Digital divide in Oaxaca's indigenous populations

Evidence of Internet access

Brecha digital en la población indígena de Oaxaca

Evidencia del acceso a Internet

Brecha digital entre a população indígena de Oaxaca

Evidência do acesso à Internet

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ABSTRACT

The digital divide refers to the form of social exclusion that affects the use of technology and has a greater impact on indigenous peoples. In Oaxaca, due to its high density of indigenous population, there is a historical continuum of inequality that is expressed in poverty, marginalization, low schooling and low purchasing power, which are barriers to access to digital technologies. The aim of this paper is to analyze the socio-demographic, economic, cultural and geographic factors that affect access to the Internet by the indigenous population, as well as a review of the digital inclusion policies undertaken to reduce the digital divide. This approach involved the use of the probit statistical model, using data from the 2020 Population and Housing Census. The statistics showed that education, purchasing power, access to basic services and residing in places with a higher population concentration are conditioning factors for promoting

access to the Internet. Likewise, the need to design and implement digital policies with the participation of the three levels of government (federal, state and municipal) and local social agents, within a framework of recognition of cultural diversity; policies that go beyond the instrumental and that promote public-private investment in telecommunications, in addition to continuing to make progress in improving the well-being of the indigenous population.

KEYWORDS: *access, Internet, digital divide, indigenous people, Oaxaca.*

RESUMEN

La brecha digital hace referencia a la forma de exclusión social que afecta el uso de la tecnología e impacta en mayor medida a los pueblos originarios. En Oaxaca, por su alta densidad de población indígena, se observa un *continuum* histórico de desigualdad que se expresa en la pobreza, la marginación, la baja escolaridad y el bajo poder adquisitivo, barreras para el acceso a las tecnologías digitales. El objetivo de este trabajo es analizar los factores sociodemográficos, económicos, culturales y geográficos que inciden en el acceso a Internet por parte de la población indígena, así como una revisión de las políticas de inclusión digital emprendidas para la reducción de la brecha digital. Tal abordaje supuso el uso del modelo estadístico probit, utilizando datos del Censo de población y vivienda 2020. Las estadísticas arrojaron que la educación, el poder adquisitivo, el acceso a servicios básicos y el hecho de residir en lugares de mayor concentración poblacional son condicionantes para fomentar el acceso a Internet. Asimismo, se vislumbró la necesidad de diseñar y aplicar políticas digitales con la participación de los tres niveles gubernamentales (federal, estatal y municipal) y agentes sociales locales, bajo un marco del reconocimiento de la diversidad cultural; políticas que vayan más allá de lo instrumental y que promuevan la inversión pública-privada en telecomunicaciones, además de seguir avanzando en mejorar el bienestar de la población indígena.

PALABRAS CLAVE: *acceso, Internet, brecha digital, pueblos originarios, Oaxaca.*

RESUMO

A brecha digital refere-se à forma de exclusão social que afeta o uso da tecnologia e impacta em maior medida os povos indígenas. Em Oaxaca, devido à sua alta densidade de população indígena, observa-se um *continuum* histórico de desigualdade que se expressa na pobreza, na marginalização, na baixa escolaridade e no baixo poder de compra, barreiras ao acesso às tecnologias digitais. O objetivo deste trabalho é analisar os fatores sociodemográficos, econômicos, culturais e geográficos que afetam o acesso à Internet da população indígena, bem como uma revisão das políticas de inclusão digital empreendidas para reduzir a brecha digital. Esta abordagem envolveu o uso do modelo estatístico probit, utilizando dados do Censo Demográfico e Habitacional de 2020. As estatísticas mostraram que a escolaridade, o poder de compra, o acesso a serviços básicos e o fato de residir em locais com maior concentração populacional são fatores condicionantes para promover o acesso à internet. Da mesma forma, percebeu-se a necessidade de desenhar e aplicar políticas digitais com a participação dos três níveis de governo (federal, estadual e municipal) e dos agentes sociais locais, num quadro de reconhecimento da diversidade cultural; políticas que vão além do instrumental e promovam o investimento público-privado em telecomunicações, além de continuar avançando na melhoria do bem-estar da população indígena.

PALAVRAS-CHAVE: *acesso, Internet, exclusão digital, povos indígenas, Oaxaca.*

1.INTRODUCTION

Today, an increasing number of indigenous peoples have access to networks and use multiple digital media for various interests. However, the conditions of vulnerability in which they live limit the exploitation, use and appropriation of ICTs to incorporate them for their economic and productive benefit. Numerous studies have agreed that the digital divide corresponds to the structural inequalities of a society (Tarazona, 2021), which is why it affects to a greater extent people living in the rural sector, sectors with low levels of schooling (Sanders & Scanlon, 2021), women because of their gender and older adults and those with low purchasing power (Arango et al., 2022).

The main reason why certain households do not have digital devices or contract Internet services is because they do not have the economic means to afford them (Rideout & Katz, 2016). The lack of investment in rural contexts is recurrent since they are not profitable spaces for the private sector due to low population density and, at the same time, they are hilly territories that can make infrastructure construction difficult (Government Accountability Office, 2006). According to what is established by the National Institute for the Evaluation of Education, in rural and indigenous schools there is a shortage of infrastructure, human resources and computer resources (INEE, 2018).

In the state of Oaxaca, Mexico, the groups with the greatest vulnerability[1] are the indigenous and Afro-descendant communities that maintain the highest degree of social backwardness, as established by the National Council for the Evaluation of Social Development Policy Council (CONEVAL, 2020)[2], and who live in precarious conditions due to the lack of labor flow, low purchasing power, illiteracy, low educational quality and schooling of the population, the lack of decent and quality housing, health and education services, and the deterioration of natural resources due to climate change and extractive practices.

