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Journal-Macroeconomics and Monetary Economy

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Support the international scientific community in its written production Science, Technology and Innovation in the Field of Social Sciences, in Subdisciplines of General aggregative models: Marxian, Sraffian, Institutional, Evolutionary, Keynes, Keynesian, Post-Keynesian, Neoclassical, Forecasting and Simulation; Consumption, Saving, Production, Employment, and Investment: Consumption, Saving, Capital, Investment, Capacity, Production, Employment, Unemployment, Wages, Aggregate Factor income distribution, Forecasting and Simulation; Prices, Business fluctuations, and Cycles: Price level, Inflation, Deflation, Business fluctuations, Cycles, Forecasting and Simulation; Money and interest rates: Demand for money, Monetary standards and regimes, Government and the monetary system, Determination of interest rates, Term structure of interest Rates, Financial markets and the Macroeconomy, Forecasting and Simulation; Monetary policy, Central banking, and the Supply of Money and Credit: Money supply, Credit, Money multipliers, Monetary policy, Deposit insurance, Central banks and their policies; Macroeconomic-Aspects of public finance, Macroeconomic policy and general Outlook: Policy objectives, Policy designs and consistency, Policy coordination, Fiscal policy, Public expenditures, Investment, and Finance, Taxation, Comparative or joint analysis of fiscal and monetary or stabilization policy, Incomes policy, Price policy, Studies of particular policy episodes, General Outlook and conditions.

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Presentation of Content

In a first article we present, *Inflation and the minimum wage in three North American countries: economic repercussions 2016-2024*, by Robles-Soto, Saúl, with adscription at Universidad Autónoma de Zacatecas, in the next article we present, *Preventive service interval extension on Caterpillar 789 and 793 off-highway trucks*, by Córdova-Villanueva, José Gabriel, Lino-Gamiño, Juan Alfredo, Ríos-Silva, Luis Octavio and Méndez-González, Carlos, with adscription at Universidad de Colima, in the next article we present *Analysis of the factors that determine the attraction, development and retention of human talent in Latin American and the Caribbean countries*, by López-Jiménez, Sergio Felipe, Álvarez-Ochoa, Martín, Lino-Gamiño, Juan Alfredo and López-Sánchez, Lina Marleny, with adscription at Universidad de Colima and Universidad Pedagógica y Tecnológica de Colombia, in the last article we present, *Sustainability reports in Mipymes with GRI standards*, by Gutiérrez-Rangel, Héctor Fabián, Tamayo-Contreras, Porfirio and Espinosa-Mosqueda, Rafael, with adscription at Universidad de Guanajuato.




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Inflation and the minimum wage in three North American countries: economic repercussions 2016-2024

La inflación y el salario mínimo en tres países de América del Norte: repercusiones económicas 2016-2024

Robles-Soto, Saúl^a

^a  Universidad Autónoma de Zacatecas •  0000-0001-6669-2781 •  1800173

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*  [\[victor_portillo@utcj.edu.mx\]](mailto:victor_portillo@utcj.edu.mx)



Abstract

This research work refers to the behavior of inflation and the minimum wage in three North American countries, Mexico, the USA and Canada in the last 9 years. A review of the evolution of these economic variables during the period 2016-2024 is carried out. We should note that an economic hypothesis holds that continuous increases in the minimum wage would immediately translate into growth in inflation, however, as of December 2018 in Mexico the minimum wage was increased and inflation was contained at levels acceptable to the financial authorities for the benefit of the working class. The increases in the last two years of Enrique Peña Nieto as president of Mexico and the six years of the current president Andrés Manuel López Obrador will be presented. The first with meagre and insignificant increases in the minimum wage and the second with considerable increases above inflation.

Mexico, Wages, Inflation, Economics

Resumen

El Presente trabajo de investigación se refiere al comportamiento de la inflación y el salario mínimo en tres países de América del norte, México, USA y Canadá en los últimos 9 años. Se realiza una revisión de la evolución de dichas variables económicas durante el período 2016-2024. Debemos hacer notar que una hipótesis económica sostiene que aumentos continuos al salario mínimo se traduciría de inmediato en crecimiento de la inflación, sin embargo, a partir del mes de diciembre del año 2018 en México el salario mínimo se aumentó y la inflación se contuvo en niveles aceptables para las autoridades financieras en beneficio de la clase trabajadora. Se presentarán los aumentos en los dos últimos años de Enrique Peña Nieto como presidente de México y los seis años del actual presidente Andrés Manuel López Obrador. El primero con raquíticos e insignificantes incrementos en el salario mínimo y el segundo con aumentos considerables por arriba de la inflación

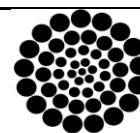
México, Salario, Inflación, Economía

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Graphical overview

Statistical tables are presented with official information from various governmental bodies, with INEGI standing out, which in a timely manner reports the development of the main economic variables in Mexico, highlighting on this occasion the case of inflation and wages for the Mexican country as well as for the USA and Canada. This information has its respective numbering with the title at the bottom and the corresponding sources, in the work 7 Boxes are presented, 3 tables and 4 figures, all of them with the corresponding title and the sources that support them, based on the body of the work, an explanation of each Box is given after its presentation in each section.

With this, we give an account of the statistical handling on this occasion based on a description and with this we make inferences, with the aim of giving the greatest clarity to the subject we are dealing with.

Introduction

Among the main variables of any economic system are wages and inflation. An economic thesis according to traditional economic theory is based on the following: the higher the wage, the more competitive the workers are, i.e., they work in a climate of harmony and well-being that immediately translates into good results for the company and, in itself, also for the system.

In the particular case of companies, they establish as a priority the implementation of adequate wages for their workers, which are established by common agreement with the federal government and trade unions, a situation that is carried out year after year and sometimes with emergency wages in the case of Mexico.

Before December 2018, it was very common in Mexico for minimum wage increases to be too low, which led to lower worker performance, resulting in serious problems for the company by lowering its daily productivity.

Based on the above, companies could lose competitiveness and workers will not have adequate minimum wages or enough money to meet their most pressing needs.

The case of the Mexican economic system is very significant; the increase in the minimum wage stagnated during the period from 1996 to 2018, to the extent that in November 2016 the Mexican Employers' Confederation (Coparmex) called for a substantial 30% increase in wages in Mexico.

It is a fact that should lead us to reflect objectively, the fact that the same employers' class is proposing significant increases in the minimum wage because it observes that the domestic market in Mexico was too depressed and needed to be revitalised in the short term.

The big problem that economic theory always argues is that constant wage increases in the working class would translate into dangerous increases in inflation, [1] for this, the government in its various agencies must be very careful about it, the maximum that in recent years has had an inflation controlled by the relevant agencies.

We will observe in this paper that this thesis has been questioned and called into question, for the Mexican case, increases in the minimum wage have not necessarily caused an escalation of prices in goods and services that are consumed on a daily basis by the population, we are talking about increases on the first of December 2018 well above those granted by PRI governments in previous six-year terms.

Methodology

Statistical comparisons are made of three countries in North America, which have very well-defined economic asymmetries, including minimum wages in the USA and Canada that are much higher than those established in Mexico, especially a large difference for the years 2010-2018. Since the last month of 2018, the minimum wage has been modified with considerable increases, which although they are not adequate, they have contributed to better and higher levels of welfare for the population in Mexico. The method used is deductive and inferential with representative data on inflation and wages in a given period. This allows us to make quantitative comparisons of the economic variables used.

Results

Among the main variables of any economic system are wages and inflation. An economic thesis according to traditional economic theory is based on the following: the higher the wage, the more competitive the workers are, i.e. they work in a climate of harmony and well-being that immediately translates into good results for the company and, in itself, also for the system.

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Before December 2018, it was very common in Mexico for minimum wage increases to be too low, which resulted in lower worker performance, which translated into serious problems for the company as its daily productivity decreased.

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The big problem that economic theory always argues is that constant wage increases in the working class would translate into dangerous increases in inflation,^[2] for this, the government in its various agencies must be very careful about it, the maximum that in recent years has had an inflation controlled by the relevant agencies.

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We should note immediately that the comparison of wages and inflation for the three North American countries is very contrasting, for this, the figures reveal that from 2016 to 2018, increases to the minimum wage in Mexico have been very low compared to those granted in the USA and Canada, although it is necessary to emphasise that from the end of 2018 a greater increase in wages for Mexico has begun to take place with an adequate control of inflation below 5 percent per year.

Likewise, for the USA and Canada, minimum wage increases have been constant and inflation control is in manageable terms for the fiscal and monetary authorities.

The minimum wage data for the three countries is very contrasting, with a much higher minimum wage in the USA and Canada than in Mexico.

The main indicators are developed below.

Main indicators

Inflation

A generally accepted definition in economics is the generalised rise in the prices of goods and services in an economy over a period of time. This increase in prices is measured through the evolution of the Consumer Price Index in the case of Mexico.

The first variable to be considered in this paper is inflation, which has interesting data to analyse in this paper related to the three North American countries. Below, we present table number 1 related to Mexico, USA and Canada for the period from 2016 to 2024. It should be noted that the three countries mentioned are members of the Free Trade Agreement, which was implemented in 1994 and revised in 2017 and 2018.

[1] It is common in the economic literature to argue that inflation below 10% is acceptable for the economic system. [2] It is common in the economic literature to argue that inflation below 10% is acceptable for the economic system.

Box 1

Table 1

Inflation in Mexico, USA and Canada for the period 2016 to 2024 in percentage terms

Country	Year 2016	Year 2020	Year 2024
Mexico	7.3	6.8	4.7
USA	0.12	1.4	3.4
Canada	1.43	0.72	2.43

Source: own elaboration with data from Inegi, SHCP, SE, STPS y LEA UAZ, 2024

It is immediately clear that in the USA in 2016 there was an increase of only 0.12% in the prices of goods and services, rising to 1.4% in 2020 and reaching 3.4% in 2024, perhaps as a result of the forthcoming elections and the Russia-Ukraine conflict that will affect international prices, especially for gas and basic grains.

In the case of Canada, inflation in 2026 is expected to be 1.43%, with a considerable drop in 2020 with 0.72% and a spectacular increase in 2024 to 2.43%.

For Mexico, the figures indicate that in 2016 inflation was the highest with respect to the USA and Canada, at 7.3%, decreasing by 2020 to 6.8% and what we have for this year is 4.7%, i.e. it has been decreasing, especially due to the measures implemented by the federal government and the country's fiscal institutions such as the Ministry of Finance and Public Credit (SHCP), the Bank of Mexico, the Ministry of Economy and even the Federal Consumer Protection Agency (Procuraduría Federal del Consumidor).

It should be noted that the difference in the graph with respect to inflation seems very high in the case of Mexico, while for the USA in 2016 it was only 0.2, for Mexico it exceeded seven points and for Canada it was 1.4.

Box 2

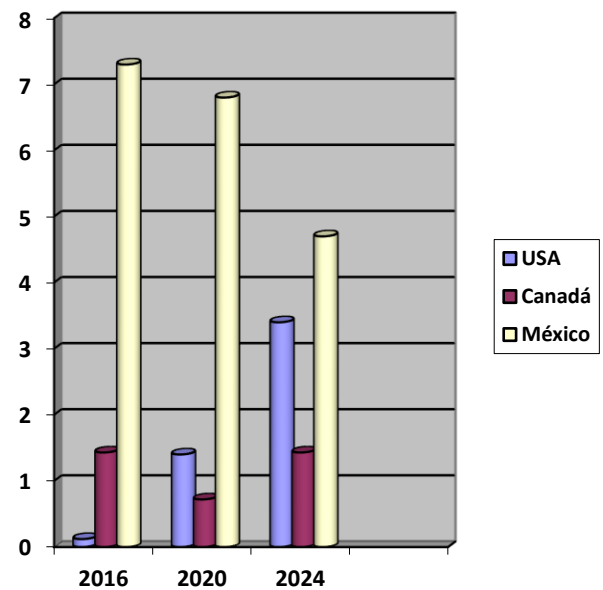


Figure 1

Inflation for three North American countries in percentage terms, period 2016-2024.

Source: own elaboration with data from Inegi, SHCP, SE, STPS and LEA UAZ, 2024

For greater clarity on inflation, Box 2 Figure 1 refers to inflation for the three countries in percentage terms in the three years considered, immediately reflecting high inflation for Mexico, which contrasts with that of Canada and the United States of America.

It should be noted that the information contained in the various Boxes and Figures throughout the work has been handled on the basis of INEGI, SHCP, SE, STPS and LEA, which gives us an acceptable reliability of the work developed.

It is necessary to highlight that, for the USA, inflation in the years considered has been increasing, although it must be said that such increases are within the margin of manoeuvre for the North American financial system.

If we look at the case of Canada, in 2016 inflation was over 1%, decreasing to 0.7% in 2020 and increasing again to 1.3% in 2024.

In the case of Mexico, inflation in 2016 was the highest of the three countries, reaching over 7%, decreasing slightly in 2020 to 6.8% and rising to 4.75% by 2024 [1].

We must insist on what is discussed on a daily basis by academia [2] in institutions of Higher Education, Colleges of Economists, Economic Research Centres, and financial and economic authorities in Mexico, referring to the fact that inflation below 10% is manageable for the economic system.

Minimum wages

The minimum wage in Mexico during the last nine years has had a very marginal increase if we compare it with the minimum wage established in the neighbouring countries of the USA and Canada.

The fundamental idea of the three sectors that define the minimum wage in the Mexican country has always been subject to an unrestricted control of inflation, which has been below 10 per cent in the last five years (2012-2016).

While in macroeconomic terms inflation control has been controlled by the economic authorities in Mexico, this has had a negative impact on minimum wage increases, with an annual average of only 3.0 per cent overall.

The gap between the minimum wage in Mexico compared to that paid in the USA and Canada is increasing year by year, as the increases in the three countries mentioned above have been more significant, to the extent that in 2016 the main trade unions in the North American country demanded a minimum wage of 14 dollars an hour[3].

The above request by the North American unions is similar to what was proposed in the same year by COPARMEX[4], which demanded an immediate increase in minimum wages that would allow workers in both countries a higher income to meet their most pressing needs.

In the case of Mexico, the increase granted in 2016 was only 73.04 pesos per day, which will be applicable throughout the country, in general terms rounded up to 75 pesos per day, a very low figure indeed for the majority of workers in the country.

These meagre increases in the minimum wage in Mexico were the result of an economic policy at the service of the Mexican business class and to the detriment of the working class for more than thirty years.[5] The following is the Box 3 below shows the minimum wage for the three North American countries for the period 2016-2024 in Mexican pesos.

In the USA, the average of 15.09 dollars per hour for the year 2024, which when translated into Mexican pesos does not give an amount of 273.20 pesos per hour, if we multiply it by 8 hours it will give us 2,185.6 pesos per day, a very significant figure if we compare it with the 248.93 pesos per day; while in the Northern Border Free Zone it goes from 312.41 to 374.89 pesos per day in Mexico.

In Mexico, for the year 2018, with the six-year term of Enrique Peña Nieto, the minimum wage was 88.32 pesos a day, an amount that is clearly insufficient to support a family that had to meet its minimum economic needs such as food, housing and clothing.

If we look at the figures for the minimum wage in Mexico from 2010 to 2024, it has increased by more than 173 pesos a day, a very significant figure that far exceeds all the increases that had taken place during the neoliberal period.

This is reflected in table 3, which presents the evolution of the minimum wage in Mexico for the period 2010-2024. Data that indicate a considerable increase from 2019 to the present year 2024.

And the current president of Mexico has already announced that by 2025 increases in the minimum wage will be above inflation,[6] with the common agreement of the workers' unions, Mexican business organisations and the federal government through the Ministry of Labour and Social Welfare (STPS).

[1] It should be noted that the inflation rate of 4.7% corresponds to the first half of the year 2024, with an increase expected at the end of the year due to the change of federal government authorities; however, the increase will not be more than 6%.

