Research Article

Institutional Connectivity: The Case of Mexico

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Abstract

In the context of the return of the state as a financier of large-scale telecommunications deployment in 2010, the Mexican government initiated an ambitious program to deploy high-quality broadband access in public institutions with federal resources. This article describes the program and analyzes, through a large-scale survey, the state of Internet access and adoption within Mexican hospitals, schools, and local government offices. The results show that the relation between the costs currently expended by the public institutions analyzed and the quality of broadband services received is highly inefficient. Thus, a policy that addresses this problem is necessary. However, such a policy may not only be one of expending public resources, but also one of a negotiation with carriers of a large-scale, high-quality connection to public institutions.

1. Introduction

More than 20 years have passed since the implementation of the first generation of market liberalization reforms where the private sector was conceived as the primary vehicle for development in the telecommunications sector. During this period, the government's role was two-fold: to develop policies that encouraged private-sector investment, and to seek more effective ways to regulate dominant carriers and promote competition.

Today, we witness the return of the state as a financier of large-scale telecommunications deployment. Australia is perhaps the most controversial example, for the high amount of resources (approximately US$30 billion)[1] to be poured into a large-scale public investment in broadband infrastructure. Some countries have followed suit in federal resource expenditure; in Latin America, Brazil has committed US$6.5 billion,[2] Argentina US$2 billion,[3] and Peru US$400 million (Flores-Roux & Mariscal, 2010, p. 50). Other developing countries, such as Mexico, are designing strategies to address their telecommunications infrastructure deficit; Mexico has only one comprehensive national transport network,[4] and the remaining networks[5] are either regional or too limited in terms of coverage to be called truly "national."

In Mexico, the causes of a lack of access to high-quality telecommunications infrastructure are related to institutional inadequacy. The design and implementation of regulatory policies continue to suffer from a lack

1. AUD39.5 billion (2009), Australian National Broadband Networks (NBN) Project.
2. R$11.5 billion, Plano Nacional de Banda Larga, May 2010.
3. ARS8 billion, Plan Argentina Conectada (2010).
4. Telephone and Internet infrastructure backbone that contains optical channels.
5. In this case, network refers to additional infrastructure that provides access to telecommunication services.

of openness, transparency, and stakeholder inclusion in policy decisions. Over the years, this has been accompanied by a lack of long-term vision in policy development for the sector.

Past universal access programs in Mexico have had limited impacts. The e-Mexico National System, housed in the Ministry of Communications and Transportation (*Secretaría de Comunicaciones y Transportes,* SCT), started operating in 2002 and was conceived as a coordinating mechanism that would monitor government Internet content produced by other ministries. SCT was also responsible for installing and operating telecenters, *centros comunitarios digitales* (CCDs). By 2007, the SCT announced that 9,200 CCDs were installed around the country (SCT, 2007). Currently, however, and significantly due to the instability within SCT of its policy officials, only 6,000 are still in operation; the right monitoring and maintenance strategies were not in place.

During 2010, with the aim of correcting the infrastructure deficit, the e-Mexico National System launched a new ambitious program, *Redes Estatales para la Educación, Salud y Gobierno* (REESG), or social coverage networks that would connect every public school, hospital, and government office in the country with high, broadband-quality Internet.

Following Wallsten (2011),[6] an accurate diagnosis of the situation is essential to the effective design of universal policy strategies. Thus, to contribute to the effectiveness of the design and implementation of a policy that addresses connectivity, this article presents the results of an assessment of the state of Internet access and use in these public institutions during the initial stages of this project.[7] Moreover, to identify whether or not the universal program that was implemented is efficient in the use of federal resources, this article also calculates the potential direct beneficiaries of high-quality broadband in the three public institutions analyzed here. Unlike numerous studies that describe Internet access in homes, for individuals, or through shared access, in this article, connectivity and adoption are analyzed within institutions. Connectivity in these public organizations is crucial to the effectiveness of such applications as e-government, e-education, and e-health.[8] This is a case study that may be compared to, and shed light on, other countries in the region.

The results from an access and use survey carried out in local government offices, medical units, and schools show that the level of access and use in Mexican public institutions is insufficient to obtain the potential benefits from the above-mentioned applications. We also find that, even though a higher quality of access is necessary across the board, there are significant differences within the institutions analyzed. While schools and hospitals show a very low level of adoption, government offices have a significantly higher access and adoption level. We find that the potential beneficiaries related to institutional connectivity are many and varied. They include citizens who use government Internet applications, students, teachers, doctors, and patients—all of whom are mainly from marginalized zones. We conclude that, in the design of universal access programs, digital use must be conceived beyond connectivity, as an ecosystem where market efficiency is sought, and where digital literacy and useful contents are offered.

The next section offers an overview of universal access policies, including Mexico's strategies; the third section shows an international comparison of connectivity. The fourth section describes the state of institutional connectivity in Mexico in 2010, based on available official information. The fifth presents a diagnosis of connectivity, access, and use in the selected institutions, based on the 2010 survey carried out by the authors in Mexico. The sixth section presents the survey results, and the final section provides policy recommendations.

2. Deployment of Telecommunication Networks

The value of a network is given by its capacity to deliver a free flow of information and capital to its

6. Presentation at the Conferencia Planes de Banda Ancha, held at CIDE, November 2011.

7. Due to the variable timing of data available, results of the assessment are not properly a baseline measurement of the levels of access and adoption prior to policy implementation. In addition, it is necessary to consider that program implementation varies in time and scope across regions and states countrywide.

8. These terms refer to the use by educational, health, and government agencies, respectively, of information technologies—such as wide-area networks, the Internet, and mobile computing—that have the potential to transform relations among actors within each sector.

users (Economides, 1996). Working from this concept, Tongia and Wilson (2011) contend that, when only a minority of the population is not in the network, the costs of exclusion are exponentially higher. In terms of ICT, an uneven distribution of access can increase social and economic disparity; exclusion from the telecommunications network has a high cost not only for the excluded persons, but also for society in general. Moreover, inequality and social exclusion diminish economic growth and create inefficiencies in a country's market function (Aghion & Howitt, 1998; Bordeau de Fontenay & Beltran, 2008).

Even though it appears that we are still in the early phases of measuring the quantifiable benefits of broadband to development,[9] most of the data points in the direction of positive effects of broadband adoption on economic growth, employment, and social empowerment (Brynjolfsson & Hitt, 2003; Katz, 2010). We agree with Kelly and Rossotto that "broadband should be viewed more broadly as an enabling ICT platform that can potentially influence the entire economy, and thus may act as a general purpose technology (GPT) used as a key input across sectors" (2012, p. 4). In this context, digital exclusion[10] is relevant to public policy, as broadband provides an opportunity to bridge obstacles that negatively affect the poor.

Following Navas-Sabater, Dymond, and Juntunen (2002), the digital divide[11] can be divided analytically into a market gap and an access gap. The market gap is the difference between the existing penetration levels and the levels that could potentially be attained under a fully efficient market. Regulation policy is the basic tool to diminish the market gap.

During the past 20 years, regulatory policies, as well as innovative business models, have substantially increased ICT adoption. In Latin America, access to voice services via mobile telephony has connected millions of people, even those in low-income sectors. However, this progress has been limited, as the problem of scarce transport networks has not been directly addressed. Mexico, as is the case for other Latin American countries, has only one comprehensive national transport network. The remaining networks are either regional or too limited in terms of coverage to be called truly "national." Mexican regulatory frameworks have not included the right incentives for carriers to provide a constant modernization of existing networks. The existing national transport network is inadequate for three reasons (Flores-Roux & Mariscal, 2010):

1. **Limited capillary capacity:**[12] Many municipalities,[13] especially smaller ones, still only have basic voice services that are collective, rather than individual. In such cases, it is impossible to provide broadband access, regardless of whether it is individual or collective.
2. **No state-of-the-art technology:** Although the latest technologies have now been installed in a large portion of the existing networks, a significant percentage, especially those in small and medium-sized towns, lack the technology capable of providing widespread access to support new services. The network was designed to transmit voice, and as such, a serious "legacy" problem remains.
3. **There is little or no competition:** The fact that there is only one network, coupled with the lack of an appropriate regulatory framework, gives ample incentive for overpricing, limiting, or degrading access by third parties, as well as for only minimum network modernization investment.

A more efficient market with a consequent increase in broadband network deployment would cover some of the current telecommunication infrastructure deficit. Nonetheless, some areas and popu-

9. For the recent debate on measuring broadband impact on development, see Forman et al. (2009), as well as Kelly and Rossotto (2012).
10. Digital exclusion refers to the inequality in terms of access to high-quality information technologies, specifically broadband, that excludes certain population segments from its potential benefits.
11. The term "digital divide" refers to the gap between those who have access to ICTs and those who do not due to geographic, educational, or economic reasons within and among nations.
12. Capillarity refers to a network's capacity to branch out and deliver telecommunication services in additional areas.
13. The SCT (2012) has identified that about 17% of the municipalities have insufficient or no broadband infrastructure.