Paradoxically, access to Information and Communication Technologies (ICT) has become an increasingly important vehicle for guaranteeing the social rights stipulated in the Constitution of the United Mexican States, and is related to virtual access to education, health, information, justice and public services, as established by the International Telecommunication Union (ITU) of the United Nations (UN)[3]. Therefore, not participating in the information society disrupts individual, family and community life and represents another form of social exclusion (Soto, Valencia & Moyado, 2020).

1 The concept of *vulnerability* refers "to the limitations that certain groups present to get out of their chronic conditions of deprivation, such as physical assets, financial savings, human or social capital, and the probabilities of access to goods, services or activities that have a positive impact on well-being" (Gaudín, 2019, p. 37).

2 The CONEVAL integrates in the social backwardness index four social deprivations of poverty measurement: educational backwardness, access to health services, access to basic services in housing and quality and spaces in housing. The state of Oaxaca is in the index with the highest degree of social backwardness and has remained so for more than 20 years (2020).

3 See: ITU (2023).

It is a fact that, in Mexico, in the last five years, ICT and Internet access has increased, according to the National Survey on Availability and Use of Information and Communication Technologies in Households (ENDUTIH) conducted by the National Institute of Statistics and Geography (INEGI), an institution that generates information on the rural sector and estimated that the user rate increased from 39.5% in 2017 to 62.3% in 2022 (INEGI, 2017; 2022c). Among the actions undertaken by the federal and state governments, the provision of devices, the opening of wifi connection points in public places stand out, but these actions have not had significant impacts in rural and indigenous areas (Martínez, García & Rentería, 2023; Trejo, 2020).

This analysis consists of identifying the contextual factors of Internet access in indigenous households in the state of Oaxaca. The research question to be answered is: what are the sociodemographic, economic, cultural and geographic factors that affect Internet access by the indigenous population of Oaxaca? The present analysis relies on the empirical strategy based on Soto, Valencia & Moyado (2020), Reddick et al., (2020) and Alderete (2019). A quantitative methodology, the estimation of a probit regression, with information from the 2020 Population and Housing Census, is used to examine the differential effect of demographic, social, cultural and economic factors on the probability of access to Internet service for indigenous households in Oaxaca.

2. BRIEF CONTEXT OF THE INDIGENOUS POPULATION AND ACCESS TO ICT IN OAXACA

The state of Oaxaca is divided into eight socioeconomic regions: Cañada, Sierra Norte, Istmo, Mixteca, Sierra Sur, Costa, Valles Centrales and Papaloapan. Throughout the eight regions, 16 ethnic groups and the Afro-Mexican people coexist; this reflects the cultural and linguistic diversity of Oaxaca and the country. According to the 2020 population census, of the total indigenous population, 51% are women and 49% are men. In terms of language, 54 linguistic variants are recognized in Oaxaca, the most predominant being: Zapotec (34.4%), Mixtec (21.8%) and Mazatec (13.9%). In education, 77.5% of the indigenous population knows how to read and write and the number of years of schooling of an indigenous person is five years (INEGI, 2020). In terms of employment, indigenous women represent 51% of the total indigenous population, a group that faces several limitations to access the labor market: only 32.2% are self-employed. Women have the highest levels of illiteracy: 43% do not know how to read and/or write (Soto, Valencia & Moyado, 2020). This educational trait by gender particularly impacts women.

According to data from CONEVAL (2018), in 2018, about 80% of the indigenous population was poor, compared to the remaining 58% of non-indigenous inhabitants. In turn, the state of Oaxaca has remained with the highest index of social backwardness at the national level and in the entity is San Simón

Zahuatlán, the poorest municipality in Mexico (CONEVAL, 2020). The main deprivations presented by indigenous contexts are related to social security, lack of access to basic services in housing, access to food, educational lag, housing quality and spaces, and health services (CONEVAL, 2018).

In terms of economic income, in 2022, indigenous households received an average quarterly monetary income of $ 15,238 Mexican pesos, compared to $ 21,194 Mexican pesos received by a non-indigenous household, that is, 39% less (INEGI, 2022a). The majority of the indigenous population aged 12 and older is engaged in primary sector activities such as self-consumption agriculture (CONEVAL, 2018) and manufacturing such as handicraft making.

Due to the aforementioned characteristics, we understand that Oaxaca is one of the most diverse territories in terms of socio-cultural and linguistic diversity. This heterogeneity poses great challenges to achieve the welfare of the population, characterized by high levels of poverty, social and educational backwardness, informal employment, among others, which are connected to the digital divide observed in the State.

3. THEORETICAL HORIZON ON THE STUDY OF DIGITAL DIVIDES

The concept of the digital divide emerged in the United States in the 1990s (Gunkel, 2003). Digital divide studies have differentiated the term into three successive levels: access, use and benefits (Scheerder, van Deursen & van Dijk, 2017; van Dijk, 2005; Selwyn, 2004):

- Access focuses on differences in the availability of infrastructure and electronic devices (ITU, 2023; Korovkin, Park & Kaganer, 2022; Selwyn, 2004). Empirical studies on this level of gap have shown that differences in demographic characteristics such as age, gender, level of schooling, ethnicity, and geographic location impact access (Helsper, 2010; Scheerder, van Deursen & van Dijk, 2017).
- Use relates to the digital skills required for effective use (van Deursen & van Dijk, 2014; Zillien & Hargittai, 2009). Research on this level indicates that there is a set of factors that determine both access and use such as age, educational level, and occupation of individuals (van Dijk, 2017; Blank & Groselj, 2014).
- Benefits, refer to the consequences derived from the use of digital technologies (van Deursen et al., 2017; Helsper, 2016; van Deursen & Helsper, 2015). The work of van Deursen, Helsper & Eynon (2016) mentions that possessing digital skills and using digital technologies does not lead to beneficial outcomes.

