

Chapter 2

Historical Background

2.1 Introduction

The digital divide has been an influence in the world since the invention of computers in the mid-20th century. Early computers were restricted to small groups of highly trained users, while the general population could only read about the innovation, an early form of divide. Today, with cell phones prevalent worldwide, the concept of digital divide has changed, but remains significant and influential. This chapter focuses on how information and communications technologies evolved and expanded over the last two decades. What was the sequence of events for this growth? What drove it? How can the broader aspects of its maturation be understood?

The chapter first examines the milestones, both of technological innovations and of recognition of digital divide concepts. Stages have been proposed for the digital divide that draw on and modify Everett Roger's Adoption-Diffusion Theory (Rogers 2003), a framework that will be examined in Chap. 3. In this chapter, Roger's adoption-diffusion stages are introduced. Stages of adoption of major technologies can also be analyzed longitudinally by considering their trajectories of growth over time, which vary across nations. It will be shown that initial highly-varied levels for an innovation become less varied with time, and that the paces of convergence of usage levels for the leading ICTs tend to be offset by 5–10 years. Even if the usage levels of a technology such as mobile phones become saturated and much more even worldwide, new questions arise about variation in the technology's effectiveness, productivity, and social impacts.

Two chapter cases are presented. Azerbaijan represents a developing nation, the government of which has promoted and invested heavily in ICT, leading a trajectory of many improvements but also challenges. South Korea constitutes one of the foremost success stories in ICT worldwide stimulated through persistent central government efforts. Not resting on its ICT laurels that country diagnosed that it faced its own internal digital divide, addressed the disparities, and reduced internal

digital imbalances. South Korea has been exemplary in sharing the lessons of its success story by providing resources and field expertise to developing nations to improve their information technologies. The conclusion sums up these historical developments, which lead into the consideration of theories in Chap. 3.

2.2 Historical Milestones and Growth in Technologies 1990–2015

After the advent of the computer in the 1940s, during its commercial introduction in the late 1950s, computers differentially diffused into countries, states, and provinces, and individuals varied in their use of them. The computer was a technological innovation, which underwent an adoption and diffusion process, as well as changing as a technological product. The computer was initially only available to organizations rather than to individuals, due to its large size and staffing needs. With the introduction of the early commercial personal computers in the late 1970s and early 1980s, including the Apple II in 1977 and IBM PC in 1981, use of computers began to grow among individuals and households, reaching 8.2 % of U.S. households in 1984, 22.8 % in 1993, 51.0 % in 2000, and 77.2 % in 2011 (U.S. Census 2013; World Bank 2013).

As seen in Fig. 2.1, major technologies were introduced over the 25 years from 1990 to 2015, each being an innovation at the time of its market launch. This section discusses the book's major technologies of personal computers, the Internet, mobile phones, the web, broadband, and social media. The objective is to provide a broad background on what the technologies are, how they evolved, and how they are distributed by world region today. The timeline in the figure also highlights prominent digital divide initiatives that parallel the evolution of technologies. In the next section, the stages of maturation of use of technologies are discussed and detailed statistical analysis is performed for mobile phones, PCs, and broadband in the 21st century.

A key technology for this book is the mobile phone, which in subscriptions today is almost as numerous as human population. The mobile phone, or cell phone, stemmed from research at Bell Labs, beginning in the late 1940s and leading up to the original handheld cell phone introduced by Motorola in 1973. Since the early 1990s, cell phones have increasingly displaced fixed, landline phones, although the latter still remain, as evidenced at a public phones, such as those in Fig. 2.2. As seen in Figs. 1.2 and 1.3, mobile phones grew rapidly per capita as well as in gross volume during the past two decades. In the decade from 2002 to 2011, India and China experienced particularly rapid mobile phone expansion on a per capita basis, each gaining 800 million mobile phones, with China starting its spurt five years earlier than India. This volume of diffusion of a single information technology was unprecedented in human history. It strengthened and dramatically expanded personal and business information flows and communications in democratic India,

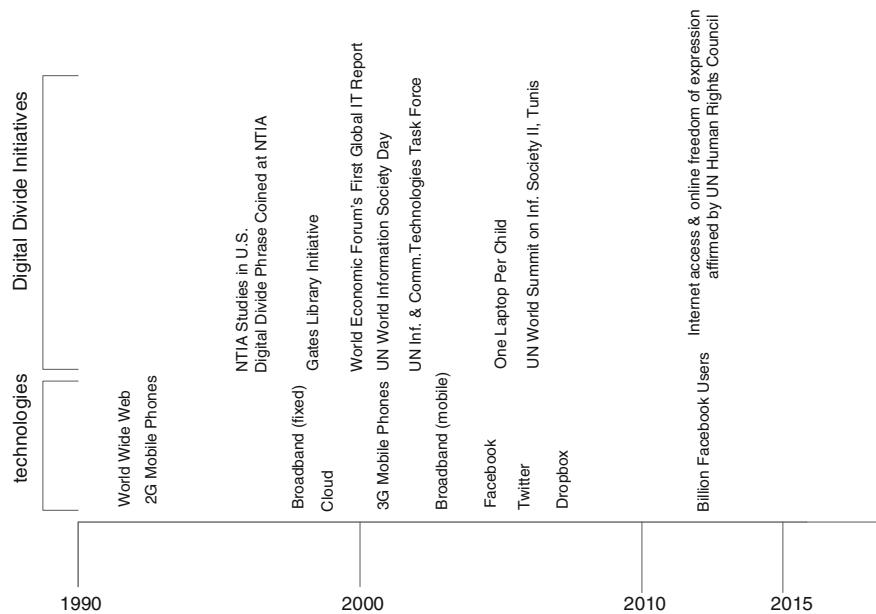


Fig. 2.1 Time line of major technologies and digital divide initiatives, 1990–2015

Fig. 2.2 Fixed, landline public phones, Illinois, USA



while radically changing the potential for citizen information flows and exchanges in China, even under the cloud of widespread censorship.

Cell phone commercial analog systems were introduced in Japan in 1979 (termed 1G—first generation systems), and the digital 2G mobile phones using the GSM protocol commenced in Finland in 1991. 3G phones, initiated in the early 2000s in Japan and South Korea, were based on broadband and packet switching; and supported internet features. Although a 3G phone is more expensive than a 2G one, there has been rapid adoption of the 3Gs especially in nations with greater internet use. Globally, by 2008, 3G (mobile broadband) was tied with fixed broadband at the level of 5 % of households, and by 2013 mobile broadband exceeded fixed broadband by threefold, at 29.5 % of households versus 9.8 % for fixed broadband (ITU 2013).

The Internet originated in 1969 with ARPANET, a research-defense network that had been started in 1966, with its first message exchange occurring at UCLA in 1969. Other internet standards such as TCP/IP were established in the early 1990s. As seen in Fig. 1.1, there was rapid increase in penetration of the Internet in advanced nations from 1996 to 2005, while their growth tapered off as levels approached 80 %. Penetration is defined as the percent of population that uses a technology. Whereas middle income nations experienced rapid internet growth from 2002 to 2011 and continue to expand rapidly, India and many lower-level developing nations were just beginning to take off in Internet use around 2008–2010.

Although broadband has grown rapidly in the past seven years, extent of use of broadband internet features by 3G phone adopters varies considerably, depending on availability and speed of broadband, education and literacy of the user, and cost of internet access. In the developing world, mobile broadband grew more rapidly than fixed phone broadband, increasing by over four-fold from 2010 to 2013, reaching 20 % of households, still far lower than its 3/4 penetration in developed nations (ITU 2013).

Another aspect of mobile broadband is its predominance as the only widespread method of broadband access in the developing world, whereas in developed nations mobile broadband is generally complementary to fixed broadband, e.g. a user might check websites on his/her cell phone and later dig in longer and more deeply on a PC. Another plus is that mobile broadband is user friendly and heavily adopted by young people, as seen in Fig. 2.3. A tradeoff is that although mobile broadband is less expensive than fixed broadband, the former tends to have volume limits on storage that constrain use (ITU 2013).

