement problems and time lags (IMF, 2001; David 2001). However, the evidence in terms of economy-wide productivity has become most clear in the case of the United States, as a range of studies have measured a contribution of about 1% in labor productivity in the 1990s (Gordon, 2000; Oliner and Sichel, 2000; Jorgensen and Stiroh, 2000; Council of Economic Advisors, 2001). Other studies have suggested significant (0.8%) increase in total factor productivity (TFP) growth, particularly driven by both ICT-producing and intensive ICT-using sectors (Kenny and Motta, 2002; Gordon, 2000; David, 2000).

Relatively more recent research suggests that ICT has driven the post-1995 revival of the productivity of US economy, almost doubling TFP (Brynjolfsson, 2003); US productivity growth continued even during the economic downturns of 2000 and 2008 (Brynjolfsson, 2009). The evidence of impact on productivity is even more compelling and persuasive across countries at the microeconomic, firm, and industry sector levels. Evidence from recent research provides a compelling case for ICT as a driver of productivity growth across many sectors of the US, EU, and emerging economies.

The relatively recent adoption and low usage of ICT in many developing countries suggest that this revolution had not yet had a significant impact on economy-wide productivity, except among the Asian tigers and perhaps a very few emerging economies. In order to have significant impact on growth, a country needs to have a significant stock of ICT or users in place, and perhaps be more advanced in using that stock for economic transformation. But even in the context of a number of middle income developing countries, studies indicate significant ICT contribution to firm productivity (for example, Brynjolfsson and Saunders, 2010). In Korea, a comprehensive ICT strategy has been a key driver in the fast rebound of its economy from the financial crisis; the ICT industry's contribution to GDP growth rose from a mere 4.5% in 1990 to an astounding 50.5% in 2000 (www.mic.go.kr). Most recent evidence on ICT contribution to growth comes from large countries such as India and China, best reflected in terms of their substantial exports in IT services or hardware.

Economic history, the cumulative learning and transformation process involved in using ICT, and the pace of this wave of technological change suggest that a "wait and see attitude" would keep many developing countries out of a technological revolution no less profound than the last industrial revolution (David, 2000; Perez, 2001;

Freeman and Soete, 1997). Countries that adopt an inactive or reactive posture, rather than a proactive one, are likely to lose windows of opportunities to leapfrog or fail to exploit a structural change to gain or maintain competitive advantage in many of their industries and services. These countries may be simply locked out and marginalized. The millennium development goals of halving global poverty, among others, are also unlikely to be met without these technologies.

Raising productivity through ICT use is essentially a developmental task that requires cumulative socio-technical learning and orchestrated investments in a combination of technological and social capabilities. Applying ICT to increase employment opportunities for the poor and empower them with information and learning also requires strategic intent, substantial experimentation, grassroots participation, social learning, and strategies for scaling up and sustainability.

New growth theorists and economic historians have characterized general-purpose technologies (GPTs) by: (i) wide scope for improvement and elaboration; (ii) applicability across a broad range of uses; (iii) potential for use in a wide variety of products and processes; and (iv) strong complementarities with existing or potential new technologies (Bresnahan and Trajtenberg, 1995; Helpman, 1998). General-purpose technologies are engines of growth. They play the role of "enabling technologies," opening up new opportunities rather than offering complete solutions. They act as catalysts, inducing complementary innovations in other sectors. While the steam engine is widely accepted as the GPT of the first industrial revolution, the electric dynamo is viewed as the GPT for the second industrial revolution.

ICT is the GPT of our age. As in earlier GPTs, the short-term impact (reflected in economy-wide productivity surge) may be uncertain, but the long-term impact will be profound and has been typically underestimated. The lead time for ICT to have its full impact may be shorter and the impact more transformative than for earlier GPTs. But advances in the technology are running far ahead of potential applications and the capacity of institutions and society to absorb and adjust to take full advantage of these technological capabilities. Moreover, the institutional changes and complementary innovations necessary for ICT diffusion and effective use in the public and educational sectors are likely to come at a slower pace than in business.

A Techno-Economic Paradigm

It is also instructive to understand the ongoing ICT revolution in terms of the overarching concept of a techno-economic paradigm that defines a new technical and institutional best-practice frontier (Box 2.1; Perez, 2002). Each technological revolution provides a new set of general-purpose, pervasive technologies and a corresponding set of new organizational practices for a significant increase in productivity in existing sectors. This combined best practice is referred to as a techno-economic paradigm. A techno-economic paradigm provides the means for modernizing all existing industries, activities, and infrastructures. This was the case

with the deployment of the mass production paradigm in the mid-20th century, and currently, the early phases of the ICT paradigm. A techno-economic paradigm articulates the technical and organizational model for taking the best advantage of the technological revolution and results in the rejuvenation of the whole productive structure.

Box 2.1 Technological Revolutions and Techno-Economic Paradigms

Drawing on Kuhn, Dosi, and Freeman, and other leading economic, development, and technology historians, Perez has articulated the overarching concept of techno-economic paradigm as a best-practice model made up of a set of all-pervasive generic technological and organizational principles (Perez, 2002, p.15). It represents the most effective way of applying a particular technological revolution and of using this revolution for transforming a whole economy. When broadly accepted and adopted, these principles or generic tools become the common sense basis for innovation and investment, for organizing activities, and for structuring institutions. A techno-economic paradigm gradually defines the new best-practice frontier.

Technological revolutions are defined by a powerful cluster of new and dynamic technologies, industries and products, plus associated infrastructures, and together be capable of bringing about a long-term upsurge of productivity and development. Each of these sets of technological breakthroughs or sets of interrelated generic technologies spreads far beyond the sectors where they originally developed. It is observed that these technological revolutions occur with some regularity, every 40–60 years, starting with the first industrial revolution around 1770, combining cotton industries, canals, and water power. The second, the age of steam and railways, started from 1830, using steam engines and steam-powered railways. The third, the age of steel and electricity, combines heavy engineering industries with rapid steel-steam ships and railways, electric networks, and the telegraph. The fourth, starting early 20th century, started the age of oil, automobile, and mass production, combined with roads, ports, airports, universal electricity, and analog telephones. The fifth, starting around 1970, is the age of information and telecommunications, combining cheap microelectronics, control instruments, software, computers, combined with a new kind of infrastructure: digital communications and the Internet (Perez, 2002).

With each technological revolution, a set of dynamic new industries are accompanied by a facilitating infrastructure. Each technological revolution induces a techno-economic paradigm shift, as it demands new organizational models and practices to take advantage of the new potential. The new possibilities and associated requirements unleash transformation in the way of doing things across the economy. This transformation reaches beyond the

economic sphere or the organization of production to involve the socio-institutional sphere and to become the shared organizational common sense of the period. For example, in the era of car and mass production, the paradigm principles were: mass production/mass markets, economies of scale, standardization, centralization, and hierarchies. In contrast, the guiding principles of the information age are: decentralized integration, network structures, adaptability, agility, customization, knowledge as capital, clusters, and economies of scope.

Without subscribing to the details of regularity of this techno-economic paradigm, this model offers a powerful lens through which to view the ongoing information technology revolution, its dynamics, and its requirements, to unleash, and harness its potential. Societies are shaped and shaken by each technology revolution, and in turn, the technological potential is steered by social, political, and policy choices, compromises and adjustments. Each technological revolution encounters powerful resistance from established institutions and vested interests. Matching and realigning the social and institutional environment to assimilate fully a technological revolution and its techno-economic paradigm involve painful changes, and at times creative disruption and destructions. Similarly, realizing the potential of the information and communication revolution requires revamping the productive structure, the building of new networks of institutions, the transformation of regulatory frameworks and governance, and even deep changes in ideas and culture.

Each techno-economic paradigm or surge involves a period of installation, during which a critical mass of investments in the new technologies and infrastructures are put in place against the resistance of the established paradigm. At about middle of the surge, there is a turning point when the built-up tensions are surmounted, creating the conditions for the deployment and wide diffusion. Such evolution by long leaps and massive economic transformations involves radical changes in production, consumption, management, organization, skills, communication, and transportation. It involves learning at all levels of society.

Understanding these dynamics and the necessary investments and changeover in governance and institutions is most critical to the information and communication revolution—perhaps the most pervasive and global technological revolution in recent human history. For the modern knowledge-based economy, the information and communication technology revolution combines the innovative and transformative powers of the earlier revolutions of the printing press, railways, electricity, and telephone. It further combines the new powers of microelectronics and the computing grid with those of biotechnology (bioinformatics), and nanotechnology. For slow moving economies, this techno-economic paradigm shift may present a tsunami rather than a new technological wave.

The transition to the new practices is not easy and takes decades. It is best described by Schumpeter (1942) as a process of “creative destruction” where the established leaders are unlearning much of the old and inventing or adapting to

the new. Despite the challenges of transition and transformation, the process of diffusion of the technological revolution and its paradigm generates a great surge of development.

Newcomers who understand the dynamics of the techno-economic paradigm shift can direct their efforts toward learning the new practices and may even find a route to leaping forward and catching up (Perez, 2001). The four "Asian tigers" took the leap forward with the microelectronics revolution, rejuvenated mature industries, and entered new and fast-growing industries. This involved intense learning and substantial investments in human capital and active absorption of technology. Similarly, development under the current techno-economic paradigm requires proactive and sustained efforts. According to this new paradigm, capacity to handle information, knowledge, and innovation will be more central than ever. This paradigm also calls for radical transformation in education and training systems, science and technology policies, and more broadly, in conceiving development strategies.

Pervasive and Increasing Impact

Early evidence from advanced economies and some new industrializing countries suggest a pervasive impact of ICT on many aspects of development. The remaining part of this chapter focuses on those impacts most relevant to governance, public institutions, and socio-economic inclusion:

- Governance and participatory democracy
- Education and health
- Poverty reduction
- Communication and service delivery
- Regional and urban development
- Innovation
- Organization
- Media and cultural development

Governance and Participatory Democracy

The information revolution is changing the institutions of governance and participatory democracy. It is enabling more access to information for all, and thus transparency, accountability, and citizen empowerment. This potential presents many promises and daunting challenges for governance. Information technology is decentralizing power over information, fostering new types of community and different roles for government (Kamarck and Nye, 2002; Eggers, 2005). Timely information on results is enabling governments to improve performance management and adopt more outcome-oriented and client-focused approaches. The

information technology revolution is also enabling new forms of democratic input and citizen feedback.

