Increasing Human Development in Rural Mexico through Policies for Internet Access

Manuel Ochoa
CITRIS Policy Lab
University of California, Berkeley
Morelia, Mexico
manuel.ochoa@berkeley.edu

Brandie Nonnecke
CITRIS Policy Lab
University of California Berkeley
Berkeley, USA
nonnecke@berkeley.edu

Abstract— **Access and use of digital technologies is essential to assure equal opportunities for education, employment, health, and political participation. Mexico is the 15th largest economy in the world, however there are important inequalities within the country that reduce its potential to reach development objectives. Only 20% of the rural population has internet access in comparison to 62% in urban areas. This digital divide threatens to further entrench social, economic, and political disparities. In this article, we analyze *Mexico Conectado,* a nationwide strategy to increase the digitalization of the country by creating internet access points in public spaces in rural and urban areas and supporting digital literacy training. We present a model to analyze the relationship and impact of *Mexico Conectado* on human development indicators in an index for the 32 States of Mexico. We found a positive relationship where rural internet access increases human development indicators measured in the United Nations Development Program's Human Development Index (HDI). Our model shows that an increase of 1% in the number of households with internet access generates an increase of .02% in the HDI. Alternatively, if the number of households with internet access decreases by 1% the HDI would decrease by .07%. We conclude with policy recommendations for digital inclusion strategies to support human development.**

Keywords— Digital Inclusion, Human Development, Mexico, Inequality, Digital Policies

I. INTRODUCTION

Mexico is the 15th largest economy in the world and the second largest in Latin America with more that 125 million people living in the country. Despite this, it has a GDP per capita of $10,784 us dollars and is ranked 66th in the world [1].

Mexico has 32 states with 2,458 municipalities. Almost 21% of the population lives in rural areas of the country, while 79% live in urban areas [2]. Approximately 50% of the total population has access to the internet. However, most are in urban areas, like Mexico City, where almost 73% of the population has access. Southern and more rural states have significantly less access, like Chiapas where only 25% of the population has access to the internet [3].

In 2013, the right to access information and communication technologies (ICTs), like the internet, was established in Article 6 of the Mexican Constitution. This is due to the 2013 telecommunications reform that transformed the sector and policy strategies to: 1) Foster competition and investment in the telecommunications sector, 2) Increase the availability and quality of telecommunications services, 3) Reduce the cost of telecommunications services, and 4) Establish state obligation to guarantee that Mexicans citizens have the right to access ICTs.

This constitutional article guarantees that the government must ensure equal access to ICTs to all citizens, regardless of their origin, ethnicity, race, or educational level. It also establishes that every person has the right of free access to information and to search, receive, and spread information and ideas by any medium.

The 2013 telecommunications reform had 6 main axes: 1) Amplify the right of free expression and information access, 2) Create an improved legal framework for the telecommunications sector, 3) Create the Telecommunications Federal Institute as a regulatory agency, 4) Increase the competitiveness in the sector by acting against monopolies, 5) Create a National Digital Inclusion Policy and a National Digital Strategy, and 6) Increase the infrastructure coverage to increase the connectivity of suburban and rural areas [4]. The 2013 telecommunications reform was unanimously approved by the Mexican Congress and implemented immediately by the Office of the Presidency and the Communications and Transport Minister.

Mexico Conectado was the key policy of the National Digital Strategy [hereinafter referred to as "Digital Strategy"] launched in November 2013, serving as the main executive plan to develop the digitalization of Mexico and was the secondary policy of the ambitious telecommunications reform in Mexico detailed above.

According to the World Economic Forum, the lack of digital inclusion leads to loss of opportunities for education, employment, and political participation that mitigates the growth and development of the digital economy [5]. Thus, the *México Conectado* strategy focused on guaranteeing the right of access and use of broadband internet service as a key driver of the digital economy. This purpose is intended to be achieved through the two components: 1) Granting internet access services in public hotspots and 2) Digital education and training.

II. MEXICO CONECTADO

Mexico Conectado was a key program of the Digital Strategy established by the federal government with the objective to guide necessary actions and policies to support development of infrastructure and access to ICTs by Mexican citizens, enterprises, and the government. The Minister of Transport and Communications oversaw the implementation of the program.