[2] Especially the Modern Conventional Economic Theory that is taught in most of Mexico's HEIs.

[3] We take as a reference the peso-dollar parity at 19 pesos, we understand that this parity has had its ups and downs in different periods and years.

[4] The Mexican Employers' Confederation, which brings together the main business organisations in the country.

[5] It was the so-called neoliberal economic model, which benefited a few and harmed millions in Mexico, period 1980-2018.

[6] The latest report on annualised inflation for the month of October 2024 is 4.66%.

Box 3

Table 2

Minimum wage developments in Mexico for the period 2010-2024

Year	Montos \$
2010	52.46
2014	67.29
2016	75.24
2020	123.22
2024	248.73

Source: own elaboration with data from Inegi, SHCP, SE, STPS y LEA UAZ, 2024

The data contained in Box number 3, table 2, reflect in a timely manner that, in a period of seven years, the minimum wage in Mexico did not reach 76 pesos per day, in truth a great purchasing loss for formal workers in the country.

On January 1, 2018, the minimum wage was 88.36 pesos per day, with the change of government on December 1, 2018, the new president of Mexico, Andrés Manuel López Obrador, increased the minimum wage to 106.68 pesos per day, for the first time it exceeded the figure of one hundred pesos and the increase was 18.32 pesos, a figure much higher than the 5 pesos maximum that the country's tax authorities were used to under the thesis that increases in the minimum wage above inflation would bring increases in inflation.

For the first time in a period of more than 30 years, it was possible to increase minimum wages above 100 pesos per day under the current six-year term, likewise, given that the same governmental orientation should continue under the presidency of Claudia Sheinbaum Pardo as of October 1, 2024, the most benefited will be Mexican workers, who will continue to improve their monthly income with minimum wages more adjusted to reality, the traditional theoretical orientation that argued for a direct increase in inflation by increasing minimum wages will be completely set aside. Box 4, Figure 2 summarizes the above in summary terms.

Box 4

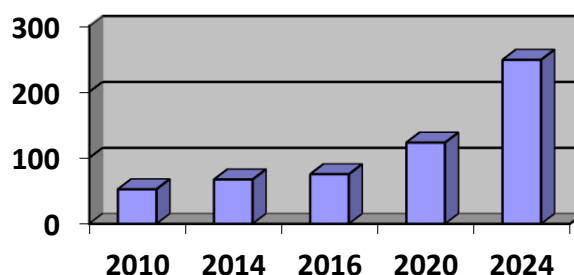


Figure 2

Evolution of the minimum wage in Mexico for the period 2010-2024

Source: own elaboration with Inegi data., SHCP, SE, STPS y LEA UAZ, 2024.

Box 4, Figure 2 is the result of the information contained in Box 3, Table 2, and when presented in the form of a bar graph, it immediately shows the evolution of the minimum wage in Mexico during the period from 2010 to 2024. The ratio between a country with a very low minimum wage in Mexico is three times more in the two North American countries of the USA and Canada, hence the idea that many Mexicans year after year seek to move to them in search of the American dream.

However, it should be noted that just as there are high wage levels in the USA and Canada, the cost of living is also higher in comparison with Mexico. There are several approaches in this regard that indicate the degree of satisfaction of the population in the three countries, in the USA and Canada people earn more but also spend more, especially in terms of basic goods and services.

Box 5**Table 3**

Minimum wage in the USA, Canada and Mexico for the period 2016-2020 in Mexican Pesos

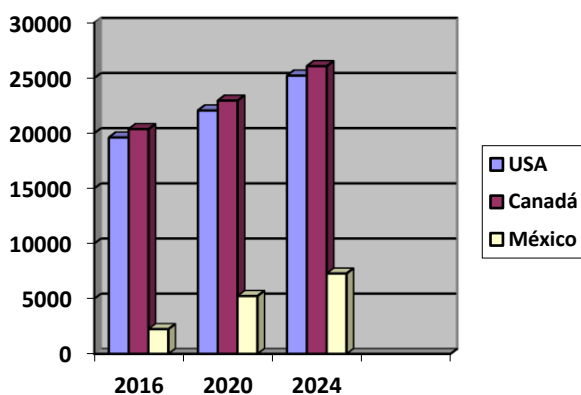
Country	2016	2020	2024
USA	19,618	22,070.2	25,230
Canada	20,378	22,867	26,090
Mexico	2,250	5,250	7,290

Source: own elaboration with Inegi data., SHCP, SE, STPS y LEA UAZ, 2024

The information in Box 5, Table 3, shows the minimum wage amounts for the three North American countries, where the disparity between Mexico with a very low minimum wage and Canada and the USA with very considerable amounts for three years in particular is directly contrasted.

It is undoubtedly true that just as the wages in the USA and Canada are higher, the cost of living services is also too expensive, especially in the area of health care, which is one of the major drawbacks of North American society if one does not have basic health insurance, and the state and federal administration in terms of social security is conspicuous by its absence.

The data contained in Box 6, table Figure 3, are reflected in Figure 3 below.

Box 6**Figure 3**

Historical evolution of the minimum wage in the USA, Canada and Mexico in the last nine years (2016-2024), in Mexican pesos

Source: own elaboration with data from Inegi, SHCP, SE, STPS and LEA UAZ, 2024

The purpose of Box 6, Figure 3, is to provide greater clarity on the historical evolution of the minimum wage in the USA, Canada and Mexico in the last nine years, information contained in Mexican pesos at a parity of 19 pesos per dollar.

With high wages in the USA and Canada, this also translates immediately into life expectancy for each country, as in Mexico it is 70 years, for Canada 83 years and for the USA 76 years, this indicator is important and will be the subject of future research.

Likewise, the total population for the three countries in 2024 is 127.5 million people for Mexico, 333.3 for the USA and just 39.1 for Canada, which can be immediately reflected in the GDP per capita for each country: 11,429 dollars for Mexico, 77,329 for the USA and 56,046 dollars for Canada.

This is a reflection of the Gross Domestic Product for each of the three countries: Mexico with 1.49 billion dollars, USA with 25.5 billion dollars and Canada with 2.18 billion dollars [1]. Returning to the case of Mexico in particular, we should note that in the six-year term of Enrique Peña Nieto (2012-2018), the increase in the minimum wage was very marginal (not exceeding 5 pesos a day), which translated into little purchasing power for the Mexican working class, who had to juggle with the meagre salary they received month after month.

If we look at the figures for 2016 and 2024 for the minimum wage in Mexico, it has increased by more than 173 pesos a day, a very significant figure that far exceeds all the increases that had taken place during the neoliberal period.

If we look at the minimum wage in the penultimate year of Felipe Calderón Hinojosa, it was 57.46 pesos a day, then in the six-year term of Enrique Peña Nieto in 2024, the minimum wage was only 67.29 pesos a day, an increase of only 9.83 pesos in four years, which translates into 2.46 pesos per year, a truly derisory figure.

Under the six-year term of Enrique Peña Nieto in 2016 the minimum wage was 73.04, and by the last year in 2018, the amount had risen to 88.32, that is, an increase of 15.28 pesos in three years, which equates to an average increase over the three years of 5.09 pesos increase per year.

We have that with the six-year term of Andrés Manuel López Obrador, the increase in the minimum wage has been very significant if we compare it with the two previous six-year terms, for the year 2019, the minimum wage was 102.68, now in the year 2024 it is 248.93, an increase of more than 146 pesos, if we divide it over the six years, it will give us an amount greater than 23 pesos per year, an amount that far exceeds the two previous six-year terms that were based on the erroneous thesis that increases in the minimum wage would cause dangerous increases in inflation.

Once again, the neoliberal economic thesis that substantial increases in the minimum wage would increase inflationary processes in Mexico falls of its own weight. [1] All the above figures were obtained from the World Bank for the year 2024.

Box 7

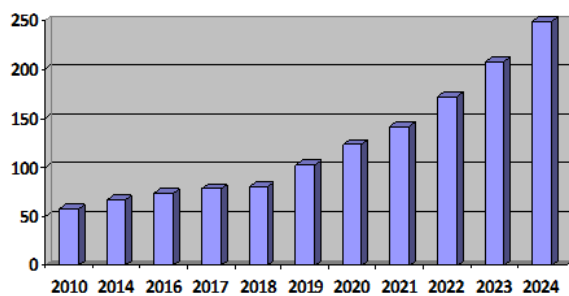


Figure 4
Evolution of the minimum wage in Mexico for the period 2010-2024

Source: Stasis Research Department, INEGI, LEA, 2024

Box 7, figure 4, presents the evolution of the minimum wage in Mexico for the period 2010-2024.

The data used in Box 7, figure 4, are the result of the main statistical agency in Mexico, INEGI, as well as the Laboratory of Applied Economics and the Stasis Research Department of the USA for the years indicated.

As of 1 December 2018, when AMLO takes office, he announces an increase in the minimum wage of 102.68 pesos, exceeding the minimum wage of over 100 pesos per day, an increase that had never been seen before in the PRI governments.

Thus, for the year 2019, the increase to the minimum wage was 20.64 pesos, exceeding the figure of 100 pesos per day, since then, the annual increases have far exceeded what had not been seen since 2018, i.e. an increase of 160.61 pesos, a record figure for minimum wages in the country, hence the importance of this increase that has a direct impact on the consumption of workers.

This strengthens the domestic market, increases production and considerably increases profits for the business class. This is a win-win situation for workers, employers and the government.[1] It should be noted that increases in wages and salaries have a direct impact on workers' consumption.

We should note that increases in adequate minimum wages increase productivity, there is less turnover in companies and in itself, the company and the worker gain in greater welfare.

One of the main characteristics of developed countries in the world has shown that by raising the wages of their workers, the welfare line also increases and thus the Gross Domestic Product increases by 1% per year directly to the extent that the money disbursed by employers goes directly to consume basic goods and services, strengthening of course the domestic market and could also encourage informal workers to move to formality in less time.

An immediate consequence of adequate minimum wage increases is an immediate reduction in the levels of inequality in economic systems, particularly in Mexico over the last six years. With the new economic orientation of the current president of Mexico, the benefits for the working class will continue for the next six years (2024-2030).

Conclusions

Inflation in North America is in a manageable range for the three economic systems, not exceeding 5% per year by the year 2024.

The minimum wage in Mexico is the lowest in North America.

An insufficient minimum wage for the working class implies a decrease in productivity in the work they do.

Insufficient minimum wage means that the economic growth of the system is affected to the extent that the internal market is depressed due to the lack of sufficient money to purchase goods and services, as was the case in the Mexican neoliberal model that lasted for more than 30 years in the Mexican economic system.

Insufficient minimum wage was the result of a great wage inequality in the Mexican economic system, which lasted for thirty years.

The low minimum wage for workers in Mexico was a consequence of an economic policy that favoured the richest and disadvantaged millions of workers.

Based on the National Survey of Occupation and Employment (ENOE), which is produced by INEGI, the proportion of people in Mexico earning up to a minimum wage rose from 8.5 million at the end of 2018 to 19.2 million employed in 2024, a remarkable growth of 10.7 million Mexicans in just six years.

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Preventive service interval extension on Caterpillar 789 and 793 off-highway trucks

Extensión de intervalo de servicio preventivo en camiones fuera de carretera Caterpillar 789 y 793

Córdova-Villanueva, José Gabriel^a, Lino-Gamiño, Juan Alfredo^b, Ríos-Silva, Luis Octavio^c and Méndez-González, Carlos^d

^a Universidad de Colima

^b Universidad de Colima • AIE-7505-2022 • 0000-0002-7022-5438 • 268945

^c Universidad de Colima • 0000-0002-3702-735X

^d Universidad de Colima • 0000-0002-2650-6830

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* jlino@ucol.mx



Abstract

Objective: The project aims to develop and implement contamination control measures to extend the service intervals of Caterpillar 789 and 793 trucks. This will reduce operating costs by extending oil change intervals, maintaining oil quality throughout the lifespan of components and systems. Methodology: The feasibility of Caterpillar's "Committed to Customer Success" program was analyzed in collaboration with TRACSA. The project included simulating results to evaluate the impact of extending service intervals on reducing lubricant consumption, establishing machinery affinities, purchase volumes, suppliers, and maintenance schedules according to the manufacturer's recommendations. Results: The simulation showed significant savings in lubricant use, achieving a 50% cost reduction. Other benefits included prolonging the lifespan of components, better cleaning conditions, reduced handling of used oil, reduced carbon footprint, increased machine availability, and reduced downtime, improving work efficiency and safety.

Resumen

Objetivo: El proyecto busca desarrollar e implementar medidas de control de contaminación para extender los intervalos de servicio de camiones Caterpillar 789 y 793. Esto reducirá los costos operativos mediante la extensión de los intervalos de cambio de aceite, manteniendo la calidad del aceite a lo largo de la vida útil de los componentes y sistemas. Metodología: Se analizó la factibilidad del programa "Comprometidos con el éxito del cliente" de Caterpillar, en colaboración con TRACSA. El proyecto incluyó la simulación de resultados para evaluar el impacto de la extensión de intervalos de servicio en la reducción del consumo de lubricantes, estableciendo afinidades de maquinaria, volúmenes de compra, proveedores y fechas de mantenimiento según las recomendaciones del fabricante. Resultados: La simulación mostró un ahorro significativo en el uso de lubricantes, con una reducción del 50% en costos. Otros beneficios incluyeron la prolongación de la vida útil de los componentes, mejores condiciones de limpieza, disminución del manejo de aceite usado, reducción de la huella de carbono, mayor disponibilidad de las máquinas y reducción de tiempos de inactividad, mejorando la eficiencia y seguridad en el trabajo.

Objective s	Methodolog y	Contributio n

Objetivos	Metodología	Contribuciones

Preventive maintenance, service interval extension, cost savings, Caterpillar

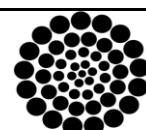
Mantenimiento preventivo, extensión de intervalos de servicio, ahorro de costos, Caterpillar

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Introduction

Peña Colorada is a mining company located in the state of Colima, Mexico. It is primarily engaged in the extraction and processing of iron ore, and is one of the largest mining operations of its kind in the country. The company is located in the municipality of Minatitlán, located in the southwestern region of the state of Colima, an area rich in mineral resources that has been fundamental to the economic development of the region.

Peña Colorada is owned by two shareholders: ArcelorMittal and Ternium, who each own 50% of the shares. It is dedicated to the exploration, extraction and beneficiation of iron ore using state-of-the-art technologies that allow it to promote safe and sustainable mining and thus generate environmental, economic and social benefits in the areas where it operates.

Its operating areas consist of an open-pit mine, a pelletising plant and the Paticajo Industrial Centre, which includes a paste plant, a tailings dam and soon a tailings filtering plant, located in Minatitlán, Colima. The mine's operations also impact some areas in the state of Jalisco.

The mine is located near the mountainous town of Minatitlán and is part of the so-called Cuenca de Hierro (Iron Basin). The ore concentrate travels through a 45 km long ferroduct using gravity to transport the ore with water from the mine to the pelletising plant in Manzanillo, avoiding overland haulage. Eighty-five per cent of the water is recovered, and its strategic location allows easy access to important transport routes that facilitate the distribution of iron ore by rail to Ternium, one of its shareholders in Monterrey, and by ship to Lázaro Cárdenas, where it distributes the other 50 per cent of the pellet to ArcelorMittal.

The Peña Colorada plant is located near Minatitlán, a mountainous town with a natural environment suitable for mining. This strategic location allows easy access to important transportation routes that facilitate the distribution of iron ore both domestically and internationally. The proximity to the port of Manzanillo, one of Mexico's main seaports, is particularly advantageous as it allows for the efficient export of products to global markets.

Strategic Scenario in the Region

Peña Colorada plays a key role in the regional economy of Colima, generating 1,250 direct jobs and more than 3,000 indirect jobs.

