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M en I LUIS ANGEL MENDOZA DEL VILLAR

DIRECTORES:

DR. EDUARDO OLIVA LÓPEZ

DR. OCTAVIO LUIS PINEDA

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Apellido Paterno:	MENDOZA	Apellido Materno:	DEL VILLAR	Nombre (s):	LUIS ÁNGEL

Número de registro: B 1 7 1 0 1 6

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Luis Angel Mendoza del Villar

Dedication

I am grateful to those beings who have been by my side; their love and understanding have motivated me to complete the achievement of this research. To Viridiana Garcia and Barbara Elena, my pillars in life who have shown me unconditional support. To Beatriz del Villar, who has lovingly been by my side at all times. To my brothers, who supported me throughout my career.

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From heart, thank you!

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MODELO SISTEMICO PARA EL DESARROLLO INDUSTRIAL SUSTENTABLE EN EL SECTOR MANUFACTURERO

Resumen

Las Naciones Unidas (ONU) han reconocido que la pobreza y el cambio climático son efectos críticos insostenibles a nivel mundial. En consecuencia, la ONU declaró los Objetivos de Desarrollo Sostenible (ODS) en la agenda 2030, con la intención de equilibrar las dimensiones del desarrollo sostenible. La industrialización es uno de los ODS para afrontar esta situación, y la inminente llegada de la cuarta revolución ha favorecido su consecución. No obstante, los resultados de los diferentes enfoques del Triple Bottom Line han demostrado una fe insostenible en el sector manufacturero mexicano. Esta investigación propone el desarrollo industrial sostenible como estrategia para pavimentar el camino y hacer frente esta situación. El objetivo es construir un modelo sistémico de desarrollo industrial sostenible en el sector manufacturero bajo la hipótesis que cuestiona si la actual estrategia industrial favorece el desarrollo industrial sostenible. Asimismo, existe un vacío de conocimiento en la revisión de la literatura que permite vincular los clusters industriales con el desarrollo industrial sostenible e inclusivo desde un enfoque sistémico. De esa manera, se utiliza el enfoque de sistemas; dada la complejidad y pluralidad de perspectivas de los interesados que influyen en el sistema para transformar el desarrollo industrial sostenible. Por lo tanto, el modelo teórico sistémico propuesto está orientado principalmente hacia el desarrollo industrial sostenible y socialmente inclusivo para fortalecer y mejorar la industria manufacturera. Asimismo, el estudio evalúa las dimensiones económicas, sociales y ambientales para el desarrollo sostenible que inciden en el sector referido. Los resultados apuntalan un cambio en la estrategia enfocado en el sistema focal de la cadena de valor donde la competitividad se basa en una fuerte diferenciación y aprovechar la cadena comparativa que ofrece una nación periférica como México.

SYSTEMIC MODEL FOR THE SUSTAINABLE INDUSTRIAL DEVELOPMENT IN THE MANUFACTURING SECTOR

Abstract

The United Nations (UN) has recognized that poverty and climate change are unsustainable critical effects globally. Consequently, the UN declared sustainable development goals (SDGs) in the 2030 agenda, intending to balance sustainable development dimensions. Notwithstanding, results on the Triple Bottom Line's different approaches have demonstrated an unsustainable faith in the Mexican manufacturing sector. This research proposes sustainable industrial development as a strategy to pave the way and face this situation. The objective is to build a systemic model for sustainable industrial development in the manufacturing sector under the hypothesis that questions whether the current industrial strategy favors sustainable industrial development. Likewise, there is a knowledge gap in the literature review that links industrial clusters with sustainable and inclusive industrial development from a systemic approach. In that way, the system thinking approach is used, given the complexity and plurality of stakeholder perspectives that influence the system to transform sustainable industrial development. Therefore, the proposed systemic theoretical model is oriented mainly towards sustainable and socially inclusive industrial development to strengthen and improve the manufacturing industry. Likewise, the study evaluates the economic, social, and environmental dimensions for sustainable development that influence the referred sector. The results underpin a change in the strategy focused on the value chain's focal system where competitiveness is based on strong differentiation and take advantage of the comparative chain offered by a peripheral nation like Mexico.

Introduction

Chapter I. Introduction

I. 1. Research Introduction

This research arises from the researcher's concern to know if there is a strategy in how the industry in Mexico is established. Based on the researcher's work experience in the consulting activity in engineering, design, assembly, and commercialization of machinery for handling and processing materials, I had the opportunity to get to know industrial areas and technological and industrial parks. Then, I observed that within an industrial park, there were companies with diverse economic activities. For instance, in the companies' manufacturing activity within an industrial park, there are companies from the food, metal-mechanic, and pharmaceutical sectors. Therefore, it is inferred that there is no consistency in the industrial activity of the zone or industrial park. Likewise, both suppliers and customers were in the best of cases in the same region or neighboring states. However, they even could be in distant states or other countries; this sometimes generates logistical problems due to an inadequate industrial configuration within the supply network.

Based on the paragraph mentioned above. On the one hand, the author led to having the concern of knowing if the industry in Mexico has a strategy for its development. On the other hand, if this strategy contemplates a holistic vision of the system and the industry's context, it is regionally located. Likewise, to know if the configuration for industrial development is affected in the absence of a development strategy that has the capacity to be sustainable.

I. 1. 1. Sustainable development

Why sustainable? Because it is considered that investing in the installation of a company is high and expected to have a favorable return on investment in

the first 3 to 5 years in the best-case scenario. Therefore, for the installation of a company, an economic feasibility study must have been carried out to reduce the risk of the firm's bankruptcy. The location of the facility is also considered in the study. So, the installation of a firm should have a sustainability focus.

Sustainability refers to continuity or perpetuity. In this case, it is continuous development or sustainable development (Luis-Pineda, 2008). Sustainable development defined as such development that meets the current needs without jeopardizing future generations' ability to meet their own needs (Artaraz, 2002). On the other hand, according to the theory of the three dimensions of sustainability or the Triple Bottom Line, sustainable development balances the three pillars shown in **Figure I-1**; the first pillar, the economic dimension; the second, the social aspect and; the third, the environmental dimension (Almagro Vázquez, 2015).

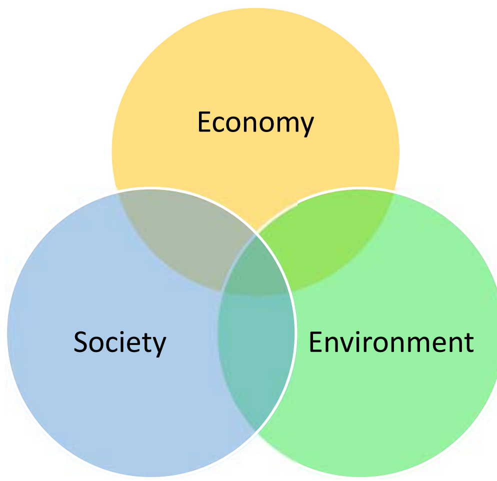


Figure I-1 Triple Bottom Line for the sustainable development (Artaraz, 2002).

One of the topics that the United Nations (UN) currently has as its central axis is sustainability for both developing and developed countries. Even in September 2015, world leaders attended the United Nations Summit. They signed the document entitled "Transforming Our World: the 2030 Agenda for Sustainable Development", which includes the 17 Sustainable Development Goals (see **Figure I-2**) with the goal of ending poverty, fighting inequality, and tackling climate change, with no one left behind (United Nations, 2015).

Figure I-2 Sustainable development goals (SDG) (United Nations, 2015).

I. 1. 2. Industry and Sustainability

Furthermore, this research project raises the problem that a poor industrialization strategy results in poor performance of the industrial activity. One of the underlying reasons for low economic growth is the low productivity of our economy (República, 2013). According to Porter (1998) productivity is a determinant of the prosperity of any state or nation, leaving behind other variables such as exports, natural resources, and tourism. This is correlated with competitiveness (Pacheco-Vega, 2007). Furthermore, factor productivity expresses the technical progress of the production process (López, 2008). Therefore, due to its importance, governments must strive to create an environment that supports increased productivity, since it is a determining factor of differentiation for regional social welfare (Oosterhaven & Broersma, 2007).

For this research, it is looking for a holistic solution that solves the current needs in terms of sustainable development, and that also supports the 2030 agenda and Sustainable Development Goals (SDGs). The proposal would contribute to the proper productive performance of the industry. Therefore, it deploys a strategical system for industrial development employing sustainable development theory. The system integrates the complex interrelationships of critical actors involved in sustainable and inclusive industrial system transformation. Moreover, they are embedded in a regional context defined by the TBL dimensions; the economic, social, and environmental aspects (Artaraz, 2002).

I. 1. 3. Agenda 2030 and the industrial Development

On the one hand, the 2030 Agenda encompasses most of the SDGs in sustainable industrial development. **Figure I-3** shows the relationship of the SDGs with sustainable industrial development that the proposal incorporates. It Highlights the main objectives dictated by the UN, end of poverty through increased employment, greater equality and better opportunities for society through the strategy of strengthening SMEs, and finally, an industrial strategy where the sustainable context is an algedonic channel parameter to face climate change.

Figure I-3 Relationship between sustainable and inclusive sustainable development and SDGs

The SDGs that the proposal for sustainable industrial development considers mainly endogenously are SDGs 8 and 9. Both are related to promoting sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all; and build resilient infrastructure, promote inclusive and sustainable industrialization, and foster innovation, respectively. However, the remaining 15 objectives, no less critical for industrial development, would have an exogenous effect on the previously mentioned objectives. The matrix in **Table I-1** shows the relationships of sustainable industrial development with the SDG goals. In general, there are 160 goals among the 17 SDGs (see the SDGs in the Annex); Of these, according to **Figure I-3**, it is related to 52% of the goals, or 74 goals of the 14 SDGs presented in the first column of the previously mentioned matrix. The last column shows the percentage contribution of the strategy for sustainable industrial development in each of the SDGs.

Table I-1 Matrix relationship of Sustainable industrial development and SDG

	1	2	3	4	5	6	7	8	9	10	11	13	14	16	17	18	19	A	B	C	D	Tot
1	X																	X	X			3/7-43%
3																				X	X	2/13-16%
4			X	X			X															3/10-30%
6			X		X	X												X	X			5/8-63%
7		X																X	X			3/5-60%
8	X	X	X	X			X	X		X									X			8/12-67%
9	X	X	X	X	X													X	X	X		8/8-100%
10	X	X	X	X		X												X	X			7/10-70%
11			X	X		X	X											X	X	X		7/10-70%
12	X	X		X	X	X	X	X										X		X		9/11-82%
13		X	X																X			3/5-60%
15									X									X				2/12-17%
16						X																1/12-8%
17	X				X	X	X	X	X		X	X	X	X	X	X	X					13/19-68%

74/160	74/142	52.1%

On the one hand, objective 8 establishes the Promotion of sustained economic growth and among the goals establishes 8.1 the annual growth of real GDP per capita, 8.3 Proportion of informal employment, 8.5 Unemployment rates, 8.9 Direct GDP of the segment as a proportion of total GDP. On the other hand, objective 9 establishes the Promotion of inclusive and sustainable industrialization, and among the goals are 9.2 Added value of manufacturing as a proportion of GDP and per capita. 9.4 Pollutant emission by GDP by purchasing power parity, 9.5 Proportion of spending on research and development (R&D) of GDP, and the number of researchers per million inhabitants (United Nations, 2015).

I. 1. 4. Industrialization and strategy

Competitiveness rules must be established so that productivity and innovation successfully govern the economy, such as protecting intellectual property and enforcing antitrust laws (Porter, 1998). To improve the population's standard of living, it is necessary to increase the economy's potential to produce and generate goods and services, resulting in increased productivity (República, 2013). Likewise, Porter mentions that the government should promote both the training and its improvement and the accumulation of public or quasi-public goods that significantly impact many related companies (Porter, 1998).

However, what does the concept of productivity refer to? According to the Government of the Republic (2013), in the National Development Plan in 2013, it relates to the way of interacting with the factors of the production process, such as technology, efficiency, and quality of production inputs. Furthermore, one of the economic advantages of real success is clusters, because they have been shown to be an essential reason for attention by the scientific community and government structures.

Economic research must provide models that can be applied at low regional levels (Boja, 2011). Industrial clusters can positively contribute to the productivity and innovation of their participants through access to inputs, information, and specialized workers; access to public institutions and goods; and better incentives (Chávez & García, 2015; Madsen et al., 2003; Pyke & Lund-Thomsen, 2016). Furthermore, in addition to increasing productivity, clusters are a potential base for the successful inclusion of Small and Medium-sized Enterprises (SMEs) and the increase of the global distribution network (Foghani et al., 2017). Rodríguez (2016) proposes in his research that developing countries need to adopt competitive positioning strategies in the regions where firms establish themselves.

I. 1. 5. Clusters

Therefore, based on the previous paragraph, the advantage differentiation of a region or state or nation is given by clusters. Michael Porter is one of the most representative researchers in the strategy field. He exposed in his article Clusters and the new economics of competition that since that time, economic maps are dominated by what he called cluster, critical masses in a place with a unique competitive advantage in a particular field (Porter, 1998).

Clusters represent a new way of thinking about localities, challenging most conventional wisdom about how companies should configure, how institutions such as universities can contribute to competitive success, and how the government can economically promote development and prosperity. However, Porter defines it in his article as a geographic concentration of interconnected companies and institutions in a particular sector. Clusters integrate an array of connected companies and other major competing entities, including specialized input providers such as components, machinery and services, and specialized infrastructure providers (Porter, 1998). Likewise, **Figure I-4** shows a cluster model that links companies, research education institutions, financial institutions, and government institutions (Gómez et al., 2011).

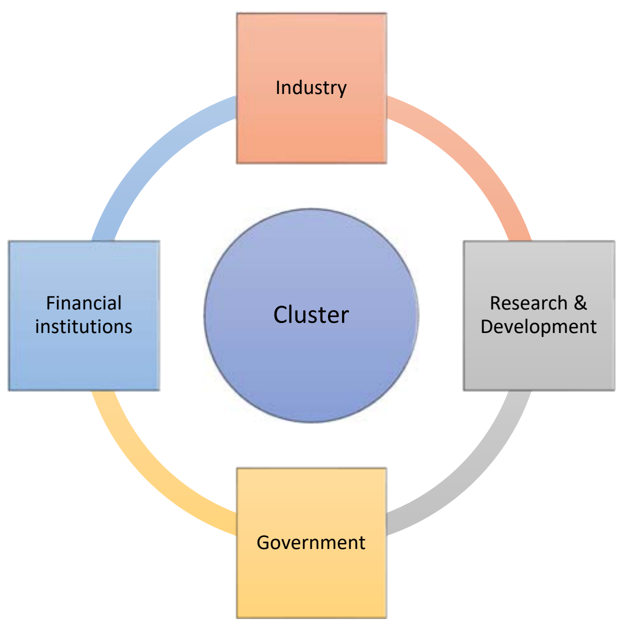


Figure I-4 Cluster elements (Gómez et al., 2011).

As a reminder, at the beginning of this chapter, the researcher's concern about whether there is a strategy for industrial development was mentioned, so it makes the following research question: Does Mexico have a sustainable industrial development strategy? Furthermore, what is the essential link between current industrial development and whether there is a sustainable industrial development strategy? To start with this thesis, it is necessary to know the indicators that measure it. However, he mentioned that for an industrial strategy, it is essential to analyze the productivity performance of the industrial activity and how efficient the performance of the corresponding economic and sustainable development is. Consequently, the context in which the situation develops must be considered, for which it will be analyzed in the next section.

I. 2. Context

I. 2. 1. Territorial context

Firstly, to know the general context, the focus context where it embeds is expressed. Then, Mexico is part of the north of the American continent and it is a part of one of the five continents that Earth. In turn, the Earth is one of the planets that is part of the solar system. This is a system contained into the Milky Way, and this is one of the infinite galaxies that are part of the universe (see **Figure I-5**).

Figure I-5 An external systemic perspective of Mexico (Own elaboration, 2020)

The model starts based on systems thinking, which will be described in the general model of open systems (Aceves, 2015). This model is adequate to express the supra-system where the focus system is embedded. Systems science is necessary because it is a set of concepts, models, and useful and practical tools to understand better and handle complex situations (François, 2004). In this way, this is adequate to understand the problem and the different components that are part of it. It also contemplates the interaction that the elements have within the system and how it affects them.

Given the qualities mentioned above and due to a perspective, that associates an adequate industrial development, the industrial conglomerate model is taken as the approximation system's conceptual basis. Then, the general model formed by the three central systems is constructed; The supra-system is the context integrated by the TBL's sustainability dimensions, where the focus system is integrated. The focus system refers to the industrial cluster system; finally, subsystems are the components derived from the focus system cluster. Hence, they can identify as the dependencies or institutions with interrelationships between industry, academia, government institutions, and financial institutions (see **Figure I-6**).