The Digital Strategy is coordinated directly from the Office of the President with the intention to democratize access to the internet, increase digital inclusion and the

efficiency and productivity of small- to medium-size businesses, and achieve a more open government [6].

The Digital Strategy strives to position Mexico as a Latin American leader in digitalization. To achieve this, the strategy is informed by five pillars of development: 1) Connectivity, 2) Digital Inclusion, 3) Interoperability, 4) Legal Framework, and 5) Open Data [8].

The five pillars of development are defined as follows:

-*Connectivity*: Development of networks and infrastructure in Mexican territory and amplification of current network capacity to increase the capacity in the telecommunications sector to reduce prices to the public.

- *Digital Inclusion*: Development of strategies to support gender inclusion in the operation and use of ICTs and digital services.

-*Interoperability*: Development of technical, organizational, and governance capacities in technological systems to share information and consolidate transactions.

-*Legal Framework*: Create a legal framework to establish a trusted environment in the adoption of ICTs.

- *Open Data*: Distribution of governmental information in useful formats to foster civic entrepreneurship, transparency, and increase the quality of public services.

The *Mexico Conectado* program was established to support the goals of the Digital Strategy. According to official documents of the Government of Mexico, *Mexico Conectado* sought to: 1) Increase and promote the coordination of digital inclusion and digital skills development; 2) link the different digital inclusion efforts currently operating and those that are developed in the short- and medium-term under common standards and objectives; 3) develop digital skills in the population with programs like @prende 2.0; 4) support lifelong learning through training in new ICTs with the digital literacy workshops on *Punto Mexico Conectado*; 5) offer users content of high value and relevance, such as educational content through schools and libraries; 6) promote access to ICTs within the community through the installation of public access networks; 7) establish cultural managers on the *Punto Mexico Conectado* sites to be in charge of supporting cultural activities and fostering strategic links with relevant community actors to promote cultural appreciation and creative expression of the population through ICTs; and 8) support regional development projects with the aid of ICTs, such as the incorporation of technology in rural health clinics [7].
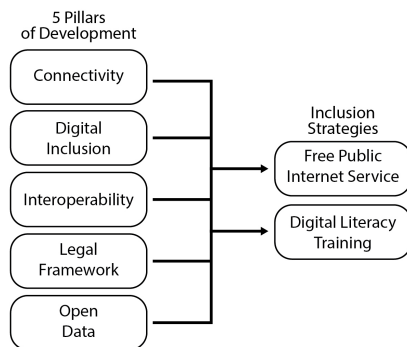

Fig 1. The Five Pillars of Development and Inclusion Strategies in the Mexico Digital Strategy

Mexico Conectado sought to achieve these goals by providing: 1) free public internet service on public sites and 2) digital literacy training. The program provided internet connectivity in public spaces and buildings, such as schools, universities, health centers, libraries, community centers, and public parks—all from the different branches of government: federal, state, and municipalities.

The program sought to develop and establish mechanisms to promote the deployment and use of technologically hybrid, neutral, and open telecommunications networks to provide broadband connectivity at the connection sites. In addition, it promoted the shared use of telecommunications networks to enable the optimal use of infrastructure that could be incorporated into core infrastructure and other assets.

Through public spaces and sites, state and municipal governments ceded the use of community facilities for the development and operation of necessary networks for the provision of connectivity services in the program. These sites were defined based on the cost-efficiency relationship with technical and economic criteria.

The quantitative indicators of internet connectivity were: 1) number of public sites connected through networks contracted by the program, 2) number of broadband links through terrestrial and satellite networks, and 3) use and exploitation of installed capacity [9].

On this last point, *Mexico Conectado* provided free internet connections to rural homes and public buildings near publicly-owned infrastructure with an internet connection. Additionally, the *Hogar Conectado* subprogram was implemented in low-income households to provide a kit that included a TV digital decoder, an antenna, a keyboard, and a mouse. The TV digital decoder connected to satellite internet and was preloaded with educational content and 5GB of internet per month free of charge [10].

According to official statistics [11], a total of 101,322 public sites were connected, of which 70,583 (70%) were connected through terrestrial networks, 29,485 (29%) through satellite networks, and 1,2999 (1%) with the most advanced optical fiber. Of the total public connected sites, 67.9% belonged to the education sector, 9.8% open public spaces, 9.6% public health buildings, 6.6% government offices, 6% community centers, and 0.1% buildings dedicated to research.

