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The Role Of Human Capital Formation And Information And Communication Technologies In Regional Development: An Approach To Tamaulipas, Mexico

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Abstract
The analysis of regional development is essential in all nations. In Tamaulipas, Mexico, it is relevant to determine whether the actions undertaken by governmental and economic actors have promoted the advancement of this agenda. The objective of this study is to analyze the conditions of human capital formation, Information, and Communication Technologies (ICTs) for regional development in Tamaulipas.
Using a descriptive methodology, consisting of document analysis and variables related to formal education and ICTs with data extracted from the State Development Plan of the Government of Tamaulipas (2018-2022 and 2023-2028) and other public sources (the Secretariat of Public Education, the National Council for the Evaluation of Social Policy (CONEVAL), and the National Institute of Geography and Statistics (INEGI)), the study demonstrates the need to deepen investments in these areas, in addition to others equally fundamental such as infrastructure, security, and the well-being of the population.
Keywords: *Human capital formation, education, information and communication technologies, regional development.*

INTRODUCTION

To achieve a higher level of regional development, human capital formation in education, as well as access to Information and Communication Technologies (ICTs), is essential. It is universally recognized that providing the population with opportunities for individual, family, and social well-being is necessary. According to Martinez Chapa (2019), knowledge plays an important role in the development of various regions worldwide. This improves material living conditions, which also means developing the capacity to create, innovate, and enhance work and its outcomes. Education, along with other investments in human capital, brings cultural and social benefits that go beyond strictly material considerations.
[1]

It should be noted that municipalities, federal entities, and the federal government of Mexico have allocated human, material, and financial resources to provide children, young people, and adults with opportunities to acquire essential competencies to face current and future development challenges. In recent decades, Tamaulipas, along with other states in the country, has achieved greater resource allocation for social policy programs. Significant achievements include increased educational coverage through the creation of more schools, ICTs, and other infrastructure that benefits its inhabitants. However, additional challenges remain related to equity, retention, efficiency in education, and the necessary quality in this field. Nonetheless, addressing the persistent social and economic lag in the region is of urgent importance.Tamaulipas is one of the six northern Mexican states that border the United States. It also shares borders with the states of Nuevo León, San Luis Potosí, and Veracruz. It is a federal entity with a diverse productive orientation. To the north, separated only by the Rio Grande, lies the U.S. state of Texas; to the east is the Gulf of Mexico, whose extension favors economic activities such as fishing, recreation, foreign trade, agriculture, and mining. Tamaulipas has rivers, streams, mountains, coasts, and other natural resources (INEGI, 2020). Its human, natural, and social capital is valuable, as it's employed in diverse productive activities across its economic sectors. A significant portion of its child and youth population is preparing to face future challenges.The economic and social development challenges faced by Tamaulipas are not unique to this entity. Similar conditions exist in other states of the country. Despite governmental efforts, social inequality persists, and contrasts are evident between those with a better standard of living and those who struggle to obtain the resources needed for a dignified life. According to Esqueda Walle (2018), Tamaulipas faces persistent disparities across its regions.Tamaulipas has 43 municipalities, 15 of which are considered rural and home to about 10% of the population, facing significant challenges in achieving higher levels of well-being. It has an area of 80,175 km², representing 4.1% of Mexico's territory. According to INEGI (2020), the state ranks 14th in population nationwide (3,527,735 inhabitants). The remaining 28 municipalities are urban, accounting for approximately 90% of the population. The economic activities are distributed as follows: 3.6% in the primary sector, 39.2% in the secondary sector, and 57.2% in the tertiary sector. The state contributed 3.1% to the national GDP. The informal labor rate reached 44.7%. In all cases, the challenges are significant, particularly those related to social inequality, educational and public health deficits, insecurity, crime, and the lack of opportunities to access better-paying jobs.This study is structured as follows. The first section reviews the literature on the subject. Then, the methodology is addressed. The third section analyzes and discusses the results. Finally, the conclusions are presented.

LITERATURE REVIEW

According to Lacy (2000), the rural sector requires bold strategies for its modernization. At the same time, greater support is needed to ensure access to essential public services for communities. Urgent attention must be given to the provision of drinking water, electricity, schools, medical clinics, roads, and other infrastructure necessary for development. Regarding the probable future of rural regions, they continue to face difficulties in obtaining well-paid jobs, education, and other opportunities for families to develop their potential.

