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THE RACE FOR SPECIALIZED TALENT: INTERNATIONAL STRATEGIES AND PROSPECTS FOR MEXICO

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Abstract: In an increasingly competitive global context, the search for and retention of specialized talent has become a priority for nations seeking to maintain their technological and economic leadership. This study analyzes the international strategies employed by countries such as the United States of America (US), China, the European Union and other technology leaders, as well as the lessons that Mexico can learn from these practices to improve its position in the global race for talent. The analysis shows that the US and China have implemented aggressive policies for their industrialization, which involves generating, attracting and retaining talent. In particular, the US has launched initiatives such as the Inflation Reduction Act, the CHIPS Act and the Bipartisan Infrastructure Act, while China has focused its efforts on the Made in China 2025 plan to reduce foreign technological dependence. In comparison, Mexico faces significant challenges in terms of talent development and retention. Although the country shows growth in the technology sector, with a notable increase in the number of jobs in cities such as Mexico City and Monterrey, a comprehensive strategy to generate highly specialized talent is lacking. The creation of industrial and academic clusters, as well as investment in education and technical training in areas such as software, artificial intelligence, electromobility and clean and renewable energy sources, are essential to improve Mexico's competitiveness. This study also examines international talent mobility, highlighting the importance of attracting not only local professionals but also highly skilled migrants from countries with political or economic problems. The comparison of different countries' policies and their impact on talent retention and attraction provides a framework for Mexico to develop more effective strategies tailored to its specific needs. In conclusion, for Mexico to compete

effectively in the global race for specialized talent, it is crucial that it implements policies that strengthen its educational infrastructure, promote collaboration between industry and academia, and take advantage of the opportunities offered by international talent mobility.

Keywords: Education, innovation, engineering, talent, nearshoring.

INTRODUCTION

Mexico faces a historic opportunity to boost its economic and social development due to the nearshoring phenomenon, in which numerous global companies are considering establishing operations in the country to export their products to the United States of America (US). However, this opportunity brings with it significant challenges that go beyond providing energy, water, housing, security and a strong rule of law. It is crucial that Mexico also guarantees the availability of highly qualified technical and professional talent, which is indispensable for the creation, operation and expansion of these companies in Mexico. The "war for talent" has already begun, and it is evident that the US could face a shortage of human resources in the coming years, which would affect its ability to maintain leadership in science, technology and innovation, especially in key industries such as the military [1].

Historically, talent creation in Mexico has been inconsistent due to the lack of long-term plans to ensure continuity in science, technology and innovation. For decades, national policies in these areas have been interrupted and modified every six years, aligned with new governments, their budgets and ideologies, which has prevented the consolidation of a robust talent ecosystem.

Article 119 of the General Education Law and Article 9 bis of Mexico's Science and Technology Law establish that 1% of the

Gross Domestic Product must be dedicated to scientific research and technological development [2], but this is not being fulfilled. For example, in the current administration, the budget for science, technology and Innovation (STI) through the National Council of Humanities, Science and Technology (Conahcyt) has been at historic lows because in 2024 it received 33170745272 Mexican pesos, less than the budget allocated in 2015 which was just over 33706000000 pesos [3]. On September 16, 2024 the dollar was sold at 19.23 pesos. The budget for CTI corresponds to 0.37% of the entire Mexican Federal Expenditure Budget. Without adequate funding, it is very difficult to develop an effective strategy for science, technology and innovation.

In contrast, the US is devoting enormous resources to boost strategic industries, some of which will be key to reshoring [4]. The Biden administration is pushing the Inflation Reduction Act (IRA), the CHIPS Act, and the Bipartisan Infrastructure Act. The IRA Act of 2022 encourages clean energy sources and domestic manufacturing through tax incentives. The CHIPS Act allocates \$5.27 billion to boost US semiconductor production, with the goal of reducing dependence on Chinese manufacturers. The Bipartisan Infrastructure Act allocates \$550000 million to improve transportation, access to clean water and high-speed internet infrastructure [5].

Mexico does not have those levels of investment, allowing it to capture only a portion of the resources that the US cannot tap, either due to lack of talent, high labor costs or shortages of raw materials. In addition, many products are no longer manufactured in the US, as production has shifted to Mexico, Asia and other regions, diminishing their productive capacities.