Since the data for mobile broadband are less reliable and often missing or incomplete at the state level, in this book we do not treat mobile broadband as a separate category. However, as data become more available, it will be important for country and state/provincial investigations to include it.

Fixed broadband had rapid growth initially in nations with strong fixed phone networks, and remains a stable but solid technology today mostly for advanced nations. Fixed broadband, commencing in 1997, was advantageous for countries with established fixed phone networks. A non-broadband household with a fixed

Fig. 2.3 Young user of Apple Tablet, California, USA



phone connection and DSL service available could easily and cheaply make the jump to DSL broadband. Also households with cable TV networks could readily obtain broadband if the service were offered. By contrast, in a developing nation without fixed-phone or cable networks, the options for broadband are often limited to mobile broadband, particularly in its urban areas which tend to be outfitted with cell phone towers or expensive satellite access.

As seen in Fig. 2.4, advanced nations such as South Korea, Japan, and the U.S. had extremely rapid broadband growth from 1999 to the mid-2000s, with slower growth subsequently. South Korea was particularly early and rapid in growth, the story of which appears later on in the case study. Mid-level economies of China, Brazil, and South Africa, which commenced broadband growth around 2002, have expanded at moderate rates, while the developing nations of India and Nigeria in 2013 have subscription rates under 4 %. Nigeria spurts upwards in 2012. The developing nation of Azerbaijan resembled its developing nation peers up to 2009, when it “shifted gears” into rapid exponential growth, a country that also appears as a case study later in this chapter.

The very concept of broadband has varied over time. For instance at its advent in 1997, broadband was differentiated from then prevalent dial-up lines by transmission speeds over 64 Kbps. The dividing line has continually been upgraded, so in 2013 in developed nations the accepted cutoff for broadband is greater than 2 Mbps (megabits per second) (ITU 2013). In the future, with a new standard of 4G, the broadband cutoff for developed nations might be as high as 100 Mbps. In Sweden’s national broadband and ICT plan, the objective is to have 90 % of households and businesses at speeds of 100 Mbps or higher by 2020 (Pepper and Garrity 2013). The reasons for an internet service or government to assign its own threshold for broadband include the type of fiber network installed in the country, how the differences between advertised and actual speeds are resolved, and how pricing is assigned at various speeds (ITU 2013). European goals of attaining speed of 100 Mbps or higher and other broadband delivered globally in new ways are examined in Chap. 12.

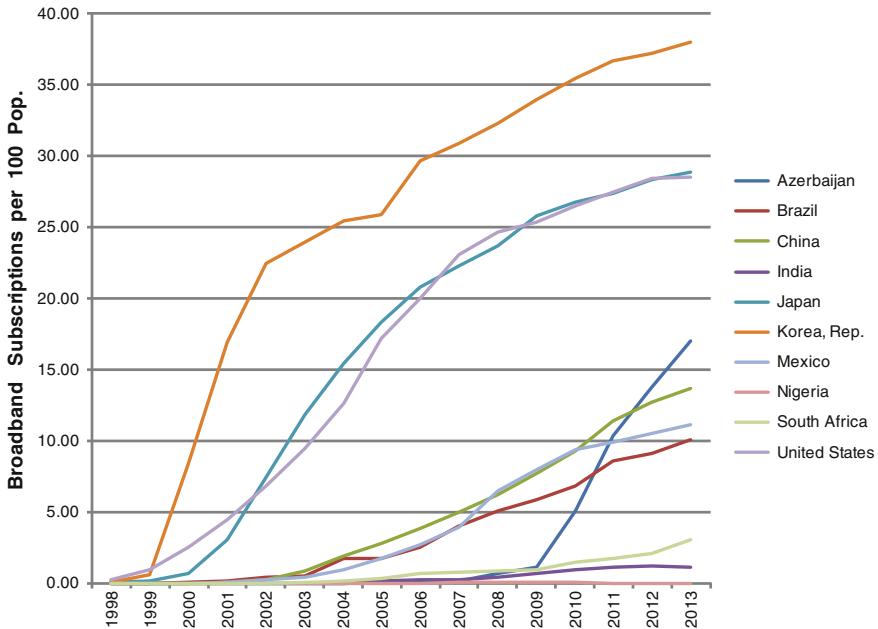


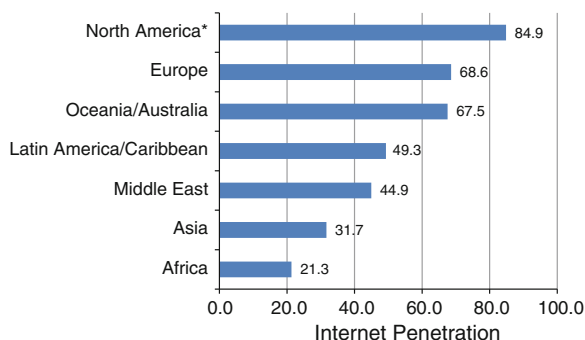
Fig. 2.4 Broadband subscriptions per 100 persons, Selected Nations, 1998–2013. *Source* World Bank (2014)

In this book, we accept the broadband definition that each data-gathering organization applies for its own datasets. The reason is that there is no systematic technique available to make accurate adjustments to multiple broadband definitions to a common standard at varied times and places. Hopefully, such a method will be developed.

The World Wide Web was introduced at the physics research center CERN in Switzerland in 2001. It has had enormous influence on Internet and broadband adoption. Data attributes for web use from samples of nations or states are not generally available from the World Bank and other leading international sources. Accordingly, we only utilize web variables in Chap. 5 for China, which has standard government variables available for number of web domain names and number of web pages.

Social media constitutes a technology that has caught on more recently. Early social networks were introduced in late 1990s and early 2000s, including Friends Reunited in 2000, Friendster in 2002, and MySpace in 2003 (Curtis 2013). Mark Zuckerberg initiated Facebook in 2004 at Harvard, while Twitter commenced in 2006 (Curtis 2013). Leading social media sites grew enormously in the past decade, with the following number of active users of the five most important social networking sites in June, 2014: Facebook (1,280,000,000), QZone (644,000,000), Google+ (343,000,000), LinkedIn (300,000,000), and Twitter (255,000,000) (Statista 2014). Qzone, popular in China and fairly similar to Facebook although in Chinese, is a service of the Chinese company Tencent. The already high, and rapidly growing,

Fig. 2.5 Internet penetration by World Region, 2013. *Note* North America consists of U.S. and Canada (84.9 %). *Source* Internet World Stats (2014)



presence of social networking worldwide and its documented impacts of education, communications, and behavior justify our including it in this volume, wherever possible. However, since there is no systematic data collection on social media use worldwide, we utilize only Facebook and Twitter and restrict their use to samples for which there is reliable and systematic data collection, in particular for the U.S. states, Japanese prefectures, and African nations. In the future, we expect that social networking data will become systematically available for nations from international sources, and for states/provinces from many national governments.

Not only have the major technologies in our research grown with a variety of starting points and speeds, but as mentioned in Chap. 1 they vary greatly throughout the world, as seen for internet penetration in Fig. 2.5. North America leads the world at 85 %, followed by Europe and Oceania/Australia (Internet World Stats 2014). North America in this tabulation consists 98.4 % of the U.S. and Canada, while Mexico is classified with Latin America/Caribbean. At the middle range of internet penetration is Latin America/Caribbean (49.3 %) and the Middle East (44.9 %), while Asia and Africa trail at 31.7 and 23.3 % respectively.