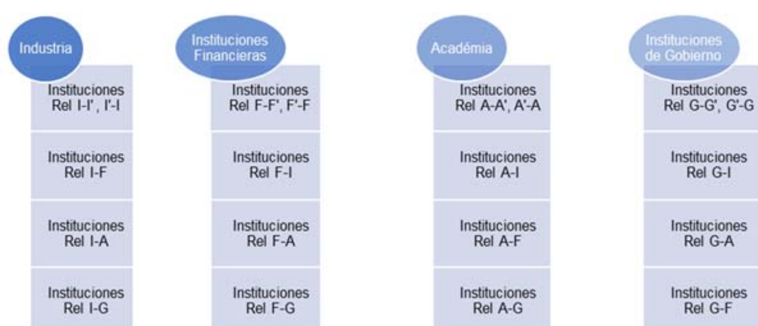


Figure I-6 Subsystems contained in the focus system (Own elaboration, 2018)

Likewise, as there are links between more than three agencies, where it is understood that there are cooperative efforts between three actors. For instance, the triple helix model; therefore, the following relationships are possible:

Industry - Academy - Government	Academy - Industry - Government
Industry - Academy - Financial	Academy - Industry - Financial
Financial - Government - Academy	Government - Finance - Academy
Financial - Government - Industry	Government - Financial - Industry

As a result, **Figure I-7** is obtained, which will be technically explained in Chapter 3. However, to measure the context of the problem situation, it is expressed here at this point, as Peter Checkland represents the soft systems methodology with the first steps, which I explain later. However, for a theoretical basis, such as the situation considered problematic, is the first step. Likewise, as a tool for the problem's context, it is necessary to present it in this section as a second step of the mentioned methodology. It highlights that knowledge and innovation are at the centre as the heart of the model.

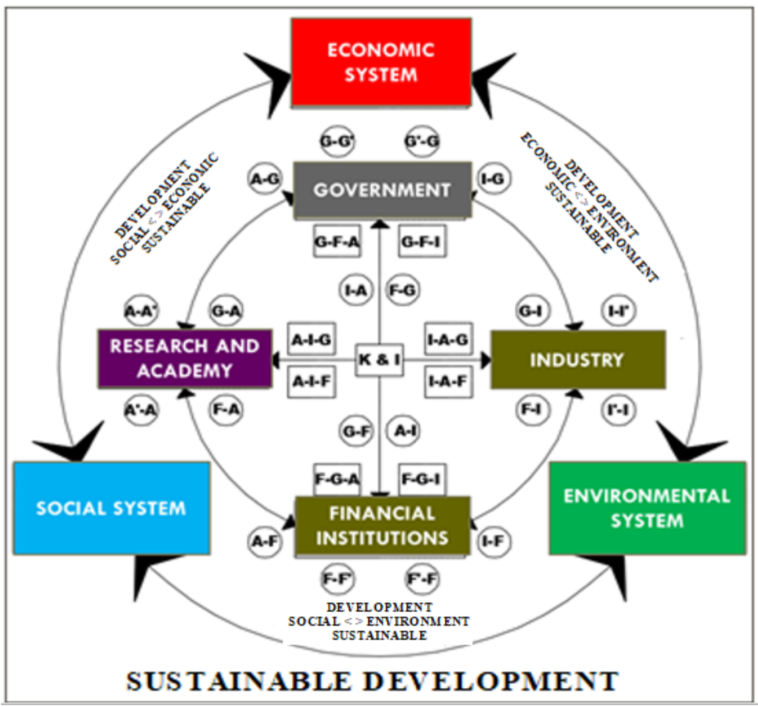


Figure I-7 Sustainable industrial development model (Own elaboration, 2018)

The supra-system must then be analyzed to know the general situation. Thus, the context can be known about the system approach, taking into account the essential elements for sustainable industrial development. Therefore, industrial development, nested in the supra-system of sustainable development, is shaped by the economic, social, and environmental systems (see **Figure I 8**).

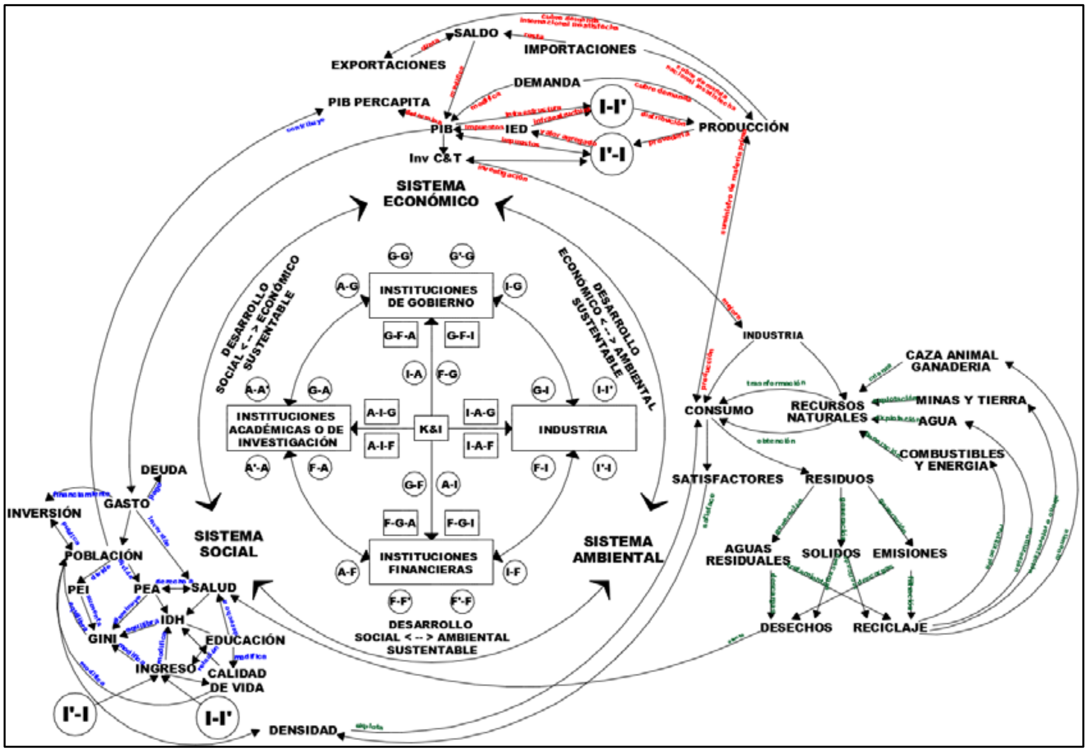


Figure I-8 Supra-system's relations of the Sustainable Industrial Development Model (Own elaboration)

Figure I-9 shows the different indicators that influence the economic system: GDP, GDP per capita, Foreign direct investment (FDI), investment in science and technology (Inv. S&T), and the balance between imports and exports. Besides, the senses in which the indicator modifies the relationship with them and other systems are mentioned. For example, some variables influence the economic dimension for the social system, such as GDP per capita and quality of life, depending on the research and social spending. On the other hand, for the environmental system, there is industrial activity and consumption. Furthermore, the relationships that the social supra-system has with other supra-systems are expressed. In the supra-economic system, as mentioned above, GDP per capita is related to population. From GDP, a budget is allocated for the social system and investment in science and technology and research to improve the quality of life. Likewise, for the supra-environmental system, the influencing variables are related, such as population density; This is also known as human overcrowding that exploits consumption and meets the social system's needs with natural resources.

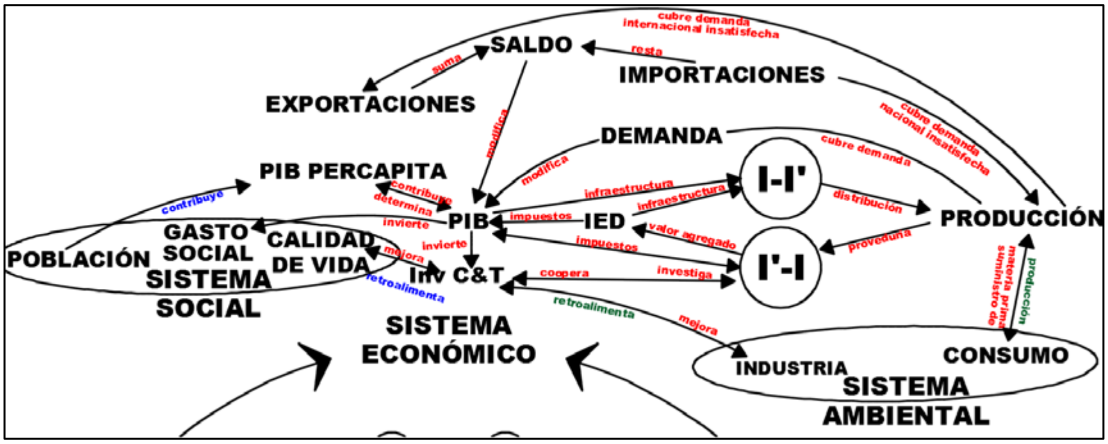


Figure I-9 Relations of the supra-economic system (Own elaboration, only in Spanish).

Then, in **Figure I-10**, depicts the social system analysis in which social interest indicators are located. For instance, the total population, and from this derives the economically active population (PEA) and the employed and unemployed population, the economically inactive population (PEI), social spending, health, and education. Likewise, social indicators are indices with an aggregate effect, such as the GINI index, which expresses that both a country or region is equitable with the distribution of wealth, the Human Development Index (HDI), and population density.

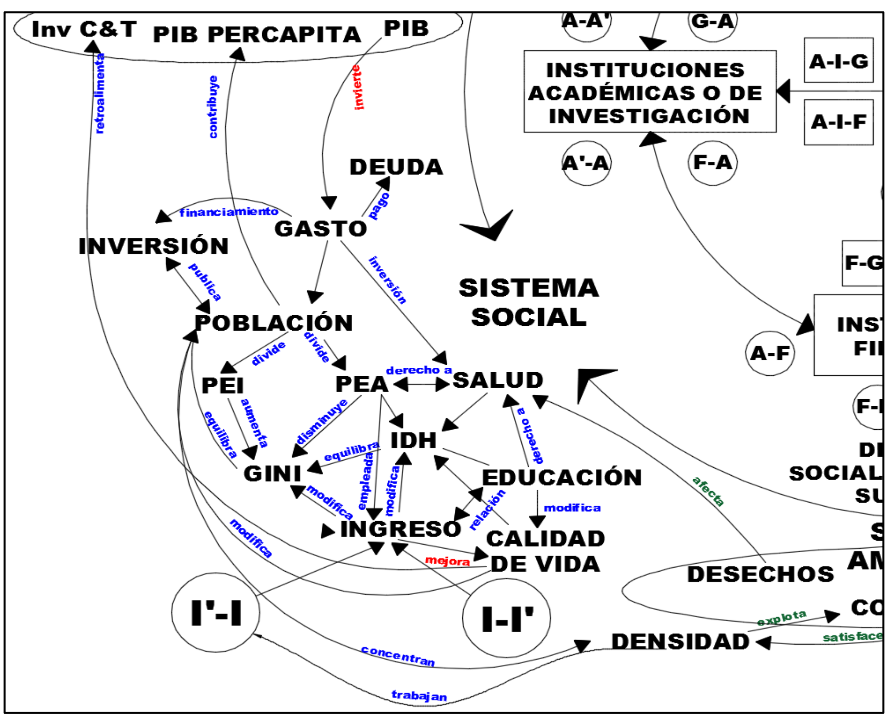


Figure I-10 Relations of the supra-social system (own elaboration, only in Spanish).

Finally, **Figure I-11** represents the systemic analysis of the environmental supra-system. Among the indicators that influence it are the exploitation of natural resources such as water, energy, land, and livestock, the generation of solid, residual waste, and greenhouse emissions such as CO2 and other pollutants generated by economic and social activities. Furthermore, relationships with other supra-systems are expressed. For example, concerning the financial system, there are the industry's production activities and their impact on the environment. Research & development with science and technology develop products and services that reduce environmental impact.

On the other hand, its interactions with the environmental system deplete the natural resources by human overcrowding, and vice versa, the satisfaction of population density through these resources. Besides, they generate waste, and improper disposal affects the environment. Therefore, it causes health problems in human beings and environmental depletion, unbalancing the regional ecosystem.

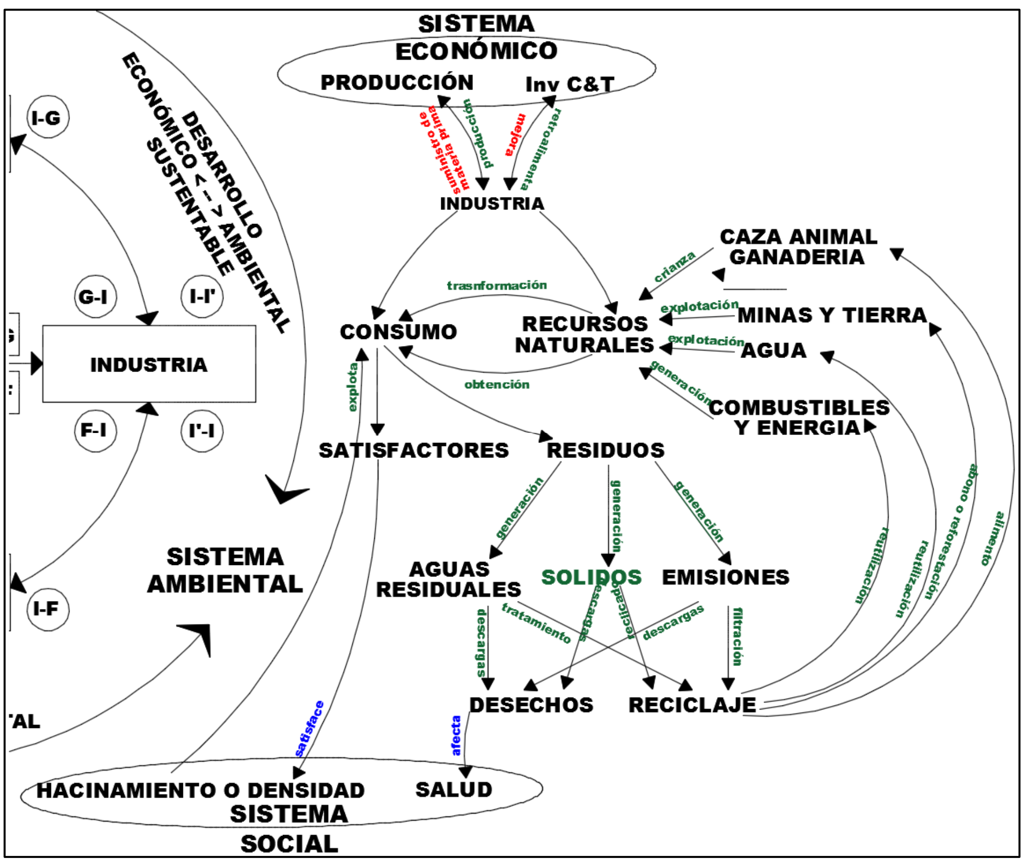


Figure I-11 Relations of the supra-environmental system (own elaboration, only in Spanish).

I. 2. 2. International context

An international analysis of disaggregated data is a comprehensive activity to determine. However, the essential indicators for sustainable development that are collected worldwide will be shown. On its platform, the World Bank presents different indicators and variables; It is also possible to compare countries. For the present analysis, the situation in Mexico is contextualized. According to the World Bank, Mexico is classified as a country belonging to the countries of Latin America and the Caribbean and an upper-middle-income country. It is then analyzed from a macro perspective to know the position of Mexico in the continental region. **Figure I-12** shows a comparison of the GDP performance of Latin America and the Caribbean. It places in the fourth position, and its contribution is not very significant compared to Europe, southern Asia, and North America. Since the GDP of Latin America and the Caribbean represents 8% of the world economy (see **Figure I-13**).