Mexico is far from achieving continually high-tech innovation like the US, largely

due to a lack of funding. This limits the development of strategic domestic industries, forcing the country to focus on those that the US considers a priority, as Mexico is a key supplier to its economy. Thus, employment opportunities for Mexican technicians and professionals are conditioned by these decisions, except in a few strategic areas that the Mexican government manages to promote with an adequate budget, so that the impulse to technological development exclusively for national problems is very limited.

This paper reviews the development of talent in Mexico in some strategic areas, some strategies that other countries are following towards industrialization, the US strategy to obtain specialized talent and offers recommendations for Mexico to generate, attract and retain specialized talent.

TALENT DEVELOPMENT IN MEXICO IN CERTAIN STRATEGIC AREAS

To analyze the impact of nearshoring in Mexico and the creation of technical and professional talent, we review the scientific and technological areas in which Mexico has trained specialized talent in the country. These areas have been strategic for the country.

Successful examples of talent generation in Mexico have been in the oil industry, especially after its nationalization in 1938. The Mexican Petroleum Institute, founded in 1965, together with institutions such as the UNAM and the IPN, has trained highly qualified professionals in this sector. However, currently Mexico continues to depend on large imports of natural gas, gasoline, diesel and turbosine mainly from the US, reflecting the lack of energy self-sufficiency. In addition, scientists and technologists in the Mexican oil industry have not achieved technological innovations that have been commercialized internationally on a large scale.

To a lesser extent, talent creation has been fostered in the electricity industry and in strategic sectors such as nuclear energy, geothermal energy, manufacturing, pharmaceuticals, medicine, agriculture and mining. Despite this, Mexico imports 45% of the corn it consumes and the US is the world's leading corn exporter. Mexico and China are the two largest corn importing countries [6]. In May 2024, Mexico's international sales of pharmaceuticals were US\$220 million and a total of US\$734 million in international purchases, meaning that Mexico had a deficit of US\$515 million [7]; the US is the world leader in the production of these products. Mexico depends on US imports of essential products for the survival of its population, it also imports from the US many parts of the many products it assembles and of course that the government and criminal groups get their arms from that country.

Mexico also promotes talent in basic and social sciences, such as management, law, architecture and the arts. However, the country has not developed enough human resources in key technologies for the future, such as semiconductors, quantum computing, artificial intelligence (AI), data science, electromobility and clean energy sources. In these industries, Mexico will continue to be mostly an assembler, requiring mainly specialized technicians and technology adopters, in industries that use some degree of automation and robotization that helps them to be more productive and competitive, although there are authors who question whether these tools crucially help productivity [8].

The low percentage of Mexicans between the ages of 25 and 64 with higher education (bachelor's, master's and doctoral degrees), 21%, limits the availability of specialized talent to face the challenges of the new global economy. This contrasts with the Organization for Economic Cooperation and Development

(OECD) average of 41%, which reflects a significant disparity in the level of preparation between Mexico and the rest of the OECD countries [9].

The arrival of new investments in Mexico in sectors such as electric vehicles and other advanced technologies requires a type of talent that not only assembles products, but also innovates and develops technology. However, the Mexican government's limited investment in strategic areas has restricted the country's ability to generate this type of talent.

OTHER COUNTRIES' STRATEGIES TOWARDS INDUSTRIALIZATION

The Mexican Institute for Competitiveness (IMCO) [5] has made an analysis of several countries' initiatives to industrialize, which are summarized below.

It was reported above that the US is devoting significant funding for its reindustrialization in strategic sectors. In July 2024, the US launched an initiative with the Inter-American Development Bank (IDB) to develop semiconductor production in Latin America, including Mexico, which could strengthen local productive capacity and generate jobs. Germany launched the High-Tech Strategy 2020 and the Industry 4.0 plan to consolidate its position as a leader in technology and digital manufacturing. The European Union is promoting key legislation related to semiconductors, critical raw materials and the development of zero-carbon industries.

With the 'Made in China 2025' plan, China seeks to lead in advanced manufacturing and reduce foreign technological dependence, focusing on sectors such as AI and electric vehicles. In 2022, Canada earmarked \$3800 million for the development of critical minerals and offered tax credits of up to \$54400 million over 10 years. It also launched the New Growth 4.0 Strategy, with funds allocated through

2027 to support semiconductor development, in response to the US CHIPS Act. Japan will invest 150 billion yen over 10 years in the 'Green Transformation' initiative to address climate change.

