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Artículos científicos

Importancia del acceso a internet en el ingreso y la educación en las zonas rurales y urbanas de México

Importance of internet access on income and education in rural and urban areas of Mexico

Importância do acesso à Internet na renda e na educação nas áreas rurais e urbanas do México

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Resumen

Las tecnologías de información y comunicación han tomado un mayor auge y relevancia en los últimos años, lo cual ha contribuido a un mejor desarrollo de la sociedad, pues ha permitido estimular habilidades para la vida y el trabajo. Sin embargo, en el caso de México, el acceso a internet no es homogéneo en todo el país, a pesar de que es un servicio de alta prioridad y con muchas ventajas, lo cual ha generado un incremento de la brecha digital entre zonas rurales y urbanas. Por lo que, el objetivo de este trabajo fue analizar la importancia del acceso a internet y su relación con el ingreso y la educación en las comunidades rurales y urbanas. Para ello, se efectuó un análisis descriptivo por análisis no supervisado mediante una asociación de clúster de K-means del acceso a internet y del nivel de ingreso y escolaridad de las zonas rurales y urbanas de México. Los resultados indican que el acceso al internet en las zonas urbanas ha provocado un mayor ingreso económico, lo cual se asocia a un mayor nivel educativo; en cambio, en las zonas tanto rurales o urbanas donde no se usa el internet, se tuvo un menor ingreso económico. Se concluye, por tanto, que existe una brecha digital entre las zonas urbanas y zonas rurales y que el acceso a internet en la sociedad fomenta un aumento en el nivel educativo y económico de las personas.

Palabras clave: internet, zona urbana, zona rural, ingreso, educación.

Abstract

Information and communication technologies have taken on a greater boom and relevance in recent years and contribute to a better development of society, which fosters skills for life and work. In Mexico, Internet access is not homogeneous throughout the country, because despite the fact that it is a high-priority service with many advantages, access is not available in all areas; which implies a digital divide in rural and urban areas. Therefore, the objective was to analyze the importance of Internet access and its relationship with income and education in rural and urban communities, through the development of a descriptive analysis by unsupervised analysis through a K-means cluster association. Internet access and the level of income and schooling in rural and urban areas of Mexico. The results indicated that access to the Internet in urban areas has generated a higher economic income associated with a higher educational level, while in both rural and urban areas where the Internet is not used, there was a lower economic income. It is concluded that there is a digital gap between urban

and rural areas and that Internet access in society promotes an increase in the educational level of people, as well as generating an increase in economic income.

Keyword: Internet; urban area; rural area; income; education

Resumo

As tecnologias de informação e comunicação tornaram-se mais importantes e relevantes nos últimos anos, o que tem contribuído para um melhor desenvolvimento da sociedade, pois tem permitido estimular competências para a vida e para o trabalho. No entanto, no caso do México, o acesso à Internet não é homogéneo em todo o país, apesar de ser um serviço de alta prioridade e com muitas vantagens, o que gerou um aumento da exclusão digital entre áreas rurais e urbanas. Portanto, o objetivo deste trabalho foi analisar a importância do acesso à Internet e sua relação com a renda e a educação em comunidades rurais e urbanas. Para tanto, foi realizada uma análise descritiva por meio de uma análise não supervisionada através de uma associação de cluster K-means de acesso à Internet e nível de renda e escolaridade em áreas rurais e urbanas do México. Os resultados indicam que o acesso à internet nas zonas urbanas tem provocado maior rendimento económico, o que está associado a um nível educacional mais elevado; Por outro lado, nas zonas rurais ou urbanas onde não se utiliza a Internet, registou-se um rendimento económico inferior. Conclui-se, portanto, que existe uma exclusão digital entre o meio urbano e o meio rural e que o acesso à Internet na sociedade promove o aumento do nível educacional e económico das pessoas.

Palavras-chave: internet, zona urbana, zona rural, renda, educação.