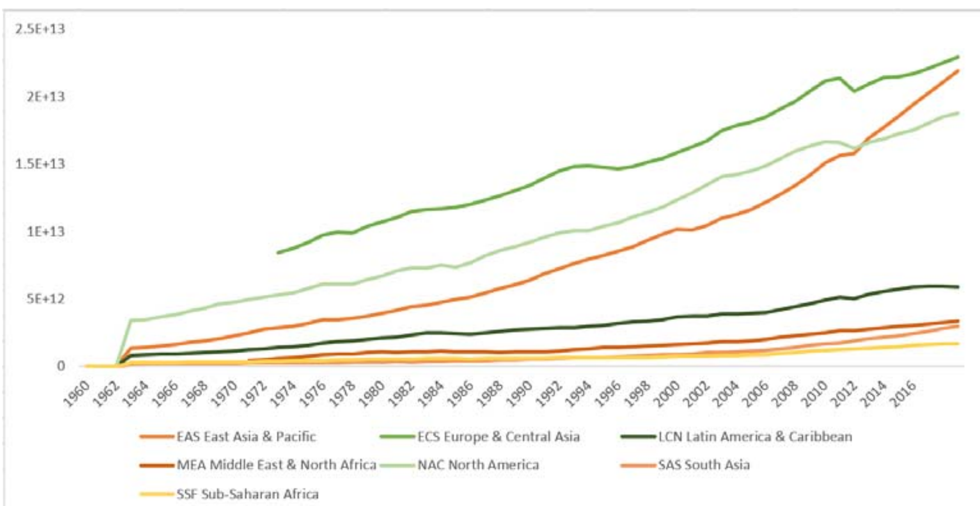


Figure I-12 Continental GDP usd constants B-2010 (Based on data from WB, 2018).

Then, the World Bank reports that Mexico is the 15th economy of the countries with the highest GDP worldwide (see **Table I-2**). It is also observed that the USA, Japan, Germany, France, England, Italy, and even Mexico have linear growth; However, China shows exponential growth behaviour (see **Figure I-14**).

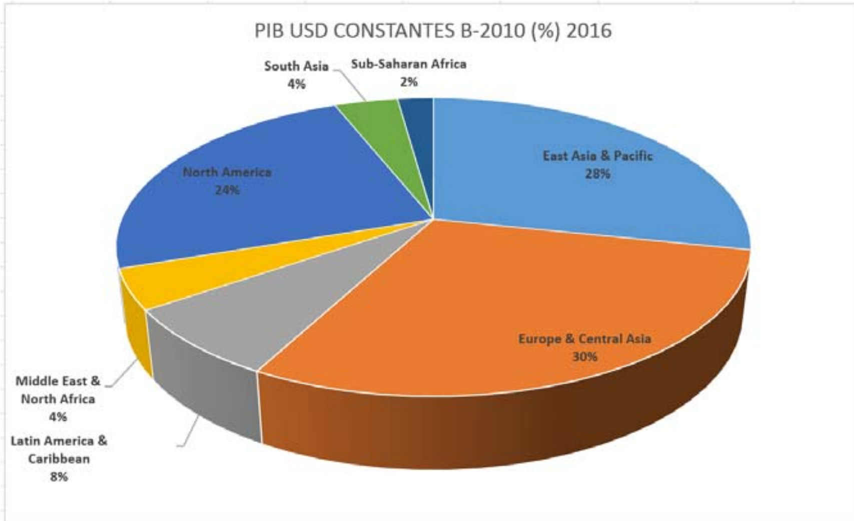


Figure I-13 Continental GDP 2016 constant USD (Based on data from WB, 2018).

Table I-2 Countries ranking with the most significant contribution to GDP (Own elaboration, 2018)

Ranking	Indicator Name	Región	1960	1970	1980	1990	2000	2010	2015
1	United States	North America	3.07807E+12	4.77968E+12	6.52917E+12	9.06441E+12	1.27131E+13	1.49644E+13	1.66727E+13
2	China	East Asia & Pacific	1.27938E+11	1.86836E+11	3.41359E+11	8.29562E+11	2.23708E+12	6.10062E+12	8.9083E+12
3	Japan	East Asia & Pacific	7.96213E+11	1.92365E+12	2.97668E+12	4.68281E+12	5.34893E+12	5.7001E+12	5.99641E+12
4	Germany	Europe & Central Asia		1.53405E+12	2.04054E+12	2.56863E+12	3.12391E+12	3.41709E+12	3.7096E+12
5	France	Europe & Central Asia	6.08176E+11	1.04543E+12	1.49211E+12	1.90728E+12	2.34648E+12	2.64684E+12	2.77754E+12
6	United Kingdom	Europe & Central Asia	7.24558E+11	9.98275E+11	1.23132E+12	1.64251E+12	2.09521E+12	2.44117E+12	2.70525E+12
7	Brazil	Latin America & Caribbean	2.47311E+11	4.4862E+11	1.01038E+12	1.19273E+12	1.53871E+12	2.20887E+12	2.33193E+12
8	India	South Asia	1.36746E+11	2.02088E+11	2.71694E+11	4.66533E+11	8.02755E+11	1.65662E+12	2.30137E+12
9	Italy	Europe & Central Asia	5.45555E+11	9.50118E+11	1.37982E+12	1.74918E+12	2.06021E+12	2.12506E+12	2.06294E+12
10	Canada	North America	3.16348E+11	5.25193E+11	7.81314E+11	1.01407E+12	1.34274E+12	1.61346E+12	1.80251E+12
15	Mexico	Latin America & Caribbean	1.40725E+11	2.71227E+11	5.17955E+11	6.19522E+11	8.80872E+11	1.05113E+12	1.21048E+12

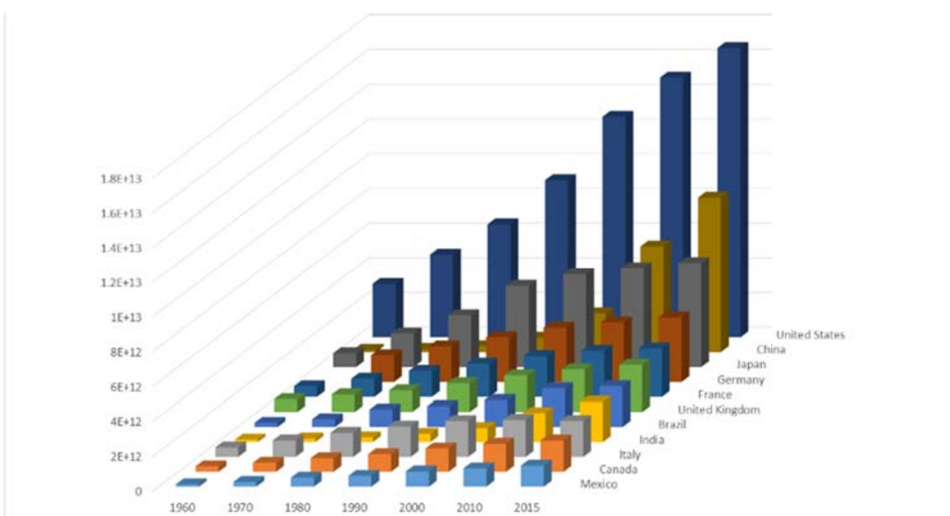


Figure I-14 GDP of the leading economies USD b = 2010 (Based on data from WB, 2018).

I. 2. 3. National context

Once Mexico is contextualized abroad, this section shows how the country is regionalized. According to INEGI, Mexico divides into seven geographic regions. **Table I-3** lists the different areas that integrate it and each of the states that comprise the regions. **Figure I-15** graphically illustrates the geographic areas.

Table I-3 Economic Regions of Mexico (Own elaboration, 2018)

RegCode	Region	State	RegCode	Region	State
Reg 1	Nort	Aguascalientes Chihuahua Coahuila de Zaragoza Durango Nuevo León San Luis Potosí Zacatecas	Reg 4	Centre	Ciudad de México Guanajuato Hidalgo México Morelos Puebla Querétaro Tlaxcala
Reg 2	Northwest	Baja California Baja California Sur Sinaloa Sonora	Reg 5	Gulf of Mexico	Tabasco Tamaulipas Veracruz
Reg 3	West	Colima Jalisco Michoacán Nayarit	Reg 6	South Pacific	Chiapas Guerrero Oaxaca
			Reg 7	Southeast	Campeche Quintana Roo Yucatán

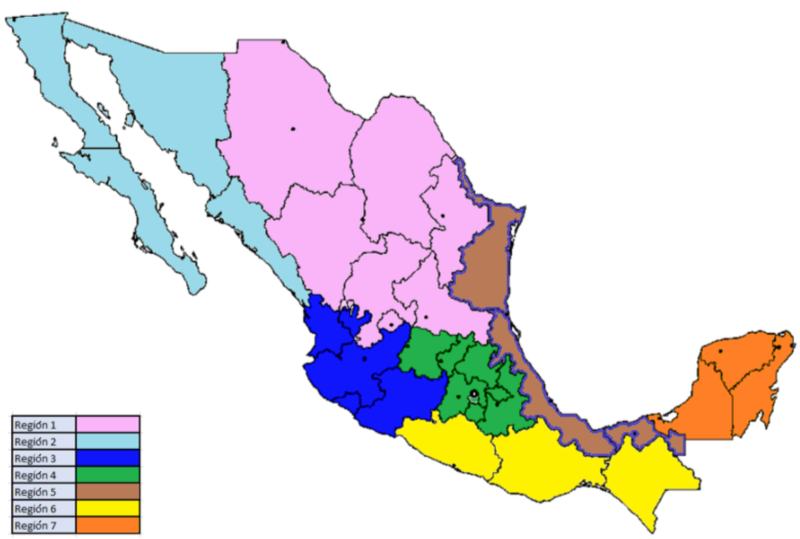


Figure I-15 Economic Regions of Mexico (Own elaboration, 2018)

I. 2. 4. Economic context analysis

It is of utmost importance to know the Gross Domestic Profit (GDP) to judge an economy's performance and its population's quality of life (Luis-Pineda, 2008). GDP is one of the main outputs concerning the performance of a nation. Therefore, for economic analysis, it is necessary to express financial information based on international standards. For this, Mexico is part of the United States-Mexico-Canada Agreement (AEUMC) countries [before the Free Trade Agreement (NAFTA)]. The information takes the North American Industrial Classification System (NAICS) to standardize the classification of different economic activities. They classify into three economic sectors, the primary one related to agriculture, livestock, and fishing activities, the secondary sector about manufacturing and processing operations, and the tertiary one for service activities. The secondary industry then breaks down the economic subsectors of interest because it integrates everything related to manufacturing activity included in NAICS as subsector 31-33. Subsequently, the branch level scales down, which is a more detailed level, in manufacturing operations. These include the focus activities as an initial delimitation analysis (see **Figure I-16**).

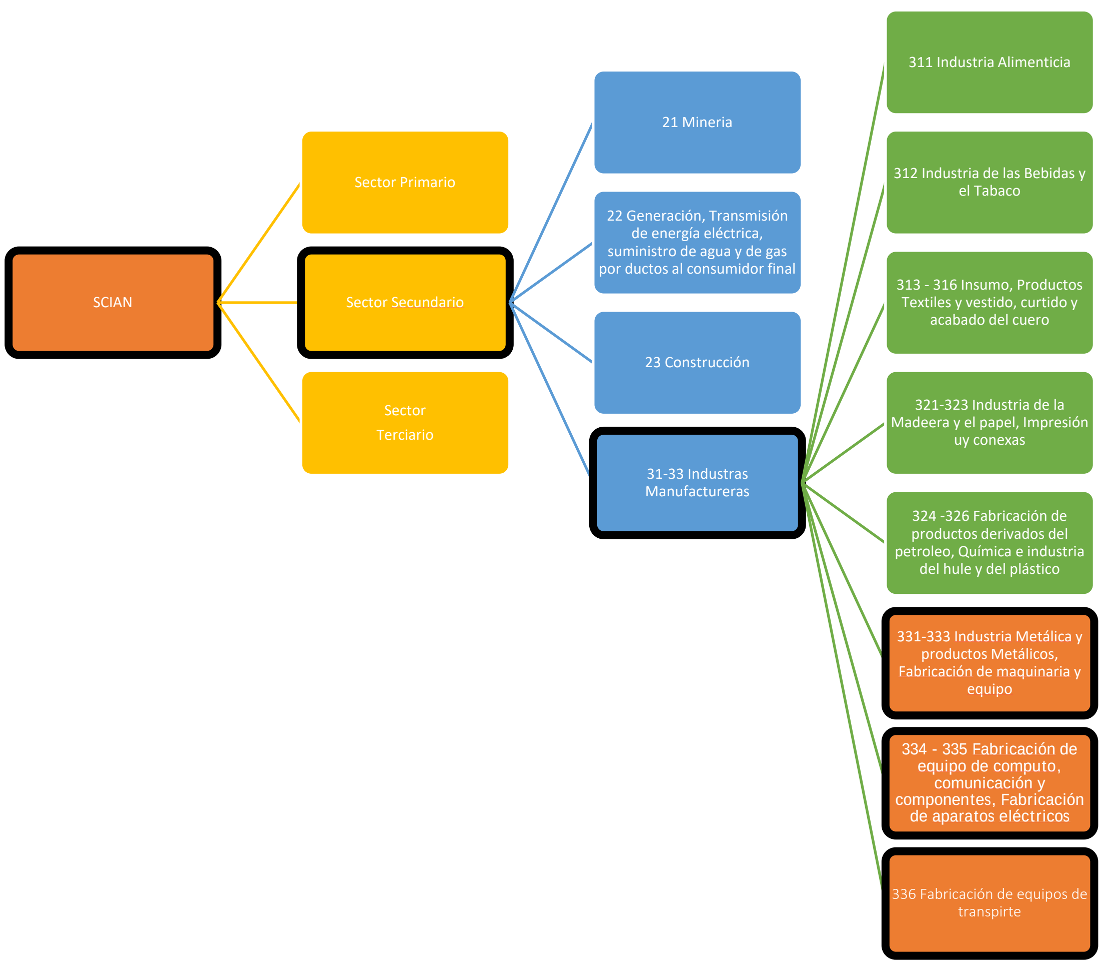


Figure I-16 North American Industrial Classification System (NAICS) (Based on data from INEGI, 2018).

Contextualization is essential in the economic field because it allows us to know, based on the economic activity attached to NAICS, the different real outlets expressed economically. The financial analysis begins with the main sectors of the economy; in **Table I-4**, for 2016, the GDP reflects a figure of MXN 18,841 billion current pesos; which, the primary industry represents 3.58%; the secondary, 31.29% and; the tertiary, 65.13% (see **Figure I-17** and **Figure I-18**).

Table I-4 Sectorial GDP, Billions of mxn at current prices (Based on data from INEGI, 2018).

Sector	2003	2006	2012	2016
Tertiary	$4,755	$6,269	$9,490	$12,272
Secondary	$2,454	$3,635	$5,343	$5,896
Primary	$272	$327	$502	$674
Total Economy	$7,481	$10,231	$15,335	$18,841

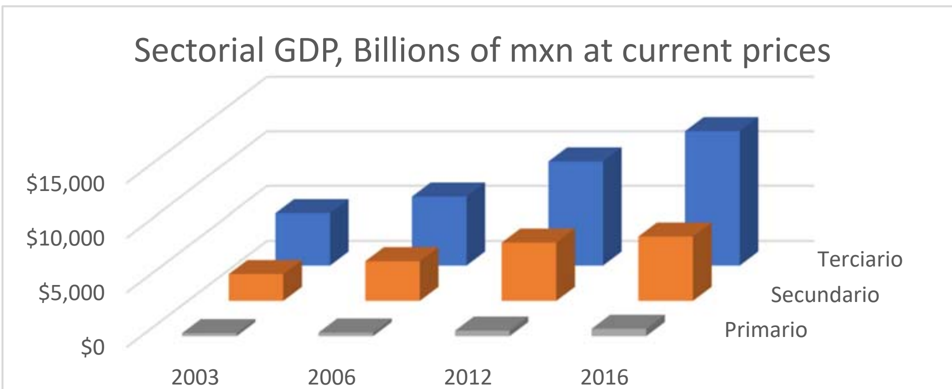


Figure I-17 Sectorial GDP, Billions of mxn at current prices (Based on data from INEGI, 2018).

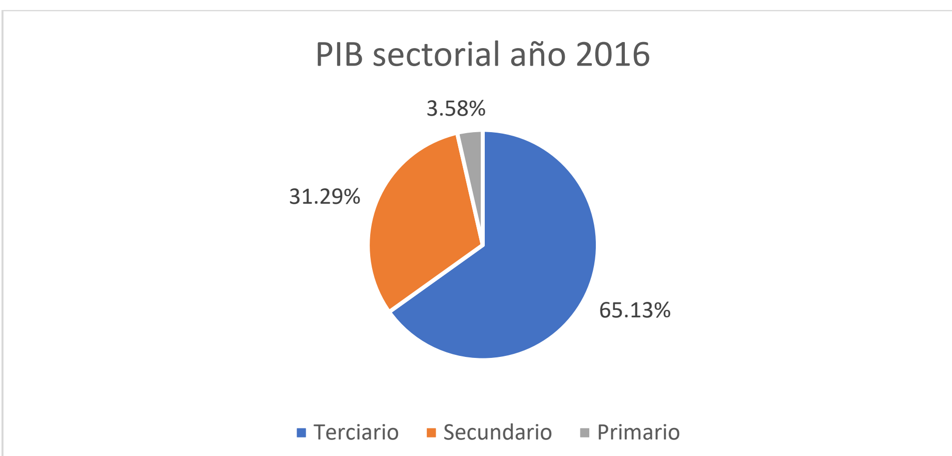


Figure I-18 Decomposition of GDP by sector, 2016 (Based on data from INEGI, 2018).