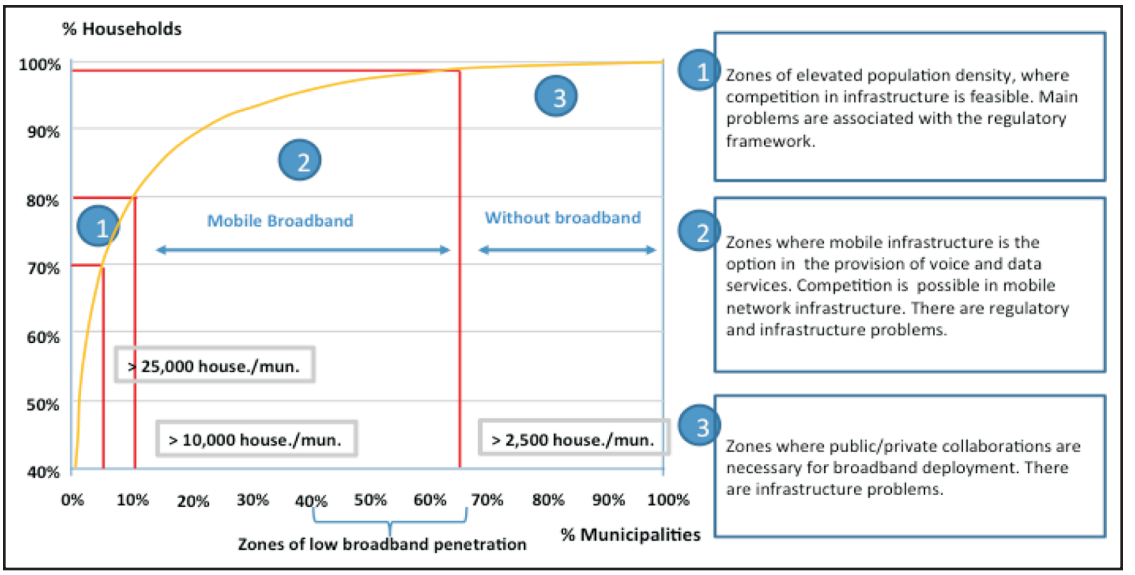

Figure 1. Digital divide according to economic and social conditions.
Source: García Zaballos, Painer, and Radaelli (2011).

lation segments are still unprofitable for private investment; this situation is known as the access gap, and often, it requires some degree of government intervention. Policies addressing both gaps can take three forms that vary according to socioeconomic conditions. As we can see in Figure 1, in Latin America, private competition to provide infrastructure services is profitable in municipalities with more than 25,000 households. In municipalities with fewer, but still more than 10,000 households (a category which represents almost half of the municipalities in Latin America), the appropriate mechanism would be, according to García Zaballos, Painer, and Radaelli (2011), the promotion of deployment of infrastructure for mobile services. Government involvement is required to provide services in municipalities with fewer than 10,000 households, through universal access policies, to diminish the access gap.

In the developing world, the most common policy used to address this gap has been the universal access fund (UAF).[14] These efforts have been evaluated, and the results show that the impact of different UAF programs has not been significant (Barrantes & Agüero, 2010; Jaramillo & Castellón, 2002; Mariscal, Gil, & Aldama, 2008; REGULATEL, 2006; Villatoro & Silva, 2005). The basic problem was their inability to effectively distribute the money collected. This is due to five main reasons: 1) the inability to adopt permanent legislation, 2) the considerable time required to elaborate, evaluate, and implement the projects to be financed, 3) the slow, bureaucratic procedures necessary to gain approval, 4) the low priority assigned to universal access programs, and 5) the additional restrictions imposed by external institutions on the allocation of universal access funds (Barrantes & Agüero, 2010).

Mexico never created a permanent UAF. One was temporarily created in 2002, but it had little impact; it focused on landline telephones in homes and public booths. Moreover, to date, the program, known as *Fondo de Cobertura Social de Telecomunicaciones* (FONCOS), has not been fully implemented. The winning carrier of the reverse auction, Telmex, has not fulfilled the contract, and SCT has not liberated the committed frequency of 450 MHz. In terms of telecenters, by 2007, the e-Mexico National System installed 9,200 CCDs, of which currently only 6,000 are in service. That is, more than 3,000 CCDs have been lost due to a lack of maintenance.

14. Policy designed to provide targeted subsidies to encourage the provision of telecommunications services by private operators in regions where there are little or no economic incentives to invest. The specific national fund's name differs from country to country.

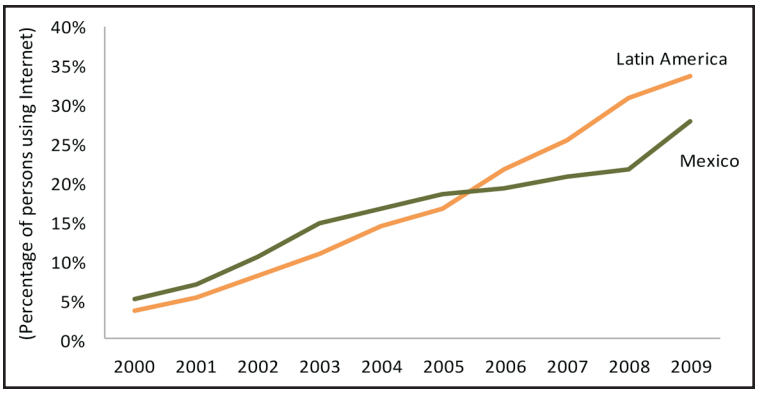

Figure 2. Internet penetration.
Source: ITU (2010) and Internet World Stats (www.internetworldstats.com).

Finally, a gap not considered by Navas-Savater is an "appropriation gap," which consists of a lack of technology use despite of its availability. To address this gap, specific policies are needed which should be oriented toward capacity building and the development of content that is useful to the population.

After years of experiencing various policies that sought to address unattended areas, we now know that reducing existing gaps requires the development of an integral program; a "broadband ecosystem" (Jordán & De León, 2010). That is, in addition to deployment of high-quality, affordable broadband connections, it is important to address other aspects of supply and demand. Regarding supply, both government and business applications must be made available to the public. From the demand perspective, it is necessary to help the public develop digital skills that facilitate ICT adoption.

3. An International Comparison of Connectivity

In the period between 1990 and the first semester of 2010, a total of US$60 billion was invested in Mexico's telecommunications sector (ITU, 2010), equivalent to 0.54% of the GDP generated during that period. The advances in infrastructure building and service and coverage quality were considerable.[15] Fixed broadband penetration,[16] for example, rose from less than one access point per 100 inhabitants in 2002 to 11 access points per 100 inhabitants in service by 2010. This penetration level makes Mexico third in the region, behind Uruguay and Chile (SCT, 2012).

In terms of connection quality, the average download speed is 2.5 Mbps, which places Mexico in third for the region, behind Chile and Brazil. In comparison with developed countries, Mexico is significantly behind in both penetration level and service quality. It is sufficient to mention the examples of the United States and Western Europe, in which, according to data from the Organisation for Economic Cooperation and Development (OECD), broadband portal penetration is almost 29%, three times higher than Mexico, with average speeds of 10.5 and 11.3 Mbps, respectively—in other words, more than four times faster than what is offered in Mexico (Flores-Roux & Mariscal, 2010; OECD, 2012).

In terms of Internet appropriation, the information available from the ITU and Internet World Stats shows that Mexico has not incorporated Internet use at the same rate as Latin America as a whole: The percentage of people using the Internet in Mexico is lower than the average percentage of use in the region (Figure 2).

Within Mexico, there are considerable geographical access inequalities to ICT services. Information from the Federal Telecommunications Commission (*Comisión Federal de Telecomunicaciones,* COFETEL) shows that, in the Mexico City area, teledensity in December 2009 was 44%, whereas in Chiapas and Oaxaca, it was a mere 6% and 8%, respectively. This disparity is more pronounced in the broadband market: In December 2009, penetration in the Mexico City area was over 15%, while in Chiapas it was 2%, and in Oaxaca it was less than 1% (INEGI, 2009b).

According to the National Institute of Statistics and Geography (*Instituto Nacional de Estadistica y Geografía,* INEGI), in 2010, approximately 70% of the population in Mexico, particularly those at the

15. Between 1990–2010, landline telephone density rose from 6 lines per 100 inhabitants to 19, while that of cellular phones went from 0 lines per 100 inhabitants to 76.
16. Penetration refers to the percentage of a population using the Internet.

low-income level, did not use the Internet (SCT, 2012). Around 65% of the Mexican population lacks access to the benefits of ICT that come via services such as telemedicine, distance education, and training, to mention a few.