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Introduction

Information and communication technologies (ICT) contribute greatly to the development of various sectors of modern societies (Torkayesh and Torkayesh, 2021). One of these technologies is the internet, which is ubiquitous in most of the world today (Hoeschele *et al*., 2021). Therefore, various studies support the suggestion of promoting the use of the Internet, since it can be of great benefit to people's quality of life (Wallinheimo and Evans, 2021). Furthermore, the pandemic caused by Covid-19 has drastically affected the lives of all people, as it has modified the ways of working and learning. This caused

learning digitally to become a key tool to develop new competencies and skills (Organization for Economic Cooperation and Development [OECD], 2020).

In fact, due to Covid-19, online activities grew significantly (Mouratidis and Papagiannakis, 2021). Consequently, promoting the learning of digital skills, as well as improving access to the internet, became essential in society to be able to face future challenges in a post-pandemic world (OECD, 2020) and even to generate more sources of income. employment, hence, policies must be promoted to promote education with the support of ICT, especially in rural areas (Siaw *et al*., 2020).

Despite these advantages, in Mexico internet access is not homogeneous throughout the country, which has repercussions on economic and social aspects. In this regard, there are various studies in different countries and regions of Mexico on the importance of Internet use; However, there is no research that includes a K-means cluster study, as well as Internet use in rural and urban areas.

Therefore, the objective of this research was to analyze the importance of Internet access and its relationship with income and education in rural and urban communities. To this end, the following questions were posed: is the use of the Internet important? What is the importance of the Internet in people's income? Does people's level of education influence whether they have access to the Internet? These questions will be answered at the end of the research, through a descriptive and cluster analysis that allowed us to see the preferences of the inhabitants of rural and urban communities.

Other background

This section presents information on other research that is related to Internet use in urban and rural areas, educational level and income level.

Internet in rural and urban areas

A study carried out in China has highlighted the importance of the problem of the digital divide, which occurs not only in rural areas of developing countries (Ye and Yang, 2020), but also in some regions of developed countries, such as Wales. (Morris *et al*., 2022). This phenomenon is because rural areas pose a significant challenge for internet service providers, as the existing infrastructure is not sufficient to offer broader access to information and communication technology (ICT) to the population. Furthermore, it is not profitable to expand technological infrastructure in these communities, given that many people in these

areas have low incomes, which in turn affects productivity in rural sectors (Franciskovic and Miralles, 2021).

An illustrative example of this problem is based on research carried out in the United States in 2018, which showed that 39% of the rural population lacked access to a high-speed broadband connection, compared to only 4% of the urban population that did not have access to broadband internet. Additionally, households with higher incomes and higher educational levels were found to be more likely to have a broadband connection in their homes. Therefore, the study concluded that "remote work has generally been positioned as a solution for rural populations seeking to access employment in metropolitan areas or for rural companies seeking to hire workers based in metropolitan areas" (Davies, 2021, p. 148).

In other words, location is a relevant factor when it comes to accessing reliable digital connectivity (Morris *et al*., 2022). Therefore, governments and communities should improve digital infrastructures (Sun and Zhou, 2021), as ICT can empower rural people to achieve improvements in their lives. Furthermore, investing in broadband expansion in rural communities can improve local GDP growth (Ma *et al*., 2020; Ye and Yang, 2020).

Internet and education

Regarding academic aspects, in Pakistan it was found that illiteracy and low levels of education are factors that cause people in both rural and urban areas not to have access to the internet (Jamil, 2021). On the other hand, in Thailand it was found that in rural households the low level of education of the head of the family is a factor that influences why all its members do not have access to the Internet (Nguyen *et al*., 2022). This leads to a lack of knowledge of technology, which is a great impediment for people to interact or access public policies (Icaza-Álvarez *et al*., 2019).