Subsequently, the GDP at the sectoral and subsector level shows in **Figure I-19** that the most outstanding activities are: 23, related to construction with 25.3%; branch 333-336 on the activities of manufacturing machinery and equipment, manufacturing of computer equipment and household appliances, as well as the production of transport equipment, with a 21.61% share. Then, branch 311 is related to the food industry, with a participation of 12.11%. Likewise, metallurgical activities rank sixth with a contribution of 5.33%, which represents 314.216 million pesos at current prices. Likewise, **Figure I-20** shows that GDP performance over time has increased in branches 331-332 and 333-336. Furthermore, it latter presents an exponential behaviour in the percentage contribution of the sector's GDP. It highlights that construction activity has led to different periods in the economy's participation in the secondary sector.

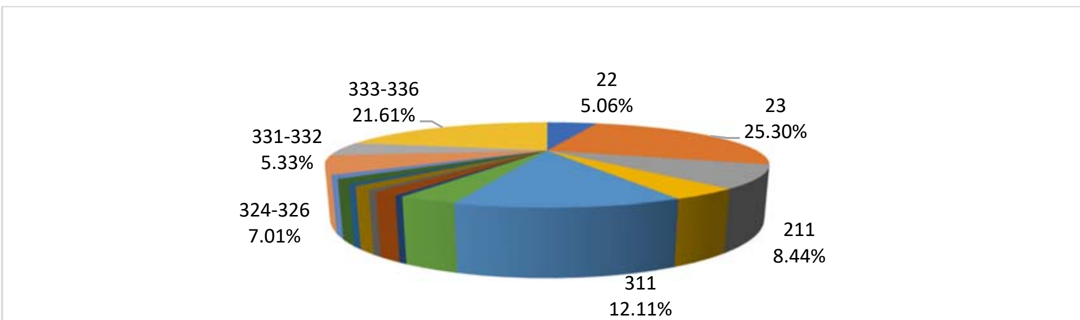


Figure I-19 Breakdown of GDP Manufacturing (Based on data from INEGI, 2018).

Finally, for the analysis of GDP, the state of the manufacturing sector is analyzed. On the one hand, **Table I-5** shows the states' contribution with the highest contribution to GDP for branches 331-332. At the same time, **Table I-6** shows the states' participation, with the highest contribution in branches 333-336, in the secondary sector. In **Figure I-21**, the states with the most considerable contribution of manufacturing activity in subsector 33, Metalworking, are highlighted; 331, in the metal industry; 332, metal products industry; 333, manufacture of machinery and equipment; 334 manufacture of computer equipment; 335, component manufacturing; and 336, manufacture of transportation equipment.

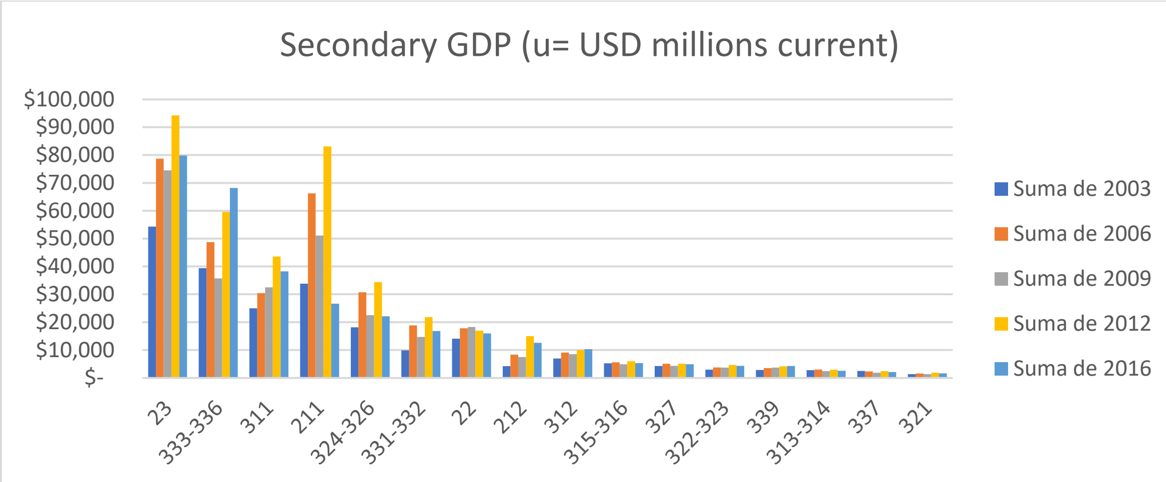


Figure I-20 Secondary GDP over time (Based on data from INEGI, 2018).

Table I-5 GDP 331-332 representative by state (Based on data from INEGI, 2018).

State	Region	GDP B MXN	(%) PART.
Coahuila de Zaragoza	North	$72.41	23.0%
Nuevo León	North	$60.17	19.1%
Sonora	Northwest	$22.20	7.1%
Veracruz	Gulf of Mexico	$19.72	6.3%
México	Centre	$19.02	6.1%
Guanajuato	Centre	$16.54	5.3%
Jalisco	West	$15.03	4.8%
San Luis Potosí	North	$14.57	4.6%
Michoacán de Ocampo	West	$13.72	4.4%
Puebla	Centre	$9.79	3.1%
Resto del País		$51.06	16.2%
Total		**$314.22**	**100%**

Then, the delimitation of the study focuses mainly on these states. However, the research is still extensive, so it is necessary to delimit it through the most potential areas and the researcher's proximity, taking the central region, which is in the first positions of **Table I-5** and **Table I-6**. It is obtained that the states with the highest contribution are Coahuila, 13.9%; Nuevo León, 11.43%. Northern region adds 25.33%; Sonora, from the Northwest region 7.55%; Jalisco, 8.04%; Guanajuato, 6.9%; and the state of Mexico, 6.53%, even though there are two different regions. However, they could be considered in a region due to proximity, with a sum of 21.47%; as a whole, they contribute 54.37% of GDP in branches 331-336 of the manufacturing sector (see **Figure I-21**).

Table I-6 GDP branches 333-336 by state (Based on data from INEGI, 2018).

State	Region	GDP B MXN	(%) PART.
Coahuila de Zaragoza	North	$148.49	11.7%
Chihuahua	North	$140.23	11.0%
Nuevo León	North	$121.37	9.5%
Jalisco	West	$112.65	8.8%
Sonora	Northwest	$97.77	7.7%
Baja California	Northwest	$93.31	7.3%
Guanajuato	Centre	$93.14	7.3%
México	Centre	$84.81	6.7%
Puebla	Centre	$84.48	6.6%
Tamaulipas	Gulf of Mexico	$61.85	4.9%
GENERAL	General	$235.84	18.5%
Total		**$1,273.95**	**100%**

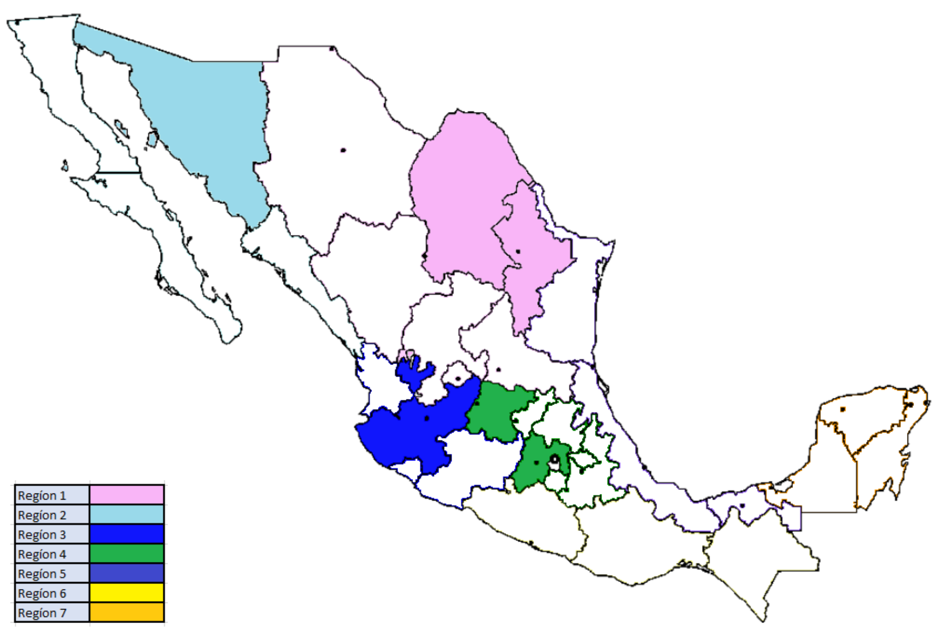


Figure I-21 States that contribute 54% of GDP in activities 331-336 (Based on data from INEGI, 2018).

I. 2. 5. Productivity and Industrial production

International context

Figure I-22 shows the level of industrial production with a base of 100 = 2013, as well as a comparison of the leading world economic powers, among which Germany and the United States stand out. Although the United States has a higher industrial production index, its data dispersion is greater, while Germany shows greater precision in its industrial production.

Besides, in the same Graph, it is shown how the 2008 crisis affected the three nations in industrial production in 2009. Still, it emphasizes how Germany had the response capacity in 2010 had higher productivity than that had in 2007, while Mexico took until 2012 and until 2014 for the United States. Although Mexico shows precision in its production performance, it has a lower slope; in 2015, industrial production reflects stagnation compared to developed countries. Based on the correlation statistic for Mexican industrial production, there is a medium-high probability that it will change favorably.

Therefore, it is essential to establish a baseline in industrial development, productivity analysis, and GDP, which is necessary to infer the industrial economic development performance. Productivity is determined as an index with a base year reference. Which denotes the GDP that contributes per active personnel or hour worked or a combination of both. For this, productivity in different contexts is disclosed, beginning with the international one. Productivity comparison with year base 100 = 2003, for the period 2005-2009, Mexico shows low productivity than other countries. The general average of productivity in first-world countries is around 1.9 times higher than that of Mexico. **Figure I-23** shows South Korea's productivity is much higher than Mexico, roughly 5.3 times higher.

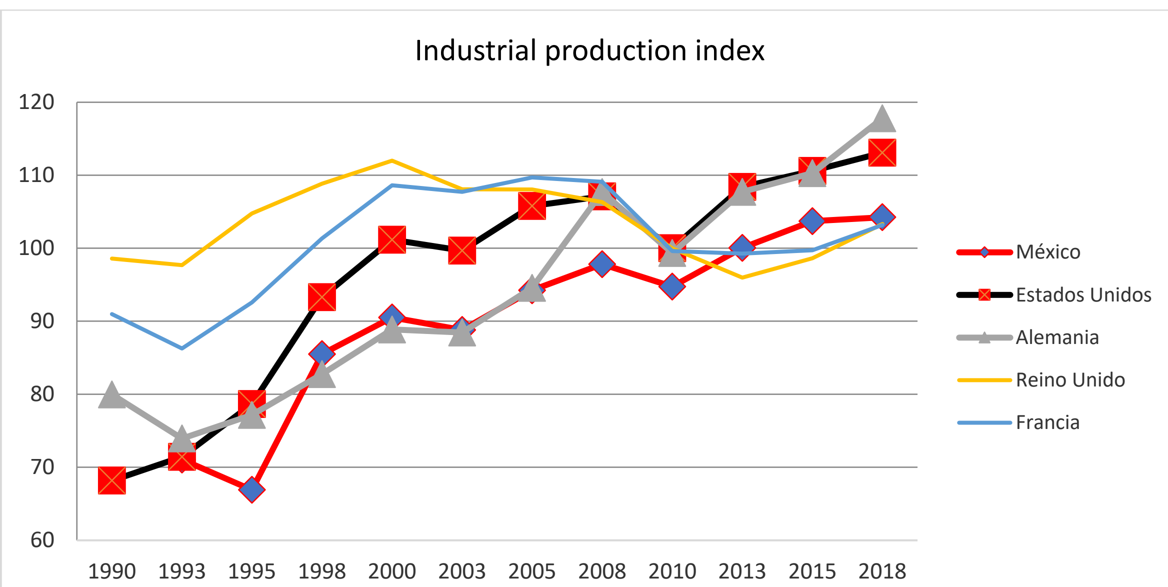


Figure I-22 Industrial production at international level (Based on data from INEGI, 2018).

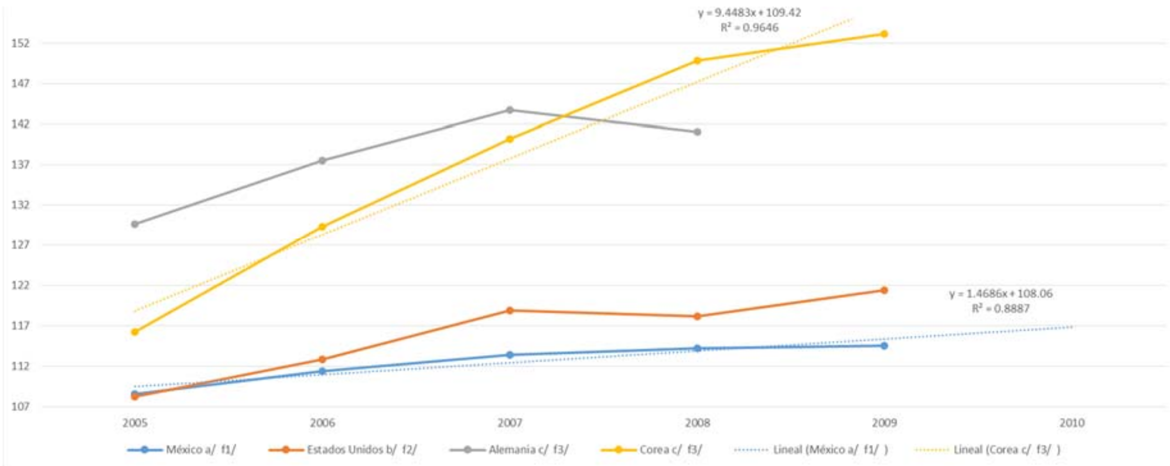


Figure I-23 International labor productivity base 100 = 2003 (Based on data from INEGI, 2018).

However, with a 2008 = 100 base and a study period from 2007 to 2017, it shows that Korea leads in productivity. While Mexico's productivity curve decreases from 2014, Mexico remains below Korea but exceeds the USA and Canada's productivity index until 2015 (see **Figure I-24**). However, the industrial production index mentioned in **Figure I-22** contrasts this. Since its index is higher, a correlation of North American industrial production is shown. Mainly due to the maquiladora industry installed on Mexico's northern border (Luis-Pineda, 2008) because a high correlation with North American production is inferred but in a much lower proportion.

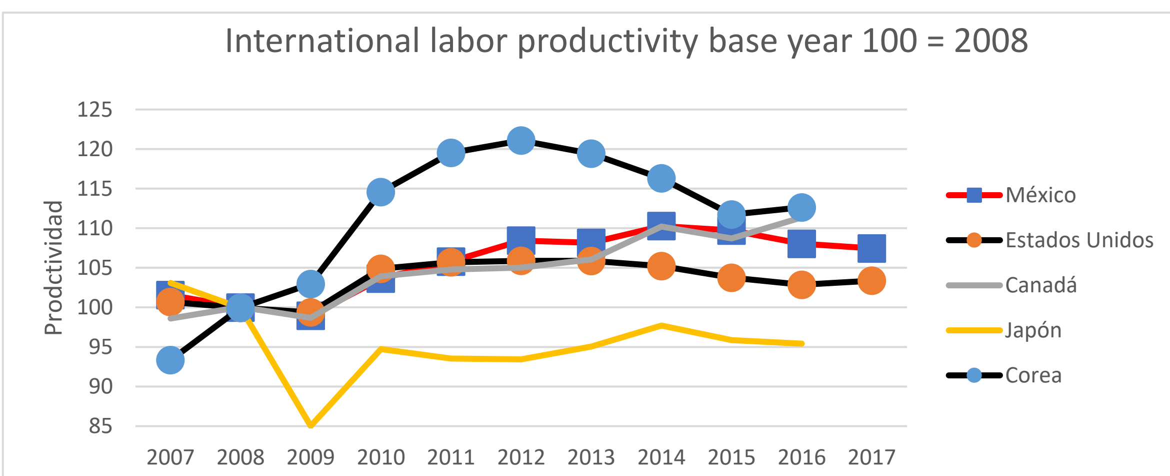


Figure I-24 International labor productivity base year 100 = 2008 (Based on data from INEGI, 2018).