In the same vein, Martinez Chapa and Salazar Castillo (2022) state that regional economies inherently involve aspects related to the market economy, for which access to information on prices, supply, credit, technologies, and other variables of interest to producers, intermediaries, and final consumers is essential. In this regard, support from universities, research institutions, and the work of non-governmental organizations is necessary. Studies and policy recommendations are relevant for both urban and rural areas. Urban areas have more infrastructure and capacity due to their stronger links with services, commerce, and manufacturing, contributing to the development of a more modern economy. Therefore, one of the main challenges is incorporating rural regions into innovation and competitiveness.

Investment in formal education, training, and skills development is crucial for overcoming social lag. Human capital is a broad concept that includes education, health, social security, infrastructure, and support for SMEs, regional innovation systems, and development initiatives. These are the main drivers of regional development, essential for fostering economic growth. When regions connect with the global economy, the focus shifts to promoting regional or local development through competitiveness (Carrión Martinez et al., 2020).Technological development drives economic growth and development, although not necessarily in an equitable manner (Carrión Martinez et al., 2020). The author's research reported that in Indonesia, investment has been made in the availability of basic ICT infrastructure, which is closely associated with reducing inequality. The study reveals that the actual use of ICTs is positively related to inequality but at a decreasing rate, showing a nonlinear relationship similar to the Kuznets curve. ICT skills are directly correlated with ICT usage. According to Faiza et al. (2021), ICT usage and inequality vary according to the level of economic development. Thus, low-income regions exhibit an inverted U-shaped relationship, whereas high-income regions display a U-shaped curve.Infrastructure, human capital, and institutions create a conducive environment for innovation, increased productivity, better-paid jobs, and investment attraction (Solleiro & Mejía Chávez, 2021). Analyzing internet content usage suggests that ICTs are not being fully leveraged for economic purposes, as their use is primarily focused on social and educational aspects. The appropriation of the internet for economic benefits should be encouraged. ICTs are underutilized due to various gaps, including gender, age, poverty level, income, education level, ethnic background, and place of residence (Martínez-Domínguez, 2020).The public and private sectors, particularly the technology and telecommunications industries, have a responsibility to positively impact children and youth. These digital technologies also contribute to creating self-employment opportunities and training for successful entry into the labor market.

Methodology and Data

This study employs a descriptive methodology, as it analyzes the literature on this line of research and presents information using statistical data. The variables used primarily relate to the concept of human capital (education, income, employment, and poverty) and ICTs as drivers of regional development. The data comes from various sources: the State Development Plan of the Government of Tamaulipas (2018-2022 and 2023-2028), the Secretariat of Public Education (SEP), the National Council for the Evaluation of Social Development Policy (CONEVAL) (2000-2020), the Statistical Yearbook of Education of Tamaulipas (2020-2021), Data México, the National Survey of Occupation and Employment of INEGI (ENOE 2010-2022), as well as the Population and Housing Census of INEGI (2020). The periodicity of these data is annual.

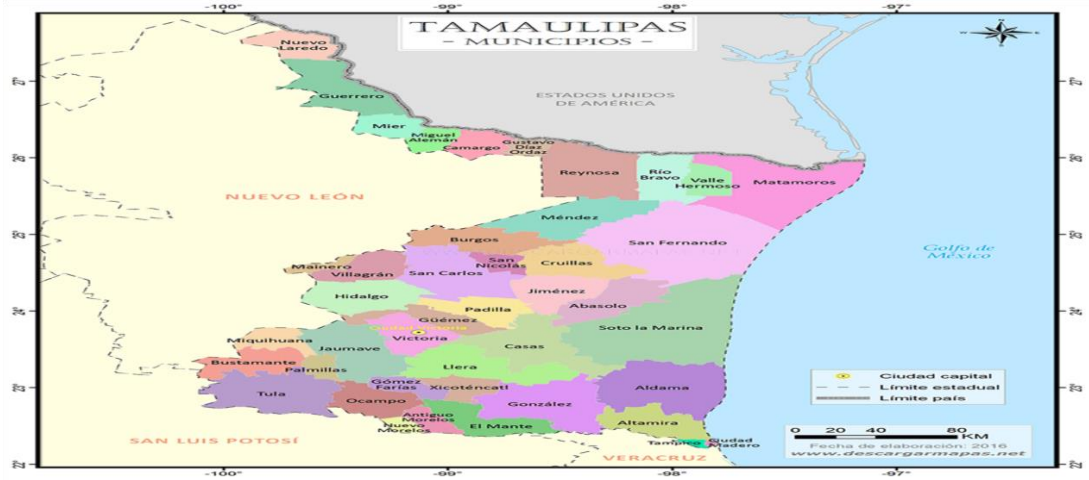


Figure 1. Map of the state of Tamaulipas, Mexico. Source: Tamaulipas (n.d.).