Socioeconomic levels, on the other hand, also influence internet connectivity; For example, in Spain, students from low socioeconomic levels were more disproportionately affected by the pandemic, mainly due to the lack of access to technological devices (Sosa Díaz, 2021). Similarly, in a study carried out in Ecuador, it was observed that there is a clear relationship between the economic level of families and access to the internet and smart devices. This makes it clear that a student who has more economic possibilities can acquire an excellent smart device for use and a better connection at home, which can be a barrier for low-income students (Criollo *et al*., 2022).

Likewise, Internet use is positively related to broadband connection and education (Rajagukguk, 2022). In other words, higher levels of education are correlated with an increase in Internet access. For his part, Yesuf (2021) mentions that other factors associated with Internet use are age and educational level. For this reason, the implementation of policies to increase Internet access and diffusion can contribute to reducing educational inequalities (Korkmaz *et al*., 2022).

Internet and income

Research conducted in Spain found that families with low socioeconomic status were unable to provide the necessary support to their children, which made it difficult for these students to follow virtual classes (Sosa Díaz, 2021). This means that better-off households have a greater ability to take advantage of the opportunities provided by the Internet, raising serious concerns that the income disparity between rich and poor could widen (Nguyen *et al*., 2022).

For example, in a study carried out in Medellín (Colombia) it was found that households without Internet access had lower monthly income, with less than half of the average household being able to have access to this service (Ramírez-Hassan and Carvajal-Rendón, 2021). Another research conducted in Ghana found that due to the high cost of internet service, citizens with low monthly income are unable to access electronic services (Tahiru *et al*., 2020).

In the case of Mexico, approximately 72% of the population used the internet, although the highest concentration of users was in urban areas (National Institute of Statistics and Geography [Inegi], 2022). Likewise, the internet can be considered as an additional tool to mitigate the incidence of poverty and complement the efforts of Mexico's welfare policy, since the benefits of having access to the internet are greater for the rural sector in terms of poverty. refers (Mora-Rivera and García-Mora, 2021).

In summary, it can be said that technology is of great help because it can connect people with friends and family; Furthermore, at the time of the pandemic, many people were allowed to continue with their work due to the risk posed by leaving their homes (Humboldt *et al*., 2020).

Method

This was research with a quantitative and descriptive approach, through an unsupervised analysis since there was no dependent variable because clusters were created through association.

Participants

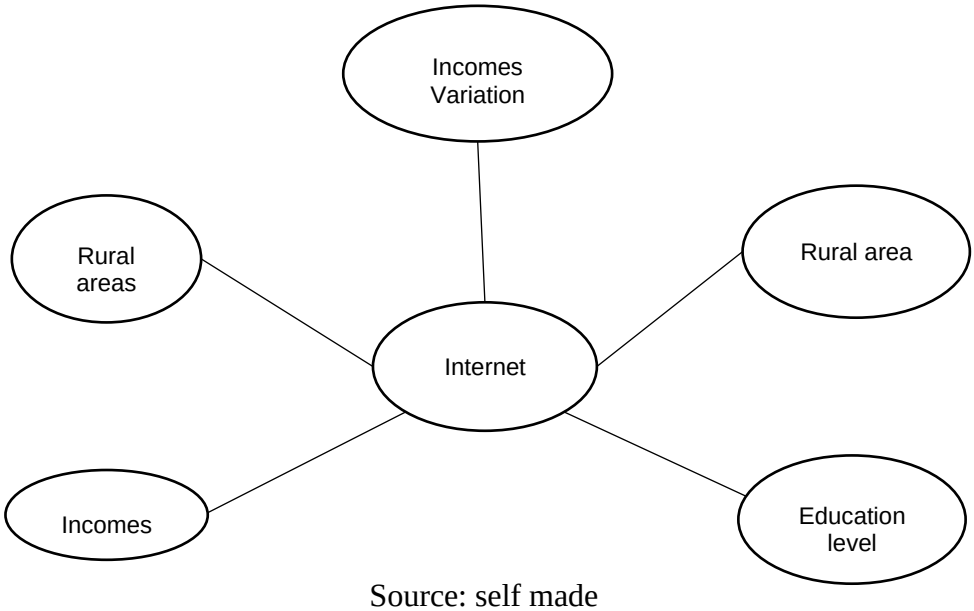
A structured survey was carried out using non-probabilistic, random and convenience sampling, with 212 people who lived in Mexico in urban and rural areas. Although they were designed in Google Forms, the interviews were in person, and they were intended to be 50% urban and 50% rural. However, this was not possible because broadband internet access was very slow in rural communities.