Nacional productivity context

Based on global labor productivity, an analysis is done at a disaggregated level. For this purpose, the behaviour of the productivity of the secondary sector is disclosed in **Figure I-25**. The graph shows that, despite the increase in total productivity based on hours worked, the productivity of secondary activities declines from 2012, as more hours worked. More employed personnel are employed and fewer contributions in proportion to GDP. Then, the analysis at the manufacturing level, despite the increase in employed staff, the real average remuneration index does not present any alteration. Because there is no growth in it while working hours increase. Since 2014 the labor productivity indexes are observed to decline both in hours worked and in employed personnel. However, the staff employed increases linearly, as do the hours spent (see **Figure I-26**).

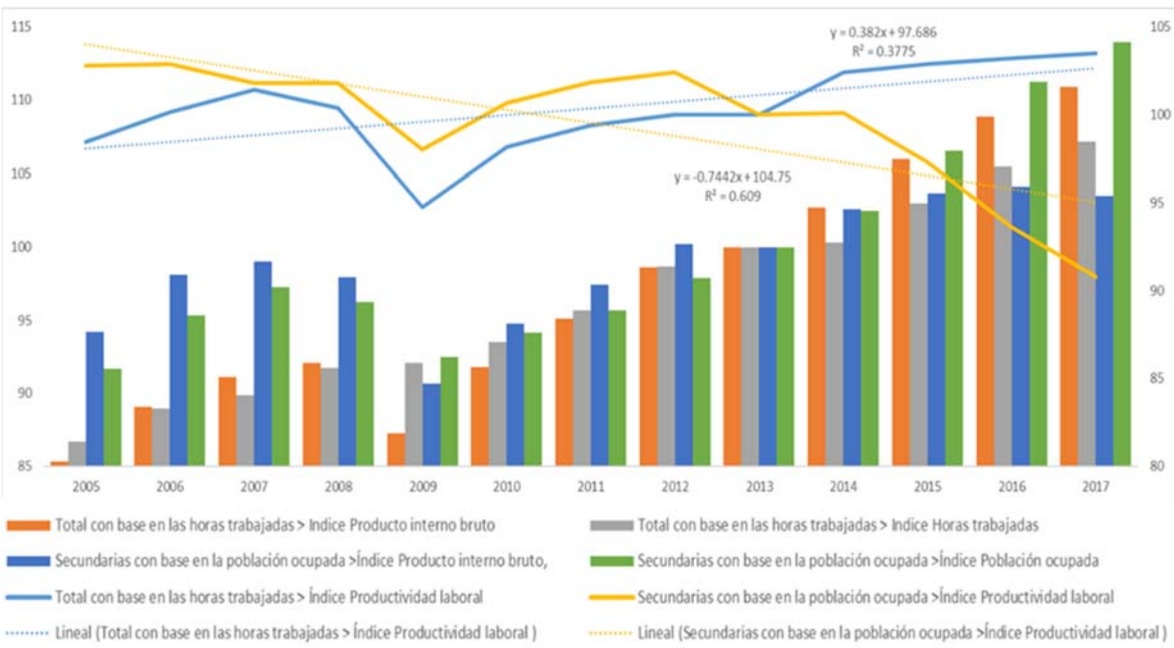


Figure I-25 National labor productivity and secondary activities base year 100 = 2013 (Based on data from INEGI, 2018).

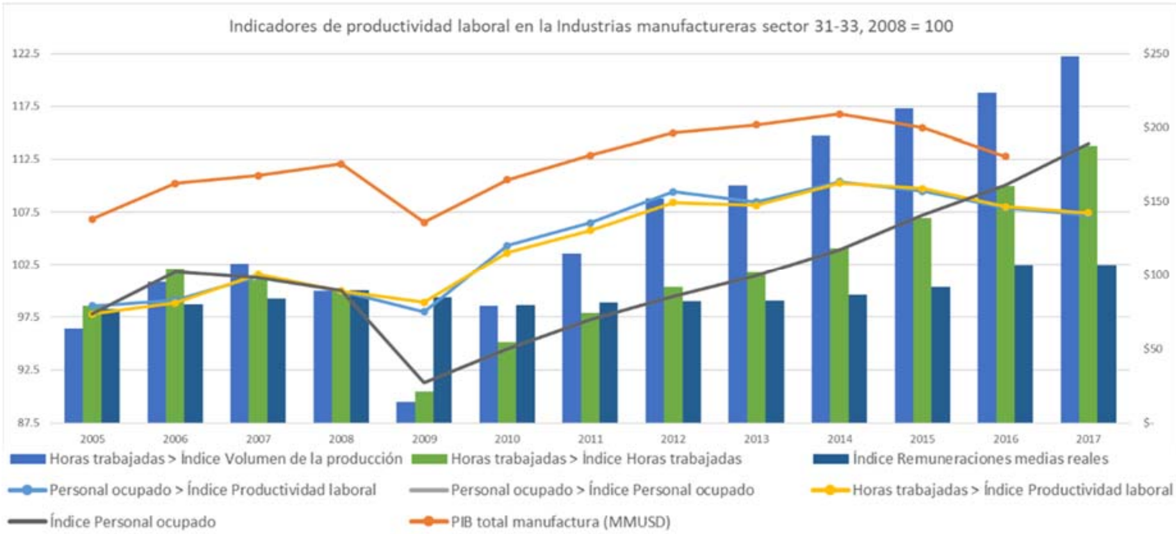


Figure I-26 Indicators of labor productivity Manufacturing sector base year 2008 = 100 (Based on data from INEGI, 2018).

I. 2. 6. Productivity state context

Through the territorial level analysis, **Figure I-27** shows the most representative states' performances according to their contribution to GDP. Besides emphasizing that the State with the best productivity performance is Guanajuato, followed by the State of Mexico, then the State of Nuevo León. Moreover, **Figure I-28** shows the production volume of the previous states, with the most considerable contribution to the production volume index being the State of Guanajuato, followed by the State of Coahuila and then the State of Nuevo León. The personnel index occupied by the previous states is positioned as follows: The State of Coahuila, then the State of Guanajuato, and finally, the State of Nuevo León see (see **Figure I-29**).

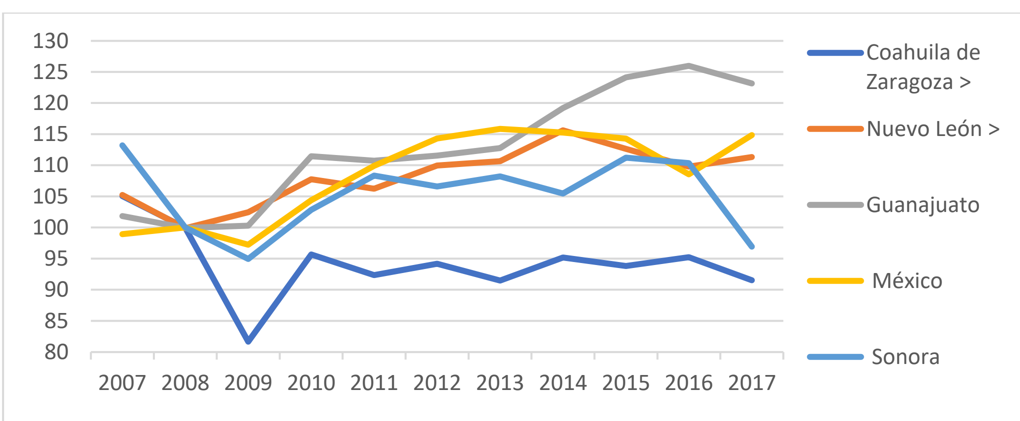


Figure I-27 Main states with the highest Productivity, base 2013 = 100 (Based on data from INEGI, 2018).

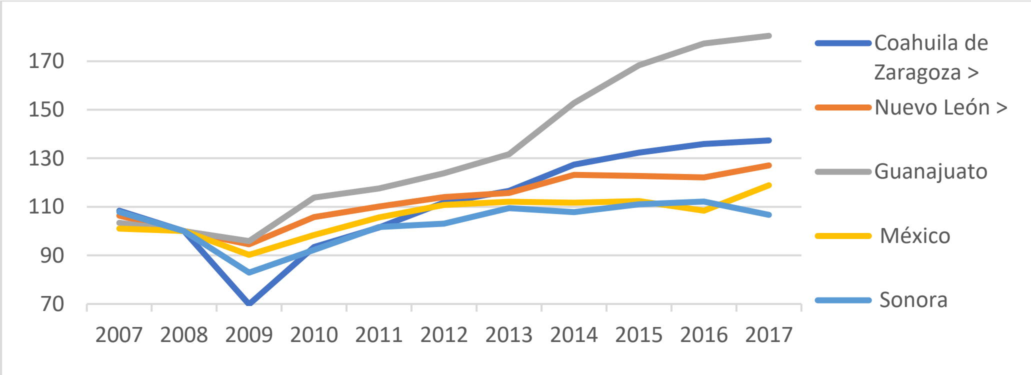


Figure I-28 Main states with Production volume, base 2013 = 100 (Based on data from INEGI, 2018).

Besides, this section summarizes the productivity of the states mentioned above (see **Figure I-29** Productivity of leading manufacturing states (Based on data from INEGI, 2018).). The figure shows that the States with the highest productivity gains are the states of Mexico and Jalisco. The productivity index is higher than the indexes of employed personnel and production volume. However, Coahuila, Nuevo León, Sonora, and Guanajuato differ on what has aforementioned. Coahuila employs a higher index of active personnel, but the production volume index is lower and contrasts with the productivity index. Nuevo León obtains a higher production volume and less active personnel; however, its productivity is more moderate than both mentioned indices. Sonora had a strong productivity performance until 2012, but in 2016 productivity declines to the degree that the index of personnel employed is higher than productivity and production volume. Guanajuato's performance is adequate until 2012, when the productivity index is less than employed personnel's index. In other words, these four states employ more busy staff and obtain lower productivity. Then it is necessary to establish the appropriate questions based on what the investigation pursues, but what do I want to get from this investigation? For this, it will be essential to develop the problems that the researcher wants to solve.

Figure I-29 Productivity of leading manufacturing states (Based on data from INEGI, 2018).

I. 3. Problematic

Due to the weak performance of labor productivity, it results in poor performance of the manufacturing GDP. That is why the low use concatenates the low efficiency of the current industrial strategy in labor productivity. However, the lack of an aligned approach to the sustainability of the industrial strategy puts at risk the achievement of sustainable development objectives. In terms of productivity, the low performance of the annual percentage change in productivity in manufacturing. Although the indicator of population productivity for manufacturing GDP shows a positive trend, there is too much fluctuation. So, there is no correlation of productivity based on manufacturing GDP. Likewise, our country's performance in labor productivity is inefficient compared to labor productivity in manufacturing, compared to what occurs in developed countries, because it is even up to 3 or 5 times higher than labor productivity in Mexico (see **Figure I-24**).

The investigation begins with the argumentation of the current context that it assumes that it involves the problem mentioned before and its exogenous effects in the absence of an industrial development strategy. The issue divides into different sections; on the one hand, the labor productivity index for the manufacturing industry sector is not proportional to the average wage growth rate at the national level. That refers to the fact that productivity is not proportional based on its annual variation. On the other hand, there is a contrast with the productivity index at the international level against developed actions such as those mentioned above, and the difference is very significant. Likewise, justification is performed with statistical data on the productivity situation at both levels, at national and international. Finally, in the different sections of the justification, the theoretical hypothesis for developing a sustainable and inclusive industrial development strategy is reached.

Likewise, the exogenous effects of a weak strategy on industrial development translate into imbalances in sustainable development. It affects not only the economic dimension but also the social and environmental ones. For instance, in terms of poverty, the industrial strategy's failure to combat social effects due to SMEs' bankruptcy. Besides, the pollution and emissions that the industry affects ecosystem depletion. Therefore, as a whole, the 2030 SDG Agenda's achievement for industrial development is at risk.

I. 4. Justification

The justification part divides into two parts, the fundamental questions for the research and the research questions for the objective pursued. The first part seeks to answer the basic questions that justify the need for this research project. While the second part, I perform a general analysis that explains the problem's approach through a statistical analysis at the national and regional levels in the different dimensions of sustainability.

I. 4. 1. Research questions

What is this research?

It is a proposal for a systemic model for inclusive and sustainable industrial development for the manufacturing sector

What is this research for?

Primarily, it seeks to develop a model for sustainable and inclusive industrial development that fosters the achievement of sustainable development goals. To do so, the Triple Bottom Line theory for context sustainable development is of utmost importance. Besides, it aims to promote productivity because it is an indicator representing the performance of the success and prosperity of a nation (Porter, 1998), which correlates with competitiveness (Pacheco-Vega, 2007) and technological progress (López, 2008) and leads to social welfare (Oosterhaven & Broersma, 2007). According to the literature analyzed, the cluster model is a strategy that can pave the way, based on competitiveness, derived from intense innovation activities in a region and knowledge that are spillovers that shape productivity in the manufacturing sector.

Who is targeted research?

Research efforts aim to fountain policymakers for inclusive and sustainable industrial development, to improve the economy, society, and the environment. Thus, develop the economy without leaving anyone behind and tackling climate change. Efforts encompass but are not limited to the development of new industrial projects, as long as it has an industrial management system covering SMEs. With its scalability to the management of industrial agglomerations defined as industrial parks and industrial clusters. Moreover, the configuration of an existing system, such as industrial cities and industrial parks, and installed industries, takes a medium and long-term project for its implementation.

Thus, as previously mentioned, this research aims to the innovator to unite the diverse objectives that stakeholders pursue in terms of sustainable industrial development. He must be primarily an innovative agent who, in his pure expression, is the core factor for economic success through innovators' activity or function. They cause technological disruption or improvement by introducing an idea, proposal, invention, or project within the economic cycle (Schumpeter, 1944). Stakeholders are managers of clusters, operators of industrial parks, government or regulatory entities, the local community and financial institutions (UNIDO, 2018), and representatives of business incubators.

Likewise, the research is directed towards the manufacturing sector's activities, as activities reviewed previously with classification NAICS 331-336. The study is limited in the activities: 331, the metal industry; 332, metal products industry; 333, manufacture of machinery and equipment. On the other hand, the 334-336 account indirectly aggregates other activities: 334, production of computer equipment; 335, component manufacturing; and 336, manufacture of transportation equipment.

Where it is carried out this investigation?

Based on the context, it was defined that the leading states that contribute to GDP in the manufacturing sector are; from the Northwest region, the State of Sonora; North, the states of Coahuila and Nuevo León; West, the state of Jalisco and; Centre, the States of Mexico and Guanajuato. Together they contribute 54.37% of manufacturing GDP. However, for reasons of proximity, it is proposed that the study carries out in an industrial management entity located in the State of Mexico, which contributes approximately 6.53% of GDP in activities 331-336, representing MXN 103,850.00 million.

¿ How it is carried out this investigation?

This question will appropriately answer in the theoretical-methodological framework chapter. However, for the appropriate structure of this section, systemic research is used for the methodology. Since the significant way to study organizations is as a system (Bertalanffy, 2014). The problem goes beyond more than one discipline, such as economics, engineering, social sciences, environmental, management, among others. Therefore, the problem is understood to be a transdisciplinary problem (Aceves, 2015). Likewise, the methodological scheme, such as the example of the soft systems methodology. To treat the problem, which is interrelated with organizations, then the viable systems model will be used to structure a system that covers a holistic solution.

Likewise, models and methodologies will be used to develop a strategy for sustainability and industrial inclusion. For this, as explained above, clusters are models of industrial management units that have been used for local, regional, and sectoral development, among others, and the quality of increasing productivity. However, to achieve the development of cluster models, innovation and knowledge management must be based. Because based on them, the strategy that leads to competitiveness models is implemented to take advantage of competitive advantages at the national, regional, and municipal levels. Furthermore, today, the fourth industrial revolution is little known in Mexico, so the analysis of Industry 4.0 will be carried out for a modern, lean, and productive cluster model.

I. 4. 2. Justification of the problem: statistical analysis

Therefore, it is of utmost for an industrial strategy to know the performance of productivity in manufacturing activity. Based on the analysis on the portal of the INEGI Economic Information Bank of the labor productivity index in manufacturing for primary metal industries (331), metal products manufacturing (332), machinery and equipment manufacturing (333), and manufacturing of transportation equipment (336), as branches with manufacturing processes used for the transformation of metal similar in the national economy, with a base of 2013 = 100, the following results were obtained.