RESULTS AND DISCUSSION

This research fundamentally addresses two essential aspects for improving material living conditions in the regions of Tamaulipas:

1. The role of human capital formation
2. The role of ICTs

Each of these aspects is described below.

1. The Role of Human Capital Formation

Human capital formation includes, among other aspects, formal education, as it is fundamental for regional development. In general, the educational situation in Tamaulipas has improved due to the reduction in the illiteracy rate, which stands at 2.6%, ranking 22nd at the national level (INEGI, 2020). It remains to be seen whether this factor will significantly change the fact that most women do not complete their higher education studies.Regarding formal education, Table 1 shows student enrollment by educational level in urban and rural areas, respectively. The table highlights a contrast between both areas, which suggests that rural areas face greater challenges in terms of study opportunities and access to better-paying jobs.

Table 1. Students enrolled in urban and rural areas in Tamaulipas, Mexico.

Level	Urban	Rural
Primary	327,071	36,182
Secondary	157,035	15,942
High School	122,452	7,208
Job Training	35,433	2,181
Higher Education	139,486	466
Total	**781,477**	**61,979**

Source: Statistical Yearbook of Education of Tamaulipas (2022).

At the upper secondary and higher education levels, differences between the formal and informal education modalities are evident. Table 2 shows that the non-formal education option has low enrollment, primarily due to a lack of infrastructure and real opportunities for utilization.

Table 2. Students enrolled by educational modality in Tamaulipas.

Educational Level	Formal	Non-formal
Technical Higher Education	7,314	26
Undergraduate	118,631	6,280
Specialization	1,670	382
Master's Degree	3,295	1,478
Doctorate	811	67
Total	**131,721**	**8,233**

Source: Statistical Yearbook of Education of Tamaulipas (2022).

Educational variables related to schooling, illiteracy, and educational lag for the years 2000, 2010, and 2020 indicate that the population aged 6 to 14 is the most likely to attend school, as this age range corresponds to basic and lower secondary education levels.

Table 3 shows how female enrollment has increased over the years. Additionally, illiteracy and educational lag have tended to decrease. The illiteracy rate in Tamaulipas dropped from 5.1% in 2000 to 2.6% in 2020.

Among the population aged 15 and over, nearly half of those at the appropriate age for upper secondary and higher education have the opportunity to access these levels.

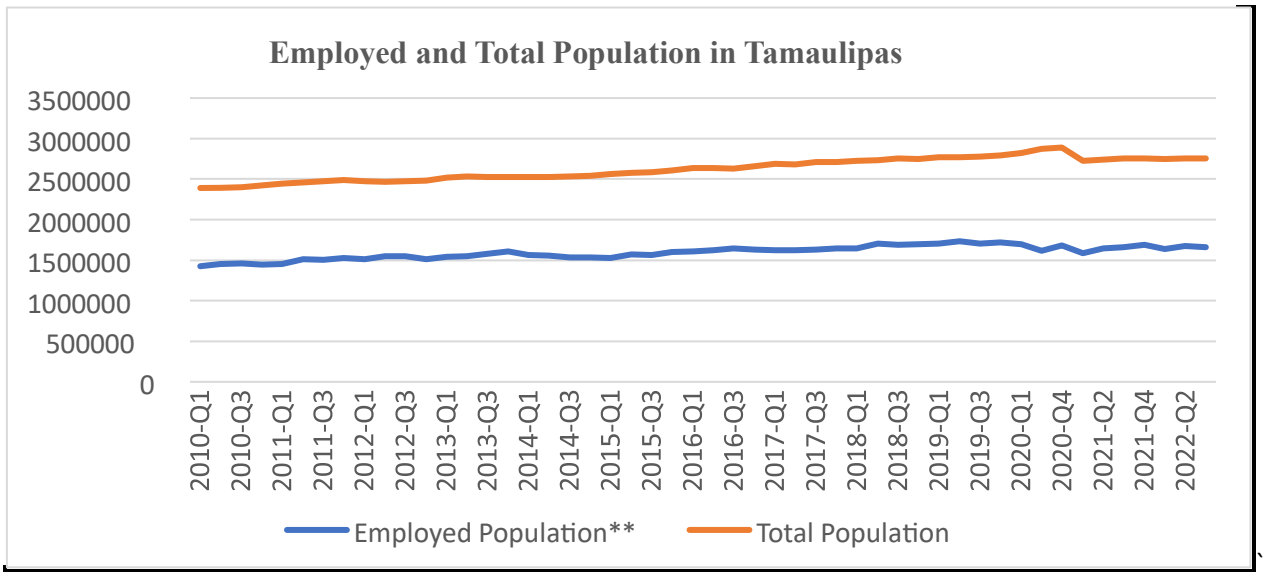
Table 3. Educational variables in Tamaulipas (2000, 2010, and 2020).