Research instrument

As an instrument, a structured survey was developed and applied, which was captured by completing Google forms. This survey included the variables internet, rural area, urban area, income, income variation and educational level (figure 1 and table 1).

Study variables

Figure 1. Study variables



Source: self made

Table 1: Study variables

Variable	Description
Internet	Know whether or not the respondent has fixed internet service at their home (1 = yes; 0 = no)
Urban or rural area	Describes the area in which the people surveyed live (1 = urban area; 0 = rural area)
Income	The average monthly income level of the respondents; A monetary amount was taken for each respondent.
Income variation	Describes the behavior of people's income during the covid-19 pandemic period (0 = decreased; 1 = remained the same; 2 = increased.
Education level	Know the educational level of the respondents (0 = incomplete primary school; 1 = complete primary school; 2 = incomplete secondary school; 3 = complete secondary school; 4 = complete upper secondary school; 5 = complete upper secondary school; 6 = incomplete technical career; 7 = career complete technical degree; 8 = incomplete degree; 9 = complete degree; 10 = postgraduate.

Source: self made

Descriptive analysis

The research included an analysis of the percentage of people who have permanent Internet access. Likewise, an analysis of the average educational level of the people was carried out by weighting according to the answers given in the survey applied. The scale applied was the following: 1) people without schooling, 2) people with incomplete primary school, 3) people with completed primary school, 4) people with incomplete secondary school, 5) people with incomplete upper secondary level, 6) people with intermediate level completed higher education, 7) people with incomplete university studies, 8) people with complete university studies and 9) people with a postgraduate degree. Likewise, an analysis of the average monthly income of people in urban and rural areas was included, as well as a descriptive analysis of the behavior of people's income during the pandemic period.

Cluster analysis

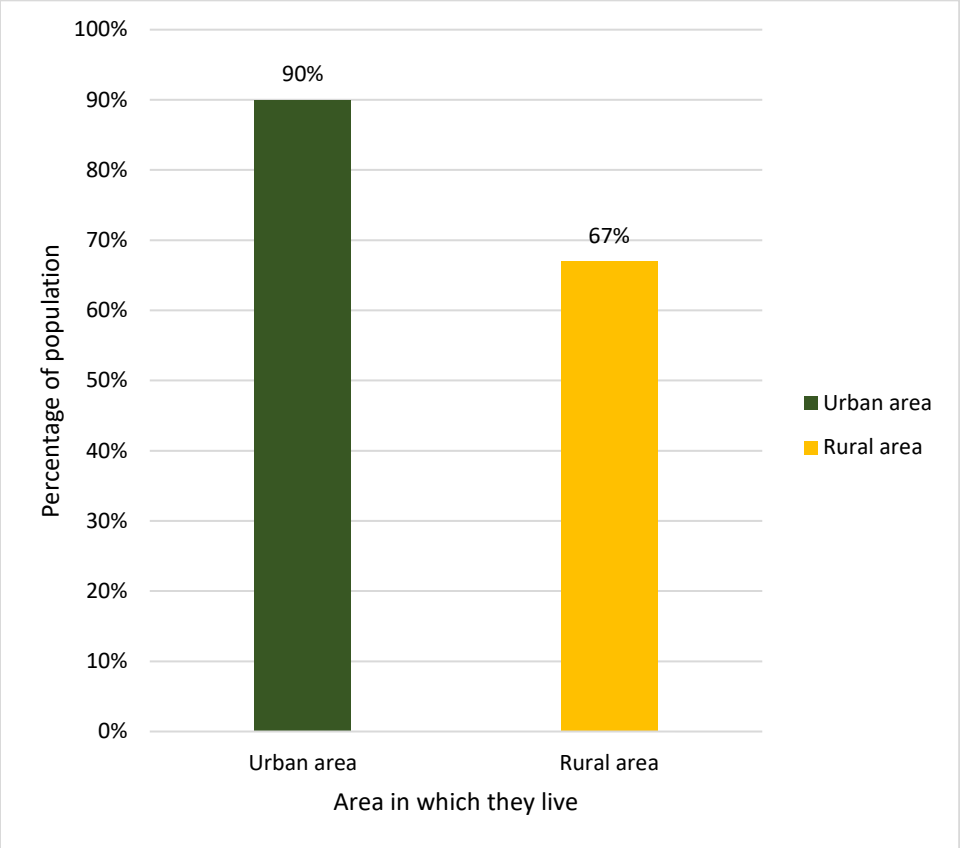
Cluster analysis is presented as one of the most relevant research directions (Yuan and Yang, 2019) due to its ability to address data heterogeneity and improve the understanding of differential responses (Windgassen *et al*., 2018). These analysis methods can enrich diagnostic criteria by providing more detailed and clinically meaningful profiles in the context of a given condition.