Figure I-30 shows the performance of productivity based from 2005 to 2017. Despite having an increase from 2009 on the employed personnel index, the real average remuneration index has remained without corresponding effect. Likewise, the labor productivity indexes of hours worked and of employed personnel declined in 2014. Therefore, a first advance to the hypothesis about the low performance of the industrial development strategy corresponds to labor productivity of hours worked and the productivity of personnel employed nationwide for the sectors mentioned earlier.

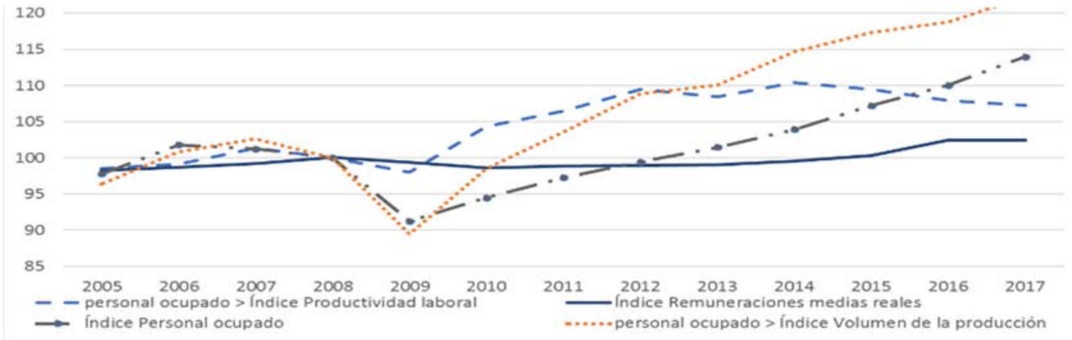


Figure I-30 The productivity of the manufacturing industry sector 31-33, 2005-2017, B: 2013 = 100 (Based on data from INEGI)

Sustainable development goals emphasize the GDP as an economic indicator. Then, the GDP of sector 31-33 of manufacturing activities are analyzed. **Figure I-31** shows the behaviour of manufacturing GDP for activities 331-336 from 2003 to 2016. The GDP performance indicates a positive trend, but in 2014 there is a turning point of negative change and a fluctuation variable. Furthermore, the manufacturing sector's GDP to total GDP fluctuates at 16.82% annual average in the same period. In 2014, likewise, the proportion of manufacturing GDP declined.

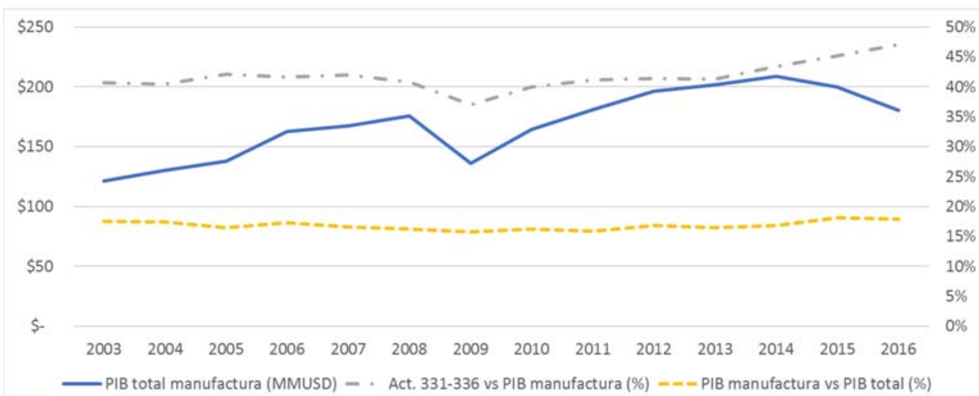


Figure I-31 Manufacturing GDP in the sector 31-33, 2003 - 2016, B: 2013 = 100 (Based on data from INEGI)

Likewise, the global productivity index and the employed population index are compared, in aggregate, with the secondary sector's GDP index. There is similar behaviour to **Figure I-30** and **Figure I-31**, in which labor productivity decreased in 2014. However, at an aggregate level in the secondary sector, it declines rapidly from 2012 (see **Figure I-32**). Besides, an even higher index of the employed population shows a correlation with the GDP index. The latter in a smaller proportion, but without a relationship with the productivity index. Therefore, after analyzing the previous indicators, an assumption of having a low performance in the current productive industrial strategy is assumed. The previously mentioned thesis would then give relevance to the proposal of a systemic model of industrial development with a sustainable approach.

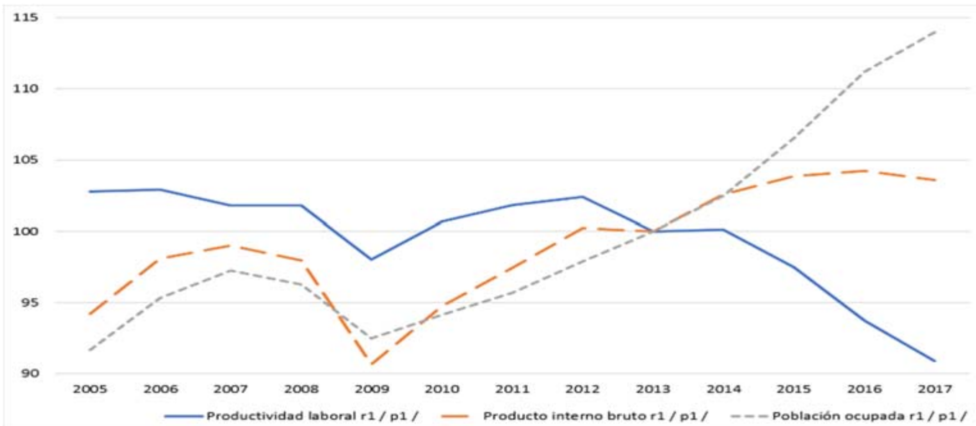


Figure I-32 Global index of labor productivity of the economy, 2005 - 2017, B: 2013 = 100 (Based on data from INEGI)

On the other hand, through an analysis of the manufacturing industry's productivity indicators at an international level. There is a significant difference compared to Mexico's productivity with other economies. From an analysis based on 1993 = 100, that includes from the year 1993 to 2008, South Korea with a function of y = 1.4902x + 73.96; R ^ 2 = .9729. South Korea has much higher productivity function than Mexico, with y = 0.4499x + 102.98; R ^ 2 = .9722 of 3.3 times above the national economy.

Likewise, through an analysis period from 2005 to 2011 with a base of 2003 = 100, compared to the same country with a function of y = 0.8602x + 112.14; R ^ 2 = .8354 has a productivity higher than 5.3 times above Mexico with a function of y = 0.1622x + 107.73; R ^ 2 = .4248, giving a global average with developed countries of 1.9 times greater than Mexico. One of the success factors in South Korean industrial development is cluster theory (Park et al., 2016).

Under a global context and in the absence of sufficient economic stewardship, the state promotes an adequate balance between competitiveness, growth, and social welfare. The state should develop public policies conducive both in technological and financial matters to economic development. However, the criteria for local and foreign investment in the private sector within a peripheral economy are made under economic growth parameters, particularly those aimed at forming an industrial cluster or any other modality within a Nation-State. In other words, they seek to maximize the return on investment compared to the competitive global market. However, this approach does not take the current context problems into account that ignores social inclusion and the region's environment depletion where these capitals locate (Luis, 2008).

This study seeks to propose a conformation model of sustainable and socially inclusive industrial development for a peripheral economy based on the Mexican situation. Based on this, both peripheral and developed economies' national and international experience is essential for developing the model, mainly in those that couple a sustainable development strategy where competitiveness has worked simultaneously with economic growth and social well-being. In this way, it contributes to the advancement of concrete proposals aimed at those responsible for formulating the corresponding public policies for this type of investment in a peripheral economy.

I. 4. 3. Analysis of the sustainable context in Mexico

The analysis of productivity only allows supporting to criticize that the strategy for industrial development is insufficient. However, its relationship with the three sustainable development dimensions is imperative for the sustainable and socially inclusive approach. In the following section, the economic pillar is summarized; then, for the social size, the essential indicators for social development are described; Finally, in the environmental part, the most significant variables are similarly denoted. Subsequently, for the study of social inclusion, SMEs' mortality is analyzed as a dominant agent for industrial development in peripheral countries.

i. Economic dimension of the sustainable development Analysis

Sustainable development aims to balance the three dimensions. Still, human activity starts from economic activity, this system is nested in society, and finally, this society locates in a context or the environment. This system will be illustrated in **Figure III-11** System for Sustainable Industrial Development and Relevant systems. Thereby, economic activity is the driving dimension for development. **Figure I-32** summarized the most significant variables for sustainable development. The index of secondary sector GDP, which involves manufacturing activity, is compared with the labor productivity index and occupied population index. It shows a close correlation between GDP and the employed population, although productivity with a negative trend at the inflection point from 2013 decouples from the working population and GDP (Mendoza-del Villar et al., 2019).

ii. Environmental dimension of the sustainable development Analysis

On the one hand, according to INEGI, the decoupling of the economy is reported concerning investment in environmental accounts. It represented 4.6% of GDP in 2016, while 8.4% was allocated in 2003. On the other hand, this amount is much higher than what is destined to science expense like research and experimental development (0.51% of GDP). Despite the state having made a weak effort to stabilize this situation, the environmental account approach is unsustainable. It means that 86.87% goes to the corrective account of ecological depletion and degradation, while only 13.13% of the ecological budget accounts for prevention and environmental protection. Likewise, **Figure I-33,** in terms of greenhouse gas emissions, by the National Institute of Ecology and Climate Change (INECC) data shows a 98.33% probability of having the same pattern and trend of behaviour (Mendoza-del Villar et al., 2019).

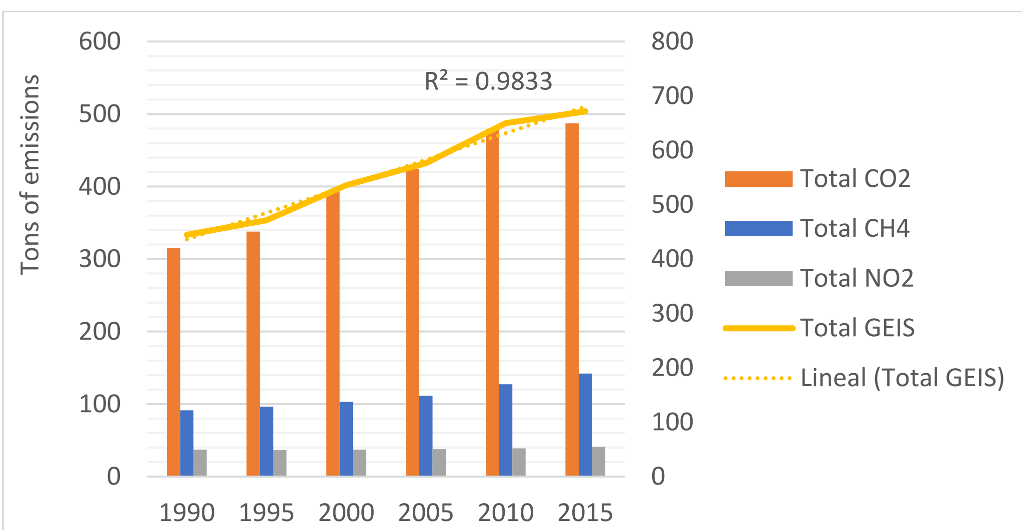


Figure I-33 Greenhouse gas emissions in tons, 1990 – 2015 (Based on data from INECC, 2019)

iii. Analysis of the social dimension of sustainable development

The most significant variables in this component are evaluated for the social analysis, which considers the Human Development Index (HDI), the coefficient of social cohesion, and the GDP per Capita. **Figure I-34** shows that HDI has a drop in the last evaluation period. The GINI index has a slight improvement but is insufficient to consider it as social inclusion. Furthermore, **Figure I-35** shows the employment situation; although there is an effective increase in employment, which reduces the gap between formal and informal jobs, there are more informal jobs than formal ones. It highlights that the unemployment gap only reaches the same number of informal employment (Mendoza-del Villar et al., 2019). This situation shows a lack of social inclusion for sustainable development.

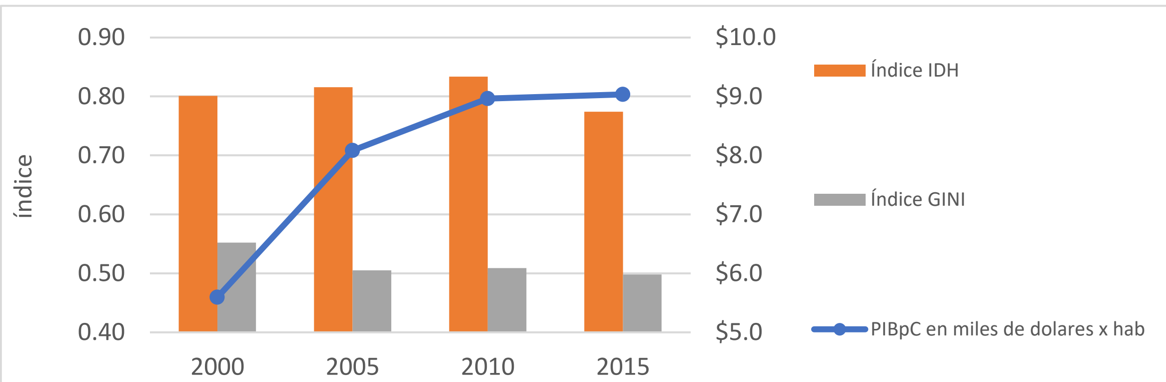


Figure I-34 National social variables in Mexico 2000-2015 (Based on data from INEGI, 2019)

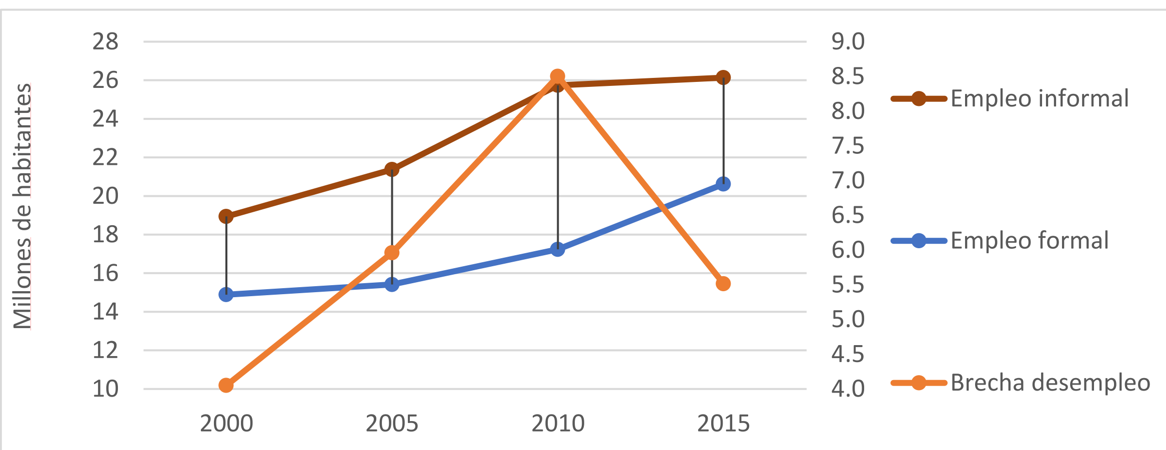


Figure I-35 Employment in Mexico and the gap to equalize employment (Based on data from INEGI, 2019)

One of the sources of unemployment is the closure of job sources. In Mexico, 78% of formal employment is provided by Small and Medium Enterprises (SMEs). SMEs represent 99.8% of established economic units and contributing 42% of GDP. The INEGI on its platform reports mortality data for SMEs. **Figure I-36** shows that as long as more employees are in the firm, the stronger it is, whereas vulnerable firms are those with few people in the fifth year. Thereby, the probability of risk of dying an SME reduces linearly with an $r^2 = 96.5$ an SME in the fifth year it stays. For instance, an SME of 5 people has a probability of dying of 70%, while an SME of 50 people has a chance that the 5th year remains is approximately 23%.