4. Mexico's Connectivity Strategy

In compliance with issue 2 of the national development plan (NDP) of 2007–2012, which seeks to "guarantee access and widen the infrastructure and transport of communications services coverage" (*Presidencia de la República,* 2007), in 2008, the SCT designed the Social Coverage Networks program, endorsed in the e-Mexico Digital Agenda.

The e-Mexico National System coordinates government agencies to promote projects that increase ICT access and use, focusing on marginal zones and content provision in the areas of education, health, commerce, and government, among others (SCT, 2001). E-Mexico receives federal funds administered through a trust *(Fideicomiso e-México).* Several programs have been implemented; however, most of its broadband initiatives have yet to be fully implemented, including the Social Coverage Networks program. This program's objective is to lay the foundation for the country's accelerated transition toward a society of information and knowledge (SCT, 2009). Specifically, through infrastructure investment, the Social Coverage Networks program seeks to increase coverage in marginalized communities. Its target is to raise broadband coverage to 22% of the national population, increase the number of Internet users from 27 million (calculated in 2009) to 60 million by 2012, to achieve levels comparable with those displayed by OECD member countries.

The Social Coverage Networks program aims to create a national platform for broadband connectivity and cloud computing[17] for educational, health, social development, and governmental systems. According to the SCT (2009), the objectives of this network are to accomplish the following goals:

1. Provide coverage for 123,000 junior high and high schools, 25,000 medical units, and 10,000 offices.
2. Reduce connectivity government expenditure by 40–60%.
3. Establish investment synergies with the state and municipal governments.
4. Implement programs for the development of the national digital agenda, such as Digital Skills for All (DSA), the Education for Life and Work Model, Open and Distance University, electronic clinical records, and telemedicine programs.
5. Establish a cloud computing platform for the rapid and inexpensive implementation of digital content and services.

The DSA program, headed by the Ministry of Education (*Secretaría de Educación Pública,* SEP), was intended to train teachers to encourage ICT incorporation in primary schools, and thus, to support students' learning process, increase their skills, and facilitate their entrance into the labor markets. The teachers would be given access to digital education and class management material. Its aim was to connect 367,017 classrooms by 2012, train more than 700,000 teachers, and receive 100,000 computers a year.

The Vasconcelos National Campaign for Digital Inclusion 2.0 was designed to mobilize university and high school students to carry out an adult digital alphabetization campaign. Its aim was to recruit 250,000–300,000 students to digitally alphabetize the records of approximately 30 million Mexicans in the next five years, but the program was eventually abandoned. In was in part supplemented by the program e-Mexico Digital Club (a model created by Intel) that allows students to obtain, in exchange for their alphabetization work, training to generate entrepreneurship and job training skills.

Overall e-Mexico has had operational problems since its creation. The initiative was conceived as an institutional coordinator among ministries to provide institutional connectivity, yet it lacks explicit faculties to administer connectivity. Additionally, the lack of continuity in its administrative body has negatively impacted the implementation of the abovementioned programs. As of December 2011, there were 42 million Mexican Internet users;[18] this means

17. "Cloud computing" refers to the provision of information resources over the Internet from a remote access point. The term includes both the applications delivered as services over the Internet and the hardware and systems software in the data centers that provide those services.

18. The most recent number was published by Internet World Stats (www.internetworldstats.com).

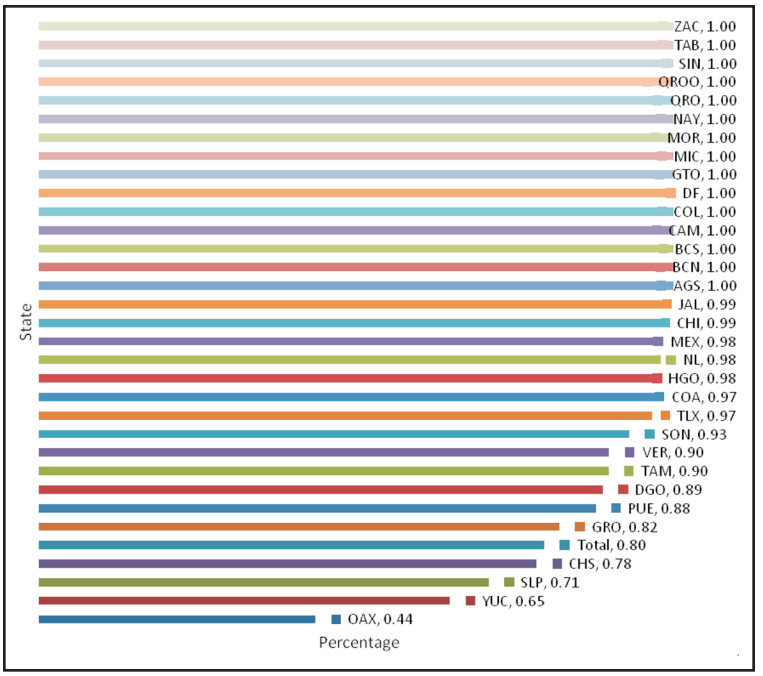

Figure 3. Percentage of local governments with Internet per state.
Source: Based on INEGI (2009a).

the program is likely to fall short of its 60 million users objective by the end of 2012.

5. The State of Institutional Connectivity in Mexico, 2010

This section presents information from various institutional sources to show the state of the country in terms of ICT access. Data sources include: 1) the 2009 National Survey on Government, Public Security and Municipal Justice (*Encuesta Nacional de Gobierno, Seguridad Pública y Justicia Municipal,* ENGSPJM; INEGI, 2009a) for local government offices; 2) the National Educational Statistics System[19] for 2012 data on public schools; and 3) the Statistics Office of the Ministry of Health (2010) for health centers and hospitals of the Ministry of Health (*Secretaría de Salud,* SSA). In all cases, the information provided does not correspond to the starting point of the social networks initiative, but is the only information available that can provide a baseline assessment of the state of connectivity prior to the nationwide expansion of the program.

In recent years, public administration modernization at all levels has included ICT adoption for the improvement of both internal processes and service provision. Local governments' access to ICT is important because they are the closest level of government to the citizens and are responsible for providing guidelines for government procedures and services; therefore, the unit of analysis for e-government institutional connectivity will be local governments per se, and not the beneficiary population.[20]

The results from the local goverments survey (INEGI, 2009a)[21] show that 80% of the country's municipalities have Internet access. In a disaggregated manner, while in states such as Baja California, Baja California Sur, and Aguascalientes, all the municipalities have the aforementioned access percentage, the states of Oaxaca and Yucatan have the lowest proportions of local governments with access: 44% and 65%, respectively (Figure 3). Note that the number of municipalities in each state affects these percentages.

Information on the availability of websites shows a significant deficit: Only 48% of the country's municipalities have a website, and fewer than 10% have sites on which it is possible to carry out transactions (Figure 4). The low availability of websites and their poor use for transactional purposes can be largely explained by the insufficient quality of

19. Sistema Educativo de los Estados Unidos Mexicanos. Principales cifras, ciclo escolar 2010–2011 [The educational system of Mexico. Main indicators, academic year 2010–2011].
20. It is important to stress that the following analysis considers only the proportion of municipalities that are connected per state; this is regardless of the number of municipalities per state or population size. The following analysis is relevant from a policy perspective, because program goals and targets can be established in terms of the number of municipalities connected.
21. The survey information was collected by INEGI in the period October 19–December 11, 2009. The survey contains information regarding organizational structure, public security, and justice drawn from 98.04% of the 2,440 municipal governments and the federal district's 16 delegations for 2008.

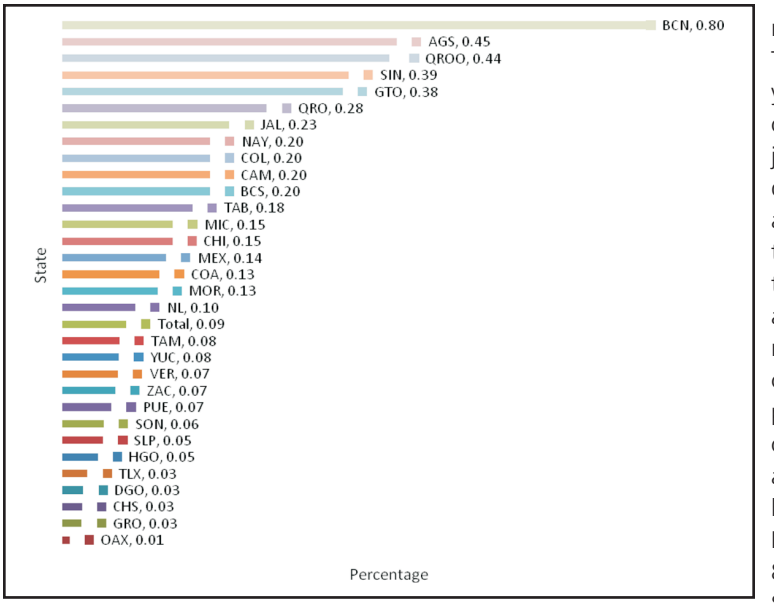

Figure 4. Percentage of local governments with transaction-enabled websites.