Accountability and trust in government rely on easy and free access to public information. Transparency keeps government accountable to citizens. In most developing countries, and until a decade or two ago, in developed countries, citizens have to go to great investigative lengths to find public information on budgets, services, and comparative performance of basic public services. Today, the Internet has become one of the most important tools in achieving a more transparent state in developed countries. In the United States, public officials are moving from a reactive stance of simply responding to freedom of information requests to proactively putting all kinds of public information online (Egger, 2005). Transparency drive is moving beyond displaying government documents to giving citizens access to government databases.

Increasing transparency in government also increases citizen involvement in government, boosts government credibility, reduces corruption, and raises performance. Transparency generates accountability, which in turn generates pressure for improved performance. Applied to government, ICT and the Internet allow citizens to scrutinize the political process. Corruption flourishes in darkness and thrives on ignorance. In Latin America, Chile is the most corruption-free country as well as the leader in electronic government. All areas where corruption thrives in developing countries—permits, licenses, fees, taxes, and procurement—are now web-enabled. In South Korea, Seoul's municipal government anti-corruption web site (OPEN) has subjected key administrative processes to public tracking and scrutiny. Customs is also another area rife with corruption in developing countries. In the Philippines, where customs is identified as the most corrupt office in the country, web-enabling the customs process has not only reduced fraud but also cut the time to release cargo by about 50–80% (Egger, 2005, pp. 134–36).

Government practices in information sharing have wide ramifications for the whole economy. Governments are the largest collectors, users, and disseminators of information resources on individuals and the economy. Their information sharing infrastructures and knowledge management practices have major consequences for individuals, businesses, and civil society, well beyond the functioning of government institutions.

Information technology is also being applied to the legislative branch of government, to enhance citizen participation in policy formulation and monitoring, and to promote democracy and the rule of law. e-Government enables a more honest dialog with the governed. Timely access to information, knowledge, and feedback is crucial to the policy-making process and the identification of policy impacts and dissemination of good policy practices. It is critical to the practice of pragmatic and evidence-based policy formulation. Creating information-rich environments means not only assuring transparency, but also assuring that multiple voices (including those of the disadvantaged) are heard.

But ICT is not a silver bullet. Local realties matter. Corruption and accountability involve complex economic, cultural, and governance issues. It usually takes intense and prolonged pressures from outside stakeholders and citizens for

governments to let the e-sunshine in. Citizens can be provided with the ability to comment online on all laws and rules before they are voted or finalized. But, will citizens use e-democracy forums to influence policy debates? Will public officials be able to manage the growing number of citizen comments on rules? Can elected officials use digital tools to enhance their ability to represent their citizens? Engaging stakeholders, building reform coalitions, and reaching more citizens by partnering with media are among the necessary measures to translate the enabling potential of ICT into improvements in governance and participatory democracy.

Education and Health

Technology and skills play critical and complementary roles in increasing productivity, and thus in economic growth theory Goldin and Katz (1998) show that during the industrial revolution of the 18th century, mechanization of industrial processes were profoundly deskilling. During the first half of the 20th century, by contrast, technical change slowed and became skill intensive. Since the last decades of the 20th century technological change has increased both in pace and skill bias. It may be the first case during which technical change has been simultaneously rapid and skill intensive (De Ferranti et al., 2002).

Globalization and the ICT revolution combined are rapidly raising the demand for, and changing the nature of, education and skills. New competencies are required for participating in the information society and knowledge economy: e-literacy, technological literacy, communication skills, problem solving, critical thinking, self-learning, team work, network management, change management, creativity, and initiative. Understanding this interplay at a relatively detailed level is critical to enable firms to adopt and adapt this general-purpose technology in developing countries and to focus reforms and content in education and training to those critical to participating in this revolution.

With accelerated technological change, a growing premium for educated and skilled manpower, and new channels for knowledge and learning, learning has become a lifelong imperative. A culture of openness and continuous learning is necessary for an inclusive information society and a sustainable knowledge economy. Educational systems have to shift from established textbook knowledge to teaching how to learn and enabling individuals and organizations to become agile problem solvers. A lifelong learning system covers learning from formal and informal sources. Much of this learning has to occur through networks that cut across academic, business, local, and global communities. Digital communication and the recent tools of social networking and collaboration technologies further enable the creation and dynamism of these learning systems.

Unlike earlier technological changes, this one is impacting the supply as well as the demand of education and training. The expectations are high that this technological revolution is central to learning and will change how education

services are delivered. Research and pilots suggest that ICT has the potential to fundamentally transform how and what people learn throughout their lives (www.techknowlogia.org; Resnick, 2002).

Learning is an active process in which people construct new understandings of the world around them through exploration, experimentation, and discussion. ICT is more than a tool to access and transmit information, but more broadly, a new medium through which people can simulate, create, express, and interact. Computers can be seen as a universal construction material, greatly expanding what children and adults can create and what they can learn in the process (Resnick, 1998). For example, children can now use computer simulations to explore the workings of systems of the world, from ecosystems to economic systems to immune systems. The Internet and distance learning are expanding the learning ecosystem beyond schools, enabling new types of "knowledge building communities" in which children and adults around the world collaborate on projects and learn from each other (Selinger, 2004; Box 2.2).

Box 2.2 The School of Tomorrow

The possibilities for using ICT to transform learning and schooling are enormous. Teaching and learning can be shaped in various ways to promote personalization, individualization, and localization. Teaching will increasingly involve teaching learners how to locate relevant information, judge the credibility of their sources, engage in collaborative problem solving, and take responsibility for how and what they learn. Young learners want to think for themselves and come up with their own complex questions. Giving students the space to do this in school time is motivating and should prepare them for real-life complex problems. Text no longer has to be the main medium for conveying meaning, as multimedia can more effectively demonstrate and develop understanding. Curricula can incorporate projects that call for teams with mixed sets of skills and backgrounds, enabling networked learning and learning communities.

In the school of tomorrow, teachers become learning companions; they accompany students on their learning journey. The borders between home and school will increasingly disappear. Schools will become community learning hubs. Knowledge will be increasingly constructed in collaborations among learners. A flexible, rich, and dynamic learning environment will emerge. The school of tomorrow will be integrated into its local and global environment and open to the world.

Source: Selinger, 2004.

The role of ICT is increasingly evident in higher education, mainly in response to the crucial role of higher education in the transformation toward a knowledge

economy. Countries are pressed to reform their higher education systems, to develop open systems that recognize prior experience and exchange schemes, and establish lifelong learning frameworks. Universities are called upon to collaborate with public and private sectors to contribute to innovation and tap global and local knowledge. New competition, modes of operation, and forms of delivery are emerging in higher education and corporate training, including distance education, mixed-mode teaching, open online universities, mega and virtual universities, corporate universities, and various forms of private sector participation and borderless educational services. Connectivity, knowledge management, education technology, and partnership are keys to these new forms of higher education. In turn, these forms raise new demands for governance and management of educational systems including flexibility, quality assurance, industry linkages, and intellectual property rights.

At a more basic level, ICT is critical to containing the fast increasing costs of education.[1] Without the redesign of education systems to make greater use of ICT (and e-learning), whose relative price is falling, the price of conventional education will continue to rise and perhaps become prohibitive to many in the developing world. With traditional educational technologies, there may have been some qualitative improvements. But productivity in the educational sector is diminishing, stagnant, or at best increasing at only a glacial pace.[2] As a consequence, the relative price of educational services tends to rise. Educational systems in many developing countries are in organizational and financial crisis. Public officials, businesspeople, families, and workers are having difficulty restructuring expenditures to finance needed increases in the coverage, quality, and duration of education. But, to gain or maintain competitiveness in a knowledge-based economy, achieving these increases is a strategic priority.

Technology-enhanced learning will require substantial innovation or reinvention of the education sector. Competition among providers of education and training services is crucial. The private sector has a comparative advantage in introducing technology to train existing members of the labor force who require just-in-time knowledge. The private sector has the flexibility, agility, competitive environment, and market responsiveness necessary to provide just-in-time training. It could also partner with governments and engage in "education on demand," and help spur productivity increases in the provision of timely learning for business and government.

In the health sector, ICT applications span health education and training, diagnostics, telemedicine and telecare, medical records and information management, patient administration, and almost all aspects of health policy, research, and delivery. Health services delivery is essentially a knowledge transfer activity that is highly dependent on communications, knowledge management, and information support systems. The health sector is changing rapidly due to ICT-enabled technological

[1] See Knight www.knight-moore.com/pubs/halflife.html

[2] See Knight (1998).

advances—but the potential for transformation remains huge. Advances in telecommunications are enabling health professionals in rural areas to receive information and specialized knowledge and to keep track of disease outbreaks. The explosion of mobile phone usage in developing countries also has the potential to improve health service delivery on a massive scale, support increasingly inclusive health systems, and provide real-time health information and diagnosis in rural areas (Box 2.3).

Box 2.3 Mobile-Health for Development

Developing countries face enormous challenges in meeting the health-related millennium development goals. The ability of developing countries to overcome these challenges is hindered by several core challenges, among them a global shortage of health-care workers. There is a growing recognition among governments, businesses, and NGO of the importance of leveraging new tools and solutions to address these interrelated challenges, and in particular, the use of mobile digital devices to capture and deliver health information (mobile-health or m-health). The range of m-health applications in developing countries is fast expanding to include: education and awareness, remote data collection, remote monitoring, communication and training of care workers, disease and epidemic outbreak tracking, and diagnostic and treatment support.

Here are some examples of m-health applications from developing countries.

Short message service (SMS) now offers cost-effective, efficient, and scalable method of providing outreach services in awareness and education applications. Pilots in India, South Africa, and Uganda have shown that interactive message campaigns have greater ability to influence behavior than traditional means, offering information about testing and treatment methods, available health services, and disease management in areas such as AIDS, TB, maternal, and reproductive health. SMS messages offer recipients' confidentiality in environments where diseases such as AIDS are often taboo. And they have proven effective in targeting remote and rural populations.