Consequently, cluster analysis was carried out using the K-means algorithm using Python 3.10 programming *software.* The purpose was to identify homogeneous groups within the population that uses the Internet and evaluate their relationship with income level and education, both in urban and rural areas.

Results

Figure 2 shows the percentage of people who have access to fixed internet in rural and urban communities. It is observed that 90% of people who live in an urban area have fixed internet service at home, while in rural areas only 67% of people have a fixed internet service. This shows that there is a digital divide when it comes to internet access within rural and urban areas.

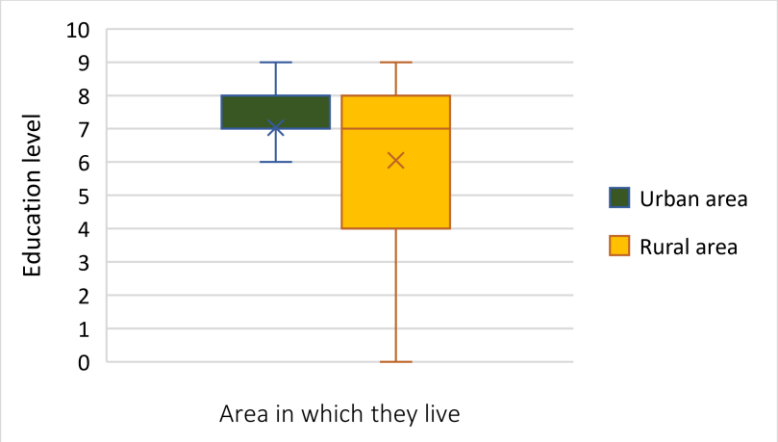
Figure 2. Internet use in rural and urban areas



Source: self made

Figure 3 shows the average educational level of people who live in urban and rural areas. It is observed that in rural areas the average is 6 (that is, high school or high school), and the majority of people in these areas are between 4 and 7 (unfinished secondary school or incomplete university). On the other hand, for urban areas the average education level is 7.1, in which there are people with university studies. This reflects that the educational level in urban areas is higher compared to rural areas, which denotes that there is also inequality in terms of education.

Figure 3. Average educational level in urban and rural areas



Source: self made

Figure 4 shows the average monthly income of people who live in an urban area and a rural area. It is observed that the average monthly income of people who live in an urban area is $18,000 per month, and the average monthly income of people who live in rural areas is $8,500 per month. Comparing the data in Figure 4, it can be seen that the level of income in rural areas is considerably lower than the income received by the inhabitants of urban areas, which makes evident the disparity between one area and another.