Currently, the digital divide is recognized as a multidimensional and multifactorial phenomenon (Chohan & Hu, 2020). As a result of the pandemic caused by COVID-19, the concept of the divide has become broader and more complex in view of the clear digital inequalities that have become evident, with particular harm to indigenous populations and communities (ITU, 2021).

Given that digital divides appear as digital technologies are incorporated into people's social lives, social appropriation helps to understand the relationships between the so-called digital divide and the social divide. Therefore, social appropriation is defined as "the set of sociocultural processes involved in the use, socialization and signification of new technologies in diverse sociocultural groups" (Winocur, 2013, p. 62).

One of the theories used in the study of the digital divide is the Theory of Resources and Appropriation (TRA) developed by van Dijk (2005). This model seeks to explain how social inequalities in Internet appropriation are produced and consists of four sequential stages: (i) attitude, referring to motivations for Internet use; (ii) physical access, related to devices and connectivity; (iii) digital skills refers to the competencies needed to use the web, ranging from operational to social, as well as those focused on content creation; and (iv) Internet use, is the final stage of Internet appropriation and refers to the time users spend online and the activities they perform on the web (van Dijk, 2020). In this study, due to the lack of data on attitudes, digital skills and Internet use, we focus on the factors that determine Internet access.

In this regard, research by Arango et al. (2022) shows that indigenous populations have more difficulties in accessing digital technologies and a greater educational lag. With the COVID-19 pandemic, the wide educational inequity in indigenous contexts was evidenced, which prevents guaranteeing digital education for all, given that the school is the priority place in the acquisition of digital skills (Torres & Torres-Madroñero, 2020).

4. DIGITALIZATION AND DIGITAL INCLUSION POLICIES IN OAXACA

Social inclusion is defined as "the process of improving the conditions for participation in society, particularly for disadvantaged people, through improved opportunities, access to resources, voice and respect for rights" (United Nations, 2016, p. 17). Therefore, digital inclusion policies respond to government efforts for the provision of technological infrastructure in the territories, the regulation of service costs and the design of digital literacy programs[4]. Therefore, this intervention must be structural, systematic and active on the part of the State (Arango et al., 2022). With the increasingly relevant role of digital technologies in people's daily lives, since the beginning of the 21st century, the design and implementation of digitization and digital inclusion policies have become fundamental and mainly integrate connectivity, digital capabilities, affordability and accessibility (ITU, 2023).

Among the most important programs applied in the state of Oaxaca, as part of federal public policies, are the following references:

4 The objective of digital inclusion policies is to achieve the incorporation of individuals and groups into a culture transversally crossed by ICTs (Fernández-Medina, 2005).

> *e-Mexico System*. Strategy focused on three aspects: 1) installation of community learning centers in the municipal capitals; 2) training in the use of digital tools, however, staff turnover due to migration brought with it the absence of qualified personnel to coordinate the learning centers; and 3) the promotion of content generation from government institutions and agencies that promote social security and public education. The lack of mechanisms for constant monitoring and complementary assistance by the three levels of government (federal, state and municipal) have limited ethnic groups' access to ICTs. (Allende & Salinas, 2017, p. 17)

Likewise, between 2013 and 2018, different programs can be discriminated framed in what would become the National Digital Strategy, a governmental action plan to foster the adoption of ICTs. Its objectives focused on government transformation, digital economy, quality education, universal and effective health and citizen security (Government of Mexico, 2018). The main programs developed during those years were:

> *Mexico Connected Program.* The objective was to provide Internet access in public places such as schools, health centers, libraries, community centers and public spaces at the three levels of government: federal, state and municipal. However, the purpose was not fulfilled due to the very limited coverage in indigenous areas, technical failures that caused slow Internet service and the development of digital skills was left aside. (Martínez, García & Rentería, 2023, pp. 183-186)

> *Mexico Connected Points Program or Digital Inclusion Centers* (CID). Its objective was to provide ICT and Internet services and promote the development of digital skills for the proper use of technologies, the main limitation was coverage, since there was only one CID in the city of Oaxaca, so that populations far from the state capital did not have access, and the courses offered had a capacity for only a group of 16 to 20 people. (Martínez, García & Rentería, 2023, pp. 190 and 191)

> *MiCompu.mx and the Digital Literacy Pilot Program* (PIAD). Both programs focused on the provision of personal devices such as tablets and laptops; however, they did not serve the country's most marginalized population, as they were implemented in large cities (Trejo, 2020). The state government promoted "the provision of computing resources through programs such as Mi compu, digital inclusion Oaxaca to provide laptops to elementary school students, prioritizing urban areas and leaving aside the indigenous population". (Díaz, 2014, p. 88)

For its part, between 2021 and 2024, within the framework of the National Digital Strategy, it is highlighted:

> *Social Coverage Program.* Focused on marginalized areas of the country, with the objective that all people in vulnerable situations have access to digital technologies and possess digital skills. According to the Ministry of Infrastructure,

> Communications and Transport (SCT), indigenous communities are a priority for this program (SCT, 2019). Progress in coverage for localities with indigenous population has been slow, the most recent figure indicates that in the 2021-2022 program 4,468 localities with 2.8 million inhabitants with high indigenous and/or Afro-Mexican presence were identified, but only 46.8% (2,091 localities) registered Internet access. (SCT, 2022, p. 20)

The implementation of such policies has faced several challenges that were exposed in several studies. The results agree that policies focused on reducing the digital divide in Mexico have been insufficient due to their instrumental nature and that they have not had a significant impact in rural areas (Trejo, 2020; Merino & Muñoz, 2017; Díaz, 2014). Programs aimed at the provision of devices and the opening of wifi connection points present a specific problem, which is that they are not sustained over time. At the same time, there is little coordination between the federal and state governments and the private sector to promote infrastructure in rural and indigenous areas.