Gathering data where patients live, keeping them updated and accessible on a real-time basis can be more effectively and reliably done via smart phones, PDAs, or mobile phones rather than paper-based surveys. Various initiatives in multiple developing countries are closing the information gap for patient data and in turn enabling public officials to gauge the effectiveness of health-care programs, allocate resources more efficiently, and adjust programs and policies accordingly. Similarly, the use of mobiles for remote monitoring of patients may become a crucial capability in developing countries where access to hospital beds and clinics is very limited. In Thailand, for example, TB patients were given mobiles so that health-care workers can remind them daily of their medication; medicine compliance rate increased to 90% as a result.

Disease and epidemic outbreak tracking m-health are being used in Peru, Rwanda, and India as an early warning system. Deployment of mobiles, with their ability to quickly capture and transmit data on disease incidence, can be decisive in prevention and containment of outbreaks, as in Cholera, TB, and SARS. Real-time tracking of incidents of Encephalitis in Andhra Pradesh helped government prioritize vaccinations, based on evidence of clusters of outbreaks.

Finally, the mobile phone is being equipped with specialized software applications for use in some African countries for diagnostic and treatment support. The phone is used as a point-of-care device. The health-care worker is led through a step-by-step diagnostic process. Once data are entered (image and symptoms of patient captured on phone), remote medical professionals can diagnose and prescribe. These applications have the potential of dramatically increase access to care.

For middle income countries, these applications will be also increasingly relevant for the prevention and early treatment of noncommunicable diseases such as diabetes and for health-care needs of the aging population.

Source: Vital Wave Consulting, 2009.

In advanced countries, the explosion of public access to health information on the Internet is changing the relationship between the patients and the organizations that care for them throughout their illness. e-Learning enables people to adopt behaviors and lifestyles that keep them healthy and productive as well as improving their quality of life. Information management support for health care can bring immense value—from shorter hospital stays and waiting times for operations to radically lower costs for health care over a patient's life. Policy makers, health-care professionals, and patients need to understand the full power and associated responsibilities that integrated information systems bring to care delivery as e-health does not simply automate paperwork but changes the way people work and relate.

Poverty Reduction

The array of ICT-enabled options for poverty reduction is growing fast (Box 2.4). As a communication and delivery infrastructure, ICT can assist the government to provide effective health and education services, facilitate citizen to government transactions, and promote participation and accountability. As a sector, ICT can create employment opportunities and improve incomes for the poor by targeted programs to support the activities of the poor and increase their productivity, improve their access to market and technical information, and lower the transaction costs of small farmers and traders. ICT can play a major role in helping to monitor food security-related issues (weather, droughts, crop failures, etc.) as well as alerting on natural

disasters. As a tool for empowerment, ICT can support democracy, participation, mobilization, and civil values. Electronic interaction between government and citizens can provide citizens with access to the information and knowledge, consultancy, and online voting opportunities, among others.

Box 2.4 A Growing Array of ICT-Enabled Options for Poverty Reduction

The promise of improving citizen to government transactions (C2G) has inspired many governments to create one-stop services, such as Singapore's eCitizen, and to integrate electronic government into their broader public sector reforms. Even less integrated and more modest bottom-up initiatives, such as land record computerization in Karnataka, India, have delivered land certificates in 15 min, instead of 20–30 days, and in the process, reduced transaction costs and corruption, created a viable land market, enhanced the creditworthiness of farmers, and improved the life of the common man.

A major opportunity for using ICT in poverty reduction is to provide information and knowledge to rural populations and to empower local development agents to serve the poor. A variety of informational and connectivity advantages can accrue to the poor through improved operational capacities of the specialized local agencies. One example is Chile's electronic rural information system which connected farmers' organizations, rural municipalities, NGOs, and local government extension agencies to the Internet. It was estimated that transmitting information on prices, markets, inputs, weather, social services, and credit facilities cost 40% less than using traditional methods (S. Balit, 1998). Similar pilots and programs have been applied in Mexico. In Maharashtra, India, a cluster of 70 villages is covered by the "wired village" project, which is modernizing the local cooperatives, and aiming to provide agricultural, medical, and educational information to the facilitation booths in the villages (Bhatnagar and Schware, 2000).

Perhaps the area of most promise but least evidence of successful large-scale application is in the use of ICT to promote broad participation, grassroots innovation, and social learning. Telecenters or community information and communication centers can play several roles: provide affordable public access to ICT tools including the Internet; extend and customize public services, including those offered through e-government; provide access to information in support of local economic activities and learning opportunities; and connect and network people. The last function proved to be the highest priority for many communities who would otherwise have remained isolated. These centers have enabled them to carry out local dialogue, share practical and locally relevant information, and support community problem solving. Given the limited relevance of the vast amount of global Internet content to these communities, the role of these centers in networking

and creating local content becomes all the more important. Community centers could also provide women with a medium to participate as producers, consumers–providers–users, and counselors–clients. In South Africa, women's organizations are linked to various resource web sites which aim to mobilize women around common concerns. Digital literacy centers in Benin and Ghana have become an important instrument of empowerment of low-income communities, enhancing employability, increasing capabilities, and extending learning opportunities beyond those available in educational institutions (Fontaine, 2000).

Recent emphasis on poverty analysis and on mainstreaming results-oriented development programs has reinforced the need for relevant, reliable, and timely information for policy formulation and program implementation and adaptation. Smart policy and dynamic investment programs rely on access to local and global knowledge and timely information on implementation and impact. Lacking reliable feedback and timely information on implementation, development planners tend to rely on rigid designs, uniform top-down solutions, and limited participation—leading to slow learning and disappointing results (Hanna and Picciotto, 2002).

Much of the practice of ICT in development has focused on pilot projects and proof-of-concept experiments about applying ICT for poverty reduction. Much of the literature on ICT impact on poverty has been anecdotal. The impact of ICT on the poor is at an early stage, even in developed countries. The potential is being demonstrated at the micro, intermediate, and macro levels. Donors and development practitioners have sought quick, off-the-shelf solutions that could be replicated in the poor communities of developing countries. However, experience has shown that such ready-made solutions could not be transferred and integrated into new development contexts and programs without raising issues of affordability, sustainability, scalability, and impact.

The impact of earlier information and communication technologies, particularly radio and television, is better known, although their use as tools for informing and educating the poor is still relatively unexploited and disconnected from poverty reduction programs. The new ICTs do not replace the older technologies but can blend with them and extend their reach, enrich, and tailor their content, and add new forms of "many-to-many" communication and action that bypass traditional power relations. For example, in Kothmale, Sri Lanka, a live radio program uses a panel of resource persons to browse the Internet at the request of listeners and thus adds value by interpreting Internet information into a local context, in local languages, and by providing a platform for feedback and local discussion (http://www.kirana.lk).

ICT can open up new opportunities for poor communities and small enterprises, even in remote areas. In Brazil's urban slums, the Committee to Democratize Information Technology (CDI) has created self-managed community-based "Computer Science and Citizenship Schools" using recycled ICT and volunteer

assistance. As of July 2008, there were almost 840 such schools located in all of Brazil's major regions and six other Latin American countries: Argentina, Chile, Colombia, Ecuador, Mexico, and Uruguay. CDI schools train students for better opportunities for jobs, education, and life changes. Many other examples are available at www.Infodev.org.

ICT also offer the opportunity to provide investment resources to groups previously denied them. In South Africa, for example, "AutoBank E" has developed an automated savings system using ATMs and aimed at the poorest depositors. The system proved to be highly popular, with 2.6 million depositors and 50, 000 added each month (Economist, 3/25/2000, p. 81). More recently, the mobile phone has become an "electronic wallet," enabling all kinds of small funds transfer and financial transactions, and as a result, in a year or so, enabling over seven million Kenyans for a country with 38 million population; (Economist, September 26, 2009) to have accounts with the mobile phone operator, that is, more than the total established accounts the population have with the local banks. Small retailers act like Bank branches. Similar schemes have become popular in the Philippines and South Africa. This can be a stepping stone towards full financial service access for the billions of people who currently lack access to savings accounts, credit, and insurance. ICT can also help intermediary institutions and local agents to work more efficiently and responsively and to target interventions to the needs of the poor: intermediaries such as health workers, agricultural extension agents, teachers, local planners, and local NGOs.

ICT may be also used to empower women, as both producers and consumers. For example, in the Philippines women account for about 65% of total workers in IT services and ITES. They account for 30% in India—a much higher rate of female participation in services than in the general economy. Given the higher wages in IT services, this participation may contribute to improving the status of women. The potential to access relevant public services, at less cost and time, at home or at a local center can be also a source of empowerment. Having access to relevant information such as rights, benefits, inheritance laws, health care, municipal services, and education should enable women and marginalized groups to access services and make informed decisions to meet their basic needs.

Various ICT tools are also used to assess and reduce vulnerability to natural disasters, where the poor are the most vulnerable—especially in cyclone warning, communication and response, awareness raising, and community involvement in hazardous reduction activities. ICT is increasingly used to improve disaster risk management at the global, national, and local levels. It can enable monitoring and enforcement of environmental quality. In Indonesia, for example, with weak enforcement of water pollution standards, government developed a public access information database rating firm compliance, and within the first 15 months of the program, about a third of the unsatisfactory performers came into compliance (World Bank, 1999).

The real challenge in all such applications is not the management of technology, but the institutional capacity and coordination processes to capture and share disaster risk management information that should go hand in hand to make effective

use of the technology. As will be discussed later (Chapters 11, 12, 13, and 14), the technology enables but does not substitute for complementary investments in institutional capacity and process innovation.

Making ICT work for the poor will require new conceptions of development, a new view of the world's poor, and a new approach to innovation with ICT (Heeks, 2008). Rural telecenters and shared access have been the focus of much of ICT for development programs targeted to poor and rural communities. But these programs have raised issues of sustainability and scalability and the search is on to address these issues (Chapter 10). We still confront the challenge of how to connect the remaining five billion people who still lack access to the Internet. Low-cost terminals will remain central to ICT for poverty reduction. But efforts to develop "people's PC" and one laptop per child (OLPC) are still struggling to deliver on their promise. Wireless technologies such as WiMax offer also major promises to leapfrog and connect poor communities.