Additionally, *México Conectado* updated 12,490 free satellite internet access sites in rural areas with Ka-band satellite technology, which allowed the download speed to reach 6Mbps in remote and marginalized communities [12].

In addition to infrastructure development, *Mexico Conectado* supported digital literacy through workshops and training programs to educate the public on how ICTs can be used to support socioeconomic development. These digital literacy workshops and training programs were delivered in public buildings, *Punto Mexico Conectado* sites, and in community public squares. The digital literacy training program sought to promote higher-level uses of ICTs to support socioeconomic development, to support cultural appreciation, and to enable greater collaboration between people and communities [13].

The main components of the digital literacy training include: 1) Education and digital training, including digital training workshops for adults to reduce anxiety and rejection of ICTs; 2) Training in science, technology, and innovation to

support users' development of creative ideas to innovate products and services using ICTs and to support entrepreneurship by linking projects with institutions that support incubation; and 3) Development of creative and cultural expression through the use of ICTs.

III. RURAL MEXICO

In Mexico, the population living in rural areas has been decreasing due to difficulties in accessing basic services. Inequality in rural areas is notorious when comparing job opportunities, access to health, education, leisure, and digital technologies.

According to the National Institute of Statistics and Geography of Mexico (INEGI), the main agency for generating data and information in the country, a population is considered rural in Mexico if it has less than 2,500 inhabitants. In 1950, the rural population in Mexico represented 57% of the total population, in 1990 it was 29%, in 2010 it was 22%, and by 2018 it is estimated that it represented 21% of the total population [14].

According to the Food and Agriculture Organization of the United Nations (FAO), the rural population in Mexico is mostly made up of young people and the elderly. Extreme poverty affects 17.4% of the Mexican rural population, unlike urban areas where it barely reaches 4.4%. Six out of every ten inhabitants in rural areas were considered poor in 2016, in contrast to four out of ten in Mexican urban areas [12].

In rural areas there are several problems of productivity and competitiveness of the primary sectors of production, including disadvantaged markets due to lack of information, access to distribution and marketing chains, high transaction costs, and low productivity; the loss of resources associated with climate change; disarticulation between management functions and promotion of production; and poor infrastructure [15]. All of the above critical issues are further perpetuated by the lack of digital inclusion in rural areas.

In Mexico, the existence of digital gaps is evident, which are even more exacerbated when analyzing the digital rural environment. At the national level, only 20% of households in rural areas have access to the internet, while in urban areas 62% of households have access to the internet [16].

Within the country itself, there are even more significant inequalities. For example, in the state of Sonora, located in northern Mexico, 61% of households in rural areas have an internet connection, while in the state of San Luis Potosí, located in the central part of Mexico, only 6% of households in rural areas have an internet connection.
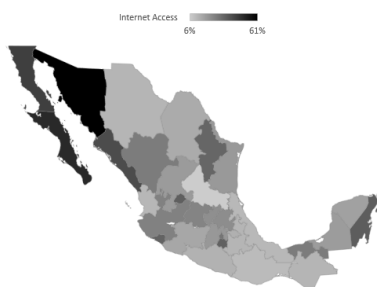

Fig 2. Map of Rural Internet Access in Mexico by State 2018. Map made by the author using data from Instituto Nacional de Estadistica y Geografia (INEGI)

As indicated in Figure 2, the northwest part of Mexico contains the states where rural areas have the greatest levels of internet connectivity, while the southern states are less connected. This has an intrinsic relationship with the level of economic development and growth between the states.

IV. REDUCING INEQUALITY

The existence of a rural-urban digital divide is evident in Mexico. *Mexico Conectado* offers one opportunity to close this divide and support attainment of the UN Sustainable Development Goals (UN SDGs) by coordinating technical connectivity strategies with digital skills training and open data initiatives.

Goal 10 of the UN SDGs is "Reduced Inequalities." According to this goal, public policies should be developed and implemented to improve the quality of life of people in vulnerable situations, in order to broaden their perspective of opportunities, and prevent digital gaps from perpetuating social, economic, and political disparities [17].

