

ANALYSIS OF THE IMPACT OF INVESTMENT IN INNOVATION BY MEXICAN ENTERPRISES IN THE 2014 – 2017 PERIOD

Moreno-Vázquez D.¹, Lozada-Lechuga J.², Ortiz-Carranco A.³, Ramírez – Rosas J. G.⁴

^{1,2}Centro Universitario CIFE, Departamento de posgrado, Tabachín, 514, 62140 Cuernavaca Morelos, México

²Universidad Politécnica de Puebla, tercer carril del ejido serrano s/n, 72640 Juan C. Bonilla, Puebla, México

Abstract

At present, innovation has become a mandatory requirement for growth, the levels of competitiveness between companies are characterized by an increasingly demanding market. In the case of Mexico, it has shown an unfavorable trend in the evolution of many of its most important variables in terms of innovation and competitiveness in recent years. The ratio of spending on research and development to GDP in Mexico is one of the lowest among OECD countries but is even considerably lower than that of other emerging economies. In this study, an analysis of investment in innovation is provided through Total Intramural Spending of Mexican companies in the period 2014 to 2017.

Keyword: *innovation, investment, México, enterprises.*

1. INTRODUCTION

The current world is constantly evolving, highlighting the relevance of decision-making processes that are based on collaboration between large and small companies. They strive to adapt to this new reality where geographic, cultural, economic, or business boundaries no longer exist [1].

Based on the aforementioned, the innovation becomes a prerequisite for both growth and business survival [2]. In this way, innovation grants companies' greater competitiveness, enabling them to position themselves in constantly changing global markets. However, it must be implemented continuously, as stated by [3]:

"Innovation is necessary to avoid stagnation; it is not enough to have innovated once.

Implemented innovations end up being imitated by others and become industry standards, demanding the need to remain active and continuously innovate. It should also be noted that innovation is not an exclusive activity of companies but, as stated by [4]: "has become an activity carried out through networks and cooperative alliances, leveraging the inputs and capabilities that public and private agents with different characteristics and located in distant territories can offer".

Within the global economic scenario, it is important to highlight, according to [5], that governments have implemented macroeconomic and social policies that impact the strategic capabilities of organizations. As a result of their strengthening, these organizations generate internal innovation processes that enable them to compete in the globalized world [6, 7].

However, in the case of Latin America, innovation has been pursued differently compared to more developed countries. Morales et al. [8] also asserts that, in contrast to industrialized nations, Latin American countries and other developing nations have not been able to expand comparable Research and Development (R&D) systems. This may be due to the characteristics of their productive sectors, or the focus of policies aimed at strengthening innovation systems. According to [8], we can indicate that innovations in this context primarily focus on technology acquisition. Innovating companies achieve this through the purchase of capital goods (machinery and equipment) rather than through the generation of new knowledge, especially that which originates from

local scientific and technological centers. In contrast, in more developed countries, research and development (R&D) activities account for the majority of innovation expenditure [9].

According to [10], investment in Mexico is linked to productivity, particularly for Small and Medium Enterprises (SMEs), as it is associated with their competitiveness. This analysis utilizes a regression methodology using data from the National Institute of Statistics, based on the premise that innovation is a competitive advantage for companies that possess the resources and skills to capitalize on it.

On the other hand, based in the study of [11], a similar situation occurs in Peru as in Mexico. The need for investment in Peru demonstrates a relationship between investment variables and labor productivity, especially in small and medium-sized enterprises operating in the manufacturing sector. The size of the company emerges as a determinant factor for investment growth in these enterprises.

In the same way, according to [12], its explain that an unfavorable economic environment is not always associated with a lack of investment incentives for businesses. However, specifically for foreign companies, it is reported that they do not make technology investments in Mexico, instead developing technology abroad to be applied in Mexico.

On the other hand, [13] point out that public policies play a crucial role in innovation, as it largely depends on governments investing in actionable strategies within the governmental sector to have an impact on the development of businesses.

In a different context, evidence has been found that investment and innovation refer to new administrative models, which do not necessarily require government or private investment in technology. This is the case with crowdfunding, which establishes investment guidelines, particularly focusing on innovation for small and medium-sized enterprises [14].