Educational Variable	2000	2010	2020
Schooling in the population aged 6-14 (%)			
Males	93.1	93.7	94.5
Females	92.8	94.3	95.0
Schooling in the population aged 15-24 (%)			
Males	32.9	33.6	46.4
Females	32.1	40.7	47.5
Illiterate population aged 15 and over (%)	5.1	3.6	2.6
Educational Lag (%)	19.2	14.4	14.2

Source: Data México, Tamaulipas.

Regarding employment and its importance in Tamaulipas, a trend of moderate growth is observed (Figure 1). The greatest employment opportunities are found in urban areas, especially in cities along the northern border (Nuevo Laredo, Matamoros, and Reynosa), as well as in the southern region (Tampico, Altamira, and Madero). In the center of the state is Ciudad Victoria. In rural areas, generalized precariousness is evident, and much of the income is associated with self-employment, as investments from large companies rarely reach these regions.

Figure 1. Employed and total population in Tamaulipas.



Source: Data México (2022).

Opportunity Costs and Educational and Employment Gaps

There are evident opportunity costs associated with educational and employment gaps, as well as the lack of opportunities to study and obtain higher incomes. Today, opportunities to study and work are more accessible, with options such as scholarships, loans, part-time jobs, or weekend employment, among others (**Table 4**). Additionally, greater commitment is required from students and their families to achieve this goal.

The table below shows that young people have greater development opportunities, especially compared to older populations.

Table 4. Indicators of Population with Educational Gaps in Tamaulipas (2018-2020)

Indicators	2018 (%)	CV 2018	2020 (%)	CV 2020
Population aged 3-21 with an educational gap (not attending school)	13.3	7.7	15.6	6.7
Population aged 16 or older (born between 1982-1997) without complete secondary education	11.5	8.4	10.9	7.8
Population aged 16 or older (born before 1982) without complete primary education	22.6	4.1	19.5	4.7
School dropout rate for ages 3-15	8.7	10.3	11.2	8.5
School dropout rate for ages 16-21	41.5	7.8	47.1	6.3

CV: Coefficient of Variation

Source: CONEVAL. Multidimensional Poverty in Tamaulipas, 2022.

It is important to highlight the differences between urban and rural populations. According to INEGI (2020), a population is considered rural if it has fewer than 2,500 inhabitants, while an urban area has more than 2,500 people. Consequently, as municipalities grow, populations tend to cluster in metropolitan areas. Larger cities attract more investment and jobs, leading to migration for employment opportunities. Many people come from small, predominantly rural areas, which require additional resources for human capital investment.This is the case for cities along the northern border of Tamaulipas, such as Matamoros, Reynosa, and Nuevo Laredo. Other cities have also grown due to their economic relevance in modern industries and exports, such as Tampico, Madero, and Altamira. Ciudad Victoria, as the state capital, has also expanded, concentrating important educational institutions such as the Autonomous University of Tamaulipas and various public and private schools. This city, therefore, requires further infrastructure and modernization **(Table 5)**.

Table 5. Population Aged 3-24 in Urban Areas Attending School in Tamaulipas

Municipalities	Student Population	Total Population	ercentage
Abasolo	2,576	3,551	72.5
Aldama	6,654	10,088	66.0
Altamira	66,340	101,722	65.2
Antiguo Morelos	2,042	3,041	67.1
Bustamante	1,885	2,949	63.9
Camargo	3,574	5,625	63.5
Ciudad Madero	45,229	63,239	71.5
González	9,280	16,277	57.0
Güémez	3,346	5,469	61.2
Gustavo Díaz Ordaz	3,488	5,826	59.9
Hidalgo	3,175	5,170	61.4
Jaumave	4,282	6,026	71.1
Llera	3,203	4,920	65.1
El Mante	24,458	35,072	69.7