Fifty years after its foundation, it maintains a strategy of sustainability and corporate social responsibility, inspired by its purpose of 'Transformation in balance' which is governed by four axes: safety, environment, governance, and community, which are developed in six vectors: education, health, environmental care, infrastructure and productive projects in order to generate well-being among its staff, as well as its other stakeholders.

In addition, Peña Colorada invests in technologies that promote the reduction of the environmental impact of its operations. This includes efforts to rehabilitate and reforest mined lands and implement technologies that minimise the emission of air, land and water pollutants.

Peña Colorada plays a key role in Colima's regional economy. Its presence not only contributes significantly to local employment, but also drives the development of infrastructure and services in the region. The company has adopted a strategy of sustainability and corporate social responsibility, focusing on responsible mining practices and reducing the environmental impact of its operations. This includes efforts to rehabilitate mined land and implement technologies that minimise the emission of pollutants.

In addition, Peña Colorada has positioned itself as an important player in community development, participating in initiatives that improve the quality of life of local communities. These include educational, health and social development programmes that seek to generate a positive and lasting impact in the region.

Peña Colorada Production

Peña Colorada is one of Mexico's leading iron ore producers. The company is mainly engaged in the extraction and processing of iron ore, which is then used in the production of steel.

Over the years, Peña Colorada has maintained a constant production of iron ore, contributing significantly to the national and international supply.

Peña Colorada, one of the main iron ore mines in Mexico, has maintained significant production since 2010. The mine mainly produces iron ore concentrate and iron ore pellets. Below is a summary of Peña Colorada's annual production.

Colorada since 2010:

2010-2015: Annual production averaged approximately 3.5 million tonnes of iron concentrate.

2016: Production reached around 4 million tonnes due to infrastructure improvements.

2017-2018: Production remained stable at approximately 4 million tonnes per year.

2019: There was a slight increase, reaching 4.2 million tonnes.

2020-2021: Despite the COVID-19 pandemic, production remained close to 4.1 million tonnes.

2022: Production was around 4.5 million tonnes, thanks to the modernisation of processing facilities.

2023: Production continued in the range of 4.5 million tonnes, taking advantage of the full capacity of the new facilities.

Iron Ore Prices (2010-2023)

Iron ore prices have experienced significant fluctuations over the last decade due to global economic factors, supply and demand, as well as international trade policies.

Annual Summary by Product and Price

Below is an approximate summary of annual iron ore production and prices from 2010 to date:
2010-2011: Global iron ore production was high, with prices peaking in 2011 at approximately \$168 USD per dry metric tonne.

2012-2015: Prices fluctuated, falling markedly in 2015 to around \$55 USD per tonne due to oversupply.

2016-2017: Prices began to recover slowly, reaching around \$80 USD per tonne in 2017.

2018-2019: Recovery continued, with prices stabilising around \$90-100 USD per tonne.

2020: The COVID-19 pandemic caused disruptions, but prices remained relatively stable due to sustained demand from China.

2021: There was a significant increase in prices, reaching approximately \$162 USD per tonne due to high demand and supply constraints.

2022-2023: Prices showed a slight correction, stabilising around \$120-130 USD per tonne.

In the strategic context, Peña Colorada leverages its location and resources to maintain a competitive advantage in the iron ore market. The company continues to invest in advanced technologies and in improving its production processes to increase efficiency and sustainability. This enables it to respond effectively to market demands and increasingly stringent environmental regulations for the control and preventive maintenance of machinery, as it is an essential practice in the management of industrial operations, ensuring the continuity and efficiency of production processes. In this context, quality control plays a crucial role in ensuring that machinery performs optimally and downtime is minimised. According to Venkatesh and Ravi (2018) 'planned preventive maintenance significantly reduces operating costs and increases the lifetime of equipment' (p. 234).

This approach not only prevents unexpected failures, but also enables proper resource planning and improves safety in the working environment.

Quality

Implementing a robust quality control system in preventive maintenance involves the use of techniques and tools such as failure and effects analysis (FMEA), statistical process control (SPC) and regular maintenance audits (Singh & Kumar, 2017). These methodologies not only help to identify potential problems before they occur, but also provide valuable data for continuous improvement of maintenance processes. According to Chen et al. (2019), ‘the integration of quality systems into preventive maintenance improves the reliability and overall performance of machinery’ (p. 189).

In the same vein, the monitoring and preventive maintenance of machinery are fundamental elements in ensuring the operational efficiency and longevity of industrial equipment. These processes not only minimise the risk of unexpected failures, but also optimise performance and reduce long-term operating costs. The implementation of quality control practices in these procedures is essential to ensure that international standards are met and a consistent level of excellence is maintained.

In this context, ISO 9001:2015 is presented as a key reference framework for quality management in organisations. This standard sets out the criteria for a quality management system (QMS), ensuring that companies can demonstrate their ability to provide products and services that consistently meet customer and applicable regulatory requirements (ISO, 2015). The application of ISO 9001 in the control and maintenance of machinery enables organisations to structure their processes in a way that promotes continuous improvement and customer satisfaction.

Another scenario is the European standard EN 13306:2017 specifies terms and definitions for the maintenance of equipment, providing a uniform basis for the planning and execution of maintenance activities. This standard complements ISO 9001 by providing specific guidelines for maintenance, which helps companies to establish clear and effective procedures (European Committee for Standardization [CEN], 2017).

Together, the integration of ISO 9001:2015 and EN 13306:2017 in the control and preventive maintenance of machinery ensures a systematic and efficient approach. This combination not only improves the quality of maintenance processes, but also contributes to the creation of a safer and more productive operating environment.

Therefore, a project whose purpose is to save money without altering the quality and production in any manufacturing or service process is the ideal plan.

Importance of Heavy Transport Unit Maintenance for Peña Colorada

Proper maintenance of heavy haulage units is crucial to the efficient and safe operation of any mining operation, and Peña Colorada is no exception. The reasons for emphasising the importance of maintenance on these units are diverse and are detailed below.

Safety

Safety is one of the main reasons for keeping heavy haulage units in optimum condition. In mining, operating conditions are extreme, and wear and tear on vehicles can lead to life-threatening mechanical failures. Regular maintenance ensures that vehicles operate safely, minimising the risk of accidents. According to the study by Perez and Gomez (2019). ‘preventive maintenance of heavy machinery in mining significantly reduces occupational accidents’ (p. 45).

Operational Efficiency

Preventive maintenance helps maintain the operational efficiency of vehicles. Well-maintained equipment is less likely to suffer unexpected breakdowns, which means it can operate continuously and efficiently. This is especially important in mining operations such as Peña Colorada, where any disruption can mean significant production losses. Venkatesh and Ravi (2018) highlight that ‘regular maintenance of heavy vehicles improves efficiency and productivity by 20%’ (p. 234).

Maintenance and Repair Costs

Performing regular, preventive maintenance may be more costly in the short term, but in the long term it results in significant savings. Serious mechanical failures, which could have been prevented with proper maintenance, often require costly repairs and prolonged downtime. A study by Singh and Kumar (2017) shows that ‘companies that implement preventive maintenance programmes reduce their repair costs by 30%’ (p. 211).

Equipment Lifetime

Proper maintenance also extends the useful life of vehicles. This means that investments in heavy machinery will pay off over a longer period, which is essential for asset management in a mining operation. According to Chen et al. (2019), ‘preventive maintenance practices can extend the service life of heavy machinery by up to 50%’ (p. 178).

Environmental Impact

Poorly maintained heavy transport units tend to be less efficient in terms of fuel consumption and pollutant emissions. Regular maintenance not only ensures better vehicle performance, but also contributes to reducing the environmental impact of mining operations. Bajwa et al. (2020) point out that ‘proper maintenance of heavy vehicles reduces CO₂ emissions by 15%’ (p. 145).

In the mobile equipment maintenance management and with the help of the local Caterpillar dealer (TRACSA), a project of the ‘Committed to customer success’ programme was developed and implemented.

The feasibility of the Caterpillar programme project was analysed for implementation at the Peña Colorada mining company. A test plan was drawn up and a favourable scenario was simulated, resulting in savings of over 50%, mainly in lubricants.

The simulation not only showed positive savings in the use of lubricants, but also fulfils the additional benefits proposed by the programme such as: a) increased component life and reduced damage to wear parts. b) improved clean area conditions.

Other benefits that were detected in the analysis were: a) The reduction of used oil handling, which is tangible in lower cost for the final disposal of used oil and reduction in the carbon footprint. b) Reduction of effective manpower time in the execution of preventive maintenance. c) Increase in machine availability and reduction of machine downtime; derived from the increased frequency of preventive service interval.

The lubricants per compartment considered in the programme are: Engine, transmission and converter, final drives and differential, hydraulics and brakes, steering and front wheels; some compartments share the same type of oil, however, the treatment and follow-up are different due to the wear elements and the purpose of the oil.

For this it was necessary to establish the affinities of machinery and purchase volume, supplier, maintenance dates.

Current situation

We began by analysing the theoretical consumptions calculated by the equipment manufacturer, as described below, since these are the litres of lubricant that each system or component carries per unit or equipment, as well as the frequency recommended by the manufacturer.

Truck model 793

1. Engine:

- Consumption: 305 litres.
- Frequency of change: every 250 hours.
- Preventive maintenance per year: 24.
- Total litres per year: 7320 litres.

2. Transmission and converter:

- Consumption: 215 litres.
- Frequency of change: every 1000 hours.
- Preventive maintenance per year: 6.
- Total litres per year: 1290 litres.

3. Hydraulics and brakes:

- Consumption: 1256 litres.
- Frequency of change: every 2000 hours.
- Preventive maintenance per year: 3.
- Total litres per year: 3768 litres.

4. Steering:

- Consumption: 282 litres
- Frequency of change: every 2000 hours
- Preventive maintenance per year: 3
- Total litres per year: 846 litres

Total annual litres of lubricant used tot alling
16,935 litres.

Truck model 789**1. Engine:**

- Consumption: 273 litres
- Frequency of change: every 250 hours
- Preventive maintenance per year: 24
- Total litres per year: 6552 litres

2. Transmission and converter:

- Consumption: 78 litres
- Frequency of change: every 1000 hours
- Preventive maintenance per year: 6
- Total litres per year: 468 litres

3. Hydraulics and brakes:

- Consumption: 531 litres
- Frequency of change: every 2000 hours
- Preventive maintenance per year: 3
- Total litres per year: 1593 litres

4. Steering:

- Consumption: 130 litres
- Frequency of change: every 500 hours
- Preventive maintenance per year: 3
- Total litres per year: 390 litres

5. Front wheels:

- Consumption: 44 litres
- Frequency of change: every 500 hours
- Preventive maintenance per year: 12
- Total litres per year: 528 litres

6. Differential control:

- Consumption: 587 litres
- Frequency of change: every 2000 hours
- Preventive maintenance per year: 3
- Total litres per year: 1761 litres

Total annual litres of lubricant used, totalling
11,292 litres.

The maintenance schedule is based on the manufacturer's recommendation, so the frequencies are the same as those recommended by Caterpillar.

Feasibility analysis of the 'Service Interval Extension' programme

The service extension program has the preponderance of extending the frequency of preventive maintenance (PM), so, it would look as follows for a 793 truck in a projection for one year:

1. Engine:

- Consumption: 305 litres
- Frequency of change: every 500 hours
- Preventive maintenance per year: 12
- Total litres per year: 3660 litres

2. Transmission and converter:

- Consumption: 215 litres
- Frequency of change: every 2000 hours
- Preventive maintenance per year: 3
- Total litres per year: 645 litres

3. Hydraulics and brakes:

- Consumption: 1256 litres
- Frequency of change: every 4000 hours
- Preventive maintenance per year: 1.5
- Total litres per year: 1884 litres

4. Steering:

- Consumption: 282 litres
- Frequency of change: every 4000 hours
- Preventive maintenance per year: 1.5
- Total litres per year: 423 litres

5. Front wheels:

- Consumption: 60 litres
- Frequency of change: every 1000 hours
- Preventive maintenance per year: 6
- Total litres per year: 360 litres

6. Differential control:

- Consumption: 997 litres
- Frequency of change: every 4000 hours
- Preventive maintenance per year: 1.5
- Total annual litres: 1495.5 litres

Total annual litres of lubricant used: 8467.5 litres.

The data is organised by vehicle system or component, specifying the volume of lubricant used, the frequency of change, the number of preventive maintenance (Mp) per year and the total number of litres consumed per year. Each system or component is described below:

1. Engine:

- Consumption: 305 litres
- Frequency of change: every 500 hours
- Preventive maintenance per year: 12
- Total litres per year: 3660 litres

2. Transmission and converter:

- Consumption: 215 litres
- Frequency of change: every 2000 hours
- Preventive maintenance per year: 3
- Total litres per year: 645 litres

3. Hydraulics and brakes:

- Consumption: 1256 litres
- Frequency of change: every 4000 hours
- Preventive maintenance per year: 1.5
- Total litres per year: 1884 litres

4. Steering:

- Consumption: 282 litres
- Frequency of change: every 4000 hours
- Preventive maintenance per year: 1.5
- Total litres per year: 423 litres

5. Front wheels:

- Consumption: 60 litres
- Frequency of change: every 1000 hours
- Preventive maintenance per year: 6
- Total litres per year: 360 litres

6. Differential control:

- Consumption: 997 litres
- Frequency of change: every 4000 hours
- Preventive maintenance per year: 1.5
- Total annual litres: 1495.5 litres

The total annual litres of lubricant used by the truck model 793 is 8467.5 litres.

The information is organised by vehicle system or component, detailing the volume of lubricant used, the frequency of change, the number of preventive maintenance (Mp) per year, and the total annual number of litres consumed. Each system or component is described below:

1. Engine:

- Consumption: 207 litres
- Frequency of change: every 500 hours
- Preventive maintenance per year: 12
- Total litres per year: 3276 litres

2. Transmission and converter:

- Consumption: 78 litres
- Frequency of change: every 2000 hours
- Preventive maintenance per year: 3
- Total litres per year: 234 litres

3. Hydraulics and brakes:

- Consumption: 531 litres
- Frequency of change: every 4000 hours
- Preventive maintenance per year: 1.5
- Total annual litres: 796.5 litres

4. Steering:

- Consumption: 130 litres
- Frequency of change: every 4000 hours
- Preventive maintenance per year: 1.5
- Total litres per year: 195 litres

5. Front wheels:

- Consumption: 44 litres
- Frequency of change: every 1000 hours
- Preventive maintenance per year: 6
- Total litres per year: 264 litres

6. Differential control:

- Consumption: 587 litres
- Frequency of change: every 4000 hours
- Preventive maintenance per year: 1.5
- Total annual litres: 880.5 litres

This results in an annual total of 5646 litres of lubricant used. This projection is based on the company's own data.

It can be seen that, as the frequency period increases, the number of MMPP's carried out per year logically decreases; if the frequency doubles its value, the number of MMPP's is divided proportionally, in this case by half.

On the other hand, extending the frequency period causes the equipment to be constantly in the workshop, so, therefore, if the number of MMPPs decreases, the annual downtime decreases, as well as the time on site in the workshop, then fewer working hours would be needed to carry out the MMPPs and fewer stays in the workshop, which logically leads us to believe that the programme is compliant.

It can also be observed that, as the frequency increases, the lubricant period increases, so the volume of waste oil that is discarded decreases. This means that the cost of handling used lubricant decreases in proportion to the project, i.e. by 50%, and therefore the carbon footprint decreases proportionally.

In terms of productivity, as can be seen with the current maintenance plan, the equipment stops 51 times a year, which in annual downtime hours constitutes for equipment 789 an annual downtime of 96 hours and for equipment 793 represents an annual downtime of 112.5 hours.

Likewise, the annual projection of the theoretical consumption of lubricants for a 789.