The elevated position of the U.S. and Canada is due to their excellent infrastructure, vigorous business environments, and educated populace, even though there are some regulatory hurdles (Dutta et al. 2011). Europe's lesser internet usage is ascribed to lower levels in Eastern Europe. In Western Europe are many of the world's leading internet nations particularly Scandinavia, the U.K., and Germany, while in Eastern Europe, there is unevenness, with moderate internet usage levels for some of the former Soviet nations now in the European Union (EU) such as the Czech Republic, Hungary, Poland, Slovak Republic, Romania, and Bulgaria, countries with moderate infrastructure and often high access costs. However, also in Eastern Europe are the nations of the Commonwealth of Independent States (CIS), most of which suffered deep drops in technology and innovation after the Soviet Union's collapse, and have only recovered somewhat (Dutta et al. 2011; Dutta and Bilbao-Osorio 2012). Two of the CIS nations with the highest internet penetration are Russia and Azerbaijan.

The Australia/Oceania region comprises the internet-leading nations of Australia and New Zealand, as well as internet-deprived ones such as Fiji and the Solomon

Islands. In Latin America and the Caribbean, although nations such as Uruguay, Chile, Argentina, and Brazil are above the world average, most countries are below average, limited by low educational levels, lack of relevant skills, marginal infrastructure, and reduced business innovation (Dutta et al. 2011, 2012).

Although Asia has some global leaders in internet such as Japan, South Korea, Hong Kong, Taiwan, and Singapore with internet penetration over 80 %, it also includes South Central Asian nations such as India, Pakistan, Bangladesh, and Myanmar which have penetration under 10 %. Africa is the most internet-deprived continent with penetration of only 21.3 %. Although this penetration is the result of rapid growth, many of its nations have rates under 10 %, including ones under 5 % in the center of the continent. The reasons for low rates in Sub-Saharan Africa include poor infrastructure, very low educational levels, relatively high internet costs, and multiple nations with sluggish and inefficient business environments (Dutta et al. 2011, 2012). The geographic contrasts in internet usage within Africa are dramatic, and have major economic ramifications, preventing viable and competitive service sectors. Chapter 9 delves deeply into reasons for Africa's stark internet disparities.

In short, this section points to technologies that have boomed worldwide in the last two decades, although following a lagged sequence of introductions and initial upward surges. Additionally there are large continental differences in penetration of ICTs, as well as wide variation within Asia and Africa.

2.3 Stages of Maturation of Technology Use

This section considers the patterns of adoption of technologies over time, in order to try to understand more thoroughly the rates at which a new technologies expand and eventually converge, and also how countries and developed versus developing regions of the world can be better understood and interpreted. Later, the progression over time and space in technologies during the period 2000–2013 is analyzed, illustrating actual sequences that the major nations have followed.

Regarded as the founder of adoption-diffusion theory, Everett Rogers formulated an extensive theory of how innovations are adopted and diffused (Rogers 2003). Although his detailed theory is discussed in Chap. 3 in relationship to the book's conceptual theory, his stages of adoption are glimpsed at in this chapter, as they relate to two subsequent digital divide stage theories. Roger posited that an innovation underwent early adoption with a few innovators; then experienced a rapid increase followed by tapering off that was rapid but slowed and became more stretched out at the end with laggard adopters. The full set of adoption-diffusion stages, seen in Fig. 2.6 consist of innovators, early adopters, early majority, late majority, and laggards (Rogers 2003). Based on this adoption curve, cumulative adoptions by percent of population over time appear as an "S-shaped curve" (see Fig. 2.7). Notice in this figure there are three "S-shaped curves" that have different rapidity of adoption.

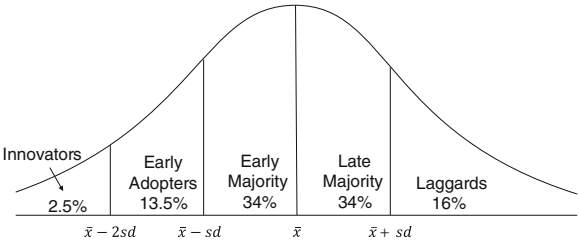
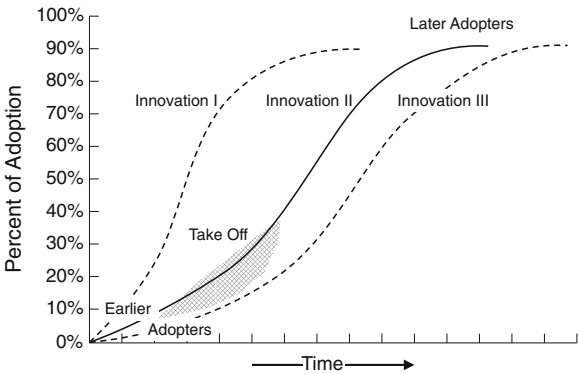


Fig. 2.6 Roger’s adoption-diffusion stages. *Source* Rogers (2003)

Fig. 2.7 Cumulative adoption curves, at different adoption rates. *Source* Rogers (2003)



A glance back at Fig. 1.2 shows cumulative mobile phone subscriptions over time, Korea, Japan, and Mexico follow S-shaped penetration curves, while the curves for Brazil, China, and India appear to be in the early adoption stage of rapid increase. The United States follows the S-shaped curve through the innovation and early adoption stages up to 2003, but differs in not tapering off in the early majority stage, and rather continuing to grow linearly. However, the U.S. logically would reach a limit and begin to taper at a future time point.

Based on Roger’s theory, a framework for digital divide was categorized into three stages (Rueda-Sabater and Garrity 2011). We have slightly modified this framework, particularly by identifying Stage 2 with “leapfrogging,” or jumping over stages.

Stage 1. First Adopters (“Early Adopters in Roger’s theory)

For internet penetration their major spurt in internet use occurred between 1995 and 2005 (“early adoption stage”). By 2010, Early Adopters tended to have 75 % of population as Internet users and most households had a broadband connection (Rueda-Sabater and Garrity 2011). This group constituted mostly developed nations. For Internet they are presently levelled off at the saturation point of the S-shaped curve, such as South Korea, Japan, and the United States.

Stage 2. “Converging” Adopters (“Early Adopters in Roger’s theory, but applying to countries with more recent ICT growth, often with “leapfrogging”)

Nations in this category are mostly developing ones that skipped the adoption of PCs and started out in ICT adoption with rapid growth in Internet and broadband (“early adoption stage”). The adoption rate was more rapid due to extensive use of internet cafes and other cheap public venues (Rueda-Sabater and Garrity 2011). Another necessary factor is to have low-cost technologies available. Skipping adopting the PC and moving to adoption of Internet/broadband is often referred to as “leapfrogging,” which implies that the nation skipped the steps of more expensive PCs and the more cumbersome infrastructure of fixed telephone networks, but rather leaped across those traditional technology steps and right to inexpensive mobile phones and Internet/broadband, such as China.

Stage 3. “Belated” Adopters (“Laggards in Roger’s theory”)

These countries are coming late to adopting ICTs. They have among the weakest economies and lowest incomes. In 2010, often Internet use is under 5 % and broadband under 1 % (Rueda-Sabater and Garrity 2011). These nations are “leapfroggers” even more than Stage 2’s “converging adopters.” However they face the barriers of the high relative cost of ICT access, low literacy and education, and poor infrastructure. However, once the cost threshold is achieved, these nations could have the most rapid rates of increase, as is being seen in some impoverished African nations today.

Another study (James 2013) expanded more on these ideas. Utilizing an extensive World Bank data set (World Bank 2008), the study indicates that although in the High income OECD countries from 1975 to 2000, 82 % of innovations reached the 50 % adoption threshold, for developing nations in that period only 9 % reached the 50 % adoption threshold (James 2013). Similar patterns occurred for innovations in earlier periods, i.e. rates in the range of 33–75 % for High income OECD countries reached the 50 % adoption threshold while only 4–11 % reached it for developing ones (James 2013). For the present research, these findings suggest that some ICTs in developing nations might stop adoption at an earlier stage and lower level and not even reach maturity.

However, James (2013) subsequently observed that for ICTs, an exception to this historical precedent is that late-starting developing nations often either equal or exceed the maturity levels of developed nations. Although starting later, the developing nations go through early adoption at much more rapid rates of increase than for developed ones, i.e. demonstrating leapfrogging similar to Stages 2 and 3 of the prior framework (Rueda-Sabater and Garrity 2011).