Municipalities	Student Population	Total Population	ercentage
Matamoros	135,217	212,255	63.7
Miguel Alemán	5,449	8,938	61.0
Nuevo Laredo	108,972	169,924	64.1
Ocampo	3,268	4,612	70.9
Padilla	3,266	4,678	69.8
Reynosa	168,761	266,328	63.4
Río Bravo	29,871	50,994	58.6
San Fernando	12,655	18,887	67.0
Soto la Marina	4,621	7,992	57.8
Tampico	70,251	95,049	73.9
Tula	7,219	10,836	66.6
Valle Hermoso	14,527	21,500	67.6
Victoria	95,382	128,420	74.3
Xicoténcatl	5,325	7,629	69.8
Sum	844,316	1'055,824	1843.6
Average	30,154.1	40,608.6	65.8

Source: Compiled using data from the Population and Housing Census (INEGI, 2020).

Rural areas have support programs aimed at improving the well-being of their inhabitants. Education plays a crucial role in regional development and is fundamental for reducing disparities within rural localities in Tamaulipas (**Table 6**). Educational institutions must maximize the potential of available natural resources, institutions, and human capital. These efforts should focus on strengthening the primary sector in these rural regions.

Table 6. Population Aged 3-24 in Rural Areas Attending School in Tamaulipas (2020)

Municipalities	Student Population	Total Population	(%)
Burgos	835	1,388	60.2
Casas	884	1,628	54.3
Cruillas	353	544	64.9
Gómez Farías	1,846	2,762	66.8
Guerrero	670	1,037	64.6
Jiménez	1,539	2,186	70.4
Mainero	428	631	67.8
Méndez	790	1,374	57.5
Mier	1,056	1,629	64.8
Miquihuana	934	1,407	66.4
Nuevo Morelos	906	1,439	63.0
Palmillas	512	696	73.6
San Carlos	1,643	2,419	67.9
San Nicolás	223	345	64.6
Villagrán	1,009	1,666	60.6
Sum	13,628	18,965	967.4
Average	908.5	1,354.6	64.5

Source: Compiled using data from the Population and Housing Census (INEGI, 2020).

Regarding vocational training for employment, most educational centers are concentrated in urban areas. Such training is usually practical, short-term, and tailored to the specific needs of productive sectors. It is clear that rural areas have limited training opportunities, as their economic scale is not large enough to support extensive training programs (**Table 7**).

Table 7. Vocational Training Courses Offered by CECATI in Tamaulipas

Careers	Victoria Campus	Matamoros Campus	Altamira Campus	Reynosa Campus
Design and Manufacturing of Fine Furniture	X		X	X
Electricity	X		X	
Electronics	X	X	X	X
Industrial Maintenance	X	X		X
Maintenance of Internal Combustion Engines	X		X	X
Mechatronics	X			
Programming	X	X	X	X
Childcare	X	X		
Industrial Welding	X	X	X	
Maintenance of Oil Facilities			X	X
Digital Graphic Design		X		X
Garment Production	X	X	X	
Machine Tools		X		
Computer Equipment Support and Maintenance	X		X	

Source: Vocational Training Centers (CECATI, 2022).

2. The Role of Information and Communication Technologies (ICTs)

With technological advancements, ICTs have evolved in definition, including:

i) New Technologies
ii) Information and Communication Technologies
iii) Learning and Knowledge Technologies
iv) New Information and Communication Technologies

Each of these terms has emerged at specific moments or highlights particular attributes (Prado et al., 2016). ICTs have become essential for various purposes, particularly in education, job training, and communication. Their importance continues to grow, making it impossible to consider regional development separately from technological access. Companies, governments, and other social actors must invest sufficiently in technology and infrastructure to increase efficiency.However, a **digital divide** persists, particularly in rural regions. Some people have full access to ICTs, others have limited access, and some have none at all. ICTs include access to the internet and the use of computers, mobile devices, and other technologies. It is crucial to reduce this divide through government investments in schools, rural communities, and local production centers.According to INEGI's 2024 Population and Housing Census **364,000 households in Mexico lack internet access**, representing **34.1**% of the total. Nationally, Tamaulipas ranks **11**th in households without internet access and **8**th in the number of users without access.Opportunities for **distance learning** in upper secondary education have increased in the state (**Figure 2**). Many of these students live in rural areas, often near urban zones. This level of education is crucial as it serves students between 15 and 18 years old. Once they complete this stage, they have the option to continue to higher education.