5. METHODOLOGY

From the previously developed analytical approach, an econometric analysis is proposed to identify the sociodemographic, economic, cultural and geographic factors that affect Internet access by the indigenous population of the state of Oaxaca. For this purpose, data from the 2020 Population and Housing Census (Censo de población y vivienda 2020, conducted by INEGI) were used. The objective of this census is to gather information on the economic, social, demographic and cultural characteristics, as well as the spatial distribution of the Mexican population. The census information is representative at the national, state and locality levels (less than 2,500 inhabitants, 2,500 to 14,999 inhabitants, 15,000 to 49,999 inhabitants and 50,000 and more inhabitants). The data collection period was from March 2 to March 27, 2020. The criteria used to select the sample were: i) if the person self-identified as indigenous[5] and ii) head of household[6].

To model Internet adoption in indigenous areas of Oaxaca we followed the procedure used by Soto, Valencia and Moyado (2020), Reddick et al. (2020) and Alderete (2019). A probit regression was estimated[7], which is appropriate for explaining the behavior of a binary variable, in this case access (1) or no internet access (0), which is determined by one or several explanatory variables

5 According to their culture, customs and traditions (INEGI, 2020).

6 Person recognized as such by the usual residents of the dwelling, through whom the kinship relationship of each of the residents with the dwelling is known. If no person is identified as the head of the household, the reference person is considered to be the first person 12 years of age or older mentioned by the informant (INEGI, 2020).

7 Model based on the utility theory or behavioral rational selection perspective (McFadden, 1973). The probit model is simple to estimate and the disadvantages are that the adjusted probabilities can be less than 0 and less than 1 and that the partial effect of any explanatory variable is constant (Wooldridge, 2010).

(Greene, 2003). Within the set of explanatory variables, we included characteristics of the individuals heading the families, as well as those of the indigenous households.

The decision to adopt the Internet by individuals can be represented by the following equation:

$$Pr_{i1}(adopción\ de\ internet) = Pr(\beta_0+\beta_1 X_{i1}+\varepsilon_i) \qquad i=1\ldots n \qquad (1)$$

Where is a vector of individual-level variables, such as demographic, cultural, economic, social characteristics and possession of digital devices. is an individual-specific idiosyncratic error that is normally distributed. In simplified form, the base model for estimating the determinants of Internet access in indigenous areas is:

$$P(adopción\ de\ internet = 1)_{i1} = \Phi(\beta_0+\beta_1 X_{i1}+\varepsilon_i) \quad i=1\ldots n \qquad (2)$$

5.1. Dependent and independent variables

The independent variables were selected based on the literature review on digital divide (Soto, Valencia & Moyado, 2020; Alderete, 2019; van Dijk, 2006; Selwyn, 2004). Among the variables included were sociodemographic, cultural, economic, geographic, possession of complementary digital technologies such as computer and cell phone, as well as the characteristics of indigenous households. The metrics of the variables used in the econometric regression are described below.

- Internet access in the home. A binary variable was considered, where 1 indicates that the household has a fixed or mobile Internet connection and 0 the opposite.
- Gender of the head of household. It is a variable that takes the value of one if it is a woman who heads the household and zero in the opposite case.
- Age of the head of household. Number of years of age of the individual at the time of the interview. In this case, persons between 12 and 74 years of age were included.
- Literate head of household. The person who heads the household can read and write an errand.
- Head speaker of an indigenous language. Variable where 1 indicates that he/she speaks an indigenous language and 0 otherwise. Ethnicity is a factor of disparity in access to digital technologies. Belonging to an ethnic group is associated with a lower possibility of ICT adoption, due to the lack of coverage of basic services in homes.
- Years of schooling of the head of household. We asked about the highest level of schooling completed at the time of the interview. In general, people with lower

levels of education are more likely to be in the digital divide (Sanders & Scanlon, 2021). While in urban areas students have greater access to the Internet in school facilities, in the case of indigenous areas there is a greater shortage of infrastructure, material and computer resources (INEE, 2018).