The two related frameworks inform our research in conceptualizing that the same innovation is likely to commence later yet grow faster in developing versus developed countries. Both are likely to reach eventually a similar maturity level, especially if costs in the developing nations became affordable.

Statistical study of sample of nations for stages of technology adoption

We explore the rates of adoption for a representative sample of 39 nations from all the continents. ICT variables for the sample are given in Table 2.1. The nations are selected as a convenience sample that includes mostly nations of large populations, and also includes the four nations studied in detail in Chaps. 5–8 as well as some African nations discussed in Chap. 9. The exploratory sample is about a third the size of the entire world sample of nations with complete data. A map of the sample, showing bar charts for mobile phone penetration in 2000, 2005, 2010, and 2013, appears in Fig. 2.8.

Before discussing the study, some background is necessary on trajectories of adoption. Cell phones and the Internet started the upward early adoption stage for advanced nations in the early 1990s, attaining late maturity in those nations about 2010 (see Figs. 1.1 and 1.2). Broadband entered early adoption for advanced nations in the late 1990s (see Fig. 2.2) and reached early maturity in about 2012–2013. However, usage of mobile phones eventually reached near saturation of population, whereas Internet use leveled off at about 80 % penetration. This difference relates to factors such as cost, infrastructure, and literacy. To use a cell phone for making calls can be done by an illiterate person at very low expense, whereas using the internet requires some literacy and is generally more expensive than a simple 2G cell phone, implying total market saturation is unlikely. By contrast broadband subscription per 100 persons, even for the most advanced usage nations such as South Korea, has reached a level of only 35–40 per 100 persons, which points to early maturity stage, with significantly higher usage expected in the future.

With this background, we analyze the usage of mobile phones, PCs, and fixed broadband, based on the sample of data from the World Bank for the period 2000 to 2011–2013. In the case of PCs, the World Bank changed its metric so that although it measured PCs per 100 population in 2000 and 2005, it ceased doing so for 2010 and beyond, but did have available percent households with a personal computer for 2011, which we used as a proxy for percent PCs. As seen in Table 2.1 and Figs. 2.8, 2.9 and 2.10, there was considerable variation between nations.

This variation reflects the varied trajectories of adoption of ICTs already noted. Consider mobile phones for twelve nations in the sample (see Fig. 2.8). It is clear that the developing nations of India and Nigeria have 2013 subscription rates of about 70 %, most of which occurred in big jumps between 2005 and 2010. By contrast, the highest levels of mobile phone use are in Finland and Saudi Arabia, both in the range of 170–175 subscriptions per 100 persons. However, Saudi Arabia, compared to Finland, started at a much smaller base in 2000 of 8 subscriptions per 100 population, and then jumped. Not only are there large differences in progression over time, but it is apparent that the starting values in 2000 had more variation than the ending values in 2013. This reflects advances worldwide in infrastructure and affordability of cell phones, leading to more convergence, as saturation gets closer.

Similar variations in progression over time are seen for PCs per 100 persons (Fig. 2.10) and fixed broadband (Fig. 2.11). For them, developing nations had

Table 2.1 Sample for analysis of longitudinal change in variation of ICT variables

	Mobile phone subscriptions/100 persons					Personal % Computers/ Households 100 persons with PC					Fixed broadband subscriptions/100 Persons				
	2000	2005	2010	2013		2000	2005	2011		2000	2005	2010	2013		
Angola	0.2	9.7	48.1	61.9		0.1	0.1	6.4		0	0	0.1	0.22		
Australia	44.5	89.8	100.4	106.8		46.5	68.3	82.6		NA	9.82	23.99	25.01		
Bangladesh	0.2	6.3	44.9	67.1		0.2	0.1	4		0	0	0.27	0.63		
Belgium	54.8	91.4	111.1	110.9		34.4	34.8	78.9		NA	0.02	17.55	29.76		
Bolivia	6.9	25.9	70.7	97.7		0.2	2.3	24		NA	0.14	0.94	1.33		
Brazil	13.3	46.3	100.9	135.3		4.4	10.5	45.4		0.06	1.74	6.8	10.08		
China	6.7	29.8	63.2	88.7		1.6	4.1	38		0	2.83	9.29	13.63		
Czech Republic	42.4	115.1	122.6	131.3		12.2	24	69.9		0.02	6.93	14.5	17.03		
Dominican Republic	8.1	38.8	88.8	88.4		NA	NA	18.9		0.11	4.82	11.68	14.81		
Egypt	2.1	19	90.5	121.5		2.2	3.8	36.4		0	0.2	1.86	3.26		
Estonia	40.8	109.1	127.3	159.7		15.3	48.3	71.4		NA	13.52	24.02	26.54		
Finland	72	100.5	156.3	171.7		39.6	48.1	85.1		0.68	22.38	28.55	30.9		
France	49.1	78.3	91.4	98.5		30.4	57.5	78.2		0.33	15.41	33.74	38.79		
Germany	57.7	94.6	106.5	119		33.6	54.5	86.9		0.32	12.87	31.43	34.58		
Ghana	0.7	13.4	71.9	108.2		0	0.1	11.9		NA	0.01	0.21	0.27		
India	0.3	8	62.4	70.8		0.4	1.6	9.5		0	0.12	0.91	1.16		
Indonesia	1.8	20.9	87.8	121.5		1	1.4	12.3		0	0.05	0.95	1.3		
Ireland	64.7	102.7	105.2	102.8		35.9	49.4	80.6		0	7.76	21.07	24.24		
Israel	73.2	117.5	122.8	122.8		25.4	74	78.2		0	18.62	23.75	25.67		
Japan	53.1	76	96.8	115.2		31.5	54.2	80		0.68	18.35	26.77	28.84		
Kenya	0.4	12.9	61	70.6		0.1	0.1	8.8		NA	0.02	0.01	0.13		
													(continued)		

(continued)

Table 2.1 (continued)

	Mobile phone subscriptions/100 persons				Personal % Computers/ Households 100 persons with PC			Fixed broadband subscriptions/100 Persons				
	2000	2005	2010	2013	2000	2005	2011	2000	2005	2010	2013	
Laos	0.2	11.4	62.6	66.2	0.3	1.7	7.8	NA	0.01	0.09	0.13	
Lebanon	23	24.9	66	80.6	0.5	11.4	71.5	NA	3.26	6.98	9.95	
Mexico	13.6	42.6	77.5	85.8	5.1	13.6	30	0.01	1.74	9.42	11.14	
Netherlands	67.8	97.1	115.4	113.7	39.4	68.2	94.2	1.64	25.15	38.09	40.08	
Nigeria	0	13.3	54.7	73.3	0.7	0.1	9.3	0	0	0.06	0.01	
Norway	71.8	102.8	114.5	116.5	49	57.3	91	0.52	21.44	34.51	36.43	
Peru	4.9	20.1	99.5	98.1	0.4	10	25.4	0	1.27	3.12	5.18	
Russia	2.2	83.4	165.5	152.8	0.4	12.2	57.1	0	1.1	10.93	16.62	
Saudi Arabia	6.8	57.4	189.2	176.5	0.6	35.4	62.8	0	0.27	5.49	7.33	
Singapore	70.1	97.5	145.4	155.6	48.3	NA	86	1.76	14.6	24.98	25.7	
South Africa	18.6	70.4	97.9	147.5	6.2	8.5	21.5	NA	0.34	1.44	3.06	
South Korea	58.3	81.5	104.8	111	23.8	54.5	81.9	8.42	25.91	35.48	38.04	
Spain	60.2	98.4	111.3	106.9	114.3	27.7	71.5	0.19	11.61	22.81	25.57	
Turkey	25.5	64.4	85.6	93	3.8	5.2	48.5	0	2.35	9.83	11.19	
United Kingdom	73.7	108.6	123.6	123.8	33.8	60	84.6	0.09	16.42	30.83	35.73	
United States	38.5	68.3	91.3	95.5	58.5	76.2	77.2	2.48	17.16	26.5	28.54	
Venezuela	22.3	46.8	96	101.6	4.5	8.2	19	0.02	1.32	5.6	7.31	
Vietnam	1	11.3	125.3	130.9	0.9	1.3	16	NA	0.25	4.12	5.62	