Source: Based on INEGI (2009a).

Internet connections, both for citizens and government offices. For local government offices, while the majority of them are connected to the Internet, these connections are of limited speed.[22]

A potential benefit of targeting education involves fostering learning by providing access to information and knowledge to pupils in remote areas. In Mexico, the average national Internet access rate is approximately 35% in both primary and secondary schools (Figures 5 and 6). This low penetration level is compounded by poor connection quality.

Figure 7 shows the relationship between Internet access and the education index from the Human Development Report of the United Nations Development Programme (UNDP, 2005). This index is calculated using the years of schooling for persons over age 25, as well as the projected years of schooling for children of school age.[23] The association is merely an illustration, as the data from the education index correspond to 2008, and the data on accessibility correspond to 2009. The results indicate that the states with a higher percentage of primary and secondary schools with Internet access are more likely to have higher education indexes.

In terms of healthcare in Mexico, 80% of hospitals managed by the SSA have Internet access. However, poorer states, such as Oaxaca, Chiapas, and Guerrero, are below this average (Figures 8 and 9).

Overall, access to applications such as telemedicine[24] is low; the national average is 14% (Figure 10). Over half of the states are below this average, and hospitals in eight states do not have access at all.

6. Use and Connectivity in Mexico

With the objective of identifying the state of ICT use in Mexico, we carried out the Access and Use of Digital Resources Survey 2010 for local government offices, medical units, and schools. The objective of this survey was to obtain a diagnosis of the state of ICT use among these institutions, and to assess the current level of use of connectivity and digital resources.

22. The National Institute for Federalism and Municipal Development (INAFED) has put into operation a program offering municipalities website design and free hosting. This has allowed a great number of municipalities to own a website. However, this does not necessarily mean these websites are complete or fully operational. See the Hosting of Municipal Webpages Program at www.inafed.gob.mx/wb/inafed09/hospedaje#

23. The average years of schooling is calculated using the duration of studies at each formative level. The projected number of years in school is determined using the schooling by age at every formative level and the population of school-age children present at each of these levels. The indicators are normalized by means of a minimum value of zero and the maximum values. The maximum values are determined by the real maximum values observed in the countries during the observed time period, that is, between 1980–2010. The education index is the geometric average of the two indexes.

24. In this article, telemedicine refers to a high-tech service that provides and supports health care services in remote populations through knowledge transfer.

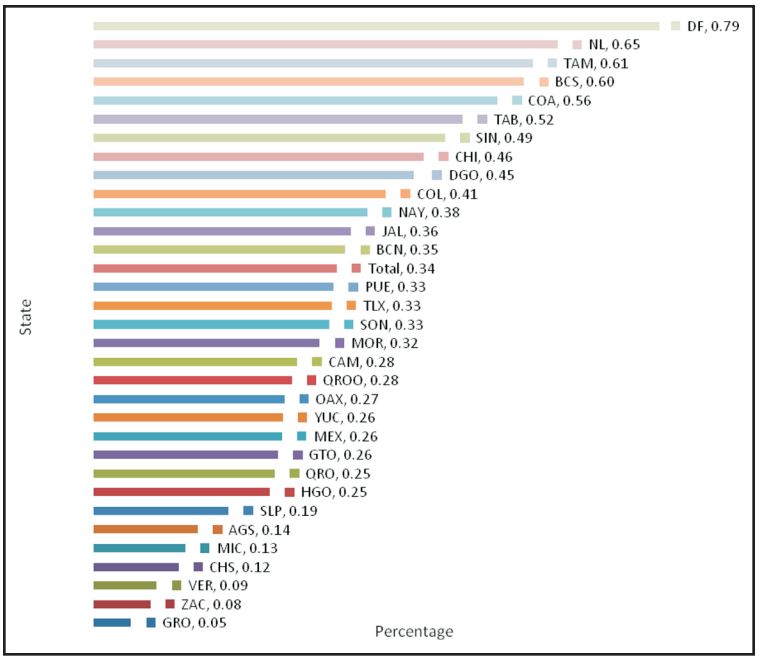

Figure 5. Percentage of primary schools with Internet access.

Source: Based on Dirección General de Planeación y Programación. SEP. Sistema Educativo de los Estados Unidos Mexicanos, principales cifras, ciclo escolar 2010–2011, November 2011.

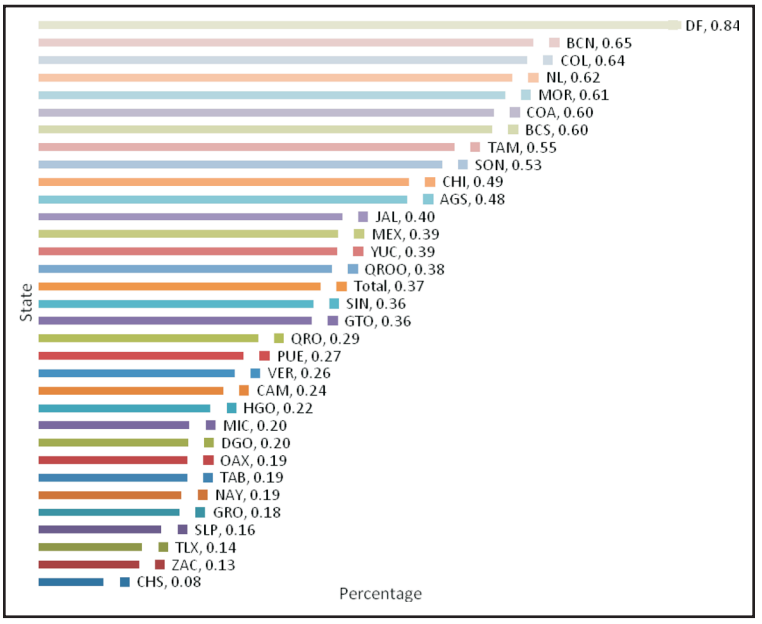

Figure 6. Percentage of secondary schools with Internet access.

Source: Based on Dirección General de Planeación y Programación. SEP. Sistema Educativo de los Estados Unidos Mexicanos, principales cifras, ciclo escolar 2010–2011, November 2012.

The study sample size was calculated to provide standard estimation parameters (margin of error = ±3%, 95% confidence intervals). Considering that the units were nested (students and teachers in schools, schools inside municipalities, etc.), the sample was selected in two stages: 1) selection with probabilities proportional to size (PPS) of 53 municipalities distributed over four geographical regions and two marginalization levels, and 2) selection of two schools and two medical units in each selected municipality (Table 1). For each case, unit selection was random.

The survey information shows that 91% of local government offices, 82% of schools, and 61% of medical units have some kind of Internet connectivity. These results are consistent with levels reported by the aforementioned institutional sources.

However, as Figure 11 shows, only 18.9% of municipalities, 11.9% of schools, and 11.2% of medical units have access to high-capacity Internet (faster than 4 Mbps). This means that more than 80% of municipalities and approximately 90% of schools and medical units have low-capacity connectivity (slower than 4 Mbps). Low-capacity levels are considered appropriate for household use, and unsuitable for performing institutional functions properly. For example, at schools, low-capacity connectivity imposes a maximum limit of 30 students working simultaneously in a classroom, and it restricts hospitals from intensive use of such data-heavy applications as telemedicine or transferring large electronic files.