The 'Made in India' initiative seeks to turn the country into a global manufacturing destination, with US\$80 billion in foreign investment and a US\$10 billion plan for semiconductor development. In 2023, the United Kingdom presented a US\$29.3 billion package aimed at critical sectors and adjusted its tax legislation to promote investments in green energy sources and digital technologies. Since January 2023, Brazil has prioritized reindustrialization through initiatives in green technologies and biotechnology, in addition to offering preferential financing through the National Bank for Economic and Social Development (BNDES).

Mexico's Manufacturing, Maquiladora and Export Services Industry (IMMEX) Program facilitates exports through tax deferral. In 2023, Mexico dropped to 58th place in the Global Innovation Index. To attract more investment, the country needs to improve its education system, innovation, competitiveness and productivity, taking as a reference programs such as the Development of the National System of Competencies through the National Council for Standardization and Certification of Labor Competencies (CONOCER). Eighty-five percent of Mexico's exports are destined for its Mexico-US-Canada Trade Agreement (T-MEC) partners [10], and leading sectors include vehicles and auto parts, machinery and electrical appliances. In 2022, Banxico identified 24 strategic clusters in Mexico to strengthen local sourcing and reduce imports. These clusters cover industries such as food, beverages, services, education, health, oil and gas extraction, manufacturing, financial services, transportation and communications, automotive, aerospace, electronics and

medical services, among others. Mexico is the world's 12th largest producer of aerospace products [5] and the 7th largest producer of automobiles [5].

MEXICO'S DILEMMA: UNITED STATES OF AMERICA OR CHINA?

Since 2018, the nationalist left-wing administration in Mexico has criticized the neoliberal policies of previous governments, pledging to achieve self-sufficiency in fossil fuels such as gasoline, diesel and turbosine by the end of the current administration that ends on September 30, 2024, without complete success to date. However, the country's greatest energy challenge in fuels is presented in natural gas, because it imported during the first semester of 2024, 6272 million cubic feet per day (mmpcd) of its total consumption of 8559 mmpcd, or 73.28% [11], a key resource for the generation of more than 50% of the country's electricity, the production of heat in industry and the elaboration of petrochemical products. This high dependence on imports, especially from the US, represents a critical point in the country's energy strategy.

At the geopolitical level, Mexico has sought to strengthen ties with leftist regimes in Latin America and powers such as China and Russia, without neglecting its crucial relationship with the US. Mexico's economy is deeply intertwined with that of the US, with 83% of its exports going to its northern neighbor, 4.8% to Europe, 3.1% to Canada, 2.0% to South America and 7.1% to the rest of the world [10]. Dependence on remittances from its migrants in the US and US foreign direct investment further reinforce this connection [12]. Despite the Mexican government's efforts to diversify its alliances, proximity and the T-MEC maintain the US as the country's main economic partner. The latter has been due in large part to the US trade war with China.

Mexico is still highly dependent on the US for its energy needs, mainly natural gas, which places it in a position of geopolitical vulnerability. This energy dependence also extends to electricity, because more than 50% is generated with natural gas. In the short and medium term, Mexico is unlikely to reduce this dependence.

New foreign direct investment is also dominated by the US, with 1334 million dollars invested in Mexico in the first half of 2024, compared to much lower figures from other countries such as Canada (238 million), Germany (106 million), China (62 million), Brazil (32 million) or Chile (4 million) [12].

Trade tensions with China, through the triangulation of Chinese products in sectors such as steel, aluminum and electric vehicles, are creating friction between Mexico and the US. Despite these challenges, Mexico maintains a significant trade deficit with China, while continuing to benefit from the relocation process of companies that previously operated in China.