Deploying ICT for poverty reduction will inevitably require engaging poor communities in grassroots innovation and in coproducing relevant content and applications. A major challenge for using ICT for poverty reduction will continue to be the development of relevant content, services, and applications on increasingly affordable platforms. Countries are experimenting with new approaches and mechanisms for developing relevant content for poverty reduction and innovating applications for community empowerment.

Communication and Service Delivery

ICT can be leveraged as a networking infrastructure to connect government agencies, NGOs, SMEs, and even the poor to participate in development. Many NGOs in Latin America, for example, are assisting micro enterprises such as artisans to integrate into the global economy by using web sites for retail and wholesale buyers in industrialized countries, providing timely information on markets and buyers, and delivering a variety of training and business support services (Susana Sanchez, 2001). Chapter 7 explores the issues surrounding the use and diffusion of ICT as a networking and delivery infrastructure for grassroots innovation and inclusive information society.

Access to information and communication is central to empowerment and to building human capabilities. Accordingly, this new infrastructure would enable local economic and social agents to network, mobilize, and share local information, access global knowledge and markets, coordinate local action, share local experiences and innovations, and accelerate social learning. It enables real-time information sharing among change agents, communities of practice, and otherwise isolated communities. No wonder that the Internet has powered global civil society movements for causes such as debt relief, banning land mines, and providing HIV drugs in poor countries. The Internet was just as powerful in mobilizing people locally in campaigns against corruption (Korea), for democracy (the Philippines), and to protect the environment (Brazil).

Strategic applications, or strategic information systems, are those of central importance to economic competitiveness and functioning in an increasingly integrated global economy, and hence should be essential to any national ICT strategy. For example, one of the most strategic and early applications of ICT in the merging economies was the modernization of the port of Singapore and establishing an electronic trade facilitation network—key steps in positioning Singapore as a global hub for logistics and regional hub for services. Another example is financial payments clearance and settlement system—a necessity for economic management and financial transaction in any globally integrated economy. In general, such systems represent new forms of national infrastructure because, like roads or utilities, they have major economies of scale, require substantial investments, and underpin other economic activities. These are the new infrastructures of the knowledge economy.

Which systems have this strategic importance is determined by country conditions and development priorities. Increasingly, globalization and international agreements are enforcing performance standards that can be met only with the aid of modern information and communication systems, as is the case with trade facilitation networks and customs modernization. Experience also suggests that there is a core group of information infrastructure and applications that all countries should put in place for the functioning of a modern economy. Included in this group are those concerning the modernization and integration of public finance and trade systems (planning and budgeting, debt management, expenditure management), tax administration, and trade facilitation.

Integrated financial information systems, for example, are being adopted to support control of aggregate spending, to prioritize expenditures across programs for allocation efficiency and equity, and to achieve outcomes and produce outputs at the lowest possible cost. For example, an integrated tax administration system for Jamaica has reduced the processing of some types of taxes from 4 weeks to 1 hour or less. Critical systems also include those enabling the functioning of financial and other markets such as payment clearance and settlement systems, financial institution oversight systems, and land and business registry systems. Others are critical to the functioning of basic infrastructures such as air transport control, port operations, and utility management. Yet others may be critical to managing natural resources such as environmental monitoring, early warning, and geographic information systems.

Past experience indicates that governments in developing countries are rather quick, comparatively speaking, to realize the benefits of the systems that improve their own internal efficiency, oversight, and control mechanisms in finance-related areas, as described above. At the same time, ICT applications and services that improve interaction of the public sector with citizens and businesses, as well as those promoting ICT use in small businesses and social applications often get limited attention. They are mistakenly perceived as “luxury” that developing countries could not afford.

e-Government services, for example, are capable of delivering both significant short-term benefits and long-lasting impact for developing countries. They can

promote transparency and improved government responsiveness to the needs of citizens and businesses. ICT-enabled services can also bring about a number of important spillover effects, such as improve competitiveness of the private sector, decrease the brain drain of knowledge workers, and promote use of ICT among citizens and businesses. Last but not the least, e-services can transcend geographical, ethnical, and administrative divisions and thus can benefit economic and social development of countries with a legacy of civil wars, ethnic, or regional unrest.

ICT use in government can also facilitate effective decentralization, more transparent and accountable governance, delivery of responsive public services, making public information resources available to all, and improving the quality and reach of health, education, and other basic services. This role is still in its infancy, but results of various pilots in many developing countries, particularly in Latin America, are encouraging. It is fast taking a central stage with e-government, e-commerce, e-learning, and other Internet-enabled activities.

Mobile telephony is serving as a digital bridge to the majority of mankind. For the short to medium term and for the vast majority of low-income population, mobile telephony is likely to be the sole tool connecting them to the information society. Among ICTs, mobile phones are most widely spread in developing countries. In the last 5 years (2003–2008), mobile subscribers in developing countries almost tripled and now account for about 60% worldwide. It has quadrupled in Africa. Mobiles do not require much complementary investment in infrastructure or skills. The cost of access has declined dramatically. Moreover, mobile telephony is growing in sophistication and functionalities. It provides a gateway to digital literacy and once it is appropriated on a large scale, the adoption of subsequent higher-level technologies may become less intimidating.

Mobile telephony is offering a growing and distributed platform for delivering services to the poor and generating income by them. With existing functionality, SMS can be used for tasks ranging from seeking market prices for farmers and fishermen, to monitoring elections, to alert in case of natural disasters. Mobiles can transform how distributed organizations operate. For example, ministries of agriculture and health, with many rural extension and health workers distributed across the country, suffer from slow reporting and feedback and much field time wasted on reporting and filling forms or awaiting information. In a pilot in Uganda, mobile phones are being used to diagnose and treat crop diseases that cause massive losses to farmers, presenting an opportunity to increase yields as location-specific information about disease threats is made available.

With smart phones (increased functionalities to affordable phones), mobiles could also be used to deliver financial and banking services to those currently excluded. They are already playing a significant role in the receipt of remittances from distant relatives. New business models are also being created by the poor themselves, starting with the use of air time as currency, turning the mobile phones into mobile wallets (Heeks, 2008). The potential of mobiles is primarily constrained by user capabilities and presents limited attention to applications for those at the bottom of the pyramid.

In particular, mobiles hold great potential for small and medium size enterprises in all types of uses ranging from communicating with clients, ordering of supplies, receiving daily price quotes for agricultural exports and local fish markets, buying and selling of goods and services through e-commerce, as well as e-payment, and e-banking. The use of mobile phone services by the small-scale fishing enterprises in Kerala, India, demonstrates the dramatic effects of simple ICT applications for poverty reduction (Box 2.5).

Box 2.5 Mobile Phone Impact on Small-Scale Fishing in Kerala

The fishing industry in Kerala is important as 70% of its population eat fish daily and over a million people work in fisheries. Fishing is done primarily by small enterprises. There is little storage of fish and little transportation between markets. Fishermen are traditionally unable to observe prices in other markets. Thus the quantity and prices of fish in any local market is determined by the local catch. This results in significant differences in prices, daily and across markets as well as wasted catches.

As mobile phone was introduced in Kerala in 1997, fishermen adopted it quickly, reaching a penetration rate of 70%. Fishermen use the phones while at sea to find out the prices of different markets and to decide where to land their catches, conducting auctions by phone. After phone adoption, 30–40% of fishermen began selling fish outside their home markets. This significantly reduced the dispersion in prices among markets, from 10 rupees per kilogram before adoption to a few rupees after adoption. It also reduced wastage. The profits of fishermen jumped by 133 rupees a day—a 9% increase. Impact on consumer is relatively modest—4% price reduction (Jensen and Trenholm, 2007).

Regional and Urban Development

The spatial implications of the communication revolution are likely to be profound, impacting governance, decentralization, urbanization, growth, and inclusion. Lower transaction and communication costs, combined with goods production that is increasingly based on flexible specialization, tend to favor the dispersion of economic activities. Yet, real-time information about consumers, easier sharing of tacit knowledge, and the proliferation of producer-support services tend to favor locating knowledge-intensive production near to large markets and dense urban centers. As for services, the ICT revolution is promoting the dispersal of services that can be delivered remotely and effectively based on codified knowledge. Meantime, for creative services, electronic communication complements and even reinforces rather than substitutes for

face-to-face communication. ICT is inducing concentration of services that are driven by innovation, tacit knowledge, and face-to-face interactions.

The twin challenges for developing countries are: how to use ICT to reduce disparities and help integrate lagging regions? And, how to use ICT to leverage the innovative and creative potential of cities in a globally connected, knowledge-based economy?

Governments have many reasons to worry about disparities in welfare among regions and to help lagging ones. When today's rich countries were developing during the 19th century, the growth of their leading areas was constrained to the rate of growth of their domestic markets and the world technological frontiers. Since, technological progress and globalization have increased market potential in leading areas of developing countries, intensifying concentration of economic activities and amplifying spatial disparities. Governments cannot stop or ignore these forces, but can help lagging regions most by strengthening their economic integration with the leading areas (World Bank, 2009a).

Governments have many policy instruments for promoting economic integration to reduce those disparities: (1) policies and institutions such as land and labor regulations and social services such as health and education; (2) incentives and investments in spatially connective infrastructure that facilitates movement of goods, services, people, and ideas; and (3) spatially targeted programs to help the lagging regions directly. Can ICT enable these three instruments and promote spatial integration? Yes, in various ways, as explored in Box 2.6.

Box 2.6 Can ICT Help Lagging Regions?

Set against this faster rise in disparities among leading and lagging regions in the developing world is the opportunity for faster convergence—because ICT tools offer a wider range of methods and more affordable access to services and knowledge to bridge the economic distance between leading and lagging areas.

ICT can be an enabler of improving coverage of social services to lagging and remote regions as well as a cost-effective tool for delivering and managing spatially targeted programs. Telecenters can help deliver much needed e-government services, as well as e-education and e-health services and in the process equalize access and quality to these regions.

The diffusion of mobile services, even in remote areas, opens new opportunities to provide financial services over a mobile phone network. Many people in lagging regions have limited access to financial services. With the rise of remittances, better access to financial services help people in these areas overcome credit constraints. In the Philippines, 3.5 million people (out of 20 million mobile phone subscribers) have access to mobile phones that can transfer money (Mas, 2008).