NA not available

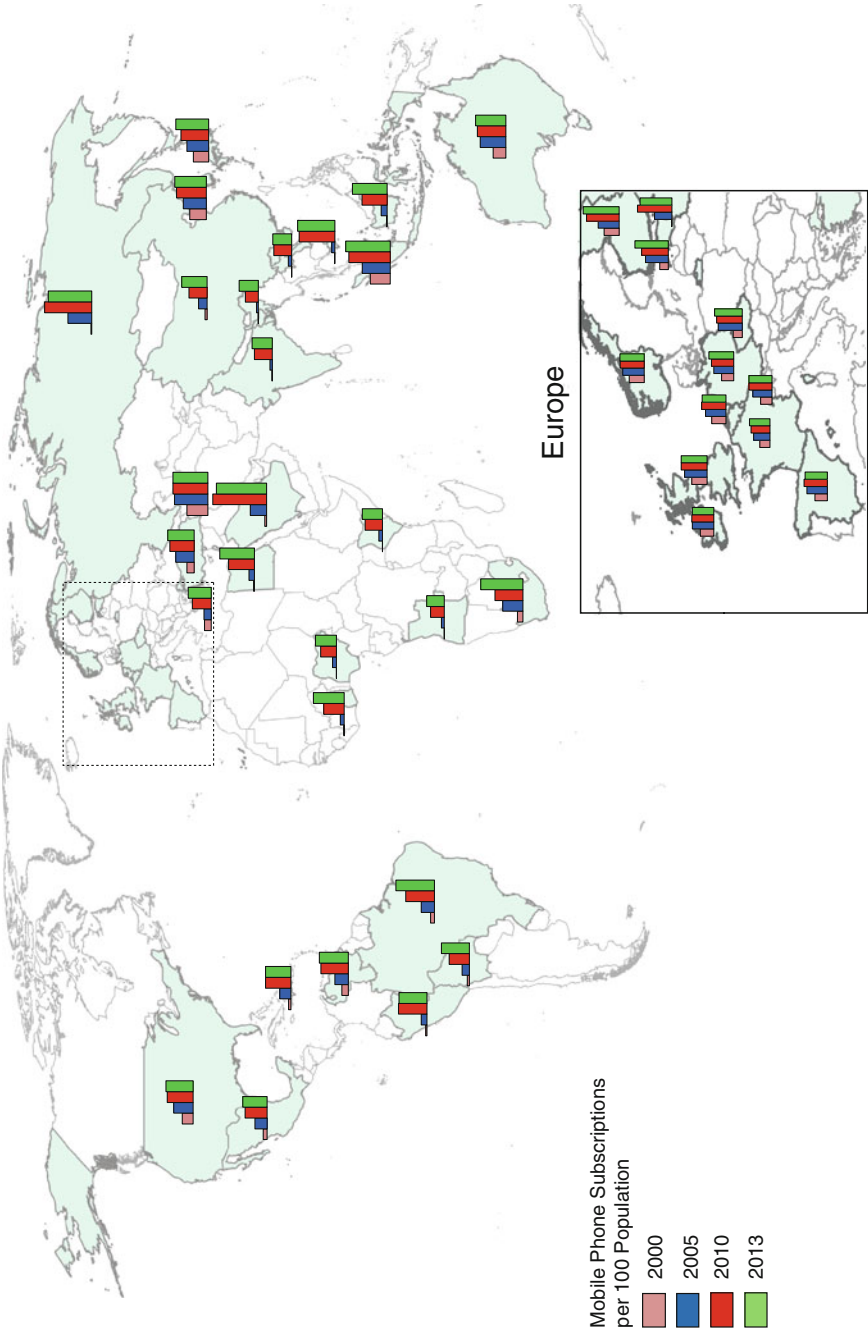


Fig. 2.8 Map of mobile phone subscriptions for 2000, 2005, 2010, and 2013, Sample of 39 Nations

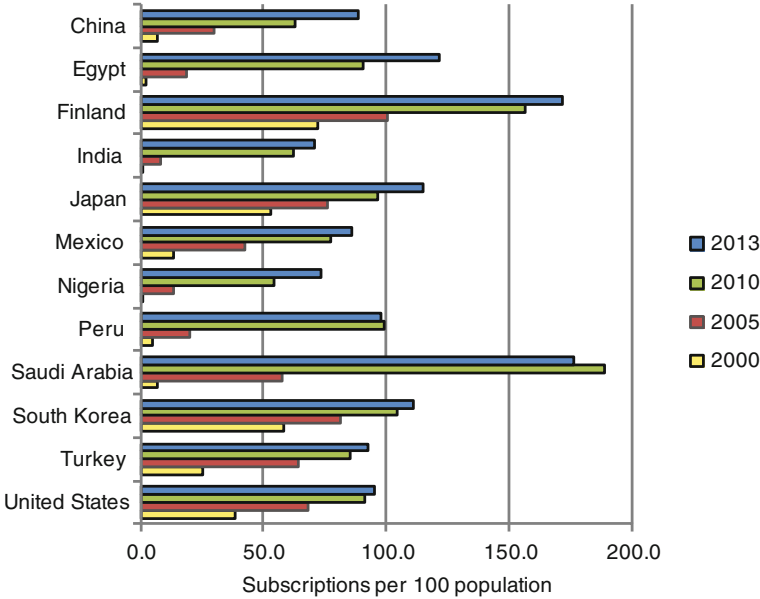


Fig. 2.9 Mobile phone subscriptions, 2000, 2005, 2010, 2013 for 12 Nations (*Data Source* World Bank 2014)

rapid growth (i.e. Roger’s early adoption stage) later on than for developed nations.

Again the variation at the end dates of 2011 and 2013 is lowered, compared to the starting year of 2000. For fixed broadband, countries such as Finland, Japan, South Korea, and the U.S. grew in steady large steps from 2000 to 2013, while the poor, developing nations of India and Nigeria revealed almost no progress over the 13 years. These large contrasts relate mostly are due to lack of availability of the infrastructure for fixed broadband. India and Nigeria had late arrival times for sub-oceanic cables, and in both, access to fixed broadband was limited by the high cost of user devices and subscriptions. Another reason is the leapfrogging noted earlier, in this case leaping from no broadband to broadband-based 3G mobile phones, skipping the step of fixed broadband.

Likewise, PCs show significant gains in penetration over time, which peaks at about 80 % of households, while the low income nations of India and Nigeria only reach levels of about 10 % of individuals. Since PCs remain considerably more expensive than mobile devices, the latter countries’ lack of adoption of PCs reflects cost and resultant leapfrogging of users to mobile devices such as 3G cell phones, which provide cloud-based applications that can substitute for PC applications.