Furthermore, evidence has also been found that innovation and investment are manifested in the sustainable context. Due to the various changes that have emerged within organizations, there has been a

recognized need to invest in the concept of sustainability [15].

Regarding the green economy, China has emerged as one of the countries that has stimulated investment and innovation in organizations. It is evident that positive outcomes and a high potential mechanism have arisen in their development [16].

In the case of Mexico, it has exhibited an unfavorable trend in the evolution of many of its crucial variables in terms of innovation and competitiveness. According to the Consultative Forum on Science and Technology, Mexico is losing competitiveness to other countries primarily due to its structural issues and inefficient functioning of domestic markets [17].

Although R&D has been encouraged from the supply side in general, desired levels of technological development that would enable sustained country growth to have not been achieved yet [18].

Despite the efforts made by the federal government through the National Council of Science and Technology (CONACYT), which established the Innovation Incentives Program (PEI), aimed at providing support to Mexican companies registered in the National Registry of Scientific and Technological Institutions and Companies (RENIECYT) engaged in research, technological development, and innovation (RTDI), either individually or in collaboration with national public or private Higher Education Institutions or Public Institutions, as well as national public Research Centers and Institutes investing in research projects, technology development, and innovation directed towards the creation of new products, processes, or services. This program comprises three modalities: INNOVAPYME, INNOVATEC, and PROINNOVA [19].

Another effort by the federal government was included in the National Development Plan since 2013, which sets the objective of making scientific, technological, and innovation development pillars for sustainable economic and social progress.

Therefore, this research focuses on studying the importance of Mexico significantly increasing its attention to innovation to approach international averages. The proportion of research and development

expenditure as a percentage of GDP in Mexico (around 0.5%) is not only the lowest among OECD countries but also considerably lower than that of other emerging economies (Organization for Economic Cooperation and Development [OECD], 2010). The objective is to analyze the impact of investment in innovation by Mexican companies during the period from 2014 to 2017.

2.METHODS

The present research adopts a mixed-methods approach, combining quantitative and qualitative methodologies. The quantitative aspect measures the phenomena related to the factors determining the innovative behavior of companies in Mexico, while the qualitative aspect focuses on examining the characteristics of innovation within these companies. This study is longitudinal in nature as the data was obtained from public databases provided by the National Institute of Statistics, Geography, and Informatics (INEGI). Economic indicators of private and quasi-public economic units for the years 2014, 2015, 2016, and 2017 were consulted, disaggregated by federative entity and economic zones.

In terms of its depth, this study is descriptive as it focuses on analyzing the variables related to Total Intramural Expenditure (TIE) expressed in Mexican Pesos (MXP) and disaggregated into various categories such as Products, Processes, and Unidentified Expenses. Additionally, it is an explanatory investigation as it involves comparative analysis of expenditure destinations, including Mining, Manufacturing, Construction, Services, Complementary Manufacturing, Complementary Services, and other relevant topics. Ranges, means, and percentage variations were calculated among categories for each year under analysis.

Regarding the methodology, data collection was conducted through the website of the National Institute of Statistics and Geography (INEGI) for the period from 2014 to 2017, considering the variables of innovation and investment. Subsequently, data validation was performed using descriptive statistics, analyzing the sectors of Mining, Manufacturing, Construction, Services, Complementary Manufacturing, and Complementary Services.

3.RESULTS

Based on the data collected from the survey in 2014, the total intramural expenditure allocated by productive sector companies for Research and Development (R&D) projects, classified according to the OECD industrial classification and categorized by expenditure destination such as Mining, Manufacturing, Construction, Services, Complementary Manufacturing, and Complementary Services, amounted to \$13,594,074 (thousands of pesos). Out of this amount, \$8,782,872 was allocated to Products (goods or services), \$4,358,290 to Processes (including methods), and \$452,912 to Unidentified Expenses.

According to the data, in the year 2015, the total intramural expenditure increased by 9.19% compared to the year 2014, reaching \$14,842,983 (thousands of pesos). Out of this amount, \$10,162,766 was allocated to Products (goods or services), \$4,249,481 to Processes (including methods), and \$430,736 to Unidentified Expenses.