Producers in lagging areas can access better information on prices they can get for their products. Small enterprises can also market their handicrafts

through web sites. Communities can attract tourists to their unique cultural heritage and ecological diversity. With coordinated efforts, locally relevant content and solutions can be widely disseminated within and among lagging regions.

ICT is an increasingly critical spatially connective infrastructure in its own right as well as modernizer of other integrative infrastructures. ICT can modernize transport, facilitate international trade, and dramatically increase quality and speed of logistics, even for remote and lagging regions. Moreover, low communication costs make it possible to control production processes over long distances and reduce the need to colocate management and experts with unskilled workers. This allows vertically integrated companies to outsource production to low-wage countries. It also facilitates the breakup of production processes into supply chains of companies distributed across countries. Low communication costs are particularly important for offshoring services.

Although urban and leading regions in developing countries are likely to benefit most from these processes, rural and lagging areas can participate in this offshoring through various measures, including telecenters combined with specialized training, as demonstrated by pilots in rural India. The biggest outsourcers, in relation to local value added of these services, have been small countries in Africa like Angola and Mozambique.

Countries such as China are giving special attention to ICT as a tool for spatial economic integration. Empirical evidence confirms the link. For 29 areas in China, between 1986 and 2002, telecommunication infrastructure was strongly associated with subnational GDP growth (Lei and Haynes, 2004). Efforts to promote rural informatization in China are growing through a variety of central and local initiatives such as developing local content, Internet-enabled rural services, and shared access centers. Rather than resisting the forces of unbalanced growth, policy makers are using some of the growing resources from fast growth to balance development outcomes across regions. ICT is viewed as a critical tool in doing so.

Traditional regional policies focus on attracting individual firms to lagging regions through taxes, subsidies, and regulations by central and regional governments. Many countries have offered incentives to create economic mass in lagging areas and offset the higher transport and logistics costs and lower levels of public services. European countries have a long history with such spatially targeted policies and interventions. But even these countries now focus on "soft" interventions such as investing in innovation and supporting science and technology institutions, parks, and infrastructures. Investing in ICT infrastructure, including broadband, research, and innovation networks is a critical part of such soft interventions.

Source: World Bank, 2009a.

What role is ICT playing in the changing role of cities? Globalization, far from undermining localization, actually intensifies local agglomeration by extending markets for regional products to the world. Globalization simultaneously frames and induces localization and locational specialization (Yusuf et al., 2000). It tends to heighten locational specialization and reinforces the advantages of large urban centers.

Cities have been always the engines of growth in regional economies and no country has achieved sustained growth without accompanying urban growth. Enabled by advanced communications in knowledge-based economies, cities are increasingly becoming the focal points for global and national economies. Cities are best endowed with knowledge infrastructure and educational institutions, higher shares of educated people, advanced communications infrastructure, and access to the global economy. Further, the scale of cities and the diversity of inhabitants create the interactions that generate new ideas. Urban regions also attract talent, as talent attracts talent (Florida, 2005). Cities are emerging as platforms or gateways to services, learning, innovation, creativity, and entrepreneurship, more than ever in history.

Cities are also differentiating and competing on a global scale, giving rise to global urban networks (Scott, 2000). They are seeking to secure and enhance their competitive advantage in a globalizing economy. They seek to combine both rich local knowledge spillovers and international best practices. They are the arenas of synergies, externalities and agglomeration. Local governing coalitions, therefore, seek to harness these synergies, upgrade local human resources, promote incubators and risk capital, build advanced information infrastructures and information services, promote information flows, cultivate collaborative relationships and firms, and promote export markets for local products. Singapore envisioned its future role as an intelligent island or a regional hub for information-intensive services. The "walled" cities of China are opening up to all kinds of information flows.

Urbanization and the growing concentration of economic power and knowledge-based services in cities are strengthening demands for a power shift to cities. Modern communications and greater openness to trade and ideas have circumscribed the authority of central government and enlarged the freedoms of subnational entities.[3] Many developing countries are acceding to diverse pressures to increase democratic participation and devolve authority to local governments. Heightened awareness of ethnic or regional identities, combined with increasing inequalities and diverse responses to globalization, is contributing to the trend of placing greater responsibilities on local authorities. Municipalities are facing greater challenges in delivering an increasing array of services and satisfying demanding and diverse clients. They have to partner with private sector and civil society.

Political and economic dynamics are favoring decentralization from national to city level. More and more national development business moves through subnational

[3]Naisbitt and Barber, among others, show how subnational and global or regional institutions are gaining relative power vis-a-vis nation states.

levels of government. In China, for example, local government budgets are more than 70% of total government spending. Cities are recognizing they have more scope to act, more leverage to effect change, more prospects for trade, and more opportunities to shape their futures. Technological changes are favoring local agglomeration. The new emerging paradigm of flexible production systems is able to achieve considerable variety and significant scale of production by exploiting ICT. It relies on external networks and intensive transactions, complementarities, and specialization.

Information and communication technologies are thus inducing or reinforcing these trends, and when appropriately harnessed, can facilitate effective decentralization and efficient and sustainable urbanization. Service sector jobs in industrial countries are increasingly contestable by developing countries. Beyond enabling global trade in services, advanced information infrastructures are increasingly important to attracting foreign direct investment, facilitating technology diffusion, and developing innovation clusters. ICT is contributing to the growth of highly dynamic, knowledge-based, and creative services, mostly clustered in cities. In turn, cities must compete for highly mobile knowledge workers and for innovative and income elastic economic activities. They have to develop skilled human resources, attract global capital flows, address quality of life issues, and develop the software as well as the infrastructure of livable cities. Shanghai drew a "smart" growth strategy to attract knowledge-based and information services industries, enhance access to information infrastructure, and enrich learning opportunities. The "digital cities" movement aims to enable relatively small cities to have many of the advantages of larger ones, without some of the agglomeration costs.

Cities are not just economic engines—they are centers for culture, innovation, and learning. They are also social communities. They are bearers of significant informal knowledge and repositories of tacit know-how. Regional agglomerations of producers are sites of accumulated cultural conventions, trust-based relationships and social capital—a key factor in economic development. Cities that facilitate active participation in local affairs and collaboration among local institutions are nourishing not only a healthy community, but also a local competitive advantage. A rich cultural environment and a vibrant local community are increasingly important for attracting knowledge workers and sustaining knowledge industries.

The cultural-generating capabilities of cities can be harnessed into productive use with the help of ICT. Cities have always played a privileged role as centers of cultural activities such as tourism, arts, crafts, entertainment, fashion, advertising, publishing, etc. That is unlikely to change. What is new is the likely impact of ICT on both the renewal of local cultures and the dissemination and use of cultural products on a global basis. ICT is leading to urban cultural synergies—strong interdependencies and spillovers in localized cultural production. Meantime, media companies are engaged in developing electronic platforms for use of cultural products on a global scale—projecting the cultural products of cities like Los Angles and Paris. Johannesburg is undergoing radical transformation in post-apartheid period, not only by modernizing its services, but also by tapping its cultural origins in music, tourism, and performing arts.

It is projected that by 2020, over four billion people (55% of the world's population) will live in urban areas, and almost 94% of this increase will be in developing countries. It is, therefore, important to create the capacity to produce and diffuse technologies that support efficient and sustainable urbanization and favor local development processes. Some examples of the roles of ICT in facilitating effective decentralization and local management are explored in the chapters concerned with e-government and e-society. ICT applications can be targeted to strengthen local government management, revenue and expenditure management, citizen participation, and monitoring and accountability. Successful decentralization is contingent upon effective local governance, resource management, and accountability.

Innovation

Understanding innovation trends and the role of ICT in accelerating and disseminating innovation is as relevant to government transformation and information society initiatives as it is for business and enterprise transformation. Information and communication technology has become a powerful enabler and facilitator of innovation—perhaps the most influential technology in powering the wave of innovation since the last quarter of the 20th century. Its application to research, design, services, logistics, finance, marketing, and learning has enabled enterprises to become more efficient, flexible, and innovative—through process innovation, product and service innovation, and the creation of new business models. Now governments are considering the use of ICT to improve not only the way public services are delivered, but also the way they are created. Governments are beginning to set a service innovation agenda.

Information and communication activities are at the heart of the innovation process, and ICT has become a tool for amplifying brainpower and for innovation. ICT is transforming the way researchers conduct their research, communicate with other researchers and potential users, and instantaneously access relevant knowledge from a vast and growing global knowledge. For example, bioinformatics has emerged as a field arising from the essential role of ICT in enabling biomedical research. ICT is further accelerating the codification of knowledge and thus knowledge sharing. Science and industry are more closely integrated with ever shorter product life cycles.

Innovation practices are changing. Why? Various forces are pressuring companies to open up their innovation process (Chesbrough, 2006). The perennial quest for growth is increasingly challenging in the era of global competition, fast commoditization, and shrinking product life cycles. In such an environment, process and product innovation have become crucial for sustained growth, competitiveness and moving up the value ladder. The combination of fast-changing demand patterns, shortening market windows and product life cycles (as in mobile phone), and the rising costs of product development (as in new drugs) compresses the economics of investing in innovation and depresses the returns to the "closed" model or internally focused innovation. How can firms compete effectively? By looking outside.

Innovation is increasingly global, multidisciplinary, collaborative, open, and driven by an ecosystem. Successful organizations will increasingly tap into a global marketplace of innovators, experts, and collaborators—the global brain (Nambisan and Sawhney, 2008). New types of innovation intermediaries, as well as the Internet and related global platforms for the digital economy have made tapping into such global networks of inventors, scientists, and innovative firms easier than ever before. Network-centric innovation relies on harnessing the resources and capabilities of external innovators, networks, and communities to amplify innovation reach, innovation speed, and the quality of innovation outcomes. Examples include open source software, open source journalism, electronic R&D networks such as InnoCentives, and the community-based encyclopedia Wikipedia.

New tools for communication and collaboration are enabling networked and grassroots innovation. ICT is reducing coordination and learning costs, enriching relationships with clients, enabling a shift in responsibility for adaptation and customization to users, harnessing knowledge from multiple experiments, and creating user communities and new forms of user-led innovations or user–producer coinvention. Global enterprises like Proctor & Gamble now draw more than 50% of new product innovations from outside the corporation's own R&D—from users and partners.[4] IBM has subscribed to the open source model and invested substantial resources to align many of its product and process innovation initiatives with the open source model.