- Access to complementary technological devices. If you own a computer and/or cell phone, in each variable 1 indicates the presence of one of these electronic goods and 0 otherwise.
- Household size. The number of people in the household was calculated. The greater the number of members in the household, the greater the probability of contracting Internet service (Alderete, 2019).
- Poverty. The percentage of people living in poverty was included, data at the municipal level (CONEVAL, 2020). According to Rideout & Katz (2016), the main reason why families do not have digital devices or contract Internet service is because they cannot afford it. The poorest families are financially unable to afford the Internet, which widens the lag and deepens the gap between rich and poor even more.
- Head of household with agricultural work. 1 denotes that the person is employed in agricultural, livestock, forestry, hunting and fishing activities and 0 otherwise.
- Head of household with work in commerce and similar. 1 indicates that the individual heading the household works in trade or similar activities and 0 otherwise.
- Head of household with a construction job. 1 means that the person is employed in construction as a bricklayer and 0 in the opposite case.
- Head of household with domestic and similar work. 1 indicates that the person is employed for a salary in domestic and similar activities.
- Regions. To capture Internet access in indigenous communities, Oaxaca was divided into eight regions: Cañada, Costa, Isthmus, Mixteca, Papaloapan, Sierra Norte, Sierra Sur and Valles Centrales. Rural areas have had less access than urban areas, but indigenous areas are the least connected, as most of them lack high-speed connections, weak or absent wireless telephone signals. Likewise, most indigenous populations lack Internet providers, pay more for a lower quality service and in general have lower incomes. It is worth mentioning that indigenous contexts are not profitable for the private sector, due to low population density, low purchasing power of families and hilly terrain that can make infrastructure construction difficult (Government Accountability Office, 2006).

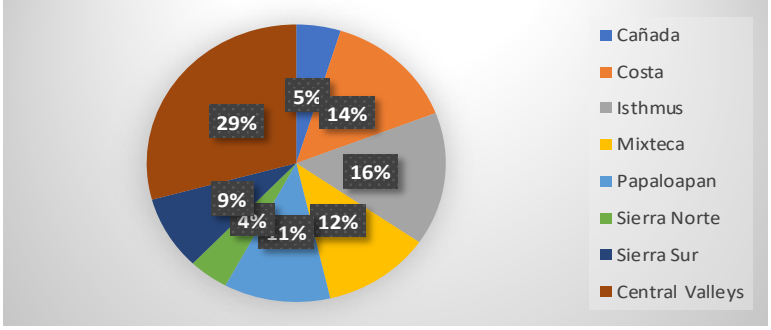
6. RESULTS

6.1. Dispersion of settlements of the indigenous population

According to 2020 census figures, 51 out of every 100 people in Oaxaca reside in localities of less than 2,500 inhabitants (INEGI, 2020). At the regional level, Graph 1 shows that 3 out of every 10 indigenous inhabitants reside in Valles Centrales and the rest reside in the other regions. Sierra Norte is the area with the lowest number of inhabitants, but in this region, in terms of

Community Indigenous Telecommunications (TIC), there are local project operators that provide mobile telephone services at low cost as in the case of (TIC-A.C., n.d.). In terms of indigenous population by region in Oaxaca, most of the population is concentrated in Mixteca, Costa and Sierra Sur, while the opposite is true for Cañada and Sierra Norte.

Graph 1. Distribution of the indigenous population by region

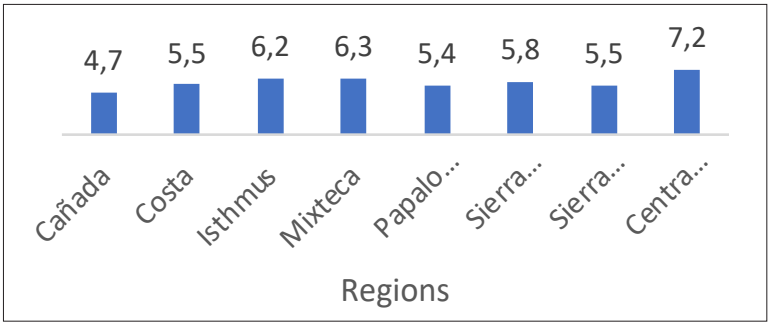


Source: Own elaboration with data from INEGI (2020).

6.2. Education

According to data from the 2020 census, the average number of years of schooling for an indigenous person in Oaxaca is five years. Graph 2 shows the level of schooling of the head of household by region, where it is shown that in Valles Centrales they have the highest schooling, the opposite occurs with Cañada. "Educational backwardness and the digital divide are intertwined and both feed back on each other, due to the fact that education today makes use of ICTs, which exposes profound inequalities in access to education" (Villela & Contreras, 2021, p. 183). Hence, the educational backwardness of the indigenous population is a constraint to digital literacy (Soto, Valencia & Moyado, 2020).

Graph 2. Schooling of the head of household

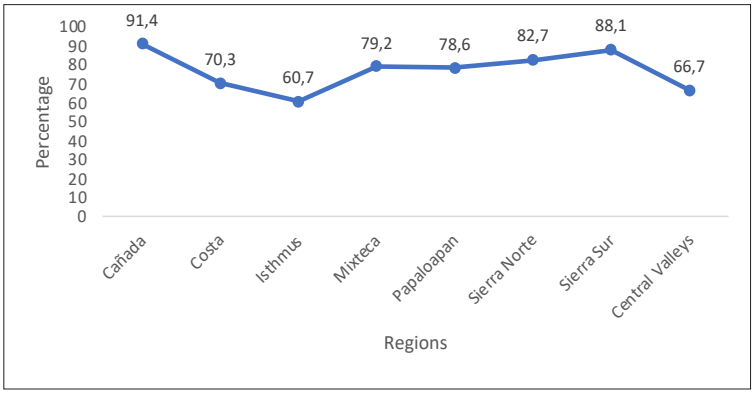


Source: Own elaboration with data from INEGI (2020).

6.3. Poverty

Graph 3 presents the percentages of population living in poverty by region, highlighting Cañada and Sierra Sur with the highest levels of poverty, while the Isthmus presents the lowest levels of poor population. Lack of economic resources is one of the main barriers to contracting Internet service, acquiring electronic devices and accessing socio-digital practices (Rideout & Katz, 2016).