According to the UN, inequality within countries has increased and economic growth is not enough to reduce poverty if it does not take into account the three dimensions of sustainable development: economic, social, and environmental dimensions. Universal policies must pay special attention to the needs of disadvantaged and marginalized populations [18].

Additionally, the UN SDG 9, "Industrial Innovation and Infrastructure" seeks to support the development of industry, innovation, and infrastructure. This objective is framed by the need to reduce the digital divide, guarantee equal access to information and knowledge, and promote innovation and entrepreneurship [19].

V. AN ANALYSIS OF THE HUMAN DEVELOPMENT INDEX AND ACCESS TO INTERNET IN RURAL MEXICO

The Human Development Index (HDI) is an indicator developed by the United Nations Development Program. The HDI was created to emphasize that human capabilities should be the ultimate criteria for assessing the development of a country, and not economic growth alone. The HDI is a summary measure of average achievement in key dimensions in human development: a long and healthy life, being knowledgeable, and having a decent standard of living. The standard of living dimension is measured by gross national income per capita, the education dimension is measured by mean of years of schooling for children, and the health dimension is assessed by life expectancy at birth. The HDI has a value between 0 and 1, where 1 is the maximum possible human development [20].

Access to the internet in rural Mexico is measured using data on internet connectivity to the household provided by the official Mexican statistics agency, INEGI. This indicator includes the number and proportion of homes that have access to the internet in rural areas within the 32 States of Mexico. This information is gathered in the National Technology Information Technologies Availability and Use Survey. Rural areas are identified as locations with less than 2,500 inhabitants [21].

In this section we analyze the relationship between rural internet access and indicators of human development within the 32 States of Mexico. We apply a cross-section econometric model. This model implies that the source of information variability is spatial and for a certain moment in time. The observations are different individuals, districts, companies, countries in the period "t." We use the following formula:

$$Yi = \propto + \beta x_i + u_i \qquad (1)$$

We use the latest data collected for the Human Development Index from 2017 and rural internet access data from the national survey of availability and use of information technologies of the National Institute of Statistic and Geography for the 32 states of the Mexican country for the year 2017.

With the above, we seek to identify the relationship between impacts of the *Mexico* Conectado program's internet access and digital literacy training in rural areas of the 32 states of Mexico with the United Nations Development Program's Human Development Index (HDI). Our work seeks to provide insight into whether the *Mexico Conectado* program successfully supported human development in rural areas of the country.

The formulation of the model is as follows:

$$lnHDI_t = \beta + lnX1_t \qquad (2)$$

HDI = Human Development Index (HDI)
β = constant
X1= Internet Access
t = Year (time)

We use natural logarithms to use a linear model to obtain the estimates of the coefficients in a minimum squares regression and obtain the elastic differences measured in percentages, which makes it possible to measure the real impact on the desired function and variables.

Using the Stata econometric software, we perform the necessary tests to ensure the consistency and prevalence of the desired model, after which we obtain cross-section regressions for the year 2017:

TABLE 1 REGRESION USING DHI AND INTERNET ACCESS IN 2017

lnDHI	Coef.	Std. Err.	t	P>|t|
lnAccess	.0256838	.0096368	2.67	0.012
_cons	-.2153316	.0168076	-12.81	0.000

TABLE 2 REGRESSION USING DHI AND NO INTERNET ACCESS IN 2017

					A
Total	.04745953	31	.001530953		R

lnDHI	Coef.	Std. Err.	t	P>|t|
lnNoAccess	-.0722942	.0259586	-2.78	0.009
_cons	-.2788468	.0100867	-27.65	0.000

It can be observed that there is a direct positive relationship between households with internet connection in rural areas and the HDI, and an inverse relationship between the lack of rural household connection to the internet with the HDI.

From the formulation established in the model, we can interpret that an increase of 1% in the number of households with internet access would generate an increase of .02% in the HDI, while if the number of households with internet access decreases by 1%, the HDI would be negatively affected by .07%. This is empirical evidence that the digitalization of the rural region is necessary to reduce inequalities by promoting the use of technologies; innovation; and access to productive, educational, economic, and political opportunities. Internet access could consequently increase the quality of life of the rural population and thus improve their human development.

Mexico Conectado was able to promote the deployment and use of the internet in rural areas of Mexico. Increased access may have influenced individual's development of different abilities and capacities that were impossible to access before, which could have had a positive impact in rural productivity and therefore on socioeconomic development.