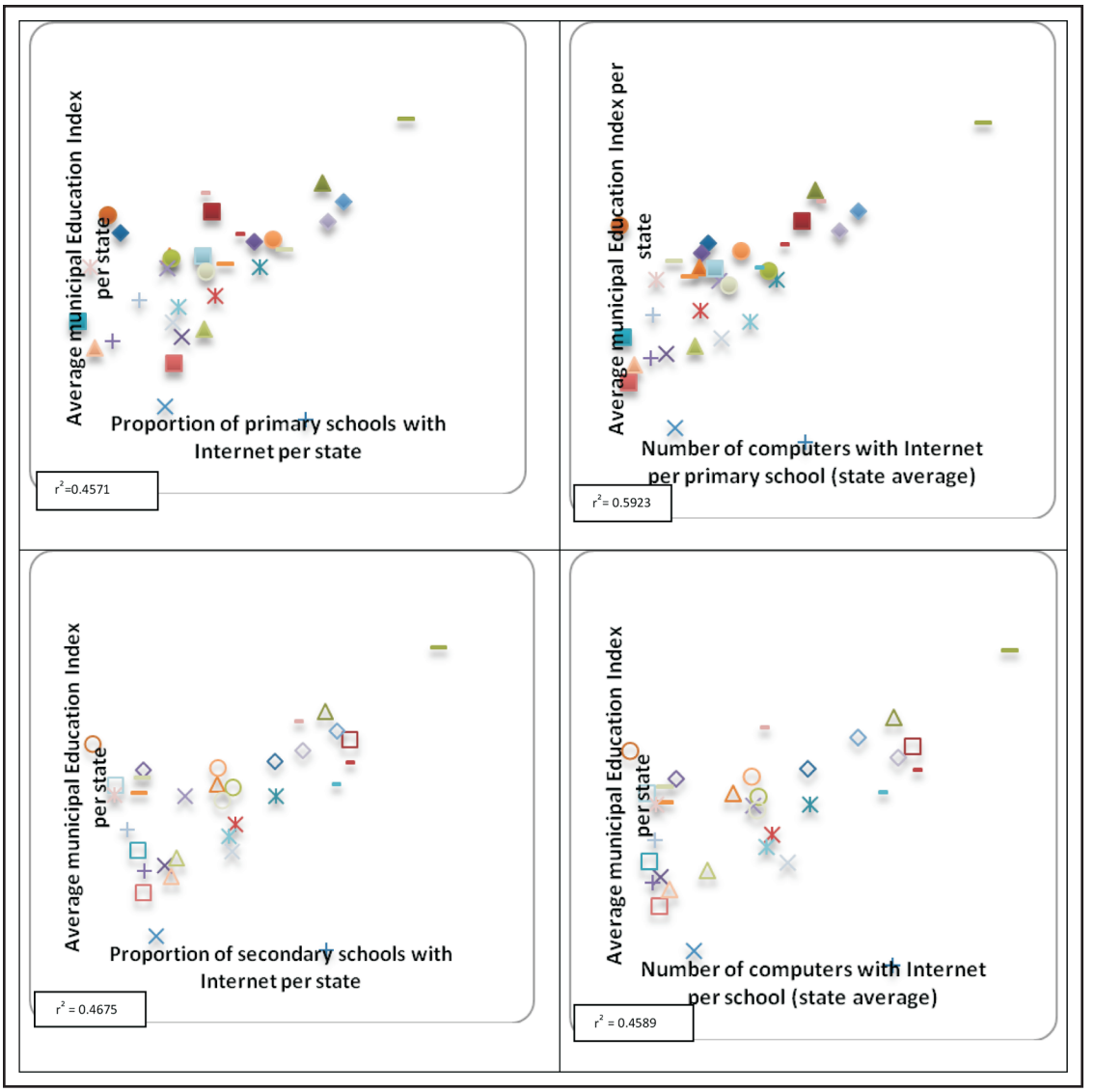

Figure 7. Education index vs. Internet penetration and education index vs. number of computers with Internet per School (primary and secondary).

Source: Composed by the author, based on information from SEP and the Human Development Report, UNDP (2005).

To compare the beneficiaries' use of the technology available, an ICT use index (UI) was created whose objective was to reflect the amount of ICT knowledge present, the frequency with which it was used, and users' perception of the benefits it wrought.

The UI includes three behavioral dimensions: 1) training, 2) type and frequency of use of Internet access, and 3) actual use. The index is calculated on the basis of a self-administered questionnaire given to users. Concerning training, the UI asks whether users have received previous training and the type of training received. Concerning the second dimension, the index incorporates frequency of use of Internet resources to perform job-related duties (or school-related duties, in the case of students), to search for information, to communicate with partners, to organize work and activities, or to submit status and other reports. For actual use, the index includes only

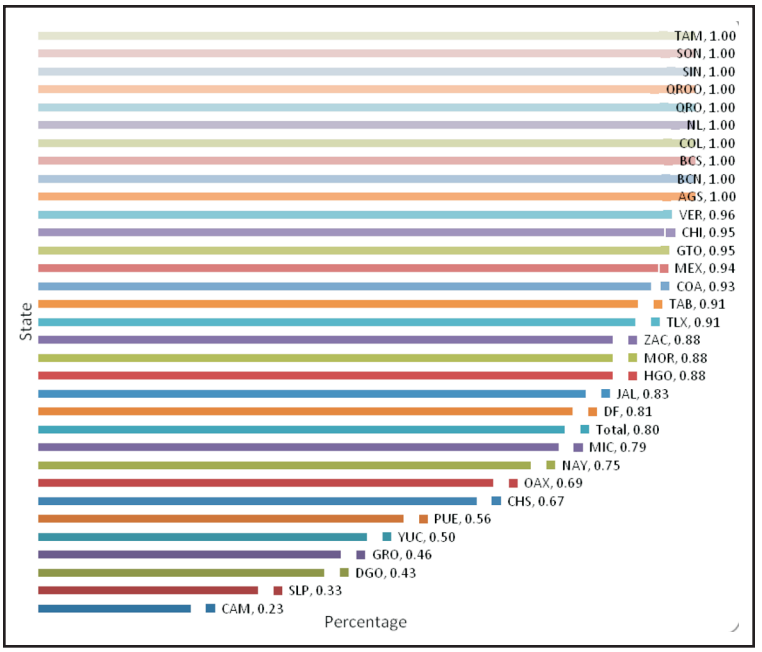

Figure 8. Percentage of hospitals with Internet access.

Source: Based on institutional data provided by the Statistics Department of the Ministry of Health, Mexico, 2010.

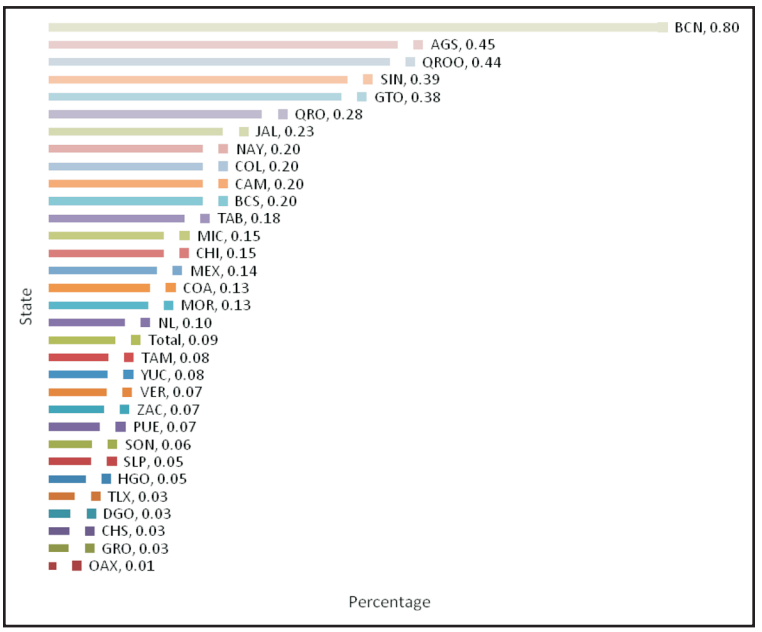

Figure 9. Percentage of external surgery medical units with Internet access.

Source: Based on institutional data provided by the Statistics Department of the Ministry of Health, Mexico, 2010.

one item—whether the user has an Internet e-mail account.

The survey results show that use levels are generally low. The average total UI of the sample was 3.2 out of a possible 10 points (median = 2.9). While the average for local government offices (the dependency displaying the highest scale) was 6.8 (median = 7.1), in schools, the average was 2.6 (median = 2.8), and in medical units, the average was 1.9 (median = 1.8). That is to say, with the exception of local government offices, use is generally very low (Figure 12).

Figures 13 and 14 show an association between the UI, which is higher in dependencies with high-capacity broadband connections, and the quality of connection (Figure 13). The case of local governments corroborates this finding, insofar as they have both higher speed connections and higher levels of use (Figure 14). This situation also applies to schools and medical units; however, as mentioned earlier, very few of these dependencies have a high-capacity connection.