In this way, in the year 2016, the total intramural expenditure showed a further increase of 16.86% compared to 2015, amounting to \$17,461,195 (thousands of pesos). Out of this amount, \$11,936,010 was allocated to Products (goods or services), \$4,890,205 to Processes (including methods), and \$519,980 to Unidentified Expenses.

In comparison to the year 2014, the total intramural expenditure allocated by companies in the productive sector for Research and Technological Development (RTD) projects, classified according to the OECD industrial classification and expenditure destination, in the "Mining" category, amounted to \$49,305 (thousands of pesos). Out of this amount, \$1,541 was allocated to Products (goods or services), \$3,840 to Processes (including methods), and \$43,924 to Unidentified Expenses.

Under the same approach, in the year 2015, the total intramural expenditure increased to \$150,418 (thousands of pesos), representing a 205.08% growth compared to 2014. Out of this amount, \$1,859 was allocated to Products (goods or services), \$80,928 to

Processes (including methods), and \$67,631 to Unidentified Expenses.

On the other hand, in 2016, the total intramural expenditure decreased to \$96,733 (thousands of pesos), reflecting a negative growth of 35.69% compared to 2015. Out of this amount, \$1,908 was allocated to Products (goods or services), \$91,851 to Processes (including methods), and \$2,974 to Unidentified Expenses.

In the field of the productive sector, for the year 2014, the total intramural expenditure allocated by companies for the implementation of Research and Technological Development (RTD) projects, according to the OECD industrial classification and expenditure destination, in the "Manufacturing" classification, amounted to \$8,214,702 (thousands of pesos). Out of this amount, \$6,454,457 was allocated to Products (goods or services), \$1,470,153 to Processes (including methods), and \$290,092 to Unidentified Expenses.

In comparison, in the year 2015, the total intramural expenditure increased by 11.84% compared to 2014, reaching \$9,187,266 (thousands of pesos). Out of this amount, \$7,376,041 was allocated to Products (goods or services), \$1,573,633 to Processes (including methods), and \$237,592 to Unidentified Expenses.

Also, in the year 2016, the total intramural expenditure increased by 16.01% compared to 2015, amounting to \$10,657,925 (thousands of pesos). Out of this amount, \$8,433,432 was allocated to Products (goods or services), \$1,928,958 to Processes (including methods), and \$295,535 to Unidentified Expenses.

In addition, in the year 2016, the total intramural expenditure increased by 16.01% compared to 2015, amounting to \$10,657,925 (thousands of pesos). Out of this amount, \$8,433,432 was allocated to Products (goods or services), \$1,928,958 to Processes (including methods), and \$295,535 to Unidentified Expenses.

In contrast, in the year 2014, the total intramural expenditure allocated by companies in the productive sector for the implementation of Research and Technological Development (RTD) projects, according to the OECD industrial classification and expenditure destination, in the "Construction" classification, amounted to \$48,131 (thousands of pesos). Out of this

amount, \$25,049 was allocated to Products (goods or services), \$23,031 to Processes (including methods), and \$52 to Unidentified Expenses.

In the same way, in the year 2015, the total intramural expenditure increased by 69.42% compared to 2014, reaching \$81,543 (thousands of pesos). Out of this amount, \$63,641 was allocated to Products (goods or services), \$17,834 to Processes (including methods), and \$69 to Unidentified Expenses.

By the way, in the year 2016, the total intramural expenditure increased significantly by 359.73% compared to 2015, amounting to \$374,881 (thousands of pesos). Out of this amount, \$146,046 was allocated to Products (goods or services), \$228,732 to Processes (including methods), and \$103 to Unidentified Expenses.

In the year 2014, the total intramural expenditure allocated by companies in the productive sector for the implementation of Research and Technological Development (RTD) projects, according to the OECD industrial classification and expenditure destination, in the "Services" classification, amounted to \$5,269,393 (thousands of pesos). Out of this amount, \$2,289,283 was allocated to Products (goods or services), \$2,861,266 to Processes (including methods), and \$118,844 to Unidentified Expenses.