At this time, the future of the trade relationship between Mexico, the US and Canada under the T-MEC is uncertain. One US presidential candidate has proposed a strong manufacturing renaissance in the US, which could severely affect Mexican exports to the north, because that candidate claims that good manufacturing jobs have moved to Mexico. Other researchers have also studied other possible relocation scenarios to the US [4]. Mexico could benefit from the production of goods that the US will need in the future, such as semiconductors, batteries and electric vehicles, but this potential benefit depends on the continuation of the T-MEC. On the other hand, Mexico's ruling party is implementing constitutional changes in the judiciary, the energy sector, the disappearance of autonomous bodies on trade competition, access to information and other changes that

could violate requirements established in the T-MEC and jeopardize the ratification of the treaty in 2026. The T-MEC has resulted in large investments in Mexico, which would be at risk if the treaty is not ratified or if certain actions by the Mexican government are taken to dispute panels if the US or Canada believe they violate the trilateral treaty. Mexico must ensure that the planned constitutional changes will not diminish democracy, competition and the rule of law that some studies have found to be crucial for countries not to fail [13].

Finally, although Mexico could seek to diversify its trade and technological relations, especially with China, its role in the immediate future will continue to be that of a key assembler in global value chains, with a high degree of dependence on US trade and political decisions. This country could force Mexico to redirect its policies due to its high dependence on that country for fossil fuels, food, remittances from Mexican migrants in that country who have not found employment opportunities in Mexico, among other things. Of course, Mexico needs to strengthen its relations with several countries in the face of an uncertain future in the event of a fall of the West [1].

UNITED STATES OF AMERICA'S STRATEGY FOR TALENT GENERATION

The concern of the US in its effort to capture talent for science, technology and innovation for its reindustrialization and production of future novel technologies is described in the US National Academies of Sciences (NAS) paper [14]. The Science, Technology, Engineering, and Mathematics (STEM) workforce in the US is essential to its innovation, economic strength, and national security; however, local talent cannot meet the growing demand in emerging technologies. Foreign STEM professionals play a key role in

US innovation, economic progress and global leadership, enriching scientific perspectives and fostering international networks. To maintain technological leadership and protect national interests, the US must continue to attract the best foreign talent in STEM. Global competition for this talent is fierce, as many countries recognize its value for economic and technological leadership. Several nations are actively recruiting STEM students and professionals, including from the US. A leader in this field, the US now faces increasing competition and can no longer assume it will attract the best minds by default.

Many countries have introduced programs to attract and retain foreign talent in STEM, offering incentives such as competitive salaries, research funding and accelerated pathways to citizenship. Some, such as China, have used these programs to rapidly advance technology, although some of their practices clash with US values of openness. However, the US lacks a cohesive strategy for recruiting STEM talent, relying instead on its academic institutions and the technology sector. However, immigration laws and political barriers make it difficult to retain foreign talent, especially from China. Moreover, at the local level, the US underutilizes the potential of STEM talent from underrepresented communities.

Foreign students and global research collaborations are vital to US innovation, despite the associated risks. While new security policies seek to protect research, they also hinder international partnerships, which could slow scientific progress. However, the benefits of global collaboration far outweigh the risks.

More than 50% of F-1 visa students in the US in STEM fields between 2004 and 2020 came primarily from China and India. More than 60% of jobs for Ph.D. graduates in computer science and mathematics in the US are held by foreign nationals on temporary visas,

permanent resident aliens, or naturalized US citizens. In engineering jobs, the percentage of these individuals who are not native-born citizens is over 62%. The number of Ph.D. graduates in the US on temporary visas has grown from less than 5000 in 1980 to nearly 20000 in 2022. The number of Ph.D. graduates in mathematics and computer science on temporary visas increased from 200 in 1980 to over 2600 in 2022, while the number of Ph.D. graduates in those fields who are US citizens or permanent residents increased from approximately 800 to just over 1800 [14].

The percentage of F-1 visa students from India applying for a change in their immigration status has increased from 33% to 44%, while those from China has decreased from 35% to 10% from 2004 to the present.

NAS developed recommendations for improving US efforts to attract and retain global scientific talent for domestic research that are summarized below.