VI. POLICY PROPOSALS

There are unique aspects of *Mexico Conectado* that may have supported its positive correlation with the HDI. *Mexico Conectado's* combination of public internet access strategies with training may have had an important impact on the income, health, and education variables that are part of the HDI. Moreover, public access to the internet can lead to increased productivity where access to digital information, software, and tools improve the quality and productivity of services offered through anchor institutions such as schools, libraries, and hospitals.

Our findings show that increasing infrastructure and promoting use of ICTs through digital literacy training have the potential to increase human development by reducing digital inequalities and ensuring the human right of access to information. All these work in favor of achieving the UN SDGs.

Countries like Mexico, where there are significant digital gaps that inhibit development of the digital economy and society, may look to the Digital Strategy and *Mexico Conectado* to establish digital inclusion policies with the following characteristics:

-*Connectivity*: Collaborative development of networks and amplification of network capacity can increase shared capacity while reducing prices and access barriers. Digital inclusion strategies should consider developing partnerships and strategies that support collaborative development of

infrastructure to share investment risks among multiple stakeholders may

- *Digital Inclusion*: Populations need not only access to the internet, but also digital skills and positive attitudes towards ICTs in order to better ensure their utilization increases economic, social, and political opportunities. *Mexico Conectado* was accompanied by trainings and workshops to teach the public how to use ICTs to benefit their livelihoods. Digital inclusion strategies should consider providing training for marginalized or at-risk groups (e.g., women and low-income populations) in the operation and use of ICTs and digital services.

-*Interoperability*: The development of infrastructure and skills training is shared among multiple stakeholders to support co-development of technical, organizational, and governance capacities. Digital inclusion strategies should consider emphasizing shared capacity building to enable resource and skills sharing among stakeholders.

-*Legal Framework*: Due to the importance of private participation in the telecommunications sector, a strong legal framework that increases competitiveness and reduces monopolies is crucial to reducing costs and increasing the availability of telecommunications services. Digital inclusion strategies should consider creating or building upon a legal framework that establishes a trusted environment to support investment and adoption of infrastructure and ICTs.

- *Open Data*: The collection and distribution of public data in standardized formats can support transparency and accountability, quality of public services, and entrepreneurship. Digital inclusion strategies should consider emphasizing the collection and sharing of public open data to create shared value that increases productivity.

VII. CONCLUSION

Our research shows that rural internet access in Mexico positively impacts human development indicators. A 1% increase in the number of rural households with internet access generates an increase of .02% in the HDI. Alternatively, if the number of rural households with internet access decreases by 1%, the HDI decreases by .07%.

The Digital Strategy and *Mexico Conectado* implemented a holistic approach to digital inclusion by incorporating innovative deployment models; digital literacy trainings; shared technical, organizational, and governance capacities to enable the sharing of information and consolidation of transactions; legal frameworks that establish trusted environments to support investment and adoption of infrastructure and ICTs; and open data initiatives to support transparency and capacity building.

While our research provides insights into the impacts of a national strategy on rural internet connectivity, it is limited in its ability to identify which specific factors of the Digital Strategy or *Mexico Conectado* detailed above may have led to the positive correlation with the HDI. Additional research should be undertaken to identify the impact of the five pillar strategies of the Digital Strategy and eight sub-strategies of *Mexico Conectado* on digital inclusion and the HDI.

Mexico should further its national digital policy strategies in alignment with the UN SDGs by not only ensuring access but also promoting high-quality connectivity, digital literacy,

and community models to take advantage of the economic and social opportunities that the digital world offers.

Data availability has been one of the greatest limitations in the research, since the information at the state level is not as detailed as at the national level. Moreover, this level of data was only available until the year 2015. Mexico must strengthen its capacity for data collection at the state and municipal levels to support evaluation of the effectiveness of public policies and programs on rural internet access.

In future research, we propose to develop a detailed investigation of the impacts that *Mexico Conectado* had on each of the 5 strategic pillars of the Mexico Digital Strategy. This work is particularly important as the new Presidency of Mexico has closed the *Mexico Conectado* program and will be establishing its own program. There is an opportunity to use insights from *Mexico Conectado* to support the development of a more impactful program for digital inclusion under the new administration.

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