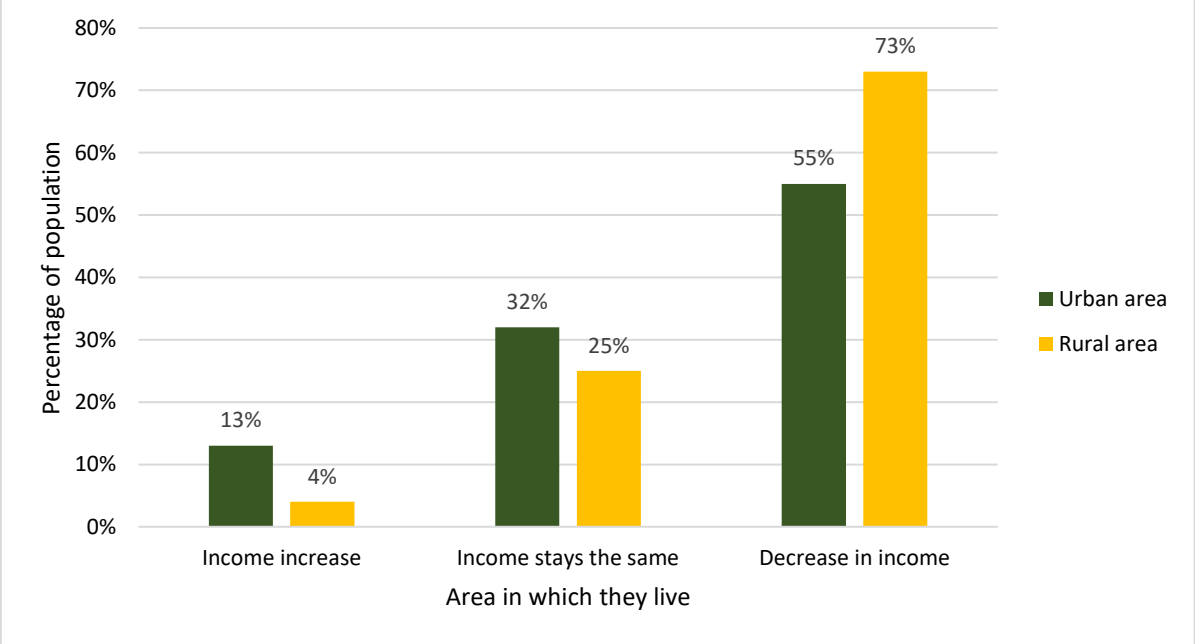
Figure 4. Average monthly income of people living in urban and rural areas

Source: self made

Figure 5 shows the behavior of people's income during the pandemic period in rural and urban areas. It is observed that the percentage of people who had a decrease in their income in urban areas during the pandemic was 55%, while the percentage of people who had a decrease in their income in rural areas was 73%, which shows that the pandemic had greater repercussions in the latter area.

As far as the income level is concerned, it is perceived that the percentage of people who had an increase in their income level in urban areas was 13%, while in rural areas the percentage of people who had an increase in their income during the pandemic period it was only 4%. Finally, the percentage of people whose income remained the same during the pandemic period for urban areas was 34%, while for rural areas it was 25%.