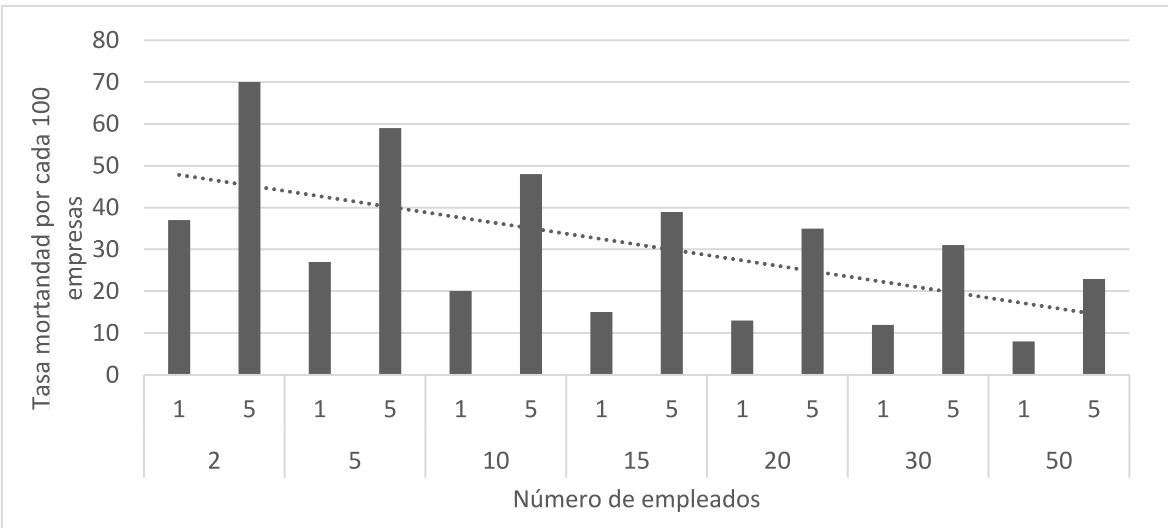


Figure I-36 SME mortality rate based on the number of employees in 1 and 5 years

I. 4. 4. Industrial policy

The policy for industrial strengthening is essentially based on Mexico's trade agreements with countries from both the North American and Trans-Pacific blocs. Although this type of treatment aims to face economic problems, the state assumes a passive role in the industry (Washington Consensus). Calderón & Sánchez (2012) mentioned that the economic stagnation results from deficient industrial policies, which are in service of the chain production for the installed manufacturing industry. They obey the comparative advantage that Mexico can contribute to the United States' economic cycle, leaving behind the primary tool to face Mexican products' low competitiveness. Thus, it disabled the national supply chain and serving the manufacturing import sectors and maquila services.

The design of appropriate environmental regulations supports firms' innovation capacity for the productive use of business resources (Porter & Linde, 1995). Porter & Linde reported that it develops a competitive advantage against those firms that do not seek to align themselves with the regulatory framework for environmental care and protection. Therefore, innovation is an instrument for developing a competitive advantage that supports to grow productivity. As long as the core advantage aligns with sustainable differentiation, which will help minimize the environmental impact through the productive use of material inputs, economic, energetic, and human. On the one hand, this function's result tends to reduce operating costs and, consequently, be more competitive. On the other hand, if lowering cost is an objective for deploying a strategy to be more competitive, then a cost differentiation would be adopted. It develops a predatory behaviour in the market because there is no way to support the sale price reduction in the absence of innovation. Therefore, productivity decreases, and operating costs increase; i

n this way, neoliberalism breaks through only because large corporations have the infrastructure to innovate in a region. Where the lowest price is the decision point to buy has an advantage in a predatory market.

I. 5. Hypothesis

Adopting a strong sustainability model and social inclusion for industrial development would support the design of a strategy at the management level to foster a sustainable differentiation based on innovation. Therefore, it tackles the negative impact of an unsustainable industrial approach.

Industrial development strategies like those used in developed countries have reasonable labor productivity rates in manufacturing with a productivity average of 1.9 times higher than Mexican performance. Notwithstanding, the single approach to economic growth has proven insufficient for a peripheral country. Therefore, a development that couples economy with social and environmental dimensions would support to get sustainability and inclusiveness in industrial development since this index ignores the inclusion of society of the sector workers (target population) and the social impact of economic activities. Moreover, it does not consider the environmental implications of the sector's economic activity at the local, regional, and national levels. Building a model for sustainable industrial development infers paving the way through a strategy to increase current labor productivity prevailing in Mexico. Therefore, to contribute to the formulation of a strategic model of industrial development, it is of utmost importance to understand how economies make the transition from their unsustainable industry to a balanced one. However, the Triple Bottom Line theory is the base for its equilibrium. Likewise, it fosters to achieve 2030 agenda sustainable development goals.

I. 6. Research objectives

I. 6. 1. General research objective

Build a systemic model for sustainable and socially inclusive industrial development in the manufacturing sector.

I. 6. 2. Particular research objectives

- Relate sustainable development with industrial development
- Formulate a sustainably inclusive strategy for industrial development
- Identify and characterize the indicators that determine the sustainability of a region for the manufacturing sector
- Identify and represent the systems and relationships of the manufacturing industry with the different actors for sustainable industrial development.
- Develop a sustainable industrial development strategy for the manufacturing sector

I. 7. Congruence matrix

The table shows a resume of the congruence of the elements previously reviewed throughout this section. Based on the title of the investigation, it deploys the parts of the research for the study. Later, the research questions seek a correlation between the questions made and the study topic's problem. Derived from the problematic sub-section, then, the matrix shows how the general objective is aligned to solve as the research hypothesis's proposal and the specific ones that answer the research questions. Finally, the theoretical and methodological part mentions the aspects that paved the way for solving the research objectives.

Table I-7 Research Consistency Matrix

Title	Problem Statement	Research questions	Hypothesis	General objective	Specific objectives	Theoretical aspects	Methodology
	The low performance of the current industrial strategy, due to the poor performance of labor productivity.	Does Mexico have a sustainable industrial development strategy?	Adopting a strong model of sustainability for industrial and inclusive development would support the design of a strategy at the management level to adopt a differentiation based on innovation. In this way, reduce the death rate of SMEs, supporting the productivity of companies.		Review of the literature on sustainable industrial development.		Systemic Meta-methodologies and methodologies
	The current industrial strategy does not have a sustainable approach	Does the industrial strategy have any correlation with productivity?			State of the art determination.	Systems theory	
systemic model for sustainable industrial development in the manufacturing sector	Poor performance in manufacturing GDP	Is labor productivity a significant factor for manufacturing GDP?		Build a systemic model for sustainable and socially inclusive industrial development in the manufacturing sector.	Identify and characterize the variables that determine the sustainability of a region for the manufacturing sector.		Triple Bottom Line for sustainable development
	Risk of not meeting the goals for sustainable development of the 2030 agenda	What impact does failure have on the achievement of sustainable development goals on industrial development?	The development of a strategy for sustainable industrial development would support the achievement of sustainable development objectives.		Develop a sustainable industrial development strategy for the manufacturing sector.		
		Is sustainability viable for industrial development?			Represent the systems and relationships of the manufacturing sector with the different actors through systemic tools.	Sustainable development theory	
	Low scientific contribution to sustainable industrial development	Has the scientific contribution a strategy for sustainable development in terms of industrial development			Discussion of the model through internal and external analysis and validation.		Strategy and competitiveness

I. 8. Literature review

For a systemic industrial development model with a sustainable approach, it is essential to define sustainable development beforehand for this research. Sustainability refers to continuity or perpetuity, in this case, enduring development (Luis-Pineda, 2008). Sustainable development defined as the satisfaction of present needs without jeopardizing future generations' ability to meet their needs (Artaraz, 2002; United Nations, 2015). On the other hand, Artaraz (2002) and Díaz (2015) agreed in their works that sustainable development integrates three dimensions (see **Figure I-1**). The dimensions are the economic aspect within a society, and it operates in an environment. Therefore, for sustainable development, these dimensions must be balanced (Diaz, 2015).

On the one hand, the firm's investment must have favorable returns, at best, between 3 and 5 years from its installation. Such investment is generally a considerable amount for small and medium-sized companies, which enter a competitive world. So, its establishment must have a strategic focus. On the other hand, sustainable development meaning has the strategy implicit in its definition because it considers the future or at least the next generation. Therefore, I define sustainability for industrial development as "*the industry that meets the present's needs by taking into account the environmental, social, and economic dimensions for suitable development and balancing them without compromising future generations' ability to meet their own needs*". In such a case, establishing a firm should have a sustainable focus and reduce the company's risk of bankruptcy (Mendoza-del Villar et al., 2019).

However, it is not enough to analyze the context in which a firm establishes. According to Porter (2012), in his diamond model, the national advantage's rhombus shapes the industrial sector; thus, their attributes must be examined. The first determinant refers to the conditions of the factors, where production factors are evaluated, such as specialized labor or the infrastructure necessary to compete. Second, the demand conditions determine the nature of the demand for the sector's product or service in the domestic market. Third, related to auxiliary industries refer to the presence and absence of competitive supplier sectors. Furthermore, strategy, structure, and rivalry are the fourth determinant, which is the conditions of the nation that govern the way companies are created, organized, and managed, as well as the nature of their competition.

As stated above, determining the strategy is essential for an organizational structure that can manage competitive rivalry in scenarios that are feasible for all industry types. For this research, the manufacturing sector's activities are delimited, especially in the SMEs that represent 99.8% of the installed industry in Mexico (Bosques-brugada et al., 2020). Since innovation in its pure concept is the central factor for economic success through the activity or function of a particular set of individuals called innovators who are the causes of technological interruption or improvement by introducing: an idea, proposal, invention, or project; within the business cycle (Schumpeter, 1944). Such innovators are also known as entrepreneurs, would promote the sustainable industrial development model in an industrial-organizational structure such as a cluster and other industrial management units. Therefore, the strategy targets those activators of the economic, social, and environmental cycle, who are in charge of industrial management units such as entrepreneurs from large companies and SMEs, government agents, researchers, and academics.

I. 8. 1. Literary review methodology for sustainable industrial development

The methodology described in **Figure I-37** was used for the literature review. It consists of 4 phases that focus on expressing the most representative research in sustainable industrial development. However, this field of study has previously been examined and put into practice by researchers and policymakers. Conversely, a pre-navigation phase related to the exploration of sustainable industrial development should be necessary to obtain an overview of an unexplored problem. Therefore, reviewing the literature as the first phase, I searched for sustainable industrial development in the SCOPUS and Web of Science scientific databases as the most representative scientific databases in the world of citations and literature summaries peer-reviewed scientific.

Figure I-37 Literature review methodology

Then, with the use of bibliometric analysis software, the second phase is carried out. During this process, in addition to analyzing the relationship of the keyword, countries that are leaders in this field of study, leading research journals with the highest impact factor in industrial development were also analyzed. Subsequently, the information was filtered to choose the publications with the highest impact index for the research. Finally, as a fourth stage, an analysis of state of the art was carried out in terms of sustainable industrial development.

I. 8. 2. Search of publications

Although international organizations have strived in this field, since, as mentioned before, sustainability is part of the United Nations' effort to face the most prominent global issues by the 2030 Agenda and the 17 sustainable development goals (SDG). Based on the UN SDG and literature review section, **Figure I-38** shows the keywords mentioned related to sustainable development. It highlights the keyword sustainable industrial development locates in the centre of the diagram, with the most related terms surrounding.

Figure I-38 Most frequent keywords in sustainable industrial development (Own elaboration)

I. 8. 3. Bibliometric analysis

I performed the bibliometric analysis with the software support "VOS viewer". A useful tool for constructing and visualizing bibliometric networks. The method consists of grouping the keywords that authors use most frequently into groups. Clusters of bibliometric data links bibliographic coupling, co-citations, or co-authorship relations. They offer helpful information such as co-occurrence networks of essential terms of the literature review (van Eck & Waltman, 2010).

The analysis in terms of sustainable industrial development and industrial cluster covers the year 2014 to 2017. It obtained five main groups that make up the keywords. Among those that stand out are the industrial clusters and cluster analysis (see **Figure I-39**). Subsequently, each cluster was analyzed, in which the most representative is the industrial cluster node with an occurrence of 207. Among the nodes with the highest weighting in this cluster are the words; industrial cluster, its frequency of 34; sustainable development, 28; industrial symbiosis, 25; industrial ecology, 24; industrial park, 17; SME, 15; circular economy, 13. Outside the cluster, the most critical nodes are; cluster in terms of economic growth, 120; the cluster focused on innovation and competitiveness, 179; cluster analysis as a methodology with 114; and finally, the industrial clusters as a social agent, with a frequency of 125.

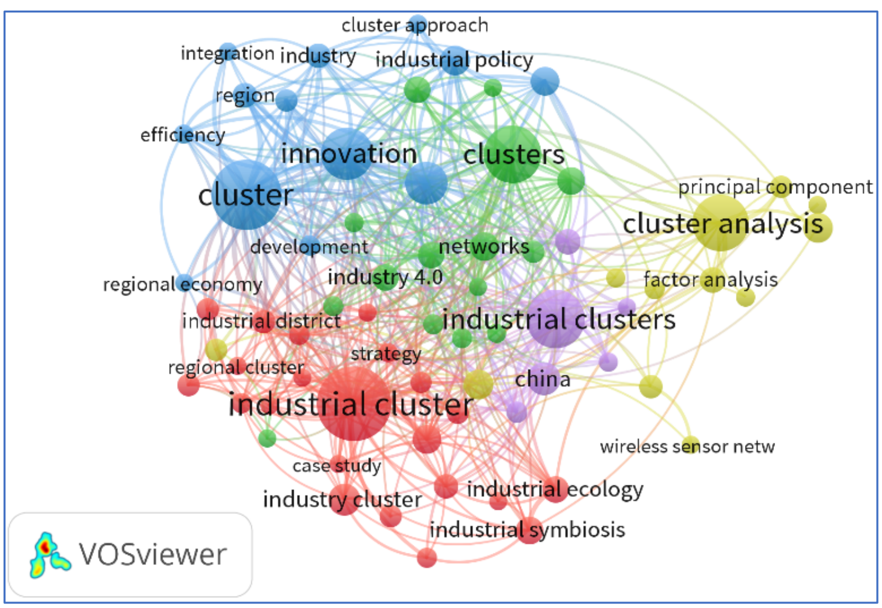


Figure I-39 Bibliometric analysis of sustainable industrial cluster (Own elaboration with VOSviewer)

For state of the art, as a result of the most recent publications, the links of cluster 1 Industrial cluster stand out from the keyword sustainability, with an occurrence of 207; cluster, with 179; innovation, with 95; competitiveness with 64; Industrial symbiosis, 25; industrial ecology, with 24. An interesting word is Industry 4.0, with 24; and SMEs; with 15. As mentioned, I 4.0 is a topic that is currently in vogue due to its significant contributions to raise productivity in manufacturing to unprecedented levels (Götz & Jankowska, 2017). **Figure I-40** shows that industry 4.0, with an occurrence of 23, is mainly linked to cluster analysis, industrial cluster, innovation, competitiveness, and industrial policy. Finally, regional development involves cluster activities, industrial clusters, cluster analysis, innovation, and economic development among the most representative.

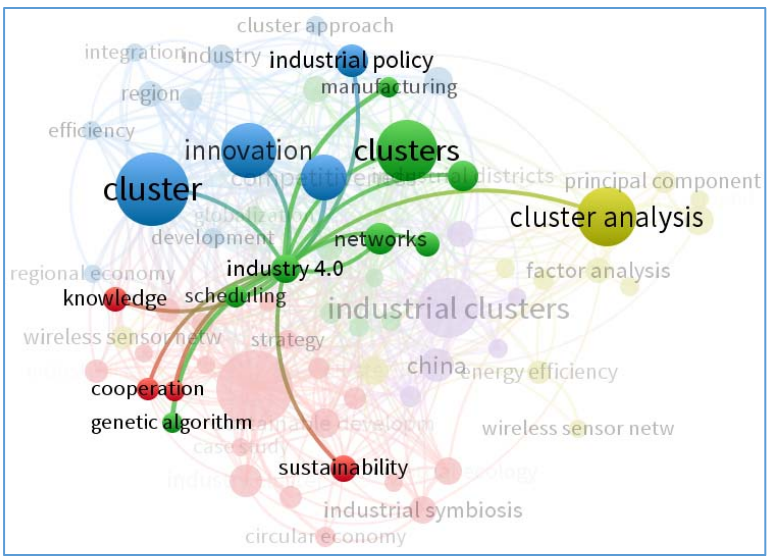


Figure I-40 Bibliometric analysis of the word Industry 4.0 (Own elaboration with VOS viewer)

Likewise, through the analysis of clusters of the countries with productivity in research and sustainable industrial development, four groups are obtained. The first group includes Russia with 206 articles; The United Kingdom and Italy lead the second, both published with 134 papers. The third group is undoubtedly the most significant, having China with 686 published articles; this makes it the country with the highest contribution in terms of field research. In turn, in terms of sustainable industrial development, Mexico has 18 articles as of 2014. Among the countries that most refer to Mexican publications are China, the United States, Russia, and the vast majority of European countries.