The information is organised by vehicle system or component, detailing the number of hours required for maintenance, the frequency of maintenance, the number of preventive maintenance (Mp) per year and the total annual hours dedicated to maintenance. Each system or component is described below:

1. Engine:

- Hours per maintenance: 2.5
- Frequency of maintenance: every 250 hours
- Preventive maintenance per year: 24
- Total hours per year: 60 hours

2. Transmission and converter:

- Hours per maintenance: 1.5
- Maintenance frequency: every 1000 hours

- Preventive maintenance per year: 6
- Total annual hours: 9 hours

3. Hydraulics and brakes:

- Hours per maintenance: 1.5
- Frequency of maintenance: every 2000 hours
- Preventive maintenance per year: 3
- Total hours per year: 4.5 hours

4. Steering:

- Hours per maintenance: 1
- Frequency of maintenance: every 2000 hours
- Preventive maintenance per year: 3
- Total hours per year: 3 hours

5. Front wheels:

- Hours per maintenance: 1
- Frequency of maintenance: every 500 hours
- Preventive maintenance per year: 12
- Total hours per year: 12 hours

6. Differential control:

- Hours per maintenance: 2.5
- Frequency of maintenance: every 2000 hours
- Preventive maintenance per year: 3
- Total hours per year: 7.5 hours

The total annual number of hours dedicated to the maintenance of all systems and components of the truck model 789 is 96 hours. As for the annual projection of theoretical consumption of lubricants for a 789, the theoretical consumption of maintenance hours for a 789 model truck is as follows. The information is organised by vehicle system or component, specifying the number of hours required for maintenance, the frequency of maintenance, the number of preventive maintenance (Mp) per year and the total annual hours spent on maintenance. Each system or component is described below:

1. Engine:

- Hours per maintenance: 3
- Frequency of maintenance: every 250 hours
- Preventive maintenance per year: 24

Article

- Total hours per year: 72 hours

2. Transmission and converter:

- Hours per maintenance: 2
- Maintenance frequency: every 1000 hours
- Preventive maintenance per year: 6
- Total hours per year: 12 hours

3. Hydraulics and brakes:

- Hours per maintenance: 1.5
- Frequency of maintenance: every 2000 hours
- Preventive maintenance per year: 3
- Total hours per year: 4.5 hours

4. Steering:

- Hours per maintenance: 1
- Frequency of maintenance: every 2000 hours
- Preventive maintenance per year: 3
- Total hours per year: 3 hours

5. Front wheels:

- Hours per maintenance: 1
- Frequency of maintenance: every 500 hours
- Preventive maintenance per year: 12
- Total hours per year: 12 hours

6. Differential control:

- Hours per maintenance: 3
- Frequency of maintenance: every 2000 hours
- Preventive maintenance per year: 3
- Total hours per year: 9 hours

The table concludes with a total annual maintenance hours of 112.5 hours.

The theoretical result shows that the application shows a proportional reduction of 50% in downtime, so that the equipment increases its theoretical availability by 2% per year.

An annual projection of the theoretical consumption of maintenance hours for a truck model 789 is also provided.

The information is organised by vehicle system or component, detailing the number of hours required for maintenance, the frequency of maintenance, the number of preventive maintenance (Mp) per year, and the total annual hours dedicated to maintenance. Each system or component is described below:

1. Engine:

- Hours per maintenance: 2.5
- Frequency of maintenance: every 250 hours
- Preventive maintenance per year: 12
- Total hours per year: 36 hours

2. Transmission and converter:

- Hours per maintenance: 1.5
- Maintenance frequency: every 1000 hours
- Preventive maintenance per year: 3
- Total annual hours: 6 hours

3. Hydraulics and brakes:

- Hours per maintenance: 1.5
- Frequency of maintenance: every 2000 hours
- Preventive maintenance per year: 1.5
- Total hours per year: 2.25 hours

4. Steering:

- Hours per maintenance: 1
- Frequency of maintenance: every 2000 hours
- Preventive maintenance per year: 1.5

Total hours per year: 1.5 hours

5. Front wheels:

- Hours per maintenance: 1
- Frequency of maintenance: every 500 hours
- Preventive maintenance per year: 6
- Total hours per year: 6 hours

6. Differential control:

- Hours per maintenance: 2.5
- Frequency of maintenance: every 2000 hours
- Preventive maintenance per year: 1.5
- Total annual hours: 4.5 hours

The table concludes with a total annual maintenance hours of 56.25 hours.

Undoubtedly, the previous analysis shows that there is much tangible and significant benefit, so when analysing the needs that are required to migrate the maintenance plan to the new frequency scale we find that Caterpillar proposes the use of the ‘contamination control’ programme, this programme focuses on the order and cleanliness of the exterior and interior of the machine, as well as a culture of order and cleanliness in the tasks performed by the maintenance technician.

This programme manages a method of auditing the process of execution of the tasks, which has 2 important preponderant edges, the follow-up of the health of the components, which manages a standard ISO cleaning code and an audit guide to follow up the quality of execution of preventive maintenance under the contamination control programme.

Based on our 2021 experience and history of component repairs being sent for repair due to hours compliance, the following is proposed for the overall percentage:

- Engine 24%
- Transmission 12% Hydraulics and brakes
- Hydraulics and brakes 25%
- Steering 15% Front wheels
- Front wheels 17% Final drive and differential
- Final drive and differential 7%

From the above it can be seen that the main damages found are due to contamination, partial loss of teeth and abrasion, loss of geometry and wear. The above shows that one cause of failure is due to contamination of abrasive particles in the lubricant, so that the Caterpillar programme shows as a benefit the reduction of costs for repair or replacement of premature parts derived from wear due to contamination. To demonstrate this, specific failures in each component are analysed, concluding that savings are possible, however, at the moment it is intangible as it depends on other variables yet to be determined.

Development of the test plan

The elaboration of the plan starts in May 22. It consists of the following points:

- a) Use ultra-high efficiency filters and vents.
- b) Implementation of the contamination control programme.
- c) Follow-up of laboratory results on oil condition and management to ISO specifications.
- d) Audit contamination control programme.

The test plan was carried out in 3 events:

- I. Installation, training and equipment.
- II. Start-up and monitoring of results
- III. Preparation of an executive evaluation report for authorisation or rejection by the company's executive committee.

In the 1st stage, with the support of the local Caterpillar dealer, training on the ‘*service interval extension*’ programme is given to all personnel, in which the objective of the programme, operational needs and requirements are addressed. Specialised needs, tools, equipment and accessories are developed and procured to make the appropriate modifications, thereby implementing the operating procedures. An action protocol is developed in case during the test any component fails or is damaged, ranging from the analysis of a possible omission during the installation or operation of the maintenance; as well as the uninstallation of the devices of all equipment to be tested.

This process took 3 months, as the company was still suffering from the COVID-19 pandemic, which complicated the transfer of samples to the oil laboratory. Another limitation was the training of personnel, which was carried out by 4 people per 4 sections to cover a total of 16 hours per technician. With regard to the need for tools, accessories for maintenance and the new system itself, a list of requirements was drawn up, which was classified into consumable parts for machinery, installation accessories and equipment. Tables 1 and 2 show the list of spare parts required for the test.

Box 1**Table 1**

Parts requirement for the 793F

Name	No. Parte	Quantity required	Required in MP's
Reducer	061-9593	1	NO
Bushing			
Coupler	190-8318	1	NO
Hydraulic	122-6870	10	NO
Hoise 1/2 -10ft Permanent	124-1920	2	NO
Coupling			
Dust Cap	201-8059	1	NO
Coupling	4c-5088	1	NO
Pipe Nipple	005-8615	1	NO
Coupler	1908319	1	NO
Adapter	1945182	1	NO
Dust Cap	2018059	1	NO
Service Tee	1L403	1	NO
Service Tee	11N8559	1	NO
Connector	456678	3	NO
Pressure Gauge	8T0863	1	NO
Ball Valve	8C1358	1	NO
Elbow	0039163	1	NO
Connector	0043099	1	NO
Hydraulic Hose CM	4568421	300	NO
Permanent	1241969	2	NO
Coupling			
Adapter	1480209	1	NO
Adaptator 2 in	1935903	1	NO
Adaptator 4 in	1935900	1	NO
Codo 45°	0015262	1	NO
Codo 90°	3H9690	1	NO
Hydraulic Hose (4.572 m) CM	4568458	460	
Hose Coupling (1-11 ½ NTP)	1241909	1	NO
Pipe Coupling (1-11 ½ NTP)	3B6491	1	NO
Bolt	8T4137	2	NO
Hard Washer	8T4121	2	NO
Head	4905253	1	NO
Bolt	0S1618	4	NO
Hard Washer	8T4224	4	NO
Filter	2237809	1	OK
Pipe Connector	2965728	2	NO
Hydraulic Hose CM	456-8423	213	NO
Permanetn	3025293	1	NO
Coupling AS Hydraulic Hose CM	4568423	160	NO
Permanent	3025293	1	NO
Coupling AS			
Half Clamp	2V0600	4	NO
Clip	1443935	2	NO
Bolt	8T4956	2	NO
Nut	8T4244	4	NO
Hard Washer	8T4223	2	NO
Filtro separador	4227587	3	OK
Filtro	4385386	2	OK
Filtro	1R1809	1	OK
Filtro	3400403	1	OK
Hidraulico			

*Source: Own elaboration***Box 2****Table 2**

Parts requirement for 793c

Name	No. Parte	Quantity required	Required in MP's
COF	6198180	1	NO
Front Table	2047392	1	NO
Sprocket			
Sprocket, HCO, Steering and Transmission	18832420	1	NO
Sprocket differential and controls	2461157	1	NO
Adapter 2 in	1935903	1	NO
Adapter 4 in	1935900	1	NO
45° elbow	0015262	1	NO
90° elbow	3h9690	1	NO
Tube	2529171	1	NO
Seal O Ring	1757897	1	NO
Bolt (3/8-16X1.25-IN)	9B7237	3	NO
Washer-Hard	5P1075	3	NO
Couple-Quick Dis	1908322	1	NO
Cap-Dust	2018552	1	NO
Bolt	8T4137	2	NO
Hard Washer	8T4121	4	NO
Head	4905253	1	NO
Bolt	0S1618	4	NO
Hard Washer	8T4224	4	NO
Filter Fuel Tank	2237809	1	OK
Pipe Connector	2965728	1	NO
Bolt	8t4224	2	NO
Thread Boss	9R9866	2	NO
Clip	7D1553	2	NO
Tee-S	5P2242	1	NO
Adapter-Pipe	8C3999	1	NO
Base	1050381	1	NO
Bolt(3/8)	0T0055	2	NO
Filter Hydraulic	1R0750	1	OK
Hydraulic Filter	1391536	1	OK
F H Steering	1328875	2	OK
Filter	2444484	4	OK
Fuel Filter	4227587	2	OK
Fuel Filter	1R0750	1	OK
Transmission	1328876	2	OK
Filter			
Parking Filter	1328875	1	OK
Primary air filter	2925863	2	OK
Transmission filter	1328875	1	OK

Source: Own elaboration

To ensure success, an action protocol is drawn up in which an internal talk is given to the personnel involved in order to ensure that the traceability of the tests is not lost. The protocol is designed and authorised in conjunction with the local Caterpillar dealer and the multidisciplinary areas of Peña Colorada, determining immediate actions in case of failure, attention, etc., and a table (Table 3) of additional replacements in case of shortages.

Box 3**Table 3**

Parts requirement for the 793c

789		
F. Used	Description	Alternative filter
1R+0722	Hydraulic Filter	139-1536
1R-773	Hydraulic Filter	132-8875
1R-716	Filter	244-4484
1R-755	Fuel Filter	422-7587
1R-750	Fuel Filter	1R-0750
132-8876	Filter	132-8876
132-4875	Filter	132-8875
251-5886	Air foot filter	292-5863
IR-0719	Transmission filter	132-8875
793		
Utilizado	Description	Alternative filter
18-0755	Fuel filter	422-7587
438-5386	Separator filter	438-5386
328-3655	Filter	1R-1809
340-0403	Filter	340-0403
4t6788	Hydraulic Filter	223-7809

Source: Own elaboration

On the other hand, the equipment required is an oil filtering system to reduce the amount of solids that are in the oil, for this, 2 filtering devices are designed and 1 is built to start the tests which will filter oil for the hydraulic system, the second one is pending its manufacture as there was a stoppage in the factories that built the filters for this equipment.

Box 4**Figure 1**

Filtering device

Source: Own elaboration

The laboratory has 3 categories to determine the quality of the oil result, green no action, this means that the result is within acceptable values, yellow follow up, this indicates that the lubricant result is within acceptable values but it is recommended to replace the lubricant, pass it through a filtering system or check the component for any beginning of damage in any component and red immediate stop, this indicates that it is out of acceptable values and requires oil replacement and physical check of the compartment or system as it may present serious damage in a component. The selection of equipment to carry out the test was based on the results of the last 6 months, the equipment must be completely (% Normal - Green) and (% Monitor - Yellow), this can be seen in tables 4 and 5.

Box 5**Table 4**

Oil monitoring of a 789

Id of the asset	% Normal	% Monitor	% Action	Total General
3-66	100.00%	0.00%	0.00%	40
3-67	100.00%	0.00%	0.00%	50
3-56	93.48%	7%	0.00%	46
3-68	92.11%	5%	2.63%	38
3-59	91.94%	8%	0.00%	62
3-64	90.74%	9.26%	0.00%	54
3-60	90%	8%	2%	50
3-62	89.29	11%	0.00%	28
3-58	88%	12.00%	0.00%	25
3-61	87.27%	12.73%	0.00%	55
3-57	87.10%	12.90%	0.00%	62
3-63	86.84	13.16%	0.00%	38
3-65	85.71	11.90%	2.38%	42
3-69	81.63%	18.37%	0.00%	49

*Source: Own elaboration***Box 6****Table 5**

Oil monitoring of a 793

Id del activo	% Normal	% Monitor	% Action	Total General
03-83	88.89%	11.11%	0.00%	9
03-76	78.00%	22.00%	0.00%	50
03-90	74.51%	25.49%	0.00%	51
03-78	73.68%	26.32%	0.00%	19
03-79	73.44%	26.56%	0.00%	64
03-81	72.73%	27.27%	0.00%	33
03-75	71.70%	28.30%	0.00%	53
03-77	70.00%	30.00%	0.00%	60
03-74	64.91%	35.09%	0.00%	57
03-80	63.16%	36.84%	0.00%	38
03-91	60.38%	32.08%	7.55%	53
03-82	50.00%	46.88%	3.13%	32

Source: Own elaboration

In the 2nd stage, prior to the start-up, 3 teams with a yellow result (% Monitor) and 3 with a green result (% Normal) were selected, giving a total of 6 teams 789 as shown in table 4; and 6 teams 793, as shown in table 5.

The start-up of the test was planned to begin in September-22, but due to the effects of COVID-19, it was moved to February-23 and also had an impact on the installation, so the test had to be reduced from 12 to 9 teams, as shown in table 6.

Execution of the test plan and monitoring of the results

In the 2nd stage, as shown in table 6, the test began in February 23 and ended in July 23. Although the plan was to install the devices in all the equipment in 2 weeks, it had to be extended to months due to the needs of the company and the effect of COVID-19, as there was a shortage of some spare parts, which prevented the test from starting as planned.

Evaluation of the project with the company's executive committee

Stage 3 is divided into three important processes:

- Analysis of results and feasibility, as a 1st step the whole team involved in the test meets and reviews the results of the test, they evaluate if the test was successful or if it has to be redone. For this project, it is a series of meetings that can take several weeks, as they have to review each of the results issued by the laboratory, compare it with the maintenance logs, mark in detail the traceability of the object of study, discard and evaluate the objects of study whose result was not altered by other variables; in the end converge if the test is successful or not. If the test is not successful, the test is revised and redone, depending on the process manager; however, if the test is successful, the feasibility and ROI of the project is evaluated.