Graph 3. Population living in poverty by region

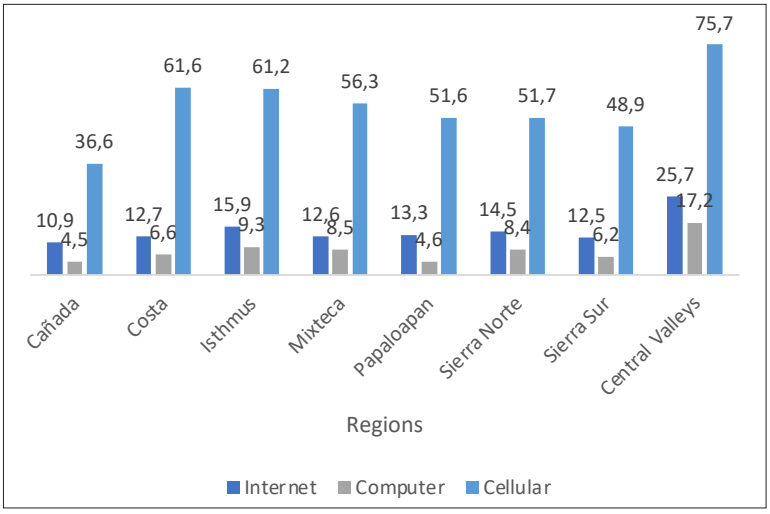


Source: Own elaboration with data from CONEVAL (2020).

6.4. Access to ICT and investment in telecommunications infrastructure

According to information from the 2020 Census, with the exception of Cañada and Sierra Sur, in the other regions half of the country's households have a cell phone. However, Graph 4 shows that the percentage of Internet service coverage in Cañada is only 11%, compared to 26% in Valles Centrales (INEGI, 2020). Providing telecommunications to indigenous populations is a challenge due to their characteristics related to geography and rugged topography, low population density and the isolation of localities that make it impossible to provide technological infrastructure.

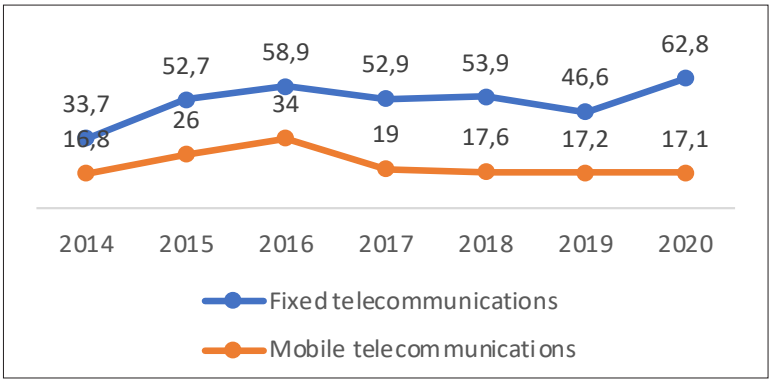
Graph 4. ICT access of indigenous households by region in Oaxaca



Source: Own elaboration with data from INEGI (2020).

Most of the investment in telecommunications comes from private agents. However, in recent years, as shown in Graph 5, there has been a reduction since 2016 in mobile and a growth in fixed in 2020. This lack of resources for telecommunications infrastructure hinders access to a greater extent for the rural and indigenous population. In particular, the geographic location of these areas increases the cost of infrastructure deployment, and as they are low in population density, they are not profitable for large companies (The CIU, 2022).

Graph 5. Private investment by companies in telecommunications infrastructure by market segment (billions of pesos)



Source: The CIU (2022).

7. DESCRIPTIVE STATISTICS

Descriptive statistics for the variables of the indigenous individuals and households are found in Table 1. The average age of the heads of household is 48 years old. When categorized by age, 2 out of 10 heads of household are younger than 30 years old. In terms of gender, 25 out of every 100 indigenous households are headed by a woman. In terms of indigenous language, 6 out of 10 people who assume the role of head of household speak a language, taking into account that Oaxaca is the region with the largest indigenous population.

With respect to education, the number of years of schooling of the persons heading households is 5.8 years of schooling, and 8 out of 10 heads of household know how to read and write.

Within economic activity, 56% of the people are engaged in primary activities, i.e., the agricultural sector is the main livelihood. This is followed by the construction sector such as masonry (13%). Wage-earning domestic work employs 12% and, to a lesser extent, commercial activity occupies only 4.4%.

With respect to family composition, the number of family members is four people. In possession of digital technologies, 56% have a cell phone, 14% have Internet access and only 8% own a computer.

On the other hand, although 77% of indigenous households live in poverty, 86% of the people own the house where they live. Regarding the indigenous population by region in Oaxaca, the majority is concentrated in Mixteca, Costa and Sierra Sur; the opposite is true for Cañada and Sierra Norte.

Table 1. Descriptive statistics of the indigenous population of Oaxaca, Mexico 2020