To test the observation of reduction over time in variation of adoption levels, we computed the coefficient of variation of the three technologies at all the time points. The coefficient of variation for a sample is defined as 100 times the standard deviation divided by the mean. As seen in Table 2.2, each of the technologies has

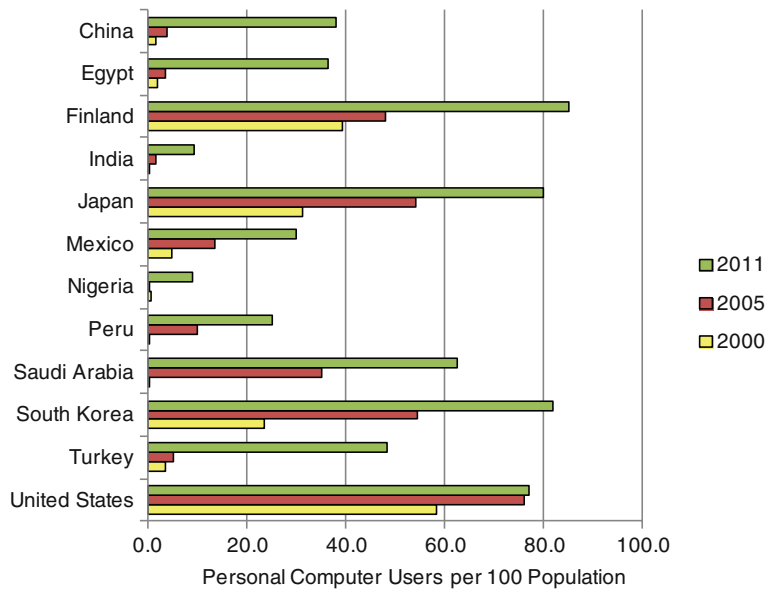


Fig. 2.10 Percent PC Users, 2000, 2005 and percent households with PCs, 2011, for 12 Nations. (Data Source World Bank 2014)

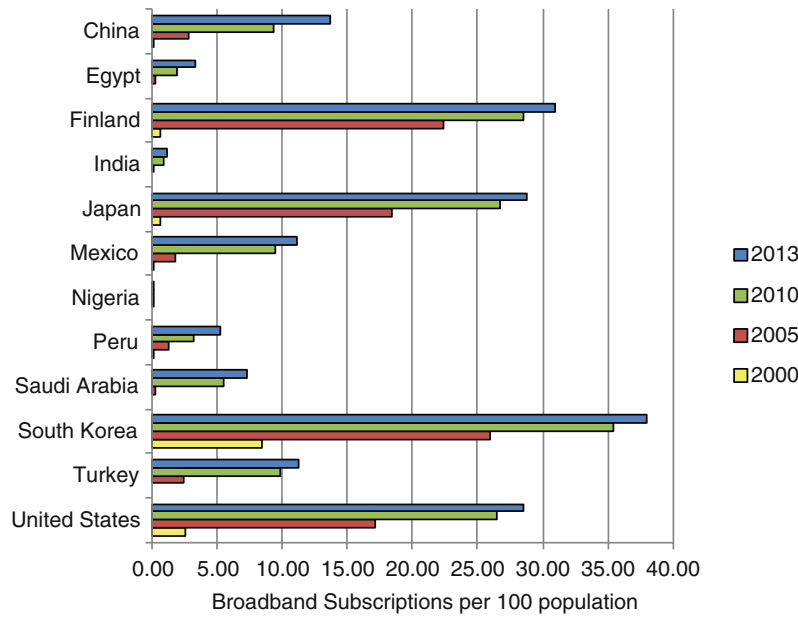


Fig. 2.11 Broadband subscriptions, 2000, 2005, 2010, 2013 for 12 Nations. (Data Source World Bank 2014)

Table 2.2 Longitudinal change in coefficient of variation of technology indicators

	Standard deviation	Mean	Coefficient of variation ^a
Mobile phone subscriptions 2000 per 100 pop.	27.61	29.52	93.52
Mobile phone subscriptions 2005 per 100 pop.	37.75	59.13	63.84
Mobile phone subscriptions 2010 per 100 pop.	21.92	98.89	22.17
Mobile phone subscriptions 2013 per 100 pop.	29.15	110.25	26.44
Personal computers 2000 per 100 pop.	24.27	18.56	130.73
Personal computers 2005 per 100 pop.	26.37	26.72	98.69
Percent households with personal computer 2011	31.37	50.33	62.33
Broadband subscriptions 2000 per 100 pop.	1.77	0.72	244.45
Broadband subscriptions 2005 per 100 pop.	8.43	7.17	117.60
Broadband subscriptions 2010 per 100 pop.	12.60	14.07	89.58
Broadband subscriptions 2013 per 100 pop.	13.55	16.30	83.14

^aCoefficient of variation equals 100 times the variance divided by the mean

substantial reduction in coefficient of variation, in the range of a half to 2/3 reduction, over the entire time period. However, even after the reductions, there is substantial coefficient of variation remaining of 26 % for mobile phones in 2013, 62 % for PCs in 2011, and 83 % for broadband in 2013. This implies that mobile phones are more converged globally, followed by PCs, and broadband is least converged. Although these findings confirm that the digital divide has been reduced, they imply that substantial divide remains for PCs and broadband.

2.4 Case Study: Azerbaijan

Azerbaijan, a nation of population 9.4 million in 2013 in the South Caucasus Region, is located along the west side of the Caspian Sea, bordering Russia, Georgia, Armenia, and Iran (Population Reference Bureau 2013). A former part of the Soviet Union with majority Turkic and Muslim population, it became independent in 1991 and has prospered economically since 2000 based on its rich petroleum production sector (CIA 2014). It forms a crossroads between Asia and Europe in transportation and energy, and has been a stable nation politically (Makili-Aliyev 2013).

As Azerbaijan became prosperous, its government leaders identified ICT as a strategic sector that would provide diversity to its economy, improve internal productivity, give it regional technological leadership, and enable the nation to start up its own ICT industry. The formal start of this thrust toward ICT was the approval in 2003 of the “National Strategy on Information Communication Technologies for the sake of Development of Azerbaijan Republic, 2003–2012” (Republic of Azerbaijan 2014). This strategic plan emphasized the three “pillars” to (1) liberalize

the telecommunications market, while adding regulations, (2) develop the nation's telecommunications infrastructure, and (3) foster and implement e-government and e-services (Republic of Azerbaijan 2014). A year later, the government established the Ministry of Communications and Information Technologies (MCIT), to be the lead agency to coordinate the government's efforts to stimulate businesses and non-government organizations (NGOs), and to encourage investors to deploy and expand the utilization of ICT. The government wisely provided MCIT with sufficient authority, capacity, and long-term funding to be able to achieve its goals (Aliguliyev and Gurbanov 2012).

Azerbaijan made large progress in its ICT base over the past decade, formalizing ICT advance as a national priority in 2007. A key starting factor, unusual for a developing country, was its extensive fixed phone network put in place originally in the Soviet era and developed further from the nation's ample petroleum resources, so that today all residential urban areas have fixed phone service (Aliguliyev and Gurbanov 2012). Accordingly, it was easier to implement broadband since the fixed phone service could be relatively inexpensively upgraded to DSL. The remarkable surge in broadband is evident in Fig. 2.12, starting in 2008 at about 1 % of households in 2008 and rising to 50 % level by 2013. Broadband by 2012 exceeded considerably cell phone and dial-up Internet access. Likewise, mobile phone subscriptions increased from a low-income-country level of 6 per 100 persons in 2000 to 101 per 100 persons in 2010, approaching the level for high income nations (World Bank 2002, 2012).

Simultaneously, the cost of broadband lowered by 11-fold as a percent of salary from 2009 to 2012 because of competition and government subsidies, (see Fig. 2.13), resulting in affordability similar to advanced nations.