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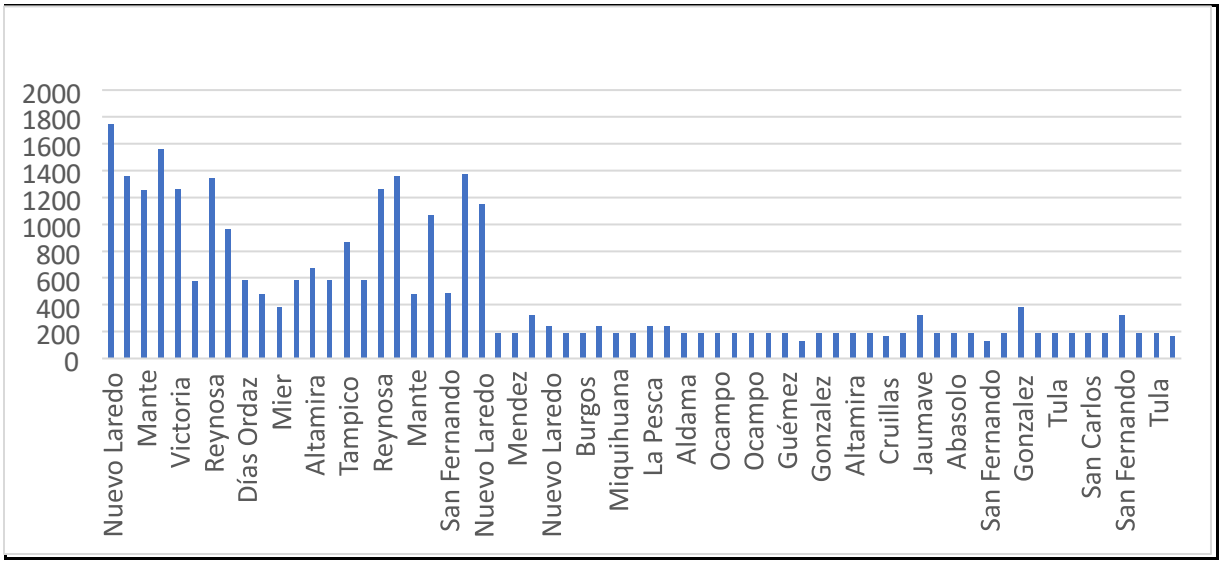
Figure 2. Students Enrolled in Distance High Schools in Tamaulipas (in Hundreds)



Source: Secretariat of Public Education of Tamaulipas (2022).

ICTs play a fundamental role in **education, communication, and economic transactions**. Regarding online education, having trained and well-paid teachers is equally important to assist students in both urban and rural areas **(Table 8)**.

Table 8. Teachers for Online Education in Tamaulipas

Municipality		Teachers	Men	Women
Nuevo Laredo		154	85	69
Reynosa		146	82	64
Matamoros		29	15	14
San Fernando		1		1
Cd Victoria		145	67	78
Tula				
Mante				
González		59	26	33
Tampico		268	139	129
Rio Bravo		94	33	61
Hidalgo				
Altamira		157	79	78
Miguel Alemán		2	1	1
Soto la Marina		3		3
Jiménez				
Padilla				
Xicoténcatl				
Aldama		4	1	3
Jaumave				

Source: Secretariat of Public Education of Tamaulipas (2022).

CONCLUSIONS

This study highlights the importance of human capital formation for regional development. Likewise, it demonstrates the preeminent position of Tamaulipas in the geography of the country. The potential of this federal entity depends on the actions and strategies of the government, businesses, and civil society. These efforts must be reflected in the design of educational policies, investment attraction, and regional and urban development initiatives. Additionally, the state must address needs related to public security, education, health, and other essential conditions necessary to achieve development.In the need to strengthen human capital for regional development, education is fundamental. Among the population aged 3 to 24, there are significant disparities between urban and rural areas. Even though education is public and free and there is a greater number of schools, teachers, and infrastructure, in reality, not everyone has access to study opportunities.For the promotion of well-being, the Secretariat of Rural Development of Tamaulipas proposes actions to promote the agriculture, forestry, livestock, and farming sectors. These initiatives focus on sustainable management and productive reconversion aimed at competitiveness. Such programs bring various types of support to the population of localities classified with very high, high, and medium levels of marginalization.In this sense, the development agenda and the attention to its diverse issues are the subject of ongoing planning meetings at various levels of government, alongside other social actors.

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