In addition to connecting the traditional actors of a national innovation system, collaborative technologies are engaging users, communities, small enterprises, and grassroots organizations in product innovation and adaptation. These actors practice new styles of innovation: being open, peering, sharing, and acting globally (Tapscott and Williams, 2006).

Collaborative ICT tools have given rise to new models of sharing knowledge and collective production of ideas and innovations, which often bypass proprietary systems. The power of these tools is reflected in many massively produced knowledge products and infrastructures: the Linux ecosystem, Wikipedia, and open source software. They draw on collective intelligence and mass collaboration. These tools can be also harnessed to promote inclusive, pro-poor innovation that would address the needs of the bottom of the pyramid and help share indigenous knowledge and empower local innovators.

Governments are challenged to leverage the creativity of their citizens and stakeholders, and to institutionalize the innovation process. Some examples of the innovation strategies offer a window on the possibilities for improving governance and service delivery with ICT. Studies of innovation in government suggest that public agencies tend to approach innovation as a "one-off" change or "big bang" instead of an ongoing process and a core value of the organization. But in an era of

[4]This "connect and develop" innovation strategy led to R&D productivity increase by nearly 60%, innovation success rate more than doubled, and the cost of innovation significantly fallen (Huston and Sakkab, 2006).

rapid changes in technology, competition, consumer demands, citizen expectations, and public sector challenges, a capacity for continuous innovation and adaptation is an imperative. Fortunately, some governments and policy makers are leading the way with innovation strategies that tap into the creativity and knowledge of employees, citizens, and external and internal partners (Eggers and Singh, 2009). Much of these strategies are enabled and made effective with the help of ICT and its applications through networks, open source, and knowledge management tools. Examples of these strategies will be shown in Chapter 3.

Organization

The ICT revolution is shaping the structures of organizations and how organizations work and relate, and this impact is fast diffusing beyond business to public and civil society organizations. New forms of organizations have become possible or even necessary to leverage ICT: flat, agile, lean, extended, globally networked, and client focused. The reorganization of production and distribution around ICT has enabled the adoption of new processes, procedures, and organizational structures, which in turn, have led to sustainable gains in productivity, quality, and responsiveness. Early evidence started to emerge in the late 1990s in the business sector in advanced countries (Brynjolfsson and Hitt, 2000; Litan and Rivlin, 2000). ICT has made it possible to have very large-scale organizations that are at the same time flexible, agile, and focused. The latest advances in areas such as mobile, broadband, and collaborative technologies (Web 2.0) have further intensified the transformative impact of ICT on organizations.

The forces of globalization and increased competition, combined with the ICT revolution, have spurred organizations to focus on their core competencies while outsourcing increasing amounts of activities and services. These organizations are also designing their supply chains ever more tightly and strategically (Fine, 1998). The ICT revolution had given rise to network-centric enterprises, virtual organizations, and business ecosystems. This involves establishing a network-centric enterprise that connects the different partners in a company's business ecosystem to support different value creation processes. The customer is put at the center of the value chain and significant infrastructure, process and data standardization enable real-time communications, agility, and synchronization across boundaries. In supply chain management, this means establishing dynamic connections between enterprisers, suppliers, customers, and other partners to maximum value. It involves integrating enterprise information systems with external partners' systems and processes to enhance "sense and response" capabilities (Nambisan and Sawhney, 2008).

Network centricity is applicable to government as well as business and NGOs. For example, it is being applied by social advocacy groups to enhance the reach, speed, and overall effectiveness of social movements. Another contrasting example comes from the US Department of Defense (DoD). In contrast to the traditional

chain of command model, which epitomized military organizations for centuries, the network-centric model is flatter, less hierarchal, and aims at "total information awareness." The goal is to give everyone, from soldiers to commanders, access to the same data, so they react and interact in real time. Radio frequency identification (RFID) and satellite tags, allowed DoD to have total asset visibility of every item in every container as it moved across the world to field operations. Sensors and Internet-based communications systems, seamlessly linked, gave forces "situational awareness"—enabling widely disbursed units to fight with real-time knowledge of each other's movements and those of the enemy (Eggers, 2005, p. 6). The promise of transition from an industrial age to information age government extends to all domains.

Information technology is also changing the workplace in fundamental ways, with important implications for human resources. Firms in industrial countries are restructuring from segmented (hierarchical, compartmentalized) organizations to holistic organizations, characterized by job rotation, integration of tasks, and learning across tasks (Lindbeck and Snower, 2000). Studies suggest increasing returns to worker characteristics such as people skills, capacity to work in teams, multitask, work without supervision, take initiative, and be entrepreneurial (Levy and Murnane, 1996). A variety of managerial innovations like total quality management (TQM) are designed to exploit these changes. Simple tasks are automated, while the premium on complex tasks increases dramatically. The demand is for both human capital deepening and widening and for workers able to adapt to rapidly changing environments.

Together, ICT and complementary organizational innovations are enhancing access to information resources and management of knowledge assets. It is also accelerating product innovation, empowering project-based teams, and enriching learning and knowledge sharing at all levels of the extended enterprise. A new breed of event-driven organizations is emerging to exploit and tailor real-time information for decision making and service delivery (Ranadive, 1999). Consequently, companies are giving increasing attention to their information infrastructure, knowledge management, and communication competencies. Investment in such intangibles (knowledge, information and communication systems, talent, intellectual property, reputation, relationships, etc.) in advanced economies now exceeds 35% of total corporate investment.

Most organizations today were designed for the world of high transaction and interaction costs of the 20th century, but a sudden fall in these costs is now underway due to the Internet and advances in ICT. This sea change opens the possibility of remaking these organizations to mobilize their intangible assets and the knowledge and creativity of their 21st century workforces (Bryan and Joyce, 2007). In a low-transaction-cost world, issues of trading off hierarchy versus collaboration and centralization versus decentralization are resolved in ways than can mobilize knowledge, innovation, and minds. ICT enables efficient and effective large-scale collaboration, greatly increases the relative value of intangibles assets relative to tangible assets, reduces organizational complexity, and simultaneously increases

the economies' scale, scope, and specialization. It has opened new frontiers to organizational and managerial innovation, beyond current best practices.

At a more basic level, information and communication are the lifeblood of efficient markets, and ICT could develop markets and alleviate poverty, even without advanced ICT applications like e-commerce. Market prices act as coordinating signals for producers and consumers. But in isolated villages in developing countries there are virtually no sources of information regarding market prices and other production-related information. Studies suggest the pervasiveness of poor and late information on prices, work, and income opportunities in rural areas, with heavy toll on the rural poor in developing countries (Eggleston, et al.; 2002). Under these conditions, even basic communication technologies could play a major role in creating efficient markets, improving producer practices, and speeding innovation. The Grameen's program to lease mobile phones to low-income women in Bangladesh indicates that close to half of all calls involved economic purposes such as discussing market prices, employment opportunities, land transactions, among others. Rather than creating a "digital divide," ICT could be used to create "digital provide."

Media and Cultural Development

One final impact of the ICT revolution of most relevance to governance and information society is that of digitization of content and communication, the emergence of the broadband and participative Internet, and the active cocreation of content by users, citizens, and grassroots organizations.

It has long been recognized that media and communications play a key role in development—social, cultural, and economic. The media plays diverse roles in development: (i) improving governance, public decision making, transparency, accountability, and responsiveness; (ii) promoting behavioral and social change in support of reforms and development (through social marketing and policy reform campaigns); and (iii) generating new sources of growth and employment, mainly through content creation by SMEs and significant multiplier effects (World Bank, 2007a; UNESCO, 2005; EU, 2007). These influences depend on the availability of relevant content that can educate and inform as well as entertain, the plurality and independence of media, enabling legislation and support for community-level broadcasting, and access to infrastructure and communication platforms (Locksley, 2009).

The media is undergoing massive transformation, as a result of digitalization of content, platforms, and devices. The digital transformation is significantly enhancing the fluidity of media content and producing an abundance of sharable content. It is changing and revitalizing the role of libraries to become active agents of knowledge capturing and sharing for an information society, as being demonstrated by the innovative initiatives of the Library of Alexandria (Box 2.7).

Box 2.7 Bibliotheca Alexandrina: Digitizing and Sharing Knowledge and Heritage

The Bibliotheca Alexandrina (BA), the new Library of Alexandria, was mandated to provide access to knowledge to all people. BA's four main objectives are to become the world's window on Egypt; Egypt's window on the world; a leading institution in the digital age and a space of freedom for vibrant intellectual discussion; and the dialogue between peoples and cultures. According to Dr. Ismail Serageldin, the BA Director, ICT is a fundamental catalyst in realizing this mission and the future of Egypt and, indeed of all the developing countries, will depend on the strategic deployment of ICT to capture and share knowledge.

Since its birth in 2002, BA's information and communication infrastructure has been the best in Egypt. Moreover, most of the standard functions, such as *Library Information System, integrated digital library services, intranet, Enterprise Resource Planning, and access control and ticketing systems*, are computerized and continuously being updated according to the latest standards, mostly through in-house developed tools. Its high-speed Internet connection allows for quick access to the wealth of information offered through the BA serving both local and international communities in addition to enhancing the quality of services provided by the Library to its physical and online visitors.

BA adopts all up-to-date technological tools, often in collaboration with the national and international specialized organizations, to document and present information in digital form. This is reflected in CULTNAT—*Center for Documentation of Cultural and Natural Heritage*; www.cultnat.org, whose main focus is documenting Egypt's tangible and intangible cultural heritage and natural heritage. Its aim is to raise public awareness by utilizing all available media as well as building the capacities of professionals in the fields of conservation and documentation of cultural and natural heritage. One of the main endeavors carried out by CULTNAT was the award-winning www.eternalegypt.org that offers guided tours reflecting the Pharaonic, Greco-Roman, Coptic, and Islamic periods in Egypt's history.