Variables	Mean	Standard deviation	Minimum value	Maximum value
Individual characteristics of the head of household				
Average age	47.66	14.032	12	74
Age1 (13 to 18 years old)	0.00	0.053	0	1
Age2 (19 to 29 years old)	0.11	0.309	0	1
Age3 (30 to 39 years old)	0.21	0.408	0	1
Age4 (40 to 49 years old)	0.23	0.422	0	1
Age5 (50 to 59 years old)	0.20	0.403	0	1
Age6 (60 to 74 years)	0.22	0.414	0	1
Years of schooling	5.86	4.073	0	24
Head literate (can read and write=1)	0.82	0.383	0	1
Gender (Female=1)	0.25	0.431	0	1
Indigenous language speaker	0.59	0.492	0	1
I work in agriculture and livestock	0.56	0.497	0	1
Work in commerce and similar	0.04	0.206	0	1
Construction work	0.13	0.342	0	1
Domestic and similar work	0.12	0.328	0	1
Access to technological devices				
Internet	0.15	0.353	0	1
Computer or tablet	0.08	0.273	0	1
Cellular	0.56	0.496	0	1
Characteristics of indigenous households				
Household size	3.89	2.031	1	39
Asset ownership (housing)	0.86	0.343	0	1
Characteristics of local contexts				
Percentage of population living in multidimensional poverty	77.01	17.972	16.9	99.6
Municipal marginalization index 2020	50.69	3.645	38.0	60.8
Cañada Region	0.09	0.292	0	1
Coastal Region	0.14	0.350	0	1
Isthmus Region	0.11	0.318	0	1
Mixtec Region	0.18	0.384	0	1
Papaloapan Region	0.13	0.335	0	1
Sierra Norte Region	0.09	0.291	0	1
Sierra Sur Region	0.13	0.341	0	1
Central Valleys Region	0.11	0.316	0	1
Remarks	268,171			

Source: Own elaboration with data from INEGI (2020).

7.1. Results of the probit regression of the factors affecting Internet access among the indigenous population in Oaxaca

Table 2 presents the results of the probit regression of Internet access, conditional on a set of sociodemographic, economic, cultural, geographic and local context variables. According to the Hosmer-Lemeshow test (Prob > chi2 = 0.0000), the model fit is adequate (Cameron & Trivedi, 2009). Marginal effects are reported, calculated as the differences between the estimated probabilities when the explanatory variables change, for example, a binary variable from 0 to 1.

The variables that encourage or restrict Internet access in the indigenous context of Oaxaca are related to factors such as age index, language spoken, employment sector, geographic location and, last but not least, access to literacy and technology, i.e., being able to read and write messages and owning digital devices.

The results of the model are presented in Table 2. In the sociodemographic variables of the people who head indigenous households, those in the 40 to 59 age range have greater possibilities of accessing Internet services. On the other hand, the fact of only speaking a native language represents a restriction to such access. With respect to gender, there is no evidence of a gap between indigenous men and women in Internet access.

In education, one more year of schooling increases the probability of accessing the Internet; however, the number of years of formal schooling of the indigenous population in the study sample is only 5.86 years, that is, most of them did not complete primary education.

In employment, people employed in activities related to the agricultural sector, the construction sector and salaried domestic work are less likely to have access to the Internet. On the other hand, those employed in the commercial sector have a higher propensity to access the Internet, which suggests that they have greater economic capacity.

Despite the fact that the cell phone is the most predominant digital device, given that 6 out of every 10 indigenous inhabitants own one, its dominance does not have a high incidence rate in Internet access, compared to the possession of a computer. The econometric results indicate that owning a computer or similar in the home increases Internet access.

In terms of geographic location, considering the coast as the reference region with the greatest access, the Mixtec region is less likely to have access to the Internet compared to the other regions. This suggests that the populations with the greatest disadvantages for Internet access are settled in places with lack of access to basic housing services such as electricity, drainage, potable water, among others.

Table 2. Determinants of Internet access by the indigenous population in Oaxaca, 2020

Variables	Marginal Effects	Standard errors
Individual characteristics of the head of household		
Age1 (13 to 18 years old)	Reference	
Age2 (19 to 29 years old)	-0.00508	-0.00439
Age3 (30 to 39 years old)	-0.00147	-0.00431
Age4 (40 to 49 years old)	0.00719*	-0.00442
Age5 (50 to 59 years old)	0.0132***	-0.00459
Age6 (60 to 74 years)	0.00696	-0.00462
Years of schooling	0.00502***	-0.000197
Head literate (can read and write=1)	0.00824***	-0.00239
Gender (Female=1)	-0.000175	-0.00174
Indigenous language speaker	-0.0211***	-0.00138
I work in agriculture and livestock	-0.0355***	-0.00189
Work in commerce and similar	0.0238***	-0.00313
Construction work	-0.00813***	-0.00198
Domestic and similar work	-0.0298***	-0.00184
Access to complementary technological devices		
Computer or tablet	0.242***	-0.00343
Cellular	0.182***	-0.00125
Characteristics of indigenous households		
Household size	0.00445***	-0.000315
Asset ownership (housing)	0.00281*	-0.00166
Characteristics of local contexts		
Percentage of population living in multidimensional poverty	0.000491***	-5.46E-05
Municipal marginalization index 2020	0.00555***	-0.000275
Cañada Region	0.0664***	-0.00364
Isthmus Region	0.0101***	-0.00243
Mixtec Region	-0.0141***	-0.00212
Papaloapan Region	0.0299***	-0.00277
Sierra Norte Region	0.0319***	-0.00312
Sierra Sur Region	0.0154***	-0.00276
Central Valleys Region	0.0340***	-0.00256
Coastal Region	Reference	
Log pseudolikelihood	-91148.344	
Wald chi2	40594.38	
Remarks	268,171	

Significance level: *** p<0.01, ** p<0.05, * p<0.1

Source: Estimates with data from the National Institute of Statistics and Geography (2020).

8. DISCUSSION

Econometric estimates highlight the set of challenges in indigenous contexts for Internet access, where telecommunications infrastructure is essential for connectivity, but the topography and dispersion of sparsely populated settlements are not profitable for private companies. Likewise, in the case of Mexico there has always been a deficit of investment in the installation of telecommunications infrastructure, however, since 2018 this situation has been further reduced (The CIU, 2022). It is worth mentioning that this lack of investment affects to a greater extent indigenous rural areas such as those in Oaxaca, places where 43% of the total population of the entity resides, as 1 out of every 2 inhabitants lives in an area of less than 2,500 inhabitants (INEGI, 2020).