- Authorisation of project implementation. Once the information is ready and evaluated by the team, a short presentation is prepared and presented to the area management, who is the only authority to authorise the modification of procedures or processes within the company. If the implementation is not approved, the reasons for the rejection are listed and evaluated again by the personnel involved. If the implementation is authorised, a format called 'Change Management' is presented; this format has a number of authorisations that are headquarters, management and direction.
- Implementation. When the project is presented to the management, the plan of activities necessary to carry out the implementation is presented. In the case of the project, we are still working on evaluating the scope of the activities, since we have to disseminate the programme to all staff, create a training plan, modify some job descriptions, develop or modify procedures and protocols, which in turn, must be understood and disseminated by all staff involved, among other activities.

Methodology to develop

The present research work is classified as mixed, using a quantitative and qualitative context:

a) Qualitative.

For the present work, an integral theoretical text analysis is carried out. It is conducted in a natural environment without controlling the observed phenomenon, i.e. the company is analysed as referred to in the phenomenological part, on the other hand, it is inductive through the readings.

b) Quantitative.

Firstly, the measurement of the phenomenon is established by means of a Likert scale supported by a descriptive and comparative statistical analysis of variances, in order to test a hypothesis, with the intention of analysing an objective reality, in order to generate results on the phenomenon studied.

Mixed research integrates both quantitative and qualitative research, this is used when a greater understanding of the problem is required, as quantitative data allows the data to be analysed statistically or, as in this case, it was carried out through surveys to answer the questions.

Results

There were different factors of the Peña Colorada company, the test was carried out in 9 equipments (5 equipments 789 and 4 equipments 793) and only in the hydraulic system.

For the selection of the equipment, the aforementioned analysis was applied again to arrive at a result as shown in the (referred tables of test equipment). So the final table is as shown in table 6 analysing the table, in the 1st column is the type of model, if it is 789 or 793; in the next column the economic number or id of the equipment, in the 3rd column the system to be checked, which for this test the hydraulic system was selected, in the 4th column is documented the date of installation of the accessories, in the next column the filtering and in the last column the date of replacement.

Box 7

Table 6

Test record

Mod	Team		0 hrs	2000hrs	4000hrs
			Installation	filtered	Replacement
793	3075	Hydraulic	01/04/2023	03/07/2023	17/11/2023
793	3076		13/02/2023	04/07/2023	27/10/2023
789	3059		23/02/2023	04/07/2023	31/10/2023
789	3057		01/04/2023	12/07/2023	14/11/2023
789	3067		27/03/2023	19/07/2023	15/11/2023
789	3066		30/05/2023	21/09/2023	07/02/2024
789	3060		31/05/2023	22/10/2023	30/01/2024
793	3092		07/07/2023	13/11/2023	01/04/2024
793	3074		20/06/2023	24/11/2023	17/05/2024

Source: Own elaboration

The oil condition results focus on:

a) Condition and contaminants; we assess the physical integrity of the oil such as viscosity.

b) Additives.

c) ISO cleanliness code.

Figure 2 has 3 lines, the red ones cut vertically describe the test period and the blue one the 2000 hrs period, which, for this test, the oil is entered into the filtration system for different periods of time.

Also, some units were considered to remove the filter elements to see if there is any difference.

Equipment 3057, the test starts in March-23 and ends in November-23, prior to the start of the test, the laboratory reports indicated the presence of chromium (Cr) in concentrations of 4µ and 6µ as can be seen in graph 4; on the day (01-abl-23), when the oil is changed and remains at 0 hours of work, the contamination in the oil had a high concentration of chromium (Cr), However, when the oil is changed for new oil, most of the particles are removed, leaving the remainder in the system. For this reason, and due to the function of the filters, the values of 4µ and 6µ were lower and increased in the following two months, as a result of the work of the equipment. When the filtering was carried out on 21-Jul-23, the result issued by the laboratory was high, this was due to a bad oil sampling technique, so it was verified and from September-23 the results were favourable until the end of the period. At the end of the period

Box 8

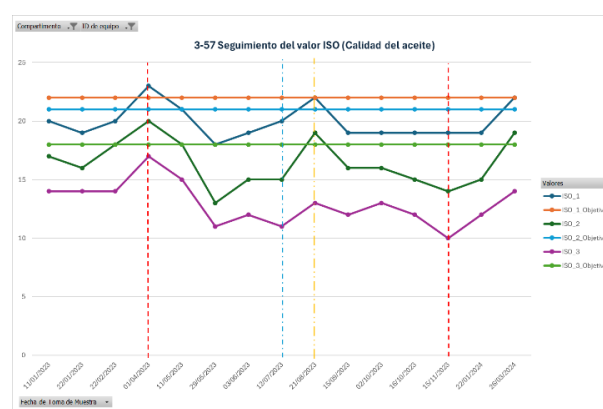


Figure 2

ISO value monitoring (oil quality)

Source: Own elaboration

The result of the 3057 test was favourable since the chemical composition and the detergents of the oil remained within the expected values, as can be seen in graph 3. With regard to the presence of solids such as chromium (Cr) in sizes of 4 and 6 μ , it is observed that, when changing the oil to new oil in a contaminated system, the concentration of particles is reduced to 93% and by the effect of the filter it is reduced by 6%.

If we look at figure 5, on 12-07-23 the expected values in the ISO cleanliness code and in the particle sizes were maintained as shown in figure 4; however, omitting the result of the sample of 21-Aug-23, after filtering the oil, it is observed that it returns to within the ISO contamination values without altering the chemical characteristics of the oil.

The result of 21-Aug-23 is discarded as it is proved that it was a contaminated sample due to a bad sample extraction technique.

Box 9

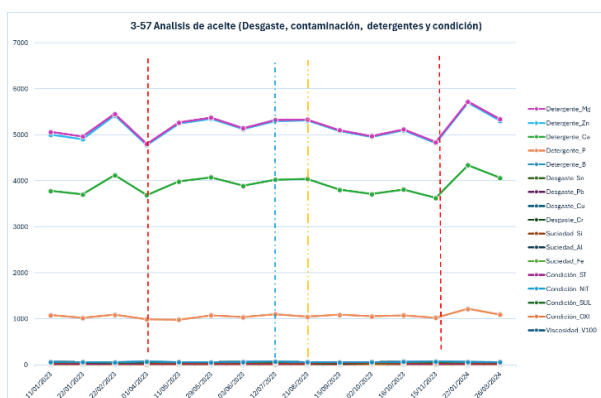


Figure 3
3-57 Oil Analysis (Wear, Contamination, Detergents and Condition)

Source: Own elaboration

Box 10

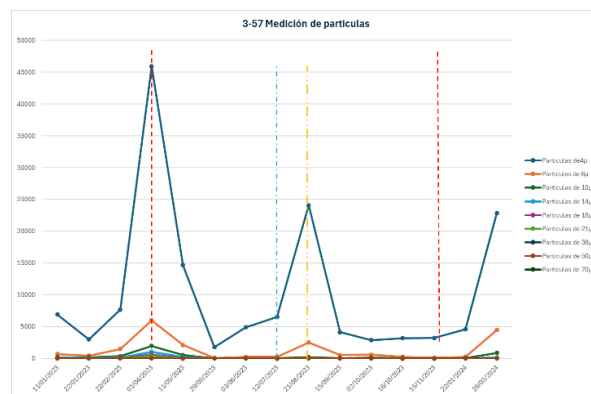


Figure 4
3-57 Particulate Measurement

Source: Own elaboration

Box 11

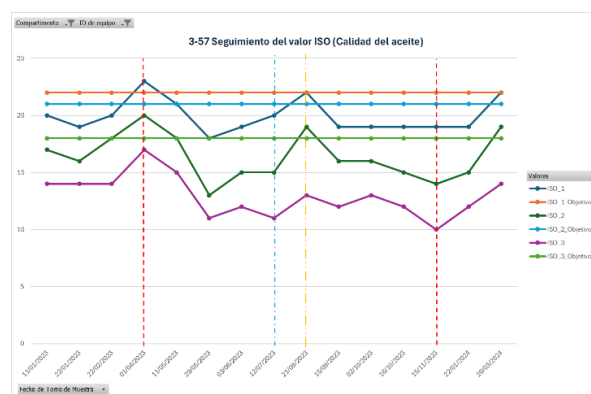


Figure 5
3-57 Monitoring of ISO value (Oil quality)

Source: Own elaboration

The 3-59 is an equipment that has sustained a history of 0 contamination incidences, in figure 6 the contamination by wear and detergents shows a stable behaviour, in figure 7 all ISO values are below the limit allowed by the test and being relevant that the values remain very low.

For this equipment, the filtering time was increased to 3 hours, so when analysing figure 6, it can be seen that after filtering in the 3 hour period, the contamination values decreased.

Box 12

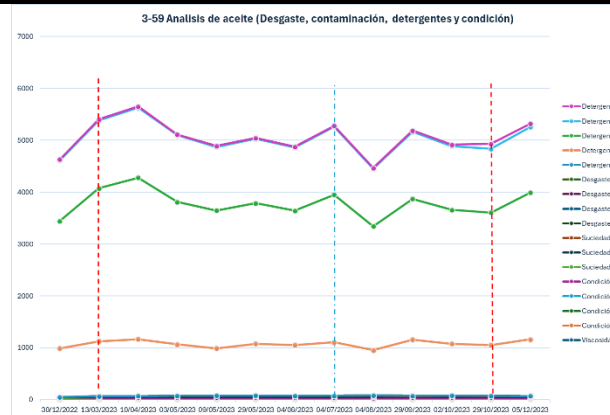


Figure 6

3-59 Oil analysis (Wear, contamination, detergents and condition)

Source: Own elaboration

The results show that the method of the programme proposed by Caterpillar to extend the oil change interval is possible as long as the method is applied; however, the cost reduction is not proportional, nor is it 50% as there are other variables not considered such as extra consumables that decrease that value, i.e. each time the oil was cleaned, the cleaning device was replaced with filters in order to ensure proper cleaning, this cost is not included in the initial plan, however, the economic impact it has is 7.6% for the use of 6 new filters, less than 10µ for the filtration system for a 2000hrs service and replacing the oil level represents 0.7%.

In order to evaluate the reduction in the execution time of activities, the time and motion technique is applied, sampling the execution of the execution of oil filtering in 4 pieces of equipment and the replacement of oil and filters in a 2000 hour service. Comparing the results, to carry out the filtration activity, 1 technician is required and the other activities are parallel to this; however, when the replacement of all the oils is carried out, which is at 4000 hrs, an average of 3 technicians are required. At the end of the cycle, it is in equilibrium and no improvement is observed. As it is such a short time interval and there are other multivariables in the mining process that complicate the calculation of the real value of the incremental benefit, however, through the time and motion analysis it is observed that there is no change of pace in the execution of the 2000hrs maintenance, therefore no increase in the KPI of equipment availability is observed.

Table 7 describes the dynamics that would take place in longer intervals, as can be seen, in the particular case of hydraulic oil that is executed at 2000hrs, every time filtering is performed, the oil replacement can be done in parallel or simultaneously, however, there are other factors that can improve the time and therefore show a decrease in time.

Box 13

Table 7
Test record

Interval	0 hrs		1000 hrs		2000 hrs		3000 hrs		4000 hrs		5000 hrs		6000 hrs		7000 hrs		8000 hrs		9000 hrs		10000 hrs		
	New	Filtered	New	Filtered	New	Filtered	New	Filtered	New	Filtered	New	Filtered	New	Filtered	New	Filtered	New	Filtered	New	Filtered	New	Filtered	
Serv 1000																							
Serv 2000																							
Serv 4000																							

Source: Own elaboration

Another point associated as a benefit of the programme is the decrease in the cost of handling used oil is analysed as follows, in other equipment of the same characteristics, the amount of used hydraulic oil that is discharged at 2000hrs is counted on 4 occasions, so there is a loss possibly caused by the attention to failures or oil work, however, this loss results in an average of 11%, in the exclusive case of hydraulic oil, and considering the value of sale to a 3rd party for treatment, this item represents 0.6% of savings of the project.

Although it is somewhat intangible, maintaining a good standard of order and cleanliness in the work area denotes the quality of the maintenance carried out by the technician, as well as promoting the prior cleaning of compartments, hoses, valves, components, etc., to avoid the entry of external agents that contaminate the system. As can be seen in image 1, it is a bay that has just been used and the technicians begin to clean the traces of dust left by the equipment on entry.

Box 14

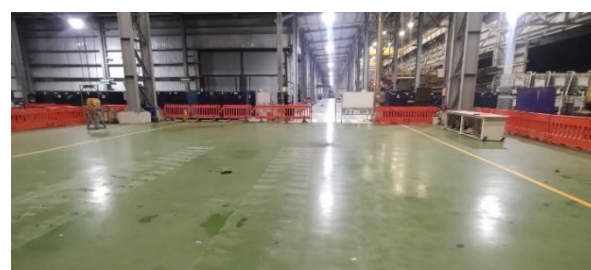


Figure 1
Clean ship or bay

Source: Own elaboration

There is something that the programme does not mark as a benefit that was detected with the filters recommended by the programme, in the 3-67 test it had several failures and they were repaired in the area where there was no controlled environment and the system was exposed mainly to silicon (Si), the benefit of the filter is that it managed to capture the particles and bring the oil within ISO values, despite the different oil replacements. Another unit that showed considerable variation was the 3-66, where, at the end of the test, the filters were removed and replaced with the other filters, and we observed an increase in particulates of 4μ .

An unprovable benefit at the moment is the reduction of costs for a repair of a component, since, in order to validate, research and follow-up is required.

We can evaluate the project through this small test where the oil interval is doubled. If we consider that the initial saving of the programme is 50%, there is a positive benefit for oil handling of 0.6%, and a loss of 0.7% for the replacement cost, another loss of 7.7% for the special filters in the filtration system; the maintenance interval programme offers a saving in oil consumption for the hydraulic system of 42.2%.

Authors' contribution

Specify the contribution of each researcher in each of the points developed in this research.

Córdova Villanueva, José Gabriel: He contributed with the basic idea of the project and is the company's floor engineer.

Lino Gamiño, Juan Alfredo: I contributed with the planning and logistics support, methodological support.

Ríos Silva, Luis Octavio: I contributed with the financial analysis report that was delivered to the company.

Méndez González, Carlos: Review and style support.

All authors provided theoretical support and field support.

Availability of data and materials

The data are the property of the company and were only provided for this work. Some of the material can be requested from jlino@ucol.mx

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Analysis of the factors that determine the attraction, development and retention of human talent in Latin American and the Caribbean countries

Análisis de los factores que determinan la atracción, desarrollo y retención de talento humano en los países de América Latina y El Caribe

López-Jiménez, Sergio Felipe*^a, Álvarez-Ochoa, Martín^b, Lino-Gamiño, Juan Alfredo^c and López-Sánchez, Lina Marleny^d

^a Universidad de Colima • AFV-4613-2022 • 0000-0001-6524-8435 • 268955

^b Universidad de Colima • LIC-4060-2024 • 0000-0003-2645-5962 • 252137

^c Universidad de Colima • AIE-7505-2022 • 0000-0002-7022-5438 • 268945

^d Universidad Pedagógica y Tecnológica de Colombia • KMY-8494-2024 • 0000-0002-8948-0658 • 963984

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* [\[sflopezj@ucol.mx\]](mailto:sflopezj@ucol.mx)



Abstract

The purpose of the research is analyse which factors and how they influence determining the attraction, development and retention of human talent in the countries of Latin America and the Caribbean. This research is documentary-descriptive and the analytical-synthetic method was used. Data from the Global Talent Competitiveness Index 2023 were used. Both the input and output pillars were reviewed and to the end it was possible to identify the reasons why the countries of Latin America and the Caribbean are attractive, how economic development is generated and why they retain human talent.

Resumen

El propósito de la investigación es analizar cuáles factores y cómo influyen para determinar la atracción, el desarrollo y la retención de talento humano en los países de América Latina y El Caribe. Esta investigación es documental-descriptiva y se utilizó el método analítico-sintético. Se utilizaron los datos del Índice Global de Competitividad del Talento 2023. Se revisaron tanto los pilares de entrada, como los de salida y al final se pudieron identificar las razones por las que los países de América Latina y El Caribe son atractivos, cómo se genera el desarrollo económico y por qué retienen al talento humano.