BA's role extends to generating the technological tools and infrastructure needed for knowledge dissemination. And this is being achieved through the International School of Information Science, ISIS, a research center affiliated with the BA. ISIS works actively as an incubator for digital and technological projects, thus nurturing innovations that encompass the spirit of the BA's mission. From documenting heritage to promoting research and development of activities and projects related to building a universal digital library, ISIS strives to be the hub for generating and deploying new technological tools to address the digital and knowledge divide.

Building a digital laboratory with state-of-the-art technologies was an essential starting point toward digitizing the Bibliotheca Alexandrina's collections

and the collections of other international libraries that are interested in pursuing the goal of "Universal Access to Human Knowledge."

Since 2002, the BA made its mark as a leading digital library, building collections of both traditional and digital materials. ISIS has worked on digitizing valued references and availing them in a user-friendly interface with the necessary search and browsing tools. In addition to digital archives, the BA holds the largest Arabic Digital Library worldwide, http://dar.bibalex.org, which contains to date more than 135,000 searchable Arabic books. This represents a significant contribution to the Arabic content on the Internet.

BA is currently working on availing the out-of-copyright books for printing through a "Print on Demand" facility using the "Espresso Book Machine." Efforts are underway to settle agreements with some publishers to include the out-of-print, in-copyrighted books in the Print on Demand system. The user will be able to choose and order online a certain book from the database where the Espresso Book Machine would start the printing process automatically upon request. Then the printed book will be sent to the client via express mail and half of the revenue will be due to the author and the publisher. ISIS has adapted the machine software to handle Arabic data, layout, and content. The project is considered a new business model for book publishing and knowledge dissemination which is consistent with the digital libraries concept, as it would ensure the availability of out-of-print, out-of-copyright, and rare books at any time and in a cost-effective manner.

In partnership with Pittsburgh University, the BA has implemented the *Science Supercourse,* a digital repository of lectures made available for free online for science students and teachers. Initially, the project started as a prototype covering epidemiology and preventive health. A network of over 65,000 scientists from 174 countries was created, reaching out to millions of students worldwide. Currently, ISIS is working on expanding the scope of *Supercourse* to cover science in four major fields: health, engineering, agriculture, and environment. The new online system is being developed using the features of web 2.0 tools that allow for further engagement and interaction of the scientific community worldwide.

The BA has also deployed ICT tools to reach out to remote areas throughout Egypt. This is being done through the *Embassies of Knowledge* that were created to replicate the full functionalities of the BA including speed of access to knowledge. So far, two regional libraries were built to be the BA's *Embassies of Knowledge* and to provide users with the functionalities privileged to users on the BA premises, such as the full searchable collection of the Arabic Digital Library and the Library's digital assets (including books, manuscripts, pictures and maps, audios and videos); a good quality webcasting service to the lectures and events taking place at the BA Conference Center; access to the Library's multimedia content; and the privilege of using the Supercomputer facility for research.

Acting as an incubator for digital initiatives, ISIS is a partner in the Universal Networking Language (UNL) program, initiated within the United Nations and devised by the Universal Networking Digital Language (UNDL) Foundation. The UNL program addresses the issue of breaking language barriers between cultures and enabling all people to generate information and to have access to cultural knowledge in their native languages. The BA has created a UNL center, which is implementing the Arabic component in the development of UNL and acts as an active language center for Arabic. The center has been working on building and designing the Arabic Dictionary in the UNL system which as of 2009 contained more than 140,000 entries and more than 80,000 concepts, conversion rules for the Arabic language, and an Arabic corpus which has reached 60 million words.

The BA also acts as a platform for scientists and researchers, offering them the necessary tools to carry out their research. VISTA, *Virtual Immersive Scientific and Technological Applications*, for instance, provides researchers with an interactive three-dimensional environment that facilitates the development of new insights and understanding to their research subject. Also, the Supercomputer—*A high performance computing cluster* at the BA represents enhanced capability for scientific research in Egypt and the region, with computational ability at a rate of trillions of operations per second.

The BA mission is challenging. According to Serageldin, "We need digital libraries of the future to be committed to providing all knowledge to all people at all times, and to help turn the 80% of humanity living in the developing world into producers of knowledge rather than just consumers of technology."

Source: International School of Information Science staff, Bibliotheca Alexandrina

Rather than diminishing the role of libraries, the Internet is liberating "the book" and the library beyond physical boundaries and opening opportunities for wired libraries to become anchor institutions for access to global knowledge. These new possibilities are being realized in various ways: by building local content through digitalization and partnerships with local universities and educational institutions; by disseminating content through local intermediaries; and by providing training and guided instructions through librarians and other infomediaries. Often, librarians are members of the communities, and the Internet can transform their roles into true guides to the digital as well as the physical content. By aggregating demand for broadband at specific locations, public libraries can also serve as initial points of community broadband access upon which local markets can build.

Digital transformation and new networking technologies are also introducing two-way, bottom-up and lateral content production, distribution, and services. The

top-down nature of traditional mass media is being challenged by the changing nature of choice from "on offer" to "on demand," from mass to individualized, and from corporate-created to user-created.

User-created content, enabled by widespread access to broadband Internet and social networking tools, is emerging as a major force in shaping media, communication, and culture (Vincent and Vickery, 2008). User-created content has exploded into major bottom-up and lateral trends (OECD, 2007). The Internet has altered the economics of content production and information sharing. With lower access barriers, increased demand for content, lower entry barriers in upstream supply, and advances in collaboratively developed platforms and news aggregators, media, and cultural content are advanced and increasingly shaped by broad user participation. The Internet is increasingly influenced by intelligent web services with technologies enabling users to be growing contributors to developing, collaborating, and distributing Internet content, and developing and customizing Internet applications. A participative web is emerging and is providing a testing ground for low-cost production of content and low-cost experimentation of services, with social change implications.

Apart from technological factors, user-created content is driven by economic factors such as lower entry barriers to content creators, increased interest to user-created content by mobile operators and search engines, and growing availability of new business models to monetize content, such as advertising-based models. Social drivers for user-created content include the young "digital natives," the growing desire to express oneself and be more interactive than possible on traditional media platforms, and the growth of community-driven projects. This is leading to increased user autonomy, diversity of users and content, and a shift from passive consumption of broadcasting to interactive and participative web.

The rise of effective, large-scale cooperative efforts—peer production of information, knowledge, media, and culture—is parallel to those of business applications. The impacts of user-created content are wider than enabling network-centric innovation and competition in the business sector. They can help influence the traditional media, create alternative information and communication channels, help change government politics and civic life, and enable mass collaboration and community-driven programs.

User-created content and the growing wealth of networks raise many legal, institutional, and governance challenges (Benkler, 2006). Among the key immediate issues are copyright infringement, privacy concerns, content quality, and cyber-attacks making user data vulnerable. They also led increased urgency to issues of media literacy, e-literacy, strengthening capacities for local content production, and widening access to broadband infrastructure and digital tools—issues of special relevance to developing countries.

But they also raise societal issues and choices that are fundamental to long-term social, political, and economic development. For more than 150 years, communications technologies have tended to concentrate and commercialize the production and exchange of information. The recent ICT developments present the possibility of a

radical reversal of this long trend—a reversal toward mass participation and radical sharing of information and intelligence. Depending on societal choices, we may also witness the emergence of a substantial component of nonmarket production and exchange of information and of information-based tools, services, goods, and capabilities. This may lead to substantial redistribution of power and wealth from the 20th century industrial producers of information, media, and culture. This raises the central issue of whether public policies will promote a common infrastructure that is governed as commons and, therefore, made available to anyone who wishes to participate in the networked information environment outside the market-based proprietary framework (Benkler, 2006). Or, will new business models emerge to appropriate and commercialize these bottom-up contributions?

How will the technological and economic forces that are shaping the media play out in the developing world? Will the Internet, digitization, and collaborative tools reduce inequalities and promote diversity in the media and communication environment at the local and global levels? Will this transformation allow more people to participate in knowledge creation and cultural sharing on a global basis? Will the economies of scale and scope of digital content production further reinforce the imbalance in trade and further displace local with global media? Unencumbered by legacy assets, will developing countries be able to leverage newly available and affordable technology platforms (mobile phone, wireless) to deliver relevant content?

Global debates on the need to foster a development-friendly New World Information and Communication Order raged during the 1970s and 1980s at UNESCO and other UN organizations, including how developing countries might use the media and communication networks to become more economically, politically, and culturally self-reliant. Since, progress has been slow. The recent World Summits on Information Society of 2003 and 2005 have revisited many of the issues of inequalities but in very different technological, economic, and political contexts. Today, equally and strongly contested are the need to expand the opportunities for open access to media content and the Internet to limit intellectual property rights protection on digital information resources and to finance literacy and other capabilities necessary for people to participate in information societies (Mansel and Nordenstreng, 2007). The outcomes are likely to be shaped as much by geopolitics and globalization as by technological advances. They are also likely to be significantly influenced by mobilizing local NGOs, building social capacity to appropriate the new tools, promoting user- and community-created content, and pursuing national media and telecommunications reforms within an inclusive e-development strategy.

While focusing on ICT use for opening opportunities and delivering services to the poor, we must also monitor and address the impact of ICT on equity and income distribution within and among countries. The ongoing revolution is likely to be a driving force in processes of restructuring economies, generating wealth, and concentrating or distributing the new wealth. Would it inevitably lead to exacerbating the income disparities within developing countries? What role should the state play in these processes? This leads us to the next topic, managing risks.

Managing Risks

The likely course of the ICT revolution is uncertain and unpredictable. ICT is a disruptive technology. There will be winners and losers. There is a legitimate worry that ICT may be promoted as a development fad, not dissimilar to earlier ones, disregarding the risks (Wade, 2002; Kraemer and King, 2005; Carr, 2008). Key risks are:

- Wasting resources: unrealized benefits at substantial costs
- Exacerbating inequalities and exclusion within and across countries
- Reinforcing existing power distributions and hierarchical structures
- Controlling, not empowering
- Polluting, not greening.

The benefits from ICT investments are not automatic. To be realized, they require complementary investments in human capital and much organizational and social learning (Abramovitz and David, 1999; Brynjolfsson and Saunders, 2010). ICT-enabled restructuring is fraught with difficulties and risks, including outright failure to deliver the promised benefits. A growing literature has documented these difficulties, particularly concerning the introduction of complex and integrated software infrastructures that require extensive process reengineering and behavioral changes in large organizations. The use of ICT in the public sector, as in e-government, is fraught with even more risks and frequent failures than the private sector (Heeks, 2006, 2002; Hanna, 2007b, 2008).