6.1 Use and Connectivity in Local Governments

According to survey data, 91% of the municipal presidencies have computing equipment, regardless of the municipality's marginalization level, and only four local governments in the sample reported not having Internet connection. Internet penetration in municipalities based on marginalization level shows that there is no statistically significant difference in connection access between municipalities with high marginalization and those with

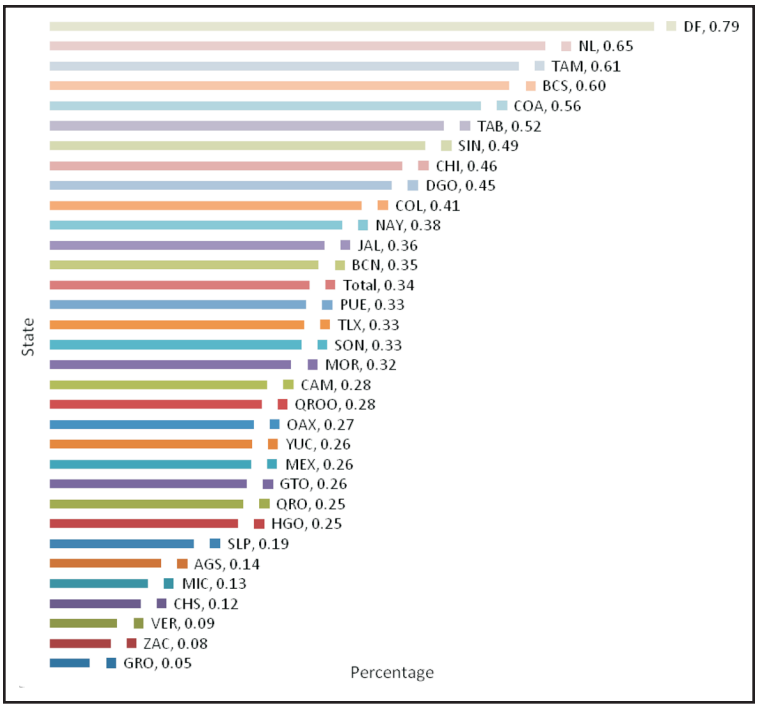

Figure 10. Percentage of hospitals with access to telemedicine.

Source: Based on institutional data provided by the Statistics Department of the Ministry of Health, Mexico, 2010.

medium marginalization ($t = 0.401$; $df = 50$; $p = 0.690$).[25]

Regarding Internet connection speed, the average local government offices have a capacity of 3.5 Mbps. Nonetheless, fewer than 20% of those with Internet access have high-capacity broadband connections. Admittedly, considering the actual needs of small localities, not all government facilities may necessarily require access to the latest technologies. Questions arise as to whether the latest ICTs are required in dispersed rural localities with limited access. Municipal Internet transactions may be unnecessary among localities with small populations where relatively few inhabitants have Internet access. This is particularly true in the case of Mexico, where, as shown in previous sections, there exists a wide variation in ICT access, as well as overall development levels.

With the above-mentioned in mind, it appears that limited connectivity becomes a barrier to technological innovation, economic development, and efficient governance among growing municipalities that increasingly participate not only in state-level economies, but also in global markets (Cabrero Mendoza, 2005; Sosa, 2012).

ICT incorporation and use in local government offices are relevant insofar as they are used to offer

Table 1. Sample of Survey Interviewees.

Dependency	Type of interviewee	Number of interviewees interviewed	Type of user	Number of users interviewed
Schools	Director or administrator	106	Teachers	600
			Pupils: 5º y 6º grade of primary and 1º to 3º of secondary	1,200
Medical units	Director or administrator	106	Paramedic staff	106
Government offices	Municipality president or designated person	53	N/A	0
Total	Total of interviews with key informants	265	Total of interviews of connectivity users	1,906

Source: Composed by the author, derived from the application methodology of the Access and Use of Digital Resources Survey 2010.

25. Here, "t" refers to a t-test for two means, unequal variances assumed; df refers to degrees of freedom, a necessary parameter to make an interpretation of the t-test value; and p is the significance level of the t-test or the probability of making Type I error in the interpretation of the t-test; this is to wrongly reject the null hypothesis.

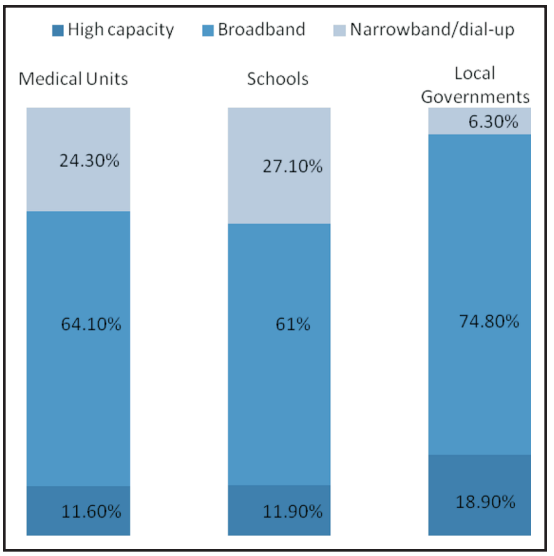

Figure 11. Dependencies with Internet access, based on speed.

Source: Access and Use of Digital Resources Survey 2010.

Note: The figure only includes data from the persons who provided information on their connection speed.

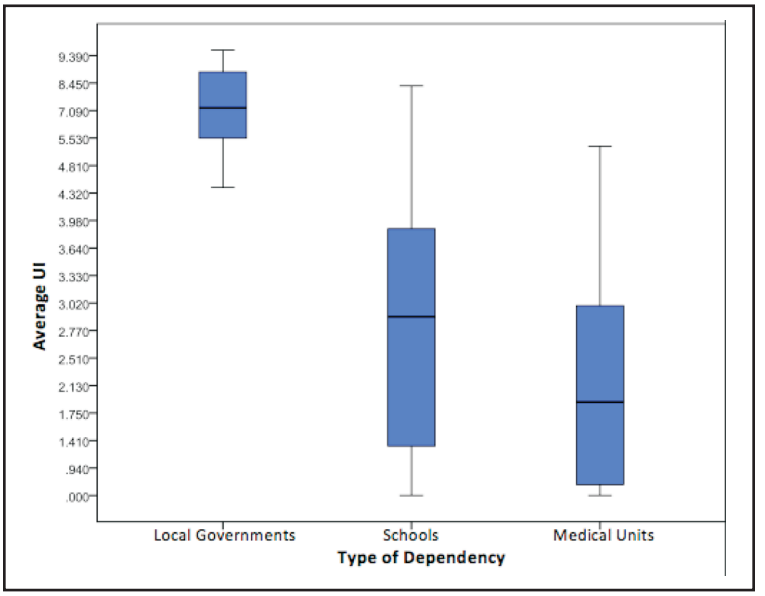

Figure 12. Use index, based on type of dependency.

Source: Access and Use of Digital Resources Survey 2010.

services to citizens; for example, the usefulness could come via a website that allows citizens to carry out transactions online. Among the municipal civil servants interviewed, 89% affirmed that their municipality has a website. The information shows that the greatest number of local government offices without a website belong to the group of municipalities with a high marginalization level; however, the difference between the proportions of municipalities with a website based on marginalization level is not statistically significant ($t = 1.394$; $df = 40$; $p = 0.169$).

The average number of sections of which the local governments' websites are composed is 18 (the fewest being 1 section, and the greatest being 65); these figures give an idea of how complete their content is. The number of procedures that citizens can carry out fully online is 15 (the fewest being 1 function, and the greatest being 185). Amongst the most used are the property tax page (24%) and civil registry procedures (10%). The average number of procedures that can be completed on local governments' websites with a medium marginalization level is 17, while the average number for municipalities with a high marginalization level is 2; this reflects the disparities in ICT use among Mexico's local governments.

6.2 Use of Connectivity in Primary and Secondary Schools

In the case of education dependencies, 80% of surveyed schools have computing equipment. In a disaggregated manner, the percentage for secondary schools is 88%, while for primary schools, it is 72.5%.

A crucial aspect in reaping ICTs' potential benefits in the educational sphere is Internet access. A disaggregated analysis of the data shows that almost 84% of secondary schools and 69% of primary schools have an Internet connection. Despite the fact that the proportion of schools with access to Internet located in municipalities with a medium marginalization level is greater than in those located in municipalities with a high marginalization level, this difference is not statistically significant ($t = 1.47$; $df = 79$; $p = 0.143$).

Access to a high-capacity broadband connection is fundamental, since it allows greater agility when

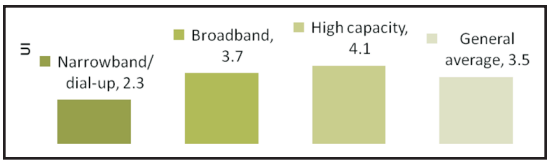

Figure 13. Use index, based on connection quality.

Source: Access and Use of Digital Resources Survey 2010.

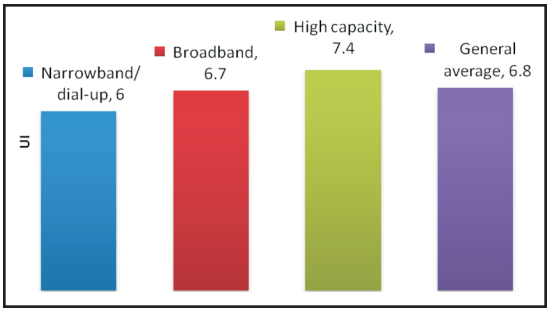

Figure 14. Use index in local government offices, based on connection quality.

Source: Access and Use of Digital Resources Survey 2010.