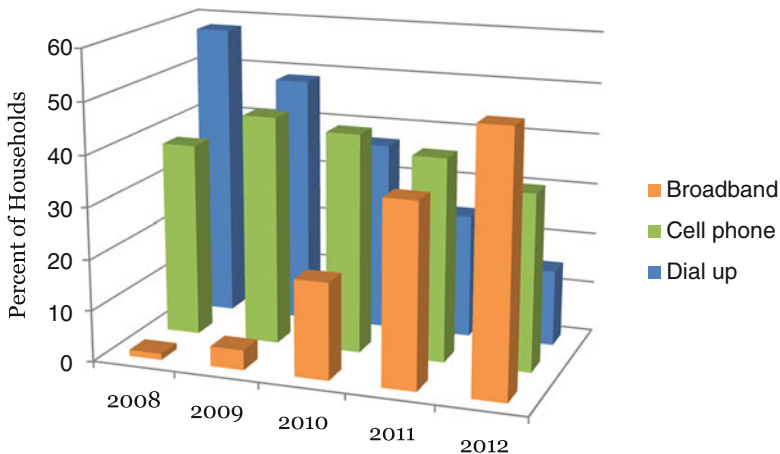


Fig. 2.12 Means of internet connectivity, Azerbaijan, 2008–2013. *Note* The other category (not shown) is less than 2.9 % of households. *Source* Republic of Azerbaijan (2012)

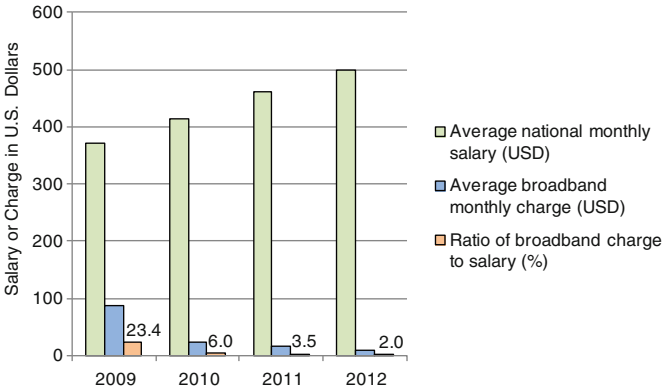


Fig. 2.13 Ratio of average broadband charges to salary (percent), 2012 (Republic of Azerbaijan 2012)

Although as noted earlier, most developing nations leapfrogged to bypass personal computers, MCIT took a different path by starting the National Personal Computer Project in 2009, which partnered with leading vendor firms such as HP and Microsoft to spread personal computers nationally at discounted prices, particularly targeting teachers and school children (Republic of Azerbaijan 2012). Hence, children who could benefit the most over their work life had much better access to PCs, albeit low by prevalence in the schools of advanced nations. Over 40,000 computers were provided this way for education (Aliguliyev and Gurbanov 2012), while the ratio of school pupils to PCs to school pupils halved from 2009 to 2012 (see Table 2.3). PCs were also used by corporations in Azerbaijan, as seen in Fig. 2.14.

Other notable government-led projects included e-government and e-services, satellites, the State Fund for Development of Information Technologies, a high technology park, and the Trans-Eurasian Super Information Highway (TASIM). In 2010–2011, several government plans and a Presidential decree started an effort to develop world-class e-government, and e-services for citizens (Republic of Azerbaijan 2012). Some highlights were the goals to achieve a state registry of citizens, e-services for taxation, e-registration of entrepreneurial enterprises, customs monitoring at a central “one-stop” website, online systems for immigration services, e-health, and the management of online availability of government information (Aliguliyev and Gurbanov 2012).

Table 2.3 Indicators of ICTs in Schools in Azerbaijan, 2009–2012

	Year			
Measure	2009	2010	2011	2012
Computer prevalence (%)	82.6	83.9	86.7	87.2
Broadband access (%)	15.8	39.1	47.4	48.3
Ratio of school pupils to PCs	35	33	27	16

Source Republic of Azerbaijan (2012)

Fig. 2.14 Corporate users of PCs in Azerbaijan. *Source* Internet Access and Training Program, Eurasia



The Trans-Eurasian Information Super Highway (TASIM) Project was started by the Azerbaijan government in 2008 to improve the connectivity of ICT infrastructure, expand the quality, and lower the cost of the Internet across the South Caucasus Region (Republic of Azerbaijan 2012). A broader and longer-term goal was to lead in linking the highly internet-developed European region through networks crossing 20 nations to link with the equally net-intensive East Asia region. Although TASIM was supported by a UN resolution in 2009, this slow-moving long-term project has so far progressed to agreements with operating firms and with cooperative governments including the construction of an undersea cable beneath the Caspian Sea connecting Azerbaijan with Kazakhstan. Ultimately, the TASIM project is intended to “contribute to create open information society in the region, to increase the speed of Internet connection and the development of Internet services, which, in turn, will lead to economic development, diversification of the economy and increased competition” (Republic of Azerbaijan 2014).

In 2010, an initiative to launch Azerbaijani space satellites commenced under the auspices of a state-owned firm, Azercosmos. This led in 2012 to successful launching of the Azerspace-1 communications satellite, with coverage of Eastern Europe, Central Asia, and North Africa (Republic of Azerbaijan 2014; Aliguliyev and Gurbanov 2012).

The government established the State Fund for Development of Information Technologies in 2012 to stimulate ICT initiatives and scientific research in state and local governments, the courts, financial and insurance enterprises, and NGOs (Republic of Azerbaijan 2014). That same year, a high technology park was established by the President in order to bring together domestic and international technology firms in a zone to encourage collaboration and exchanges.

Among the ICT challenges remaining for this country is to embed ICT in private companies, educate many more skilled ICT workers, reduce regulations on ICT, and increase openness of information (Aliguliyev and Gurbanov 2012).

This case study relates to the historical trends examined in the chapter. The country is an exception to the usual historical pattern of ICT development of a developing nation. The government took a lead role in breaking the usual developing-nation sequence, which often is reactive, and to boldly prioritize ICT as a

primary national goal and pursue it concertedly for over a decade and a half. The achievement of the goals was made easier by the country's petroleum riches, which filled government coffers and made the funding of ambitious ICT plans possible. Referring to the three stages of technology development discussed earlier (Rueda-Sabater and Garrity 2011), Azerbaijan would be categorized in Stage 2-Converging Adopter. This stage was speeded up because broadband grew at very high rates, thanks to leveraging the DSL services from an existing widespread fixed phone network; because usual leapfrogging of PCs could be avoided by special targeting programs to bring PCs to schools; and because the nation's leaders were highly motivated to try to emulate a Rueda-Sabater and Garrity Stage 1-First Adopters profile, an attempt made possible in a resource-rich nation.

2.5 Case Study: South Korea

South Korea is among the most ICT-intensive of countries. In 2012, it was 12th out of 142 nations on the Networked Readiness Index (World Economic Forum 2012). In East Asia/Oceania, it ranked higher than Hong Kong (13th), Japan (18th), Australia (17th), and China (51st), although Singapore (2nd) exceeded it. In households with internet access it ranked 1st, with 97 % average access, while on broadband internet subscriptions it ranked 4th and for extent of business internet use it was in 2nd place (Dutta and Bilbao-Osorio 2012). South Korea has been careful also in planning its ICT, resulting in societal impacts in 1st place.

This was a success achieved early; in fact by 2002 South Korea had top rankings, in including 1st place worldwide for broadband penetration. Since then major indicators have continued to move upwards as seen in Table 2.4. In some cases, household and business access or use of ICT reached nearly 100 %.

How did South Korea achieve its remarkable ICT global leadership status? Does the nation have remaining issues or problems in ICT? The answers can be useful both to advanced-nation peers and to aspiring developing nations.

Table 2.4 Access and use of ICT by individuals, households, and businesses, South Korea, 2004–2011

	Year			
	2004	2007	2009	2011
Households with a computer (%)	77.8	80.4	81.4	81.9
Households with internet access (%)	86.0	94.1	95.9	97.2
Individuals using internet in last 12 months (%)	72.7	78.8	81.6	83.8
Businesses with a computer (%)	92.2	97.0	98.6	98.4
Businesses with broadband access (%)	96.3	97.7	98.8	98.7

Source Republic of Korea (2012)

Some of the explanation relates to the following factors (Choudrie et al. 2003; Choudrie and Lee 2004; Choudrie and Middleton 2014):

1. Competition. South Korean private firms competed intensively to provide the best infrastructure, encouraging continual modernization.
2. Pricing. Early pricing was targeted at the middle income person, and the competition pushed the prices lower.
3. “PC Bang.” At the turn of the 21st century there was a huge sprouting of “PC bangs” (i.e. Internet cafes) around the country.
4. Evident benefits to the user. The starting base of users was targeted in the education and entertainment sectors particularly the Internet game industry which quickly perceived the benefits and value of ICT.
5. Government strategy, vision, and commitment. Strong and long-lasting commitment came from the central government.
6. Urban geography and population density. South Korea is highly urbanized into dense populated areas, enabling considerable savings on infrastructure.