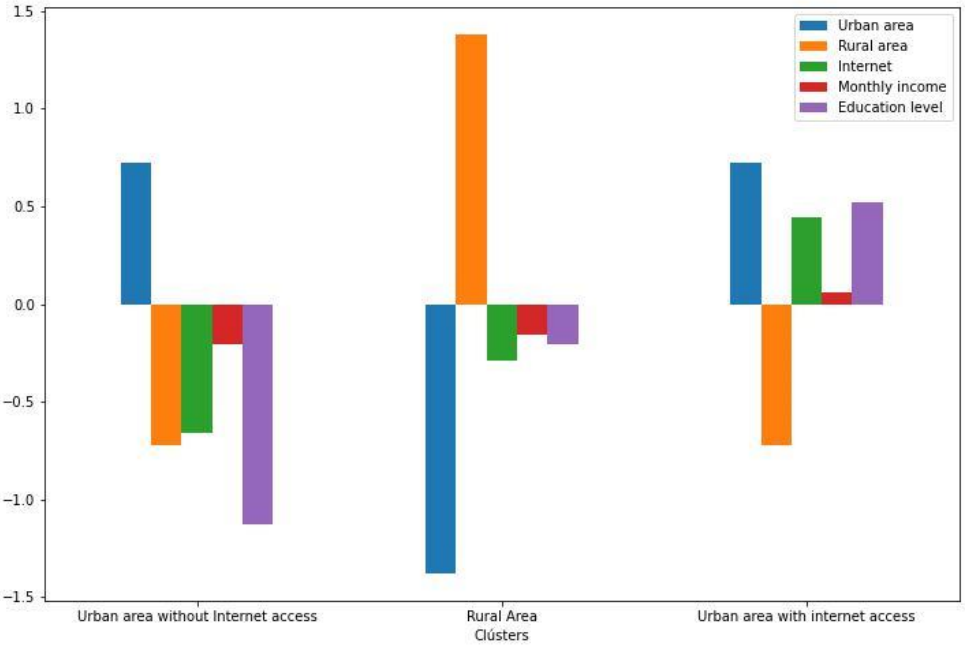
Figure 5. Variation in income of people living in urban and rural areas during the covid-19 pandemic period



Source: self made

Figure 6 shows the three clusters that were defined with the K-means method, which are defined as 1) urban area without Internet access, 2) rural area and 3) urban area with Internet access.

Figure 6. K-means cluster



Source: self made

Discussion

In Figure 6, point 0 represents the average. In the case of the "Urban area without Internet access" cluster, it is observed that, despite the fact that these people live in urban areas, their Internet use is considerably lower than average. This translates into lower economic incomes and lower educational levels compared to the other clusters. It is evident that this group is at a technological and economic disadvantage in urban areas.

On the other hand, the "Rural Area" cluster is characterized by the absence of access to technology, resulting in low economic income and Internet use well below average. Furthermore, educational levels are significantly lower. These findings support economic theories that emphasize the role of human capital and technology in economic growth.

The "Urban area with internet access" cluster stands out for having higher educational levels and an above-average income. This supports the idea that internet access and technology can contribute to increased economic income, as some economic theories suggest.

Having noted the above, it can be indicated that the proposed research objective has been met, since it has been confirmed that Internet access in rural areas is significantly lower. This is clearly reflected in figure 2 and in the "Rural area" cluster, where the absence of technology is evident, which agrees with the statements of Ramsetty and Adams (2020), who have indicated that digital exclusion is a global problem. in rural communities.

Furthermore, these findings support the statements of Mora-Rivera and García-Mora (2021), who argue that in Mexico approximately 50% of households lack internet access, and this lack is even more pronounced in the rural sector. The internet adoption rate in the rural sector of Mexico stands at 39%, while in the urban sector this percentage rises to 71.2%.

In relation to the use of the Internet and its link with the income level, it is confirmed that in rural areas the use of the Internet is lower than in urban areas, as evidenced in Figure 2. Furthermore, in the cluster "Zona urban with internet access" a positive trend is observed between internet use and income levels. These results complement the conclusions of Nguyen *et al*. (2022), who, in their research in Thailand, demonstrated that using the Internet for productive purposes can increase household income.

Regarding the use of the Internet and the educational level, it has been confirmed that the educational level in urban areas exceeds that of rural areas, as evidenced in figure 3. Furthermore, in the cluster "Urban area with access to Internet" it is observed that the use of the Internet tends to increase both the average income level and the educational level in urban areas. These findings coincide with what was stated by Martínez-Domínguez and Mora-Rivera (2020), whose research confirms that the wealth index and educational level are key factors for Internet adoption. In other words, households with greater physical resources and human capital tend to have greater incentives to use the Internet. Therefore, improving income levels can increase internet access and, in turn, reduce educational inequality.