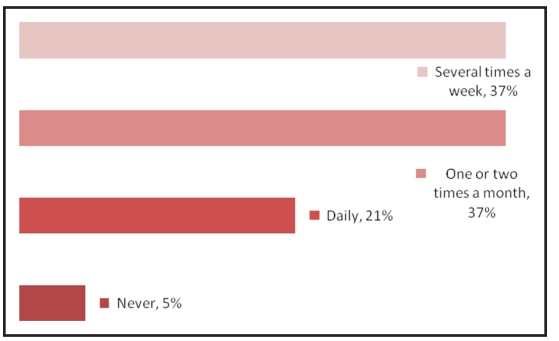

Figure 15. Frequency of school computer use by teachers.

Source: Access and Use of Digital Resources Survey 2010.

working, access to more applications, and a higher level of interaction. The information from the study shows that the average available speed in schools is 1.7 Mbps, and that only 12% of the surveyed schools have a high-capacity broadband connection.

Regarding the frequency of computer use for general tasks, 58% of surveyed teachers declared that they use a school computer daily or several times a week, 37% stated that they use it very infrequently, and 5% said that they never use it (Figure 15). In addition, 50% of respondents rated both the computing equipment and the Internet connection as average, poor, or very poor.

A central question is whether the teachers incorporate ICT into their school-related activities. Table 2 shows the frequency of use of computers and Internet for academic tasks.

In regard to teachers' principal uses of the Internet, the most common are general information searches (64%), support for school work (62%), and checking e-mail (58%). These activities are carried out daily or several times a week (Figure 16).

On the other hand, 45% of the students said they use the school computers daily or several times a week (a percentage lower than that of their teachers, at 58%), while the remaining 55% use it infrequently or do not use it (Figure 17). As opposed to the teachers, only 52% of the students stated that they have a computer at home, and of these, 46% have an Internet connection. Moreover, the perception of the service quality plays an important part in their use: 52% of the students think that their school's computing equipment is average to poor, while 66% have the same opinion of the Internet service.

In regard to Internet use, the students said they use it most frequently to support their school home-

Table 2. Frequency of Use of Computers and Internet for Teaching and Research Work.

	Use of the computer to prepare classes	Use of the computer to present classes	Use of the computer to present research / conferences	Use of Internet to look for information for classes	Use of the Internet for research work	Requests to students to look for information on Internet
Once a week	44%	19%	11%	42%	45%	35%
Fortnightly	15%	10%	8%	14%	14%	16%
Occasionally	24%	18%	21%	26%	27%	28%
Almost never or never	15%	52%	58%	16%	14%	21%

Source: Access and Use of Digital Resources Survey 2010.

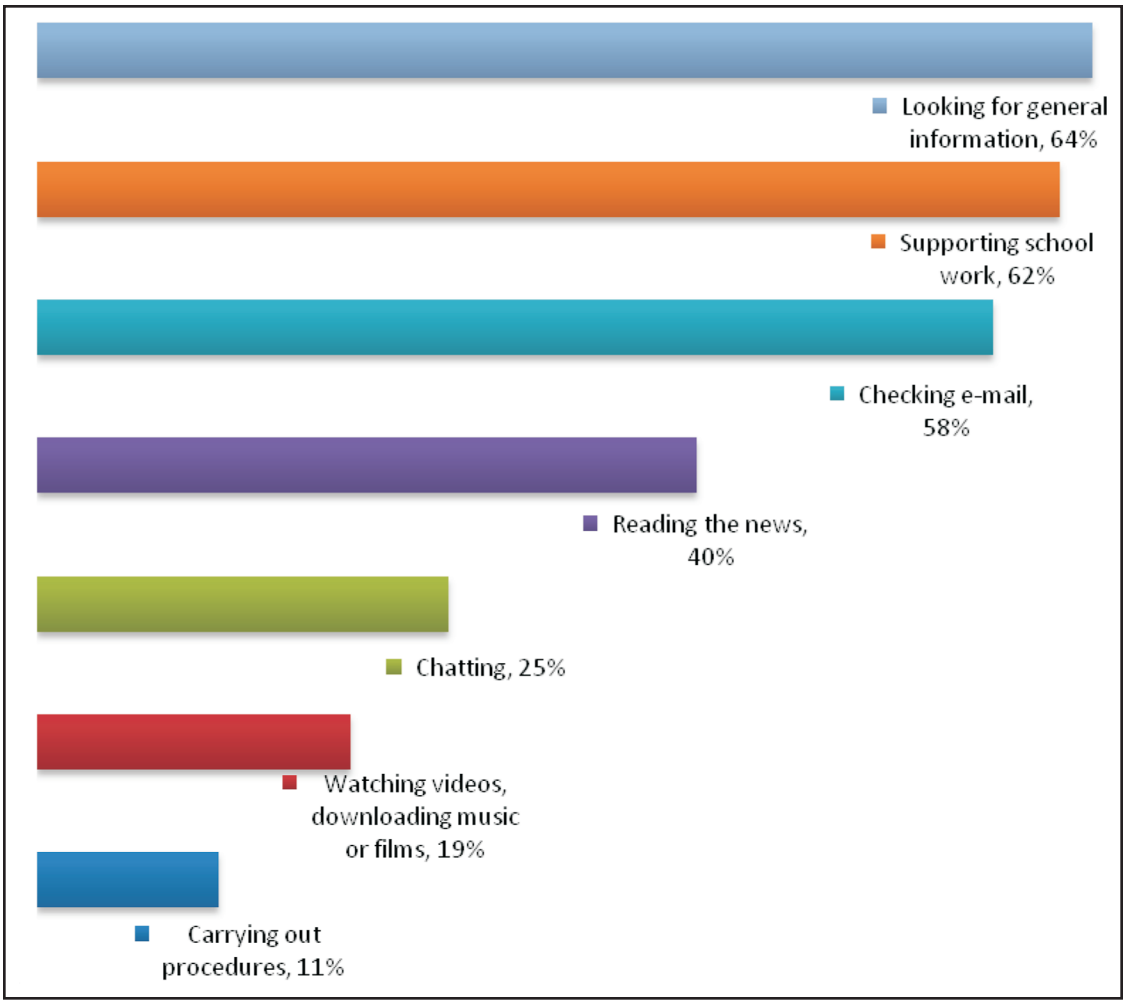

Figure 16. Main uses of Internet by teachers (daily or several times a week).
Source: Access and Use of Digital Resources Survey 2010.

work (55%), to watch videos or download music and films (49%), to surf entertainment sites (46%), and to check their e-mail (41%). They carry out these activities daily or several times a week (Figure 18).

6.3 Use of Connectivity in Medical Units

The success of programs incorporating ICT in the health area depends largely on Internet access, as well as quality, as determined by connection speed. The survey information demonstrates that 81% of the medical units operate using computing equipment, and that of these, 90% have an Internet connection. An analysis of computer access in medical units, based on the marginalization level of the municipality in which they are located, shows a greater percentage of access in those located in municipalities with medium marginalization (91%) than in those located in municipalities with high marginalization (60%); this difference is statistically significant ($t = 3.858$; $df = 94$; $p = 0.000$).

The potential ICT benefits are obtained once these are translated into practical applications, and to this end, it is necessary to have high-quality connections. The survey data show that this is not the case in the health sector, in which only 11% of the surveyed units have a high-capacity Internet connection (faster than 4 Mbps). As long as this situation persists, the incorporation of applications such as telemedicine will be limited.

For example, the survey results show that 53%

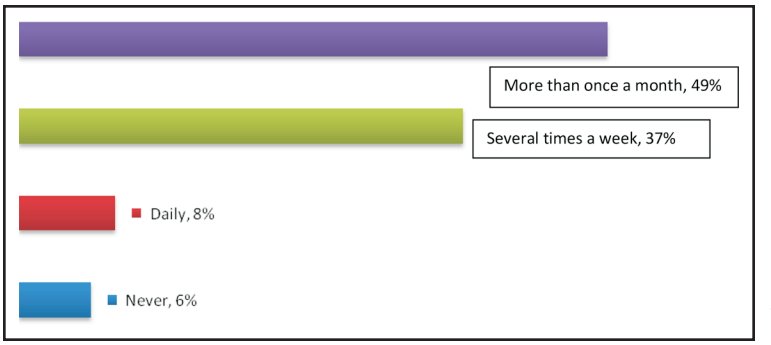

Figure 17. Frequency of school computer use by students.
Source: Access and Use of Digital Resources Survey 2010.

have the technology required to use electronic files, 32% have the technology to use teleteaching, and 22% have the technology to offer teleconsultation services. Moreover, the main reason that medical staff do not use ICT, according to the interviewees themselves, is the lack of access (Table 3).

Technological adoption in the country's medical units requires additional efforts beyond those made during the first decade of the 21st century. Finally, due to a significant disparity between access and use, a more effective strategy is required to train staff and increase their awareness of the benefits that such technology as the Internet, electronic files, and teleconsultation can offer.