- a. The US Government, led by the Office of Science and Technology Policy (OSTP), must coordinate a comprehensive strategy to recruit and retain international researchers.
- b. Collaboration between government, universities, industry and national laboratories should advance international research partnerships, maintain openness and continue to develop guidelines on research safety.
- c. National security concerns in research collaborations must be addressed by the US Government.
- d. Government and the private sector must proactively develop domestic talent in STEM.
- e. The US must strengthen collaborations with trusted allies to support international talent in strategic fields.

f. The US Government should support international partnerships and educational development, particularly in low-income countries.

g. Congress should create pathways toward permanent residency for foreign-born STEM talent, including increasing the number of green cards for critical areas of expertise.

h. The Executive Branch should use existing authority to retain foreign-born STEM experts already in the US.

i. Efforts must be made to mitigate the negative effects of the China Initiative and ensure inclusive talent policies.

j. The US Government should develop a national dashboard to monitor international talent metrics, including visa denials, funding opportunities and benchmarking against other countries.

k. Scientific and industry groups should educate policymakers about the value of foreign talent and the importance of international collaborations.

In US statistics on talent retention, Mexico is not explicitly mentioned, indicating that Mexico hardly counts for the US. However, it should be relevant, as it could increase its share of talent creation, especially for border states such as Texas, Arizona, New Mexico and California.

It is curious, but the document of the US Academies of Sciences does not mention a crucial aspect for the US to generate talent, and that is that US universities, although they are the best in the world, are very expensive and the poor population, especially minorities in that country, cannot have access to higher education. That is a very big barrier to the generation of talent.

There is also a paper that analyzes high tech talent in the US [15]. High tech employment

refers to jobs in professional and business services (including high tech), transportation, warehousing and wholesales, high-tech (this includes computer software and related services, as well as the manufacture of computer products), finance, insurance, real estate and others.

A summary of the findings in that paper [15] are listed below:

i) In 2023, US technology employment grew by 3.6%, with a notable increase of 213140 jobs. AI-related roles grew at nearly double that rate, underscoring the growing importance of this area.

ii) Software developers and programmers make up 72% of new technology jobs, reflecting their predominant role in the AI sector. In total, US tech jobs will reach 6.16 million in 2023, with a combined figure of 7.3 million in the US and Canada.

iii) Remote work has broadened the diversity of the technology workforce. The average annual salary for high-tech talent was significantly higher (\$109651 in 2022) compared to other sectors (\$94024), indicating higher compensation in this field.

iv) Most of the AI talent in the US and Canada is concentrated in San Francisco and Seattle, where young, highly educated workers predominate. Job creation in software engineering is aligned with the number of graduates in this field.

v) Technology talent markets tend to form around technology clusters near universities that drive innovation. In Mexico, the phenomenon could be reversed, with universities moving to locations with emerging technology clusters, because in Mexico universities in general do not create technologies that are the basis for generating industrial products.

vi) In Latin America, technology talent is on the rise, especially in software development. Mexico has experienced remarkable growth in this sector, with Mexico City and Monterrey standing out for the increase in jobs and salaries. Although salaries in Mexico are less than 40% of US salaries, these salaries are much higher than those reported by a Mexican publication [16].

Comparing these US figures with those of Asia and Europe can offer insight into future global dominance in high tech, highlighting the need to nurture tech talent in different regions.

Mexico needs to increase its specialized talent without allocating large resources to its training, because currently only a small fraction of the population has a university degree. In addition, many students opt for traditional careers that, although valuable, do not always contribute significantly to the future economic development of the country and offer low salaries [16]. Careers such as law and administration are the most popular, but they are not expected to generate a relevant impact on key sectors for the Mexican economy [17].

Traditional careers tend to offer fewer job opportunities and lower salaries compared to STEM disciplines, Medicine, Economics and other high demand areas [16]. This is compounded by the difficulty faced by higher education institutions in adapting or creating new careers. In 2024, the average salary of an Information Technology (IT) professional in Mexico was approximately 26000 pesos per month, while in careers such as Philosophy and Letters, the average was 10000 pesos. This mismatch reflects the lack of a strategic plan at the governmental level to promote careers that will be key to the country's industrial future. Added to this is the difficulty faced by higher education institutions in adapting or creating new careers; some Mexican universities have

introduced only one or two new engineering degrees in the last 50 years, as in the case of the Universidad Autónoma Metropolitana (UAM) Campus Azcapotzalco. Even if Mexico is not interested in creating new talent, it is necessary for Mexico to be concerned that a greater proportion of the population can study a career and also that they earn more in their jobs as can be inferred from results in the USA, where the population that has university studies and earns more have a longer life expectancy, have less physical body pain and less illnesses [18].