Analysis of the factors that determine the attraction, development and retention of human talent in Latin American and the Caribbean countries		
Objetivo	Metodology	Contribution
Analyze the entry and exit pillars of the Global Talent Competitiveness Index to determine how they influence the attraction, development and retention of human talent.	This research is documentary-descriptive and the analytical-synthetic method was used.	Based on the analysis of the input pillars: Enable, Attract, Grow and Retain, as well as the output pillars: Professional and technical skills, and Global knowledge skills, it is possible to design innovative strategies.

Análisis de los factores que determinan la atracción, desarrollo y retención de talento humano en los países de América Latina y El Caribe		
Objetivo	Metodología	Contribución
Analizar los pilares de entrada y salida del Índice Global de Competitividad del Talento para determinar cómo influyen en la atracción, desarrollo y retención de talento humano.	Esta investigación es documental-descriptiva y se utilizó el método analítico-sintético.	A partir del análisis de los pilares de entrada: Habilitar, Atraer, Crecer y Retener, así como de los pilares de salida: Habilidades profesionales y técnicas, y Habilidades de conocimiento global, es posible diseñar estrategias innovadoras.

Competitiveness, Motivation, Human talent

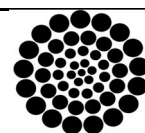
Competitividad, Motivación, Talento humano

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Introduction

Analyzing the factors that determine the attraction, development and retention of human talent in Latin American and Caribbean countries is a very important economic, social and global competitiveness issue. This analysis addresses how LAC countries can maximise the value of their human talent, the most valuable asset for sustainable growth and innovation in an increasingly competitive world.

This analysis is critical because human talent is the key driver of innovation, productivity and economic growth. Countries that do not invest in attracting and retaining talent risk falling behind on the global stage. In many Latin American and Caribbean countries, there is a phenomenon of ‘brain drain’, where talented professionals emigrate in search of better opportunities in other countries.

Capable, motivated and committed human capital not only boosts the region's economy, but also contributes to improving quality of life, reducing inequalities and promoting a more united and innovative society.

In the era of digital transformation, knowledge-based economies occupy privileged places that give them competitive advantages. Latin America and the Caribbean must prepare for these transformations by establishing policies and projects that foster talent development in emerging economies.

The added value of this research is that from the analysis of the input pillars: Enable, Attract, Grow and Retain, as well as the output pillars: Professional and technical skills, and Global knowledge skills, it is possible to design innovative strategies tailored to current needs and challenges.

The article is made up of the following sections:

1. Human Talent: a description of what it consists.
2. Attraction, Selection, Development and Retention: a definition of each of these concepts.

Human Talent

Human talent is the most valuable asset that companies possess; the development and proper functioning of organisations depends on them. According to Gary Dessler and Biju Varkkey (2020), human talent is ‘the set of skills, knowledge and abilities that people possess and that are essential for the effective and efficient performance of work tasks, thus contributing to the achievement of organisational objectives’ (p. 45).

With the passage of time, an important evolution has been generated that involves both workers and companies, representing a competitive advantage for those that know how to strategically manage the knowledge, skills and abilities of people. This dynamic allows organisations to carry out their processes in a synchronised and proactive manner.

This evolution is mainly due to two core factors: globalisation and technological development. These factors have contributed to the gradual extinction of rigid production models, giving way to flexible organisational schemes that generate added value by incorporating Information and Communication Technologies (ICT) in most of their processes.

It is worth noting that technological advances have contributed to transforming society. Gradually, people have moved away from physical tasks (mostly for men) and those inherent to home care (usually performed by women), to give way to intellectual activities. In the case of women, during the 1950s it was very common to see them spending most of their time on household chores and daily shopping for food supplies, as it was not easy to keep them unrefrigerated in good condition for a long time. With the arrival of household appliances, women began to dedicate more time to their academic education, to acquire products and services exclusively for women and to work in companies carrying out increasingly sophisticated activities (Jericó, 2008).

On the other hand, it is important to highlight the disruptive effect that technology has (Figure 1), since in addition to being a factor of change in society, it also allows people to understand how things work at a given time.

Box 1

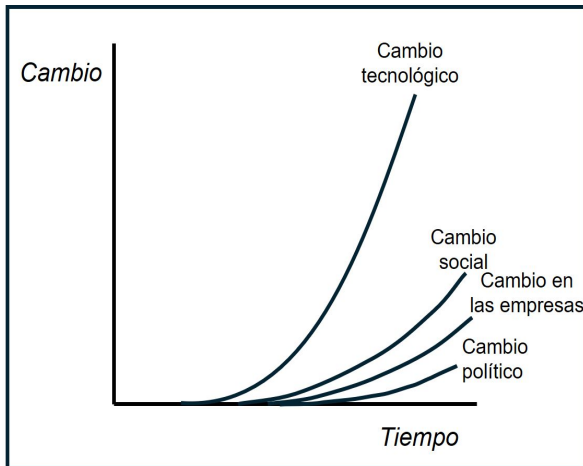


Figure 1
The law of disruption

Source: Downes, L. and Mui, C. (1998)

The force of technology, globalisation and social change on human talent has placed it at the forefront of organisational dynamics, as it is not an abundant capacity in companies. Business success depends on talented professionals (Table 1), mainly on the ability of their workers to perform some activity.

Box 2

Table 1
From the traditional worker to the talented professional

Traditional worker	Profesional con talento
Loyalty to the organisation.	Loyalty to himself, his team and his projects.
Search for stability.	Passion for action and change.
Medium level of trust.	High level of confidence.
Long-term career plan.	Expects to be with the company for a short time.
Focus on salary and position.	Focus on personal growth, opportunity and money.
Would like a balanced life.	Demands a balanced life.
Fear of change.	Comfortable with change.
Adjustment to new technology.	Use of technology as second nature (Habit).
Works long hours.	Prefers to be judged by results.
Believes that management is able to respond to everything.	Wants management to be consistent.
Can operate in environments where fear is used.	Does not operate in fearful environments. Needs room for manoeuvre.
Motto: 'Work hard and succeed'.	Motto: "Work well, enjoy your work and excel".

Source: De Miguel, A. (2000)

An increasing number of companies are putting their efforts to recruit the best candidates for positions ahead of projects on: increasing non-industrial service activities or transforming material goods, analysing the technology to be incorporated into the organisation to make its processes more efficient, or integrating global economies through trade and financial movements. Their priority at the moment is to seek, find, recruit, hire, develop and keep talented people (Figure 2).

Box 3

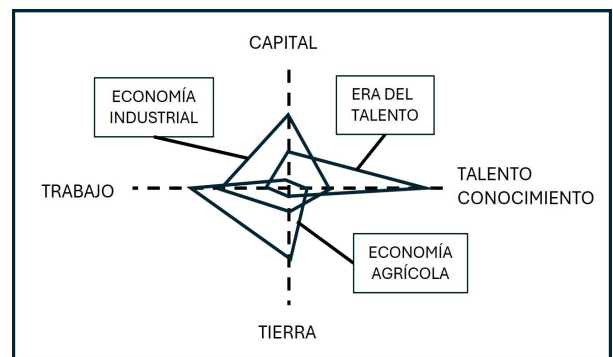


Figure 2
The evolution to the Talent Era

Source: Bueno, E. (1999)

Attraction, selection, development and retention

It is the responsibility of senior management to create conditions that make companies *attractive* to the professionals they wish to recruit. In addition to basic aspects such as security, peace of mind and protection, among others, talented people require freedom and autonomy to commit themselves to the organisation.

From the first interview or contact with the company, it must be made clear to applicants the essential aspects that form part of the organisational DNA, what emotional salary they will be offered, as well as the rights and obligations they will have once they join the work team (Jericó, 2008).

No matter how competent the candidate for a position may be, and no matter how hard you try to motivate him or her, it will be difficult to establish a serious commitment to the company if it does not manage to move his or her emotions.

It must be clear what value proposition he or she will receive, what the company will provide to attract his or her attention, how it will motivate him or her and how it will get the candidate to accept the proposal.

In order to exceed the expectations of prospects, companies must first apply a high dose of self-criticism, something that does not usually happen in Western cultures, which are distinguished by highly bureaucratized customs. Talented people prefer settings that guarantee success, where they can work with freedom and autonomy to develop professionally, not places where fear is used to control them.

With regard to *selection*, each company applies different methods, some prefer verbal interviews, others prefer to go to unusual places such as sporting or leisure events in search of talent.

In these meetings with people, in addition to checking their academic qualifications, another aspect that attracts them is to discover or intuit the emotional intelligence (a fundamental quality for establishing a commitment) that the candidates possess.

It is not new that selection processes leave both parties dissatisfied, both the companies and the people chosen. According to Pilar Jericho (2001), in a study conducted with 150 organisations covering large companies, non-profit organisations, as well as small and medium-sized enterprises, it was found that 49% of the executives surveyed responded that the company that had hired them 'poorly' fulfilled the expectations of the position they had been given in the selection process, while 15% did not know or did not answer. On the other hand, 77% of the executives who requested a professional for a position they needed to fill indicated that their level of satisfaction was 'low', with respect to the degree of suitability of the people selected for the position to be filled.

For human talent to *develop* and reach levels of excellence, it is necessary for people to be in a company where such development is promoted, but which also motivates them. It has been proven that human talent goes beyond logical-mathematical intelligence. All people are born with talent, but it is clear that human beings do not have the talent to develop any activity.

According to Juan Carlos Cubeiro (2000), human talent does not depend on people's IQ, the prestige of the family to which they belong, or the quality of the educational centre where the person has been trained, but on other requirements, among which are: 'the motivation they have (to enjoy what they do and have fun), the tools of knowledge (to perfect it), to generate new habits (to materialise actions) and availability (to invest in development)'.

In addition, David McClelland (1989) mentions that it is not enough to have developed especially one of the five groups of emotional competencies: a) Self-awareness, b) Self-management, c) Motivation, d) Empathy and e) Social qualities, but it is necessary for people to have a special strength in each of them to reach the 'critical point'.

The *retention* of human talent is not a simple task, nor is there an infallible recipe that companies must follow to retain their workers, it depends on the prevalence of many factors in the companies, for example: leadership style (Table 2), organisational climate and culture, motivation, among others.

Box 4

Table 2

Leadership styles

Style	Characteristic phrase	Basic objective
Orientative	"Come with me".	Providing employees with a long-term vision and guidance.
Trainer	"Inténtalo".	Long-term development of people.
Participatory	"What do you think?"	Creating commitment and generating new ideas and initiatives.
Afiliative	"People first."	Creating harmony with and among employees.
Imitative	"Do as I do".	Immediate completion of tasks with a high level of excellence.
Coercitive	"Do as I say."	Immediate completion of tasks.

Source: Goleman, D. (2000)

On the other hand, care must be taken not to abuse imitative or coercive leadership styles, as these are the ones most frequently used by managers, as well as becoming an obstacle to the development of professional skills and the generation of commitment, which in the long term causes talented professionals to change companies.

In this respect, it is important to note the difference between a manager and a leader (Table 3). The leader is distinguished by being risk-takers and not being afraid to delegate, while the manager is distinguished by controlling, rather than leading, monopolistic companies where human talent management is not a strategic priority.

The leader focuses more on achieving short- and long-term goals, promotes meaningful emotions in his or her collaborators and moves away completely from the limelight when the contributions of others must be acknowledged. The manager is the opposite, seeking to be the centre of attention, to be publicly recognised and adulated, to give the impression that everything is possible thanks to his or her intervention, without recognising the contributions of his or her team.

Box 5

Table 3

Differences between leader and manager

The manager:	The leader:
Administers.	It innovates.
Is a copy.	It is original.
Maintains.	It develops.
Accepts reality.	It questions.
Focuses on systems and structure.	It focuses on people.
It is short-termist.	It has a long-term perspective.
He asks how and when.	It asks what and why.
He looks at the result.	It sets its sights on the horizon.
Imitates.	It originates.
It accepts the status quo.	It tries to challenge it.
He is a good soldier.	It is itself.
He gets things right.	It does the things that need to be done.

Source: Bennis, W. y Goldsmith, J. (2010)

The commitment of the people

According to Juan Roig Alfonso (2006), business success is based on the Universal Law of Reciprocity (LUR), where the first thing is to give, to satisfy people's needs. Subsequently, you must ask for what you need from those people and finally you must demand from them if they do not fulfil their commitments.

The construction of commitment (Figure 3) must involve the talented professionals and the company. An employee's commitment to his or her company is realised when he or she brings value to the company and wants to stay with it. While the company's commitment to its people is perceived through the emotional and rational salary.

Box 6

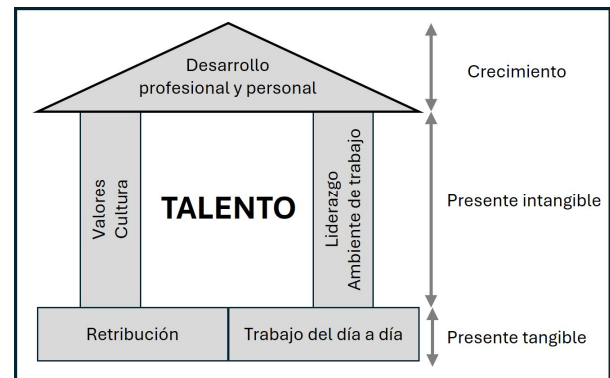


Figure 3

Policies to build commitment

Source: Jericó, P. (2008)

Emotional commitment arises when people are committed to the company where the existing work environment generates trust and security, together with the good relationship they have with their leader or immediate boss. On the other hand, rational commitment arises when workers consider that the company for which they provide their services is the best option for them to work or because they like the fact that the project leader promotes the professional development of the members of their team and they consider that there they will have the opportunity to grow professionally and aspire to better positions.

It is also important that companies include in their strategic plans the development of the principles or values that best describe them, and above all, that they put them into practice, so that when faced with a difficult or uncertain moment, they can remain strong and united to overcome it.

Companies are responsible for always shaping a valuable intangible environment that represents competitive advantages by integrating business values, culture and organisational climate, enjoying what is done, offering fair compensation, as well as executing a guiding, empowering or participative leadership to reinforce the daily commitment of talented professionals.

Global Talent Competitiveness Index (GCTI)

Since 2013, The Global Talent Competitiveness Index (GTCI) has become a global benchmark in the field of talent competitiveness, thanks to the initial support of the Human Capital Leadership Institute (HCLI) in Singapore, as well as the European Institute of Business Administration (INSEAD).

From the inception of this project to date, there have also been important contributions from companies such as Adecco (a global leader in HR solutions), TCS (a company specialising in IT consulting and services) and Google, key players in the field of employment generation and strategies for harnessing human talent (Lanvin and Monteiro, 2023).

Methodology

The present research is of the documentary-descriptive type and the analytical-synthetic method was used.

The total number of indicators used for the analysis was 69, which were divided into *input* and *output* pillars. The *inputs* allow to identify what countries are doing to produce and acquire talent, while the *outputs* help to assess the type of skills that are available to them as a result.

The input pillars considered are: Enable, Attract, Grow, and Retain, while the output encompasses Professional and Technical Skills, and Global Knowledge Skills.

The Enable pillar includes the following dimensions and variables:

1. Regulatory overview.

- Effectiveness of government.
- Rule of law.
- Political stability.

- Regulatory quality.
- Corruption.

2. Market overview.

- Degree of market dominance.
- Domestic credit to the private sector.
- Cluster development.
- R&D expenditure.
- ICT infrastructure.
- Urbanisation.

3. Business and employment outlook.

- Labour rights.
- Worker-management cooperation.
- Professional management.
- Relationship between remuneration and productivity.
- Business software.
- Cloud computing.
- Companies with a website.