6.4 Potential Beneficiaries

The design of any universal access policy must identify the potential program beneficiaries to assess the possible impact of public resource expenditure. We performed a basic exercise using estimated figures to identify potential direct beneficiaries of a high-quality broadband connectivity every year.

As noted above, although 91% of local government offices have an Internet connection, more than 80% have a poor-quality one. The possible number of local government employees benefiting from a high-capacity broadband connection would

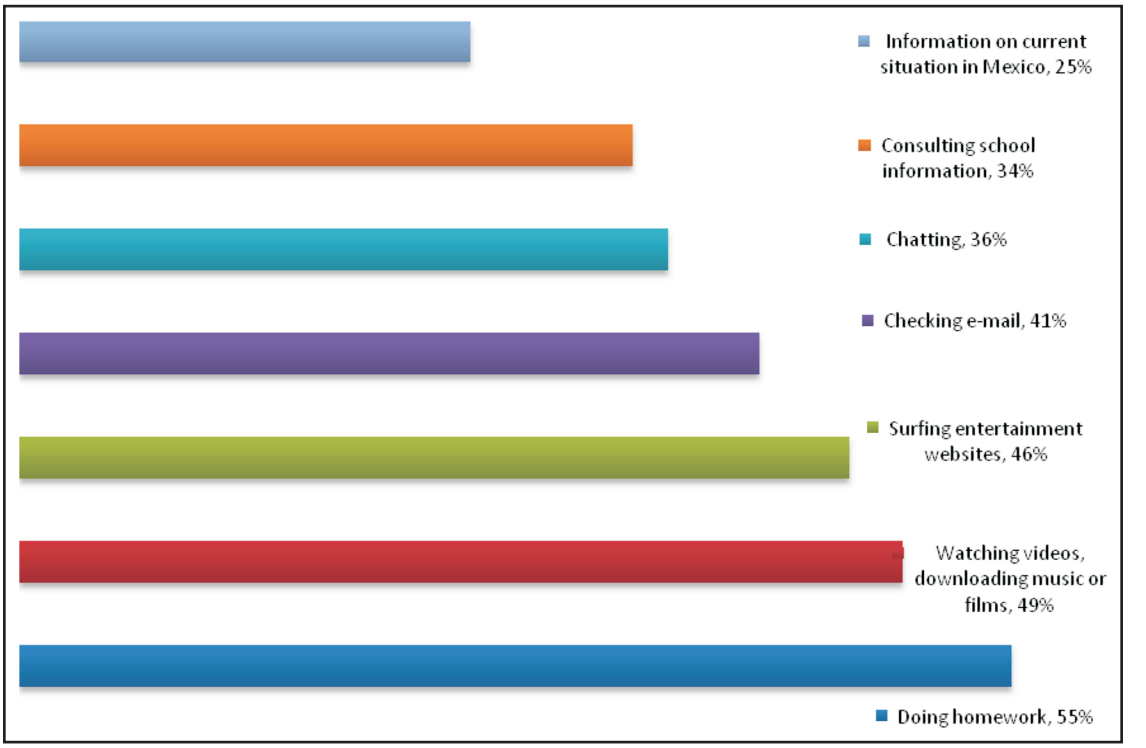

Figure 18. Main uses of Internet by students (daily or several times weekly).
Source: Access and Use of Digital Resources Survey 2010.

Table 3. Reasons Why Medical Staff Do Not Use ICT.

	Internet	Electronic files	Teleteaching	Teleconsultation
I am not given access.	60%	50%	48%	23%
I do not know how to use it.	10%	6%	19%	23%
I do not need it.	13%	33%	19%	23%
It does not work.	7%	2%	9%	47%

Source: Access and Use of Digital Resources Survey 2010.

Table 4. Estimate of People with Access to a High-Capacity Connection and Number of Potential Direct Beneficiaries from a 100% High-Capacity Coverage in Local Government Offices, Schools, and Hospitals.

	Total number of pupils and employees nationwide, based on office type	Number of pupils or employees with a high-capacity connection	Number of pupils or employees in units lacking high-capacity connection (potential direct beneficiaries)
Pupils	21,383,656	2,631,771	18,751,885
Medical unit employees	1,906,764	209,744	1,697,020
Local government employees	623,824	112,288	511,536
Total			**20,960,441**

Source: Composed by the author, based on INEGI 2009a state statistical yearbooks, and the Access and Use of Digital Resources Survey 2010.

be more than 500,000 nationwide. In the case of educational centers, the information, taken from the state statistical yearbooks published by INEGI, shows that approximately 65% of Mexican children of primary and secondary school age lack Internet connection in their schools. Likewise, our survey shows that only 12% of those school centers with Internet have a high-capacity connection. In this case, the number of pupils who could potentially benefit from a high-capacity connection would be roughly 19 million.

Finally, the institutional information both from the SSA and our survey shows that, while many hospitals do have a connection, this result cannot be generalized to the whole health sector, in particular to external surgery clinics. More than 60% of medical units have Internet connection access; however, of these, only 11% are high capacity (faster than 4 Mbps). In terms of staff, there are more than 1.5 million workers in units with either poor-quality connections or no connection. Table 4 summarizes the total of potential direct beneficiaries.

It is important to bear in mind that there are also indirect beneficiaries, such as hospital patients and external consultation clinics, as well as the population living in the municipalities whose local government offices lack a connection or only have a low-capacity one.

7. Toward a Universal Access Program

The survey results show that, in Mexico, institutional high-quality connectivity is insufficient in all of the entities analyzed. However, the problem is more acute in hospitals and schools, especially in highly marginalized geographic areas. These entities should constitute a high priority in a universal access policy, as schools (with a high number of users) and medical units (that often exchange complex data) have a greater need for high-quality connections. Although institutional connectivity per se does not guarantee efficient and effective operation of governmental institutions, adequate connectivity is a *sine qua non* condition for effective use.

The first step in addressing the current situation must be to improve the market gap. In this regard, the Mexican telecommunications sector has undoubtedly increased its efficiency—more so in the

last couple of years, with their advances in achieving lower interconnection rates and spectrum allocation.[26] However, it still faces barriers to entry, and private sector investment has been insufficient to counter the lack of access to broadband by a large portion of the Mexican population. Eliminating barriers to entry to the sector includes strengthening institutional processes, as well as releasing additional spectrum bands and licensing more fiber optic capacity and rights of way. Less than a year before the end of the current administration, a new initiative was announced by SCT that considers these strategies. With this time restriction, it is unlikely that any of the strategies will be implemented.[27] Undoubtedly, this course of action would increase investment and improve the current telecommunications infrastructure deficit, thus diminishing the current market gap. Expected results would include a higher level of ICT access, as well as higher quality.

Despite efficient market conditions, the access gap, where unprofitable areas remain unattended, would need to be addressed through a comprehensive universal program. Over the last 20 years, we have learned that connectivity is only one element of a universal access program; digital appropriation must be conceived as an ecosystem. Apart from providing quality infrastructure, it is necessary to develop content and digital literacy (Jordán & De León, 2010). A case in point is governmental offices: Available evidence shows that a substantial investment has been made to enable each municipality to have broadband access. However, poorly educated public officials make little use of digital resources.

In its design, the Social Coverage Networks program includes the critical elements that comprise an ecosystem. Apart from institutional connectivity, the program contemplates additional objectives in terms of content development and digital literacy. However, the program has yet to be fully implemented. Last year, with the latest change in the direction of the e-Mexico program, a new digital agenda[28] was announced. Although some of its components provide continuity, it is once again unlikely that they will take effect before the presidential change in December 2012.

A new universal program would need to include a comprehensive perspective of the ICT adoption issue. It should include low-cost, efficient connectivity and a vigorous training program for intermediaries: teachers, government employees, nurses, and doctors.

In terms of institutional design, the e-Mexico program as a coordinating body has limited its room to maneuver and its implementation capacity, and it has created discontinuity within its own programs. Its current status as a division that reports to the undersecretary of SCT has also made it subject to political changes.

Moreover, a new universal program should provide a long-term vision of the state's role in promoting broadband development. During this administration, the changes in the SCT administrative body brought about contending visions that generated a stalemate of policies. The fundamental issue that has been part of the controversy is the extent to which the government will finance large-scale broadband projects, or if it will create public-private associations to address broadband diffusion. We recommend the use of the newly enacted Law on Public-Private Associations,[29] which promotes the participation of private investment in infrastructure projects. More important, however, is a long-term vision that provides a clear justification of a chosen path that includes an open process of stakeholder consultation. ■

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26. The SCT and COFETEL have adopted a policy of gradual reduction of interconnection tariffs. For example, for fixed telephone lines, the reduction has gone from US$1.25 in 2000 to US$0.32 in 2011. In terms of spectrum allocation, before 2010, Mexico had about 150MHz, which was increased by about 60% to 240MHz (SCT, 2010).

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