The ongoing technological revolution may also exacerbate inequalities, as technological change always favors the prepared. In this case, ICT has been the fastest technological change in history, thus exacerbating adjustment problems. While as far reaching as the agricultural and industrial revolutions of the past, the current technology revolution is unique in its pace of change and diffusion: it took a century for the printing press to reach 50 million people, 40 years for the radio, and 4 years for the Internet. Driven by "Moore's Law," ICT advances are proceeding at enormous speed.[5] Some developing countries may take advantage of their late start and leapfrog intermediate technological stages, as in wireless communication technologies. But, for reasons of financial and human resources and other complementary factors, and the presence of "network externalities," the majority of poor developing countries are likely to face the risk of a widening digital divide.[6]

This fast-paced technological revolution is also divisive within countries as individuals are in different positions to adapt. The digital divide may merely parallel

[5]Gordon Moore observed an exponential growth in the number of transistors per integrated circuit and predicted a continuation of this trend. This has been generalized into a continued exponential growth in ICT capacity.

[6]Network externalities are derived from the fact that the value of a telephone line increases with each new subscriber by the number of potential connections between users. This indicates substantial externalities and there may be a threshold effect through which ICT begins to have substantial impact only when at a certain penetration level in the economy.

to similar disparities in income and access to services such as education and health. But ICT and e-government services, in particular, may reinforce the divide in access to services, and even dampen the pressure to reform and improve such services for all citizens. The already highly skewed access to literacy and ICT may well deepen all other divides. The inequality effects of the early stages of installation of ICT can be at least partly reversed at later stages, as occurred in the case of deployment of the mass production paradigm (Perez, 2002). Unless strong countervailing policies are established, this divide is likely to grow over time.

A number of factors point to the threat of exclusion of the poor in the current information revolution. With the exception of mobile phones, the gap in the provision of new ICTs is much larger within and among countries than income disparities. Benefiting from ICT requires complementary investments and skills, including literacy. Threshold effects are also at work: network externalities, scale economies, lack of local content in local languages, fragmented markets for software applications, and high cost of access for remote areas—factors that lead to or reinforce poverty traps and economic isolation for poor communities and poor countries. Poor and disadvantaged groups, particularly women, often face special constraints in accessing ICT and using them for their specific needs. The risks of economic exclusion suggest that countries should be concerned with the level of connectivity and ICT provision—and with enabling access and deploying ICT and content in ways that expand relevant information for the poor, increase their voice in decision making, and address bottlenecks to their trade.

Then there is the risk of ICT becoming a tool for reinforcing current hierarchies and power structures, rather than reform and empowerment (Kraemer and King, 2005). The potential for ICT to produce reforms and broaden participation, in government and society, can be thwarted because public administrators and local elites will instead use ICT to serve their own interests and maintain the status quo. There is a long history of literature and empirical evidence that suggest ICT has been used most often to reinforce existing structural arrangements and power distributions rather than change them (Kraemer and King, 2005). Top managers use ICT to enhance the information available to them, to increase their control over resources, and in general to serve their own interests. In less liberal and more unequal societies, ICT benefits are less likely to be fairly distributed, unless political will and social values push for applying ICT for empowerment and public sector reforms.

Although government and business organizations exhibit fundamental differences that influence the outcomes of ICT use, political and societal organizations are under increasing social and global pressures to perform and open up, and they can learn a great deal from the lessons of business organizations. Many political and public leaders are expressing interest in using ICT to improve government operations and enable new services. They are increasingly aware of the rising demands of businesses and citizens and of the shrinking public resources. The most recent US Presidential elections (of 2008) has shown the potential of ICT use in political mobilization, including the Internet-based fund raising, weblogs and Internet-based news sites, mobile messaging. There is no reason that government cannot learn to take advantage of ICT for mobilization of public opinion and reform.

A related risk is that ICT may lead to control rather empowerment of citizens, and the poor in particular. Despite its promise for personal liberation, the Internet can become a tool of bureaucratic control. As search engines and data mining algorithms are refined and made more powerful, they will enable governments and corporations to discover hidden relationships among the various information we place on the web. Analyzing these relationships can unlock substantial confidential information about Internet users. While these capabilities put enormous power into the hands of individuals, they put even more power into the hands of companies, governments, and other institutions whose business is to control or influence individuals (Carr, 2008, p. 191).

The technology's ultimate impact on public good will be determined by how the tension of its dual nature—liberating and controlling—will be resolved. Although ICT as a tool for personal and community empowerment has been shaping modern society in recent years, large and powerful institutions have been adopt at reestablishing control, and ICT continue to be applied at higher levels of control (Carr, 2008, pp. 196–209).

Finally, ICT may become a major source of pollution and energy consumption, rather than a greening technology. A major challenge of the 21st century is catastrophic climate change and the growing pollution of the environment of most urban areas of developing countries. A key promise of ICT is to provide less energy and less material consuming solutions to all kinds of manufacturing, services, and entertainment. This promise is particularly important to meeting the challenge of climate change as well as urban pollution, with the emergence of smart transportation and urban systems, smart energy networks, lean supply chains, telecommuting, and other energy-efficient practices. Yet ICT products, such as televisions, mobiles, and computers may become a major source of dumping and pollution in developing countries. The energy consumption of data centers is also rising rapidly. Without a deliberate strategy, strong incentives and political commitment, the promise of the "green IT" may not materialize.

Productivity, Growth, and Technological Determinism

Will the ICT revolution lead to a "soft landing" or to an upheaval as traumatic as that of the first industrial revolution? Would it lead to new divides, break up of neighborhoods, increased job insecurity, financial volatility and concentrated wealth, or lean and green production, revitalized and connected small-scale communities, and more inclusive societies? Will ICT lead to further centralization and control by a small group of elite, or fulfill the promise of becoming a tool for reform and empowerment?

The author does not subscribe to technological determinism and the inevitability of the promises or risks of ICT. The role of technology is neither deterministic nor wholly malleable. The printing press, for example, has been an agent of change, but its impact varied across societies (Einstein, 1979). Different technologies make

different kinds of human action and interaction easier or harder to perform. So, there is no guarantee that ICT will lead to improvements in productivity, growth, employment, and poverty reduction—or even more ambitiously, advances in innovation, empowerment, decentralization, human freedom, organizational transformation, cultural diversity, and social production of information (Benkler, 2006). These are societal choices. They depend on many cross-cutting social and economic policies.

Consider the potential impact of ICT on growth and productivity. We need to assess the prospects and conditions for ICT contribution to productivity, growth, and poverty reduction in developing countries. The "productivity paradox" and the slow emergence of ICT impact on productivity even in OECD countries can be explained among others by the considerable time needed for the diffusion of new technologies and for institutions to adjust or transform—changing from hierarchical to networked organizations, upgrading the workforce, or reengineering and inventing business processes. It takes time to build networks within and across firms and to enable new forms of interactions throughout the economy. Understanding this time lag is important in the development of ICT-enabled development strategy.

OECD (2004a) research shows that several conditions or complementary factors influence the extent of diffusion and use of ICT and thus its impact on firms and economies: the extent of competition and nature of the regulatory environment, the availability of appropriate human capital, the ability and willingness of organizations to restructure and change work practices, the relative total costs of ICT deployment, and of course, the nature of the business, or the structure of the economy. While complementary factors are important to payoff from all kinds of investments, they are most critical in the case of ICT investment since ICT transforms the intellectual content and human interaction as well as the physical aspects of work.

Significant differences between OECD and developing countries are likely to influence the extent and speed of impact of ICT on growth and productivity. Relatively few developing countries have sizable ICT production sector and their ICT sectors have fewer backward and forward linkages into their domestic economy than in OECD countries. With the exception of a few large developing countries, most lack mass markets for ICT goods and services, resulting in higher costs and less efficient use.[7] ICT investments are generally higher in developing countries where equipment is imported and telecommunications user charges are much higher than in OECD countries. Most developing countries also have poor communication infrastructures, mostly limited to the urban centers, and with poor quality international connectivity. The most critical difference is in the absence of complementary factors: enabling legal and regulatory environment to reward innovation and entrepreneurship, competitive regulatory telecommunications framework, extensive human capital to use ICT, and access to high-quality business advice and venture capital.

[7]This could change with strategies to develop and produce low-cost ICT products that are adapted to local markets in poor countries.

These differences are not insurmountable. Rather, they point to ways in which governments, businesses, and aid agencies can act to increase the pace of ICT diffusion and the rate at which contributions to economic growth can be realized. The benefits and risks associated with this revolution are not predetermined. They are a product of social and political choices. A passive public policy stance that leaves to market alone the direction of change will reinforce divides (ILO, 2001; UNDP, 2001). Passivity will also lead to economic marginalization and increasing social stress. The unprecedented advances in ICT and decline in prices imply a faster rate of diffusion than in previous technological revolutions. The constraints and risks to realizing the full benefits are significant, but a vigorous and coherent effort to harness the potential of ICT and synergize with complementary factors is likely to be critical to future growth and poverty reduction.

In a similar vein, whether the ICT revolution would exacerbate inequalities and reinforce existing power distributions, or promote more equitable and inclusive societies would ultimately depend on socio-political and economic policy choices. These choices cover the whole gamut: trade policies, tax policies, safety-net policies, training and education policies, competition and innovation policies, capital and labor market laws, and civil service and governance systems, among others. These policy choices encompass a broad spectrum of development issues and actors. They shape and can be shaped by the strategic options for leveraging ICT for development.

In sum, the ICT revolution will have profound impact on all aspects of growth, equity, and governance for countries at all levels of development. It presents a fundamentally changed global context for development. It offers unprecedented opportunities, risks, and strategic options. Neither the benefits nor the downside risks are predetermined. The opportunity costs of failure to respond are high. These prospects argue for integrating the ICT agenda into the governance reform and development strategy agenda. Leveraging ICT for transforming government and building the information society can no longer be left to the technologists or ignored by policy makers and mainstream development practitioners.

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