The Attract pillar includes the following dimensions and variables:

1. External openness.

- Regulatory restriction of Foreign Direct Investment (FDI).
- Financial globalisation.
- Migrant population.
- International students.
- Brain gain.

2. Internal opening.

- Tolerance towards minorities.
- Tolerance towards immigrants.
- Social mobility.
- Economic empowerment of women.
- Gender parity in highly skilled jobs.
- Leadership opportunities for women.

The Grow pillar includes the following dimensions and variables:

1. Formal education.

- Professional enrolment.
- Tertiary education expenditure.
- Reading, mathematics and science.
- University rankings.

Article

2. Lifelong learning.

- Master of Business Education.
- Prevalence of training in companies.
- Employee development.

3. Access to Growth Opportunities

- Delegation of authority.
- Inclusion of youth.
- Use of virtual social networks.
- Use of virtual professional networks.

The Conserve pillar includes the following dimensions and variables:

1. Sustainability

- Pension coverage.
- Social protection.
- Brain retention.
- Environmental performance.
- Vulnerable employment.

2. Lifestyle.

- Personal rights.
- Personal security.
- Medical density.
- Sanitation.

The Professional and technical skills pillar includes the following dimensions and variables:

1. Middle Level Skills.

- Labour force with secondary education.
- Population with secondary education.
- Technicians and Associate Professionals.
- Labour productivity per employee.

2. Employability.

- Ease of finding qualified employees.
- Relevance of the education system to the economy.
- Skills mix.
- Highly educated unemployed.

The Global Knowledge Skills pillar includes the following dimensions and variables:

1. High-level skills.

- Labour force with tertiary education.
- Population with tertiary education.
- Professionals.
- Researchers.
- Senior officials and managers.
- Digital skills.

2. Talent impact.

- Innovation results.
- High-value exports.
- Software development.
- New business density.
- Articles in scientific journals.

Of these, 49 are high-income countries, 34 are upper middle-income countries, 39 are lower middle-income countries and 12 are low-income countries.

On the other hand, the regional distribution was follows: 9 countries are in Central and South Asia, 15 countries are in East and Southeast Asia and Oceania, 39 are in Europe, 19 are in Latin America and the Caribbean, 18 are in North Africa and West Asia, 2 countries are in North America and 32 are in Sub-Saharan Africa.

Results*a) Global overview*

The top ten places in the 2023 ranking of the IGCT scores are occupied by high-income developed countries: Switzerland (1), Singapore (2), the United States of America (3), Denmark (4), the Netherlands (5), Finland (6), Norway (7), Australia (8), Sweden (9) and the United Kingdom (10).

In contrast, the countries in the bottom 10 are characterised by low and lower-middle income countries: Madagascar (125), Mauritania (126), Mali (127), Guinea (128), Burkina Faso (129), Angola (130), Mozambique (131), Ethiopia (132), Democratic Republic of Congo (133) and Chad (134).

European countries continue to dominate the IGCT rankings, occupying 17 of the top 25 positions. Switzerland held the top spot for 2023, followed by Singapore and the United States. This has been the unchanging trio from 2013 to date.

Of the other non-European countries in the top 25 are: Australia (8), Canada (13), New Zealand (18), the United Arab Emirates (22), South Korea (24) and Israel (25). The most notable change in the 2023 top 25 was that, for the first time, Japan did not appear, ceding that position to South Korea, also for the first time.

b) Latin America and the Caribbean

In the Latin America and Caribbean region, the countries with the five highest scores in the Global Talent Competitiveness Index 2023 were Chile, Uruguay, Costa Rica, Trinidad and Tobago and Argentina.

In the Enable pillar, the five top-ranked countries were Uruguay, Chile, Costa Rica, Jamaica and Brazil.

In the Attract pillar, the five top-ranked countries were Costa Rica, Chile, Uruguay, Trinidad and Tobago and Jamaica.

In the Grow pillar, the five top-ranked countries were Uruguay, Chile, Costa Rica, Mexico and Argentina.

In the Retain pillar, the five best-placed countries were Chile, Uruguay, Trinidad and Tobago, Argentina and Costa Rica.

In the Professional and technical skills pillar, the top five countries were Trinidad and Tobago, Chile, Jamaica, Argentina and Costa Rica.

While in the Global Knowledge Skills pillar the top five countries were Chile, Colombia, Brazil, Mexico and Costa Rica.

According to the Global Talent Competitiveness Index 2023, the countries that lagged the most in Latin America and the Caribbean are Guatemala, Honduras and Nicaragua.

c) Chile, the best indicators

As can be seen, Chile is particularly strong in the Attract and Retain pillars. In the Attract pillar, Chile shows a high degree of Internal Openness that derives from good social inclusion and advances in issues related to gender equality.

The Retain pillar is mainly driven by Chile's broad pension coverage, which has a positive impact on its Sustainability ranking. The country's lowest rankings are in the two outcome-related pillars Vocational and Technical Skills and Global Knowledge Skills.

A higher proportion of technicians and associate professionals would boost its position in the Mid-Level Skills sub-pillar, while an increase in the proportion of researchers, senior officials and managers would raise its ranking in High-Level Skills.

Conclusions

Understanding and acting on the factors that determine the attraction, development and retention of human talent is essential for Latin American and Caribbean countries to develop sustained economic growth. Investing in education, innovation, improved working conditions and human development, in addition to retaining talented people, will also attract the most outstanding professionals globally, consolidating a solid foundation for economic and social development.

Over the next decade, talent competitiveness will become even more important as a critical element for competitiveness, innovation and geopolitical power. This will apply to nations as well as to cities and public and private companies.

Competition for talent will become increasingly aggressive. As international uncertainties and tensions continue to accumulate money through trade, investment, politics and diplomacy, more conflicts over talent are expected. This will be encouraged by the growing needs to address internal tensions in labour markets and the increasing tendency to adopt nationalist and political stances on issues such as immigration or "helping those most in need".

Important aspects of the world of work will be uprooted by a combination of increasingly pervasive factors, including: new expectations and attitudes of younger generations, the emergence of new economic and organisational models, as well as new possibilities offered by technologies such as Artificial Intelligence.

Developed cities and regions will pave the way for new talent strategies and talent-based innovation. Quality of life and sustainability will be key assets to attract talent and become talent hubs. In this uncertain world that is fast moving into the future, skills and education will remain the strategic tools that will provide workers with opportunities to contribute to economic and social growth in a meaningful way.

Statements

Conflict of interest

The authors declare that they have no conflicts of interest. They have no known competing financial interests or personal relationships that might have appeared to influence the article reported in this paper.

Authors' contribution

López Jiménez Sergio Felipe: Contributed with the idea of the project, analysis of various concepts, research method, analysis of indicators and drafting of conclusions.

Álvarez Ochoa Martín: Contributed to strengthening the theoretical framework and the analysis of indicators.

Lino Gamiño Juan Alfredo: Contributed to strengthening the analysis of the input and output pillars.

López Sánchez Lina Marleny: Contributed to broadening and strengthening the theoretical framework, as well as providing quantitative and qualitative information from Colombia and Chile.

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Abbreviations

GTCI	The Global Talent Competitiveness Index
HCLI	Human Capital Leadership Institute
IED	Inversión Extranjera Directa
IGCT	Índice Global de Competitividad del Talento
INSEAD	Instituto Europeo de Administración de Negocios

LUR	Ley Universal de Reciprocidad
TIC	Tecnologías de la Información y la Comunicación

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Sustainability reports in Mipymes with GRI standards

Informes de sostenibilidad en las Mipymes con estándares del GRI

Gutiérrez-Rangel, Héctor Fabián^{*a}, Tamayo-Contreras, Porfirio^b and Espinosa-Mosqueda, Rafael^c^a  Universidad de Guanajuato •  0000-0002-7068-4490 •  745113^b  Universidad de Guanajuato •  0000-0002-3448-7721^c  Universidad de Guanajuato •  0000-0002-1415-0355

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*  [\[fabiangr@ugto.mx\]](mailto:fabiangr@ugto.mx)

Abstract

The 2030 agenda of the United Nations (UN) issued a series of objectives regarding sustainability as a result of various problems that arise in our world, such as climate change, poverty, inclusion, equality, equity and education. Quality among others. In this context, the UN has been working for several years on strategies to have a better world. One of these strategies was the global pact of shared values and principles between businessmen and civil organizations, with the aim of giving a human face to the global market through the adoption of ten principles in the areas of human rights, labor standards, the environment and anti-corruption. In turn, 17 sustainable development goals (SDGs) were created, where all actors can influence by helping to implement strategies that contribute to a better world.

Objective	Methodology	Contribution
Design a guide for MSMEs in Mexico to issue reports on sustainability.	The method used in this research is qualitative, exploratory and documentary.	Guide for issuing reports on sustainability in Mipymes in Mexico.

Sustainability reports, GRI, ODS

Resumen

La agenda 2030 de la Organización de las Naciones Unidas (ONU) emitió una serie de objetivos en materia de sostenibilidad a raíz de diversos problemas que se presentan en nuestro mundo, como el cambio climático, la pobreza, la inclusión, igualdad, equidad y educación de calidad entre otros. En este contexto, la ONU ha trabajado ya por varios años en estrategias para contar con un mundo mejor. Una de esas estrategias fue el pacto mundial de valores y principios compartidos entre empresarios y organizaciones civiles, con la finalidad de dar un rostro humano al mercado mundial a través de la adopción de diez principios en las áreas de derechos humanos, normas laborales, medio ambiente y anticorrupción. A su vez, se crearon 17 objetivos de desarrollo sostenible (ODS), donde todos los actores pueden incidir coadyuvando en la implementación de estrategias que coadyuven a un mejor mundo.

Objetivos	Metodología	Contribución
Diseñar una guía para que las Mipymes en México emitan reportes en materia de sostenibilidad	El método utilizado en esta investigación es de carácter cualitativo exploratorio y documental.	Guía para la emisión de reportes en materia de sostenibilidad en las Mipymes en México.

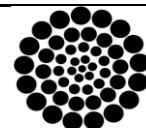
Reportes de sostenibilidad, GRI, ODS

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Introduction

Mexico as a member country of this body has worked hand in hand with various bodies for the adoption and monitoring of the SDGs. The Financial Reporting Standards Board in Mexico (CINIF), in May 2024 published the first two sustainability reporting standards (ISRS). The first one NIS A-1 oriented to the conceptual framework of sustainability reporting standards and the second one NIS B-1 related to core sustainability indicators. Undoubtedly, business models in Mexico are changing as a result of the new regulatory requirements in this area and it is therefore important that the business sector in all its representations adopt new strategies to continue in the current markets in accordance with sustainability trends.

This paper aims to generate a guide for micro, small and medium-sized enterprises (MSMEs) to adopt and operate strategies that allow them to contribute to the achievement of some of the 17 SDGs and to monitor the indicators through the issuance of sustainability reports.

In this context, we will first review the current sustainability regulations based on the standards proposed by the Global Reporting Initiative (GRI), a non-profit organisation whose members have worked internationally with organisations in order to lay the foundations for entities to issue sustainable reports.

Theoretical framework

As a result of the implementation of the SDGs, various concepts have been developed in administrative management to provide a basis for justifying the actions of organisations. In this sense, Rivas (2023) defines corporate sustainability as companies that create economic, social and environmental value in order to contribute to the well-being of the communities where they operate and of future generations. On the other hand, Amezcua (2023), assures that sustainability aims to preserve, protect and conserve resources for both present and future generations, ensuring their continuity and use, in such a way as to guarantee a better and, above all, sustainable planet for the future.

Amezcua (2023) also considers that the concept of Corporate Social Responsibility (CSR) is related to the concepts of sustainability and sustainability, since a company assumes responsibility for the impacts of its decisions and activities on society, communities and the environment through ethical and transparent behaviour.

For this reason, a socially responsible company contributes to sustainable development, taking into account the vision of its shareholders and stakeholders and above all abiding by all regulations in an integral manner. At the international level, the International Sustainability Standards Board (ISSB) is an independent body that was established in 2021 by the IFRS Foundation (International Financial Reporting Standards Foundation) with the aim of developing a global set of financial reporting standards on sustainability. These standards seek to improve the comparability and reliability of the information that companies disclose about their environmental, social and governance (ESG) impacts to help investors make informed and aligned decisions to contribute to the SDGs. In March 2023, the ISSB published the first two standards known as IFRS S1 which refers to the General Requirements for Disclosures on Sustainability Related Financial Reporting and IFRS S2 which focuses on organisations' climate-related reporting. They also set out clear rules on what information companies must disclose about their ESG performance. This means that ESG reporting will be more comparable and reliable, which in turn will give greater confidence to all stakeholders in the market.

In addition, the Integrated Reporting Framework (IIRC) issued a set of principles and guidelines to help companies produce integrated sustainability reports that effectively communicate actions to stakeholders. The Global Reporting Initiative (GRI), on the other hand, is an independent organisation that develops global standards for sustainability reporting. These standards, known as GRI standards, provide a framework for companies and organisations to communicate their environmental, social and governance (ESG) performance in a transparent and comparable manner.

Literature review

Servín (2023), analysed the evolution and importance of the accounting profession for sustainability reporting that includes issues such as climate change, food security and social equity, and how indicators contribute to the Sustainable Development Goals (SDGs). Undoubtedly, management and accounting must work hand in hand and adapt to new realities, integrating sustainability knowledge into their daily practice and highlighting the importance of continuous training on these issues. On the other hand, Cruz (2023) highlights that sustainability has been the driving force for change in different areas, but actions in business, regulatory or fiscal environments have not been sufficient in the face of the challenges of environmental damage and poverty.

In recent decades, business leaders have sought to align their goals with at least one of the 17 Sustainable Development Goals (SDGs), thus integrating sustainability principles into their business models. Among the most common strategies to achieve this transition are eco-innovation, pollution prevention, circular economy, eco-efficiency and clean technologies. The responsibility for implementing these actions lies with top management, which requires leaders capable of meeting these challenges (Cruz; 2023).

For a company to be truly sustainable, its management must have a social focus, seeking future opportunities through the identification of key factors that promote the creation of sustainable value. In this sense, today's businesses must be managed with a sustainable vision that embraces social aspects, transparency and legitimacy, in order to create a more environmentally responsible future. As Cruz (2023) points out, it is important to take stakeholders into account and give a voice to vulnerable communities, fostering an environment of change, learning and adaptation. In Mexico, the challenge for the business sector is to incorporate in its mission and vision to contribute to the fulfilment of an action of the SDGs.

When talking about sustainability in both environment and finance, it is often believed that they are unrelated, but in reality they are connected in several ways. Integrating the economic, environmental and social spheres is key to improving as a society and ensuring a better quality of life for future generations. This way of thinking emerged in the 1980s, in particular with the sustainable development model proposed by the UN in 1986. The effort towards sustainability is reflected in the 2030 Agenda, which includes 17 goals and underlines the crucial role of business.

González (2023), highlights that in recent decades business sustainability has gained importance, making it necessary to understand its historical evolution in order to grasp its current and future relevance for business. Economic growth driven by technological and scientific advances in the 20th century also brought negative effects on the environment, as companies did not prioritise the protection of natural resources. In this context, the concept of sustainability.

The implementation of global standards and their possible enforceability will push companies to include environmental impacts in their organisational culture. Although progress in the fight against climate change may be perceived as slow, the business approach has allowed progress to be made without relying exclusively on national or international regulations. Businesses now incorporate sustainability as a key component of their mission, vision and strategies in the short, medium and long term. This is a great challenge for micro, small and medium-sized enterprises in Mexico, as they do not see it as something important to address because of their culture. However, if there were agile mechanisms and tax benefits that would allow them to incorporate sustainability actions into their management, they could have a great impact on contributing to the SDGs.

On the other hand, Carrillo and Galarza (2022) point out that social responsibility has acquired a prominent role in both business and academia. In this context, several South American organisations produce sustainability reports using various methodologies.