The South Korean government’s support for ICT development began in the mid-1990s, as the Internet started its initial upswing. The South Korean economy was growing strongly internally and its businesses had commenced to enter world markets. The central government recognized its deficiency in making available PCs and access to the Internet, and responded by starting up the Information Telecommunication Training Center (ITTC) to address the deficits in infrastructure. ITTC became the Korea Agency for Digital Opportunity and Promotion (KADO) in 1997. Its early thrusts centered on “Cyber 21,” a program for housewives and other non-tech citizen segments to learn basic skills, and on the “Ten Million” program, which aspired to teach 10 million Koreans how to perform basic activities of Internet access; a goal achieved by 2002.

In 2004, the u-Korea Master Plan was introduced including strategies to develop wireless broadband, digital multimedia broadcasting, RFID, home network services, and telematics (Choudrie 2014), services that were cutting edge and ambitious at the time. Another part of the Master Plan was the Broadband Convergence Network (BCN), a public-private consortium that provided technology transfer to private firms between 2004 and 2008 (Choudrie 2014).

KADO established a remarkable program throughout the country, which refurbished old or discarded PCs for use by disadvantaged population. In all it provided 60,000 of these PCs which contributed to strengthen the underserved in the nation’s ICT development.

Another objective of KADO’s activities was to close South Korea’s internal digital divide, helping disadvantaged citizens, such as elderly, poor, immigrant, and disabled persons. This divide in 2007 was significantly wider than for the U.S., as seen in Table 2.5; (Wong et al. 2010).

For disabled people, KADO established usage guidelines and provided software and special devices to assist them, KADO paying up to 4/5 of the costs (Woyke 2009). Another program targeted providing training and assistance to North Korean

Table 2.5 Digital inclusion in South Korea and the United States in 2007

Population groups	USA		South Korea	
Internet users (%)				
Gender				
Male	78		82.4	
Female	75		71.9	
Age				
Old	56	(Age 62–71) ^a	20.1	(Age 60+) ^a
	29	(Age 72+) ^a		
Income				
Low	61		48.4	
All	76		77.6	
Completed secondary education				
Age groups				
25–35	87		97	
55–64	87		37	

Note a = age range. *Source* Wong et al. (2010)

refugees, mostly devoid to IT skills. KADO maintained careful metrics on its detailed progress in narrowing the digital divide. Results showed steady progress, although by no means closing the gap. An example is the 7-year narrowing of the gap between all households and disadvantaged households in percent computer penetration, as seen in Fig. 2.15.

In 2009, KADO merged and became part of the National Information Society Agency (NIA), which had since 1987 been the lead government agency for implementing ICT in Korea, including support, management, and operation of many government networks and development and promotion the National Framework Plan on Informatization Promotion (Republic of Korea 2014).

Since the internal digital divide by 2009 had been narrowed considerably, NIA refocused KADO’s former initiatives on external programs to assist other nations in narrowing their internal digital divides. This included offering consulting and technical assistance to nations requesting it, setting up IT Cooperation Centers, which collaborated with the partner country in providing physical centers in that country for consulting, technical advice, and sharing of technology experiences (Republic of Korea 2014). The Korea IT Learning Program convened high level meetings with technology experts from Korea and policymakers from developing nations to strengthen and improve national IT policies and planning. On request of developing nations, the Korea IT Volunteers sent volunteer groups called World Friends Korea to developing nations for 1–3 month periods, in which Korean students and IT professionals offered ICT consulting, basic training, collaborative projects, and sharing of Korean language and culture (Republic of Korea 2014).

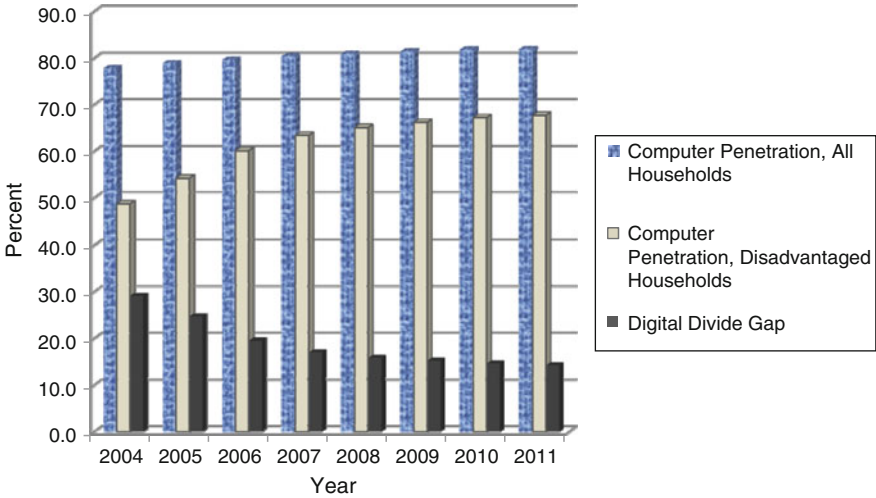


Fig. 2.15 Computer penetration and digital divide gap of disadvantaged households, South Korea, 2004–2011. *Source* Republic of Korea (2012)

During 2001–2013, the program sent 5100 Korea IT Volunteers to 70 countries, serving 100,000 people in the recipient nations.

Another initiative of the Korean central government has been to advance the development of the concept of Ubiquitous City or U-City. This is a contemporary concept that allows the users located in U-Cities to have net access anywhere/anytime and also to have access to advanced high-speed services including the Internet of Things i.e. communication with a variety of smart devices. The cities themselves take over much of the policy and planning, with several examples being U-Chongna, U-Changwon, and U-Songdo. This topic of U-Cities focusing on U-Songdo is covered in more detail in Chap. 11.

The South Korean case study demonstrates how a prosperous developed nation can be smart in planning and realizing world leading ICT levels, while simultaneously closing its own internal disparities among disadvantaged groups. However, the nation did not rest on its laurels with its success of achieving world leadership, but has increasingly extended outwards to help some of the world’s poorest nations make gains in ICT knowledge, skills, and government initiatives. The case falls into the Stage One (First Adopters) in the Rueda-Sabater and Garrity model, but with the added concerns and actions to address internal and external digital divide gaps.

2.6 Conclusion

The history of the digital divide reveals rapid changes which are uneven among nations and within countries. The historical milestones caution that this history largely applies to the last two decades and that some technologies are still new and emerging. There are organizations that have recognized and worked on making the digital divide and its issues widely known.

The stages of the digital divide have a basis in the early work on adoption-diffusion of innovations (Rogers 2003) that is elaborated on in the next chapter. Stages of the divide for world regions and nations were formalized into 3-stage model (Rueda-Sabater and Garrity 2011). Another aspect of the longitudinal progression of the digital divide is that, although starting out with great variability among nations, the variation has reduced considerably over 11–13 year periods, yet substantial variation remains between nations. That remaining variation implies that the digital divide will not disappear soon, but is likely to continue to be reduced over the next several decades.

Metrics of actual behavioral and social improvements from use of ICTs reveal a divide that will continue even if technology availability is more standard. For instance, although television is fairly evenly available worldwide, differences remain in the behavioral benefits of television. The worldwide study framework of this book presently lacks the data to include such behavioral and social measures, especially at the sub-national level.

Azerbaijan represents a developing nation that might ordinarily fit into a trajectory of leapfrogging over more traditional technologies such as personal computers and fixed broadband, but instead it developed its traditional technologies as well as sprinting ahead with newer ones. This was achieved through government's strong and consistent focus on ICT as a primary priority and by an abundant petroleum base providing for citizen prosperity as well as government resources and budget.

Korea fits into the highest stage of ICT deployment, a leadership position achieved by careful government planning, implementation, and metrics. A remarkable aspect is that achieving high ICT national status was not enough, but more recently South Korea has emphasized extending its success to help multiple impoverished, developing nations worldwide close their divides.

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