This underlines the importance of ICT development in fostering economic growth and technological advancement (Sun and Zhou, 2021). Therefore, it is essential to bring the Internet and ICT closer to rural areas to reduce the existing digital divide in Mexico. This aligns with what was stated by Ma *et al.* (2020), who emphasize the need to promote policies and regional coordination of internet strategies for rural development. The goal is to boost both internet access and telecommunications infrastructure, as there is a significant return on investment in these infrastructure elements through increased family income.

On the other hand, Siaw *et al.* (2020) argue that extending connectivity in rural areas should be a priority for public policymakers due to the positive and significant effect that

internet use has on income. Therefore, rural development strategies must be designed in a way that improves internet access in rural areas, recognizing its potential impact on the economic well-being of these communities.

In short, digitalization requires the participation of all individuals in a society, that is, institutions and relevant stakeholders, as each sector, whether public or private, has a role to play, and each role is important to the agenda. digital (Jamil, 2021). In fact, among these components, communication infrastructure stands out as one of the most crucial (Kabalci *et al.*, 2019).

Finally, regarding the strengths of this study, we can mention the association analysis between urban and rural areas, and its relationship with monthly income and educational level in relation to Internet use. Despite the existence of several investigations, in Mexico research on the association by specific groups in relation to Internet use is scarce.

However, this research has certain limitations, such as the sample size used. That is, with a larger sample size we could develop predictive models that provide greater depth in understanding Internet use in rural and urban communities. Therefore, it is recommended to expand the sample to obtain more precise data on the relationship between Internet use and monthly income and confirm some of the economic theories proposed.

Conclusions

According to the results of this research, the following conclusions can be drawn: 1) A technological gap is evident in Internet access between rural and urban communities, 2) The educational level in urban areas exceeds that of rural areas, 3) In terms of income, a disparity is observed between people in rural and urban areas. Those in urban areas with internet access and a high level of education tend to have higher incomes, 4) During the pandemic, there was a significant decrease in people's income, especially those who did not use the internet and had a high level of education low. However, an increase in income is observed when using the Internet, 5) People in urban areas without Internet access tend to have below average income and educational levels, suggesting that, even in urban areas, during pandemic, many people did not have access to this service, 6) In the case of people in rural areas without internet access, a lower economic income and a lower educational level are observed. This is related to the limitation and low speed of internet access in rural areas. 7) Those people in urban areas with internet access enjoy higher economic incomes

and above-average educational levels. This suggests that certain economic theories hold true that technology can drive greater growth in economic income.

Finally, and based on the analysis of the clusters, it has been shown that Internet access in society has a positive impact on people's educational level and income. This underscores the importance of implementing short-term technological infrastructure in rural communities to close the digital divide between them and urban areas. This effort seeks to ensure greater economic income and a higher educational level, aspects that are related to greater economic growth.

Additionally, the government must establish equitable public policies that promote internet access in all communities, both rural and urban, in order to ensure a more equal distribution of these technological opportunities.

Future lines of research

Given the social and economic conditions in Mexico, especially with regard to the monthly economic income of inhabitants of urban and rural areas, this research highlights the prevailing need to expand Internet access in rural areas, where there is currently a limitation due to below the national average. This expansion is essential to raise educational levels and, therefore, improve the monthly income of the rural population, as corroborated by the results obtained in urban areas where Internet access is broader.

These findings open the door to future research that should delve into issues related to limited Internet access, focusing on quantitative aspects and considering telecommunications infrastructure. Additionally, it is essential to include economic variables, such as education, to better understand how to improve economic income. Furthermore, it is important to underline the need to prioritize basic variables of society, such as health, education and essential public services, such as the supply of water and electricity, as well as addressing environmental problems such as pollution.

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