Although Mexico has great potential, with brilliant minds capable of acquiring advanced knowledge quickly, many times these talents do not find job opportunities with competitive salaries in the country, which fosters the "brain drain". It is estimated that Mexico loses around 20000 highly qualified professionals per year due to this phenomenon, something common also in other Latin American and Caribbean countries [19], where economic, political, insecurity and lack of opportunities challenges drive talent migration.

In the context of international mobility, Mexico could take advantage of the presence of skilled migrants. The crisis in Venezuela has spurred the arrival of well-trained professionals, and Mexico also receives migrants from countries at war, such as Ukraine and Russia. These individuals represent an opportunity to strengthen the labor force in growing industrial and technological sectors. In addition, Mexico is an attractive destination for Americans working remotely, taking advantage of the low cost of living. It is estimated that more than 1.6 million Americans live in Mexico, and perhaps some could be integrated into the Mexican labor market.

Despite this, Conahcyt has no plans to attract foreign talent, unlike the US science academies [14]. Nevertheless, the Mexican government has shown willingness to hire

foreign professionals in sectors where there is a shortage of local talent. A recent example is the hiring of Cuban doctors to fill vacancies in rural areas and marginalized communities. This strategy could be extended to the hiring of STEM professionals from countries such as Russia, Ukraine, Argentina or China, but in a planned manner and with a focus on specific areas of knowledge and technology.

Mexico should implement a talent attraction and retention program whose results could be evaluated and improved. An example would be to attract software developers from Argentina, where salaries in this sector are very low compared to those in Mexico [19]. Thus, Mexico could not only retain local talent that emigrates, but also attract foreign talent in key areas for the country's scientific and technological development. This diversified strategy would allow Mexico to advance in its economic and technological development, without relying exclusively on the creation of its own talent, optimizing existing resources and opportunities in the international market.

Of course Mexico could not follow the US strategy to attract talent because the US is a magnet for many professionals in the world due to its many prestigious universities that are among the top 20 in the world, its enormous capacity to generate technological innovation and the salaries that high tech professionals have. It should not be forgotten that high tech is currently the important thing, because more and more people have a computer, because we have applications on our computers and cell phones to make payments and money transfers at the bank, to get information, to use AI and for many other things that are already necessary in our lives.

DISCUSSION

Mexico could adopt strategies similar to those of the US to strengthen its development of specialized talent. It is essential for the country to define clear plans to generate domestic talent, attract international talent, retain Mexican professionals and take advantage of the potential of migrants fleeing problems in their countries.

To industrialize the country and focus production on high value-added goods, it is necessary to upgrade and strengthen public and private universities. This includes training students in key areas such as semiconductors, software development, AI, automation, digitalization, robotics, renewable and clean energy sources, and electromobility. The development of clusters that integrate industry, academia and research institutes in strategic areas is crucial.

China, with its rapid progress in industrialization and leadership in electromobility, and the US, with its initiatives to attract and retain talent, offer examples of how to meet global competition in the development of specialized talent. Meanwhile, Mexico should recognize the growing interest of Indian and Latin American professionals in the US due to high salaries and political and economic stability. It should also consider the importance of safe havens for specific communities, such as the LGBT community, provided by places like San Francisco and Seattle, which are leaders in attracting and retaining high-tech talent - after all, freedom and human rights encourage innovation.

UAM should maintain and publish a salary history of its graduates in the careers it teaches so that its students are aware of them and should also train teachers to improve the quality of student training. In addition, a comparative analysis of the curricula of AI careers in the US and Mexico should be carried out to identify areas for improvement in Mexico.

CONCLUSIONS

Mexico could adopt similar strategies to countries like the US and China to generate and retain talent. This includes attracting foreign professionals, especially from countries in crisis, and avoiding the Mexican brain drain through salary incentives, job stability and growth opportunities. The country should prioritize key areas such as semiconductors,

software development, AI, automation, digitalization, robotics, clean and renewable energy sources and electromobility. It is essential to train both technicians and professionals in these disciplines. In addition, Mexico must create clusters that link industry and academia, fostering innovation. It is important to recognize that there is already a “war for talent”, especially for high-tech talent, and we must prepare to avoid a national defeat.

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