The publication and online availability of these reports is crucial to keep stakeholders and the general public informed. The study identifies the sectors with the highest percentage of reports in each country and relates the number of reports to GDP per capita, highlighting Peru, Brazil, Colombia and Argentina as the countries with the most reports under the GRI methodology.

The study by Inglés da Costa, et al (2023), highlights the importance of issuing financial information on the social dimension, especially in the external sphere of organisations. In addition, they identified environmental activity and capital ownership structure as factors indicative of the levels that would be reported in such reports. The conclusions suggest that future studies should apply multivariate statistical techniques such as correspondence and discriminant analysis, in order to observe indicative, as well as explanatory or conditional factors of the levels of voluntary evidence of socio-environmental reporting in Brazilian companies.

Methodology

The method used in this research is of an exploratory and documentary qualitative nature with the aim of consulting the current regulations on the issue of sustainability reports in companies and also to investigate how international and national organisations are adopting management models to adapt their strategies to the new paradigms that require companies to contribute to the development of the SDGs in order to have a more humane global market.

Research question

Are there regulations that facilitate financial reporting on sustainability in MSMEs in Mexico?

Propositions

The Sustainability Reporting Standards NIS A-1 and B-1 allow the issuance of financial reports on sustainability in companies.

The Global Reporting Initiative (GRI) standards enable the adoption of corporate governance and facilitate the issuance of financial reporting on sustainability.

Objective

To design a guide so that MSMEs in Mexico can adopt a management system that allows them to meet some of the Sustainable Development Goals by issuing sustainability reports.

Results

Currently there are regulations related to the issuance of sustainability reports, in order to contribute to the SDGs of the 2030 agenda. It is an important challenge for authorities worldwide that micro, small and medium-sized enterprises (MSMEs) adopt these practices, since in many Latin American countries they represent the economic engine of the country. This section will address different methodologies that have been proposed by international organisations for the issuance of sustainability reports.

Magaña (2023) presented the Guide to Key Indicators (GCI), an essential tool for companies to prepare sustainability reports and monitor their compliance with the Sustainable Development Goals of the 2030 Agenda. The GCI has 34 indicators that make it easier for companies to integrate sustainable practices into their operations and reporting. The GCI is based on simplicity and existing frameworks, ensuring the relevance and application of the indicators determined for various industries and types of entities.

Some of the criteria considered were relevance to at least one SDG monitoring indicator, universality that can be applied to all entities, comparability of reporting across industries, as well as the ability to facilitate convergence of financial and non-financial reporting principles and data.

The 34 indicators have been suggested, covering economic, environmental, social and institutional performance areas. For each indicator the guide provides the definition, measurement methodology, possible sources of information and relationship to the SDGs. Some of the indicators are:

A. Economic area

Revenue

Green investment

Article

Total investment and development expenditure

Social area

Proportion of women in management positions

Percentage of employees covered by collective bargaining agreements

Environmental area

Recycling and water use

Water stress

Hazardous waste generation

Energy efficiency

Institutional area

Number of council meetings and attendance rate
Corruption incidents

In business activity, the methodology for obtaining environmental data involves sustainability management (De la Rosa-Leal, 2009, 2021), consisting of:

Definition of areas with environmental and social effects in the company.

Evaluation and weighting of the risk analysis of environmental issues.

Communication of environmental indicators, in qualitative and/or quantitative information.

Qualitative or quantitative measurement of the effect caused, suffered or prevented by the environmental indicators and their relationship with the company's position and results (De la Rosa Leal, 2021).

Among the environmental indicators are emissions and discharges, typified by law: water, air, soil, waste, noise, the result of combustion and production processes, solid, liquid and gaseous waste, wastewater (De la Rosa-Leal, 2009; Mejía Soto, Montilla Galvis, and Montes Salazar, 2010; De la Rosa Leal, 2021), which contribute to global warming and the deterioration of the quality of ambient air, soil and aquifers.

In this sense, the Inter-American Development Bank (IDB) (2021) proposes as an effective assessment an analysis methodology composed of:

A comprehensive environmental analysis with all the basic aspects:

A broad analysis in relation to the development process and a formal analysis in relation to legal requirements.

The proposal establishes that analysing the environmental impact of an organisation from the inside responds to a creative innovation of the organisation's management, which incorporates environmental sustainability as part of the business model, in which anthropogenic actions are related to preventive attention. Socio-environmental indicators (Garmendia Salvador, Salvador Alcaide, Crespo Sánchez, and Garmendia Salvador, 2010 cited by De la Rosa Leal, 2021) can be:

Social sustainability indicators;

Environmental sustainability indicators; and Economic sustainability indicators.

Socio-environmental indicators vary between companies and require a process of understanding that relates to accounting standards, accounting fundamentals, costs, environmental auditing, environmental education, policy and advocacy with the sustainable development approach to be accountable to society for their impacts (Silva Da Rosa, Joao Lunkes, Dahmer Pfitscher, Ripoll Feliu, and Crespo Soler, 2012).

The next step is the identification of environmental impacts and their control in corporate environmental management through environmental policies as control criteria, and the correlation with appropriate methods of valuation and measurement of environmental vulnerability and its translation into financial, economic and social resources, a situation that is under debate.

With a view to environmental attention, the proposed sustainable business management strategy is the ESG (Environmental, Social and Governance) system as a guideline for environmental management in a feasible and viable proposal for the company.

This system changes the Sustainable approach to Sustainable and implements it in a feasible management ad hoc to corporate business interests, leaving behind what it does not consider necessary in its socio-environmental proposal. Where the sustainable approach maintains the focus on the balance of social, economic and environmental axes, while the sustainable approach decides on the degree of economic feasibility, not necessarily on the balance (Archer, 2022).

ESG management aims to involve in the company's business model, vision, goals, standards and use of assets to achieve an openness to social and environmental aspects with its medium and long-term governance intervention, becoming a system of environmental risk control, as well as the exercise of its capacity and interest to respond financially and socially to its investors (Archer, 2022; De la Rosa Leal, 2023a).

With the corporate approach, the International Finance Corporation (IFC) (IFC, 2021a) establishes two types of ESG performance indicators applicable to financial institutions and companies in the management of environmental and social issues, such as standard management indicators and risk assessment indicators.

Based on these indicators, in order to manage risks in agricultural companies and their supply chain, the International Finance Corporation (IFC), the private sector representative of the World Bank, has developed eight environmental and social sustainability performance standards (Bastida Cañada, 2022; IFC, 2021 b).

Assessment and management of environmental and social risks and impacts; Standard 2. Labour and working conditions; Resource efficiency and pollution prevention; Health, safety and community protection; Standard 5; Land acquisition and involuntary resettlement (applicable to companies involved in acquiring land to develop new or expand existing land); Biodiversity conservation and sustainable management of living natural resources (applicable to companies with impacts on modified natural habitats, wildlife and ecosystem services); Standard 7.

Indigenous peoples (applicable to companies with impacts only on indigenous peoples); and Cultural heritage (applicable to companies with impacts only on cultural heritage).

The IFC proposal links environmental performance and assessment with the Sustainable Development Goals of the UN 2030 Agenda, discriminating when they should be applied, a situation that brings to the table the degree of understanding of environmental issues and added value. Thus, socio-environmental indicators are related to the production or service process and at the same time are independent of each other, which allows for corrective and preventive actions (De la Rosa Leal, 2021).

For example: generation of greenhouse gases, water scarcity, concentration of pesticides in water, excess of pH in water and soil, community with related diseases, soil contamination, among others, which arise from the analysis and distinction of risks of actions and significant effects on natural resources, quality of working and community life (De la Rosa Leal, 2021).

In this context, the management development framework is continuous and interdisciplinary, which corrects possible negative impacts on the environment in advance, while optimising the positive ones, leading to decisions and commitments on regional economic policy and the quality of community life (Inter-American Development Bank, 2001).

The Global Reporting Initiative (GRI) is a non-profit organisation whose purpose is to generate standards that facilitate sustainability reporting by any type of organisation. Since 2001, the GRI indicators have established criteria for disclosure and sustainability reporting as a complement to financial accounting statements. It is currently the most widely used international guide for the preparation of these reports.

In this context, for the purposes of this research, it is proposed to adapt the GRI standards to MSMEs in order to make a proposal for the issuance of financial information that is achievable and adaptable for this business sector.

The intention is for the business sector in Mexico to acquire a culture of care for the environment and above all a process of continuous improvement towards a sustainable business. Therefore, a sustainability report should contain economic, environmental, social and governance information, as shown in figure 1.

Box 1

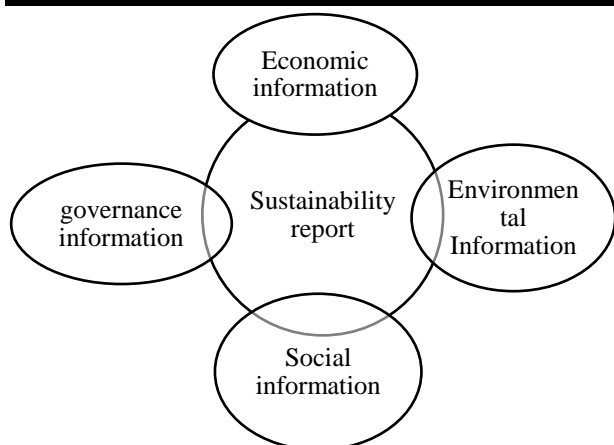


Figure 1
Elements of a sustainability report
Source: Prepared by the authors with information from the Deloitte 2018 study

Likewise, the GRI standards are structured in universal and thematic standards interrelated to each other, to facilitate the issuance of comparable and quality reports for decision making. Table 1 provides a general description of the structure to facilitate understanding.

Box 2

Table 1
Structure of the GRI standards

Universal Standards	Thematic standards
GRI 101: Fundamentals Describes the principles for defining the content and quality of the report.	
GRI 102: General Content Used to indicate contextual information about the entity and its sustainability reporting practices. Includes information on the organisation's profile, strategy, ethics and integrity.	200 Series: Economic standards 300 Series: Environmental standards 400 Series: Social standards These are made up of various thematic standards and are used to present information on the impacts of an organisation on economic, environmental and social issues
GRI 103: Management Approach Used to provide information on how the entity manages the material issue, i.e. it allows the organisation to explain why a particular issue is material, where the impacts occur and how the entity manages the risk.	

Source: Own elaboration with information from Deloitte 2018 study.

In addition, the GRI standards propose two options for those organisations that wish to prepare their sustainability reports in accordance with the standard; one of them is the essential one, which contains the minimum information necessary to understand the nature of the organisation, its material issues and related impacts and how these are managed; the second is the exhaustive one, which is created from the essential option and additionally requires information on the strategy, ethics, integrity and governance of the organisation. In this sense, a guide is proposed for the MSME sector in Mexico that involves both options in such a way that it is clear and can be applied and adopted by the majority of the entities' leaders.

Firstly, an action plan should be generated to train entrepreneurs in Mexico on the importance of contributing to the SDGs and having a better world; after that, it is important that entrepreneurs implement an action plan to incorporate elements of sustainability into the vision and values of the company; then it is important to identify the thematic standards to be reported and how they will manage them for continuous improvement as shown in Figure 2.

Box 3

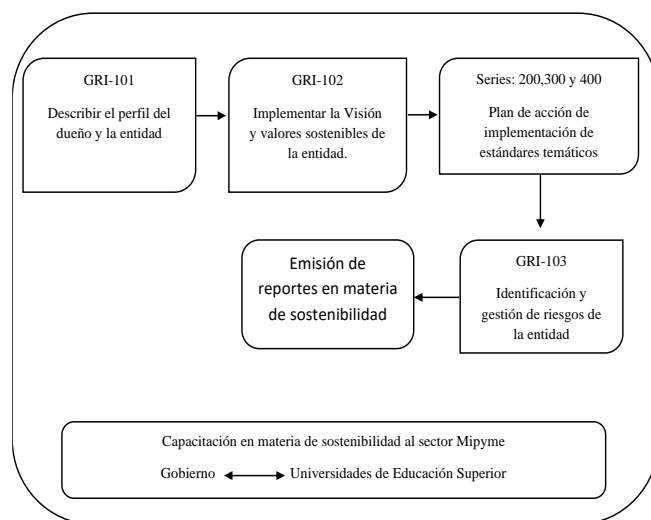


Figure 2
Guide to the application of the GRI standards in the MSME sector in Mexico

Source: Own elaboration

It is important to point out that the proposal for the leaders of the entities to adopt good practices in terms of sustainability, it is necessary that the government and higher education institutions work in a coordinated manner, with the aim of training the entire MSME sector, providing support in the implementation of actions and the preparation of sustainable reports.

It is also necessary for owners and senior managers to carry out a self-diagnosis in order to identify their knowledge, their willingness and above all their qualities as a leader who communicates and sets an example of change in terms of sustainability. The GRI standards are divided into three specific groups; economic, environmental and social standards as described in table 2.

Box 4

Table 2
GRI Thematic Standards

GRI 200: Economic standards	201: Economic performance 202: Market presence 203: Economic impact on the market 204: Procurement practices 205: Anti-corruption 206: Unfair Competition
GRI 300: Environmental standards	301: Materials 302: Energy 303: Water 304: Biodiversity 305: Emissions 306: Effluents and waste 307: Environmental compliance 308: Supplier environmental assessment
GRI 400 Social standards	401: Employment 402: Worker-Company Relations 403: Health and safety at work 404: Training and education 405: Diversity and Equality 406: Non-discrimination 407: Freedom of Association 408: Child Labour 409: Forced Labour 410: Security Practice 411: Indigenous Peoples' Rights 412: Human Rights Assessment 413: Local Communities 414: Social Assessment of Suppliers 415: Public Policy 416: Health and Safety 417: Marketing and labelling 418: Customer privacy 419: Socio-economic compliance

Source: Own elaboration with data from Deloitte 2018 report

It is important to point out that for the business sector it is advisable to start with the identification of issues that are achievable for the entity, whether it starts with waste separation or with energy and water conservation schemes, for example. It is important to support the MSME sector in Mexico with comprehensive government programmes to make it attractive for the entities in terms of taxes.

Conclusions

The proposed guide for micro, small and medium-sized enterprises to join in sustainable management and to issue reports in this area is viable, given that the model proposes the participation of the government and higher education institutions in Mexico to join in by implementing a training centre for this sector and accompanying entrepreneurs and leaders to incorporate concrete actions to identify thematic areas according to their line of business and number of employees and then determine the way in which risk will be managed and the issuance of sustainable reports.

This will help Mexican companies to contribute substantially to a better world, less poverty and the creation of a dignified life. The relevant thing is to contribute in one way or another to some of the Sustainable Development Goals set by the UN.

Conflict of interest

The authors declare that they have no conflicts of interest. Likewise, we have no known competing financial interests or personal relationships that might have appeared to influence the article reported in this paper.

Authors' contributions

Gutiérrez Rangel Hector Fabián: Main idea and development of the guide proposal and conclusions.

Tamayo Contreras Porfirio: Development of the theoretical framework.

Espinosa Mosqueda Rafael: Literature review and methodology.

Availability of data and materials

The GRI standards are publicly available and can be consulted for implementation by public and private institutions to contribute to the achievement of the Sustainable Development Goals.

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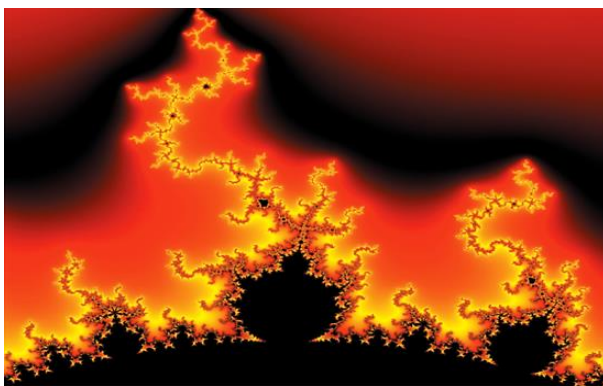


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