In 2015, the total intramural expenditure increased by 2.76% compared to 2014, reaching \$5,414,694 (thousands of pesos). Out of this amount, \$2,712,163 was allocated to Products (goods or services), \$2,577,087 to Processes (including methods), and \$125,445 to Unidentified Expenses.

In 2016, the total intramural expenditure increased by 14.76% compared to 2015, amounting to \$6,214,104 (thousands of pesos). Out of this amount, \$3,354,069 was allocated to Products (goods or services), \$2,638,667 to Processes (including methods), and \$221,368 to Unidentified Expenses.

Although, in the years 2014 and 2015, there was no intramural expenditure allocated by companies in the productive sector for the implementation of Research and Technological Development (RTD) projects, specifically in the "Complement of Manufactures"

classification, according to the OECD industrial classification and expenditure destination.

For the year 2016, the total expenditure amounted to \$1,997 (thousands of pesos), and the entire amount was invested in Processes (including methods).

In the case of the year 2014, the total intramural expenditure allocated by companies in the productive sector for the implementation of Research and Technological Development (RTD) projects, according to the OECD industrial classification and expenditure destination, in the "Complement of Services" classification, amounted to \$12,542 (thousands of pesos), and the entire amount was spent on Products (goods or services).

For the year 2015, the total intramural expenditure decreased by 27.75% compared to 2014, with a total investment of \$9,062 (thousands of pesos), allocated entirely to Products (goods or services).

It should be noted that, in the year 2016, the total intramural expenditure decreased significantly by 93.88% compared to 2015, with only \$555 (thousands of pesos) invested, and the entire amount was allocated to Products (goods or services).

The following tables (Tables 1, 2, and 3) present the aforementioned information.

Regarding the support provided by CONACYT, considering all the modalities: PROINNOVA, INNOVAPYME, and INNOVATEC, it amounts to \$11,710,643.45 MXN. The allocation of this amount is illustrated in figure 1, presented below.

Table 1. Total intramural expenditure, allocated by companies in the productive sector to carry out research and technological development projects, grouped by type of OECD classification (2014), in thousands of Mexican pesos (MXN).

Industrial sector	Total (MXN)	Products (Goods and services)	Processes (Including methods)	Unidentified Expenses
Total	13,294,074.00	8,782,872.00	4,358,290.00	452,912.00
Mining	49,305.00	3,840.00	3,840.00	43,924.00
Manufacture	8,214,702.00	1,470,153.00	1,470,153.00	290,092.00
Building	48,131.00	23,031.00	23,031.00	52.00
Services	5,269,283.00	2,289,283.00	2,861,266.00	118,844.00
Manufacturing add-on	-	-	-	-
Services add-on	12,542.00	12,542.00	-	-

Table 2. Total intramural expenditure, allocated by companies in the productive sector to carry out research and technological development projects, grouped by type of OECD classification (2015), in thousands of Mexican pesos (MXN).

Industrial sector	Total (MXN)	Products (Goods and services)	Processes (Including methods)	Unidentified Expenses	Percentage change between 2015 and 2016 (total)
Total	17,346,195.00	11,936,010.00	4,890,205.00	519,980.00	16.86
Mining	96,733.00	1,908.00	91,851.00	2,974.00	-35.69
Manufacture	10,657,925.00	8,433,432.00	1,928,958.00	295,535.00	16.01
Building	374,881.00	146,046.00	228,732.00	103.00	359.73
Services	6,214,104.00	3,354,069.00	2,638,667.00	221,368.00	14.76
Manufacturing add-on	1,997.00	-	1,997.00	-	100
Services add-on	555.00	555.00	-	-	-93.88

Table 3. Total intramural expenditure, allocated by companies in the productive sector to carry out research and technological development projects, grouped by type of OECD classification (2016), in thousands of Mexican pesos (MXN).