The results reflect that the lower the poverty and degree of marginalization, the greater the access to the Internet, so indigenous populations present a connectivity limitation, due to their condition of poverty (Romualdo, 2022; Arango et al., 2022; Soto, Valencia & Moyado, 2020). Such localities still lack access to basic services, in 2018 only 1 in 5 indigenous people had basic services such as drinking water and electricity inside their homes (CONEVAL, 2018).

The lack of favorable economic conditions restricts the affordability of devices and Internet service (Selwyn, 2004; van Dijk, 2006). This situation is reflected in figures from the National Occupation and Employment Survey (ENOE) for Oaxaca, where 8 out of 10 people work in informal jobs (INEGI, 2022b), that is, self-employed activities such as primary (agriculture and livestock) and secondary (handicrafts and construction). Thus, people's economic condition and labor profile affect Internet access to the extent that they eventually become limitations for the acquisition of devices and their maintenance.

Likewise, in order to access the Internet, it is necessary to reduce educational backwardness and increase the number of years of schooling, i.e., combating illiteracy is fundamental for access to and use of the web. It is worth mentioning that Oaxaca has the third highest rate of illiteracy and educational backwardness in the country (INEGI, 2020).

The number of years of schooling continues to be low (7.9 years at the state level), but in the case of the indigenous population it is reduced to 5 years (INEGI, 2020). Likewise, the low coverage of infrastructure and school materials continues to persist; in some localities there is only preschool and elementary school, so students who want to receive secondary education have to travel to the municipal capitals.

In addition to the above, there is a very low level of connectivity in schools, barely 3 out of 10 schools have, in principle, a computer with Internet access (INEE, 2018).

Based on the findings presented here, if new schooling rates are not achieved beyond five years of primary school, the acquisition of digital skills

will be limited, given that school is the main space for access to literacy, which allows later digital literacy. Therefore, it is urgent that, in addition to connectivity, digital literacy is implemented not only within schools, but also outside them, to include the older adult population that does not have such digital skills. It is necessary to recognize the challenges faced by educational actors in the use of ICTs in indigenous areas, considering the economic differences and technological access (Cortés, Vega & Vega, 2022).

With respect to public policies, although the state government has prioritized technological endowment policies (Díaz, 2014) as part of a worldwide trend with an instrumentalist emphasis, the results show a failure in closing the digital divide, so that in addition to encouraging Internet access, strategies are required at the levels of use and benefits (Arango et al., 2022). In other words, providing digital devices to low-income indigenous families is not enough, it is necessary to develop comprehensive policies for digitization and digital inclusion (Tarazona, 2021), in addition to continuing to work on reducing the social and educational backwardness in which the state has been mired for decades and in particular the indigenous population.

9. CONCLUSIONS

In this paper we sought to explain that the concept of the digital divide is a process that consists of three levels: access, use and benefits. This study focused on the first level of the gap or access to the Internet by the indigenous population of Oaxaca. The results of the econometric regression show that the facilitators of Internet access by the indigenous population are related to a higher level of education, lower illiteracy and residence in areas with higher population density and access to basic services. On the other hand, the barriers to Internet access are related to topography (mountainous areas), localities with very low population density, advanced age, lack of economic resources to contract Internet services, due to the fact that most of the population is employed in the informal sector, as well as the lack of basic services inside the homes.

Therefore, Internet access in the indigenous contexts of Oaxaca requires the participation of authorities from the three levels of government (federal, state and municipal), the private sector and local social agents to explore solutions linked to the particular specificities, in order to expand telecommunications coverage, especially in regions of the Cañada, where only 11% of households have Internet access compared to the Valles Centrales region.

However, as access is covered, it is necessary to approach the social appropriation of the Internet, that is, to learn to use it in the social, educational, economic, commercial, health, institutional and administrative spheres, which is why the Mexican educational system is the ideal place to encourage digital literacy. This implies implementing strategies to ensure access to the Internet

and electronic devices, providing digital skills to users and adapting learning processes, considering cultural and linguistic diversity.

As previously mentioned, indigenous areas have a varied and diverse cultural wealth, but also present historical structural conditions that place them at a disadvantage. Therefore, political will is required to consider the following strategies: i) link connectivity with the diversification of activities in indigenous contexts; ii) guarantee the human right of indigenous peoples to Internet access; iii) provide high-speed Internet; iv) design training that is localized, flexible and adapted to the linguistic needs of the local population; v) establish digital libraries in indigenous localities and optimize available computer resources; and vi) establish initiatives to provide Internet devices and connectivity for the most vulnerable families.

Public policies of digital inclusion for vulnerable groups such as the indigenous population should be based on a perspective of social justice, to ensure education and digital economy for all inhabitants of a territory. In such a way that the access and use of the Internet is reflected in obtaining economic, social, cultural and political benefits, i.e., to promote the social appropriation of the Internet.

Among the limitations of the study is the lack of data for a more comprehensive analysis of the digital divide of the indigenous population, related to the use of the Internet, the possession of digital skills and the benefits derived from its use, such information would allow to deepen on the phases of use and benefits of the digital divide of the indigenous population, a topic little explored. Future research should study other marginalized populations such as Afro-descendants, given their relevance in Oaxaca, since 6 out of every 100 inhabitants self-identify as such.

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