Industrial sector	Total (MXN)	Products (Goods and services)	Processes (Including methods)	Unidentified Expenses	Percentage change between 2014 and 2015 (total)
Total	14,842,983.00	10,162,766.00	4,249,481.00	430,736.00	9.19
Mining	150,418.00	1,859.00	80,928.00	67,631.00	205.08
Manufacture	9,187,266.00	7,376,041.00	1,573,633.00	237,592.00	11.84
Building	81,543.00	63,641.00	17,839.00	69.00	69.42
Services	5,414,694.00	2,712,163.00	2,577,087.00	125,445.00	2.76
Manufacturing add-on	-	-	-	-	-
Services add-on	9,062.00	9,062.00	-	-	-27.75

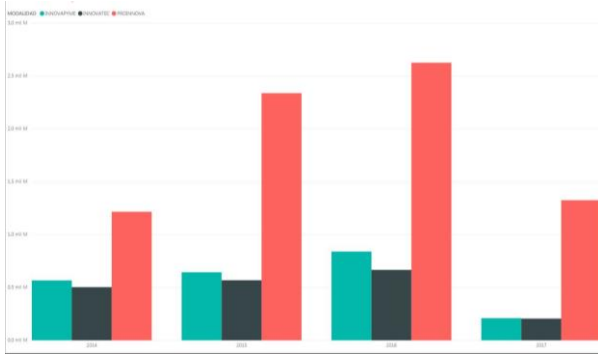


Figure 1. Support provided by CONACYT, according to each modality for innovation (2017).

4. CONCLUSIONS

Based on the findings, several significant increases were observed in the Total Intramural Expenditure (TIE), as listed below. In the Mining sector, there was a remarkable growth of 205.08% in TIE from 2014 to 2015, indicating a substantial investment in research and technological development.

Similarly, the Construction sector experienced a notable rise of 69.42% in TIE during the same period. It is important to note that the highest increase of 359.73% in TIE was observed in the category of Unidentified Expenses, though it is necessary to further investigate the nature and allocation of these expenditures. These findings highlight the dynamic nature of investment patterns in different sectors and emphasize the significance of monitoring and understanding the factors contributing to such fluctuations in intramural spending.

Additionally, the analysis reveals other noteworthy trends in TIE. For instance, the Manufacturing sector demonstrated consistent growth over the years, with increases of 11.84% in 2015 and 16.01% in 2016 compared to the previous year. This sustained upward trend suggests a strong commitment to research and technological development within the Manufacturing industry.

On the other hand, the Services sector displayed relatively stable intramural expenditure, with a modest increase of 2.76% in 2015 and a more substantial rise of 14.76% in 2016. These findings underscore the diverse

investment patterns across sectors, highlighting the need for sector-specific strategies to foster innovation and drive technological advancements.

Some of the most significant decreases observed in the Total Intramural Expenditure (TIE) are as follows: a decrease of 27.75% in Products (goods or services) compared to 2014. In 2016, the TIE decreased considerably by 93.88% compared to 2015 in the Complement of Services category. These findings suggest a positive impact on innovation indicators based on the analyzed data, as the most of them have experienced an increase ranging from 10% to 200%. Therefore, we can affirm that a significant number of Mexican companies are investing in TIE and showing a tendency to maintain this type of investment, aiming to enhance their competitiveness.

Regarding the grants provided by CONACYT, it is notorious that the Mexican state of Nuevo León was the entity that received the highest level of support. However, in the case of Mexico City, small enterprises obtained the most significant amount of assistance during the analyzed period. It is worth noting that the support levels were affected in the year 2017, and further investigation is required to determine the underlying causes for this phenomenon.

The substantial support received by Nuevo León indicates the region's strong commitment to fostering research and technological development. The favorable conditions and ecosystem for innovation in Nuevo León have likely contributed to attracting significant support from CONACYT. On the other hand, the prominence of small enterprises in Mexico City suggests a vibrant entrepreneurial landscape, with a focus on promoting innovation and driving economic growth.

The fluctuation in support levels in 2017 raises questions about the factors that influenced this decline. Understanding the causes behind this decrease is crucial for designing effective strategies to mitigate any potential challenges and ensure the sustained support for research and development initiatives. It is essential to conduct an in-depth analysis to identify the specific factors, such as changes in funding policies, economic conditions, or administrative processes, that contributed to the observed impact on support levels in 2017.

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