Besides, the published journals are mentioned to conclude with this section, in which it obtained three clusters. The first group locates the *advance materials research, applied mechanics and materials, journal of computer science e international journal of applied business and economic research*. The second one, the most representative journals are the *journal of cleaner production, environmental science and pollution research, environmental earth science*. The third cluster contains *European planning studies, journal of economic geography, regional studies, industry and innovation* y *competitiveness review*.

I. 8. 4. Information classification

Finally, by purging the information, I eliminated words that lacked meaning for the investigation; therefore, the analysis generated five clusters. **Figure I-41** depicts that the most significant cluster is the red one, which links to the words cluster, industrial cluster, agglomerations, business incubators, industrial policy, and the one with the highest occurrence is innovation. Then, the second cluster relates to knowledge management, productivity, cluster, and industry 4.0. The third group contains sustainable development, systemic thinking, development, economic growth, and sustainability. Moreover, the fourth cluster consists of industry 4.0, Smart manufacturing, automation, digitization, and the Internet of things. Industrial clusters, industrial symbiosis, industrial ecology, and management formed the fifth group.

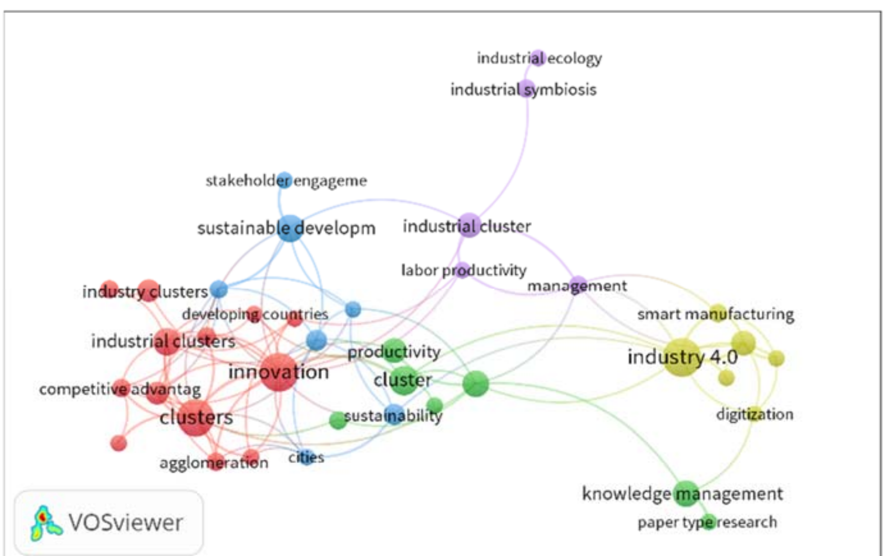


Figure I-41 Bibliometric analysis purged (Own elaboration with VOS viewer)

I. 9. State of the art

Once the research trends for sustainable industrial development are devised, the countries with the highest contribution, the leading Journals, and a classification of the information, I proceed to develop state of the art.

Being the most mature and modern manufacturing revolution, Industry 4.0 (I4.0) represents a breaking point for innovation on knowledge management digitalization (Mendoza-del Villar et al., 2019). This maturity revolution stems from the three previous stages, namely industrial revolutions. The first industrial revolution, which became with the first mechanical loom in 1784 with the crafting production paradigm; then, the second revolution, it was launched in 1870 with the innovative technology developed with electricity for mass production. Later, the third one, with the development of the automated devices due to Programmable Logic Controller (PLC) and IT systems (Mendoza-del Villar et al., 2020).

Eventually, the fourth industrial revolution, mainly characterized by introducing Cyber-Physical systems, interconnects vertically and horizontally throughout the firm's processes (Bodrow, 2017; Bortolini et al., 2017). Such interconnection of the firm links internal processes and external ones that associate procedures involving suppliers and customers' instances. Therefore, these links begin with the firm's horizontal operations, such as the supply of raw material until the final product's delivery to customers or end-users. Meanwhile, vertical integration processes interact with stakeholders' communication of the complex network value (Strandhagen et al., 2017). Finally, integrating both interaction types with cyber-physical systems along the chain value is well known as the end to end engineering (Garbie, 2016; Götz & Jankowska, 2017).

I. 9. 1. The importance of knowledge in economic development

Nowadays, knowledge management has significantly changed the industrial sector, even with the I 4.0 launch in Germany, it has developed a vast field of the labor market. On the one hand, it is not just employment in the manufacturing sector created, but the service sector has also been growing for intense knowledge services (Götz & Jankowska, 2017). This sector is more robust than those in clusters of high technology manufacturing services (Temouri, 2012). One of the leading human activity is industrial activity. Moreover, it is one of the economic drivers, especially the manufacturing sector, which is the pillar for civilized lifestyle (Papetti et al., 2018); it generates 2.2 jobs in other areas per each employment generated in this sector (UN, 2019a).

On the other hand, knowledge is the most critical resource. Yu et al. (2007) identified it as an asset, the same as earth, productive infrastructure, and capital. The difference between them is that knowledge is an endless resource that leads to the knowledge economy (Adler, 2001). However, knowledge needs a suitable environment and a regional scope delimited for the organizations. Innovation leads to productivity, so the focus is on exploiting this innovation in industrial clusters for sustainability under the perspective of who creates innovation. According to Schumpeter (1944), an innovator can be anybody who exploits the economic cycle of the service or product into a market, like an entrepreneur or even a cluster manager, who utilizes the core competence of cluster by cluster policies creation based on the life cycle (Pacheco-Vega, 2007). Since knowledge requires a favorable and spatially limited environment, it implies that firms are attracted by clusters or regional platforms (Götz & Jankowska, 2017).

I. 9. 2. The industrial cluster role in economic development

Götz & Jankowska (2017) proposed strategic industrial development in their research because its environment is conducive to the development of I 4.0 thanks to industrial clusters' advantage. The productivity growth brought about by the knowledge economy allows a regional specialization network of interconnected activities of complementary companies and the creation of synergies in research centres. On the other hand, competitiveness focuses on globalization; Furthermore, due to its challenges, it is necessary to promote SMEs' inclusion in industrial clusters, thus increasing the probability of success in the global market. On the other hand, Foghani et al. (2017) proposed a model for this inclusion. Under a collaborative approach and sharing infrastructure, industrial symbiosis initiatives are created to be adopted by SMEs installed in a cluster to obtain environmental benefits and achieve sustainable industrial development. Likewise, Daddi et al. (2017) propose a life cycle assessment method to measure the benefits of implemented and non-implemented initiatives in the cluster's core product. The results emphasize the implemented initiatives that achieved relevant benefits in sustainable development.

In South Korea, cluster theory has been useful in creating industrial policies in balancing economic development and national success in the industrial ecosystem. Park et al. (2016) mentioned a way to classify high-impact industries in the South Korean economy, with variables that are significant for the success of industrial clusters' performance. The analysis of variances of variables such as the growth rate of income, the new jobs created, and the companies' profitability that are within the clusters and compares them with companies that are not.

In Italy, Di Giacinto et al. (2014) intended to define industrial districts, correlating productivity analysis with econometric tools to calculate coefficients; This study helps determine industrial clusters. Furthermore, there is research on the cluster's life behaviour as the life cycle of a product. Pacheco-Vega (2007), in his work " *Una crítica al paradigma de desarrollo regional mediante clústers industriales forzados*", exposed under the topology of industrial districts and through the innovator's figure to manage and support processes both in the government or in external agents. Based on the cluster's life cycle stage and its origin, the innovator is responsible for the cluster's economic reactivation.

At the national level, the 17 sustainable development goals mentioned at the beginning of the research measured by different government agencies, such as INEGI with its various hubs and the Mexican government (INEGI, 2020). Although there is little information on this topic, there is a significant contribution to the field of industrial clusters. Rodríguez et al. (2016) developed an analysis through Forrester's system dynamics to determine the causal relationships that define an industrial cluster. According to Porter's diamond, the dynamics consist of the complex analysis of factors that intervene in competitiveness, which contains the macroeconomic, political-legal, and social contexts. The result is a causal model representing the formal relationships of the competitiveness variables for the development of a cluster. The Bank of Mexico in 2015 provided a methodology applied in the Mexican manufacturing industry for the identification of regional clusters through the estimation of location coefficients and spatial autocorrelation measures. Among their findings, Chávez & García (2015) mentioned the effects of the manufacturing industry's relocation. The entry into force of the North American Free Trade Agreement (NAFTA) affected the agglomeration patterns of manufacturing activity differently (Calderón & Sánchez, 2012). Finally, an econometric model was developed based on the CDM methodology (Crepón - Duguet - Mairesse). This methodology has been tested and has been useful to test and identify the determinants of innovation and the effects of its benefits, such as productivity (Crespi & Zuniga, 2012; De Fuentes et al., 2015).

Visser et al. (2013) compared their work "*Growing but not Developing: Long-Term Effects of Clustering in the Peruvian Clothing Industry*" clusters and dispersed companies. Their findings interestingly contradict clusters' theory because producers' productivity within the cluster decreases despite creating higher employment and business. However, they maintain advantages over-dispersed companies since the static position declines in the producer's lag once they are located in the area and develop at the level of entry and exit transactions.

Table I-8 summarizes the literature reviewed for the state of the art of industrial clusters as a strategy for industrial development. The table contains essential information, such as title, objectives of the article, result of contributions, authors, and year of publication.

Table I-8 State of the art literature review

Title	Objective	Results	Author
Clústers and the new economics of competition	Identify the parts that industrial cluster integrates, in addition to defining it and reported its success in developed countries	A model that the government should adopt for economic development, which motivates differentiation.	(Porter, 1998)
Are firms in clústers really more innovative?	Innovation performance comparison between companies established in and out of the cluster.	Clustering alone does not lead to high innovation performance.	(Beaudry & Breschi, 2003)
Exploring the interaction between incubators and industrial clústers: the case of the ITRI incubator in Taiwan	Identify the significant links of business incubators and industrial clusters.	It identified an industrial cluster's successful performance due to the interactions of the incubator development with the ITRI industrial cluster.	(Hsu et al., 2003)
Industrial and spatial spillovers and productivity growth: evidence from Taiwan high-technology plant level data	Measure and evaluate the different types of economic spillovers mechanisms, which allow quantifying the cost of the effect and assess the contribution of such interdependence on productive performance.	Substantial economies of scale, specifically industrial clusters and spatial spillovers, meet inter- and intra-industrial spill and spatial effects of spillovers, rapidly expanding economy costs.	(Tsai & Lin, 2005)
The viable systems model applied to a national system of innovation to inform policy development	The VSM can provide insight into a national innovation system with the variety approach required to relate to the external changing system.	Suggests that governments need to understand centralized compensation management and increase the variety required in policymaking.	(Devine, 2005)
Sector structure and cluster economies: a decomposition of regional labour productivity	Labor productivity decomposition at the regional level within a sector structure, the economy clusters, and the regional residual component	A new methodology for the decomposition of double profitability such as the growth of regional labor productivity.	(Oosterhaven & Broersma, 2007)
El concepto de competitividad y su medición a nivel regional	It establishes through the systematic approach the dimensions of competitiveness.	Bases for the development of systemic measurement of competitiveness establishment that supports decision-making.	(López, 2008)
Processes of business incubation and clústerization to support the creation of a network economy in Serbia.	Establishing the most adjustable structure for the specific needs of the local economic region	The diagnosis of the life cycle of the industrial cluster, in which the affirmation and stimulation between a work network and economic actors begin.	(Milanović et al., 2010)
Clústers models, factors and characteristics	The study Highlighted the cluster's typology, models, significant determinants through a literature review, and the importance of the advantages of clusters. Besides, its complexity is also a critical factor.	Economic development based on industrial clusters' model represents a policy adopted by many economies, competitiveness in the industry. In addition to general the economic environment that can be easily adapted to financial crises or other social transformation	(Boja, 2011)
Guía para la planeación y desarrollo de parques tecnológicos en México	The study analyzed the technology park concept, the proper conditions for technology park development with a higher chance of success, and the importance of its planning.	A guide for technological parks installation.	(López, 2012)
Regional innovation policy in Taiwan and south Korea: impact of science parks on firm-productivity distributions	Evaluate the effectiveness of the regional innovation policy through the creation of science parks. These create support for regional innovation and growth that usually focuses on productivity gains.	The policy established in science parks can generate a real improvement in productivity if the incentives offered are from a specific sector. Otherwise, these incentives could protect inefficient companies.	(Klaiber & Sheldon, 2014)
Productivity growth and job creation in the development process of industrial clústers	Examine the role of the industrial cluster, management capacity, and negotiation to improve productivity and create the labor market.	Management skills are the most critical determinants in companies for labor supply and productivity growth. These	(Sonobe et al., 2013)

Title	Objective	Results	Author
		skills are the high capacity for innovation, accompanied by a high level of managerial ability.	
Mapping local productivity advantages in Italy: industrial districts, cities or both?	Analysis of empirical evidence of the productive advantages in two types of spatial concentrations, urban areas and industrial districts	Some companies are convenient for being within an urban area, while others are convenient for the arrangement of industrial districts.	(Di Giacinto et al., 2014)
Assessing centralized governance in a software cluster	Economic dynamics discussion of the cluster in the presence of a formal centralized body of government, considering internal and external relations	A series of advantages obtained throughout clusters, at the regional level provides more than knowledge since it considers the socioeconomic dynamics and the centralized role of government.	(de Oliveira et al., 2014)
Identificación de clústers regionales en la industria manufacturera mexicana	It Presented a methodology to identify regional clusters by the estimation of location coefficients and spatial autocorrelation measures.	The results indicate heterogeneity in the regional agglomeration patterns of manufacturing activity at the aggregate and group level. NAFTA as an effector of agglomeration patterns.	(Chávez & García, 2015)
Determinants of innovation and productivity in the service sector in Mexico	Determinant's investigation of innovation and their link between innovation and productivity in the service sector through the CDM econometric model and through benchmarking of manufacturing companies.	A series of structures, performances, and behavioural factors increase the probability that a company will invest in innovation.	(De Fuentes et al., 2015)
Transformando Nuestro Mundo: la Agenda 2030 para el Desarrollo Sostenible	Menciona los 17 objetivos para el desarrollo sostenible, así como sus metas	Unveils the strategy so that by the year 2030, humanity contributes to the world sustaining life for the next generations, fighting poverty, inequality and facing climate change.	(UN, 2015)
Desarrollo de clústeres industriales: un enfoque de dinámica de sistemas	Determine the causal relationships employing system dynamics that industrial clusters present as complex structures. Besides, it establishes the factors that intervene in the competitiveness of a region for its development.	A causal model for the industrial cluster development that depicts the formal relationships of the regional competitiveness indicators.	(Rodríguez et al., 2016)
Promoting clústers and networks for small and medium enterprises to economic development in the globalization era	Explore the importance of cluster-based systems with readiness for SMEs to pursue the global goal.	The development of a model that emphasizes SMEs towards globalization based on an industrial cluster.	(Foghani et al., 2017)
Clústers and industry 4.0 – do they fit together?	Analyze if industry 4.0 and industrial clusters can fit together.	Clusters can make a stable favorable environment of trust and cooperation through its advantages such as knowledge; this could facilitate the digital transformation, especially for the test phase.	(Götz & Jankowska, 2017)
Using life cycle assessment (LCA) to measure the environmental benefits of industrial symbiosis in an industrial cluster of SMES	Compare two scenarios of symbiosis initiatives in environmental benefit by assessing the life cycle; a cluster, where there is already initiative; a cluster, and less developed.	Research shows a positive contribution of symbiosis initiatives on the impact of various life cycle assessments.	(Daddi et al., 2017)
A Practitioner's Handbook for Eco-Industrial Parks: Implementing the International EIP Framework.	Development of installation guide of ecological industrial parks	It is a tool developed by the UNIDO widely used by OECD countries; it emphasizes the South Korean practices for its industrial development.	(UNIDO, 2018)

Theoretical - Methodological Framework

Chapter II. Theoretical - Methodological Framework

For sustainable industrial development, in addition to a systemic approach to its viability, it also considers other elements shown in **Figure II-1**. For instance, knowledge management is one of the pillars for the implementation and development of Industry 4.0 (Götz & Jankowska, 2017). Besides it, industrial management units such as industrial clusters (Götz & Jankowska, 2017; Porter, 1998) and industrial parks (Foghani et al., 2017), innovation (Beaudry & Breschi, 2003), and the industrial policy (Calderón & Sánchez, 2012; J. Romero, 2016) are industrial development elements. Furthermore, it takes into account sustainability (Porter & van del Linde, 1995) per se and its current context (UN, 2015) as a broader sense for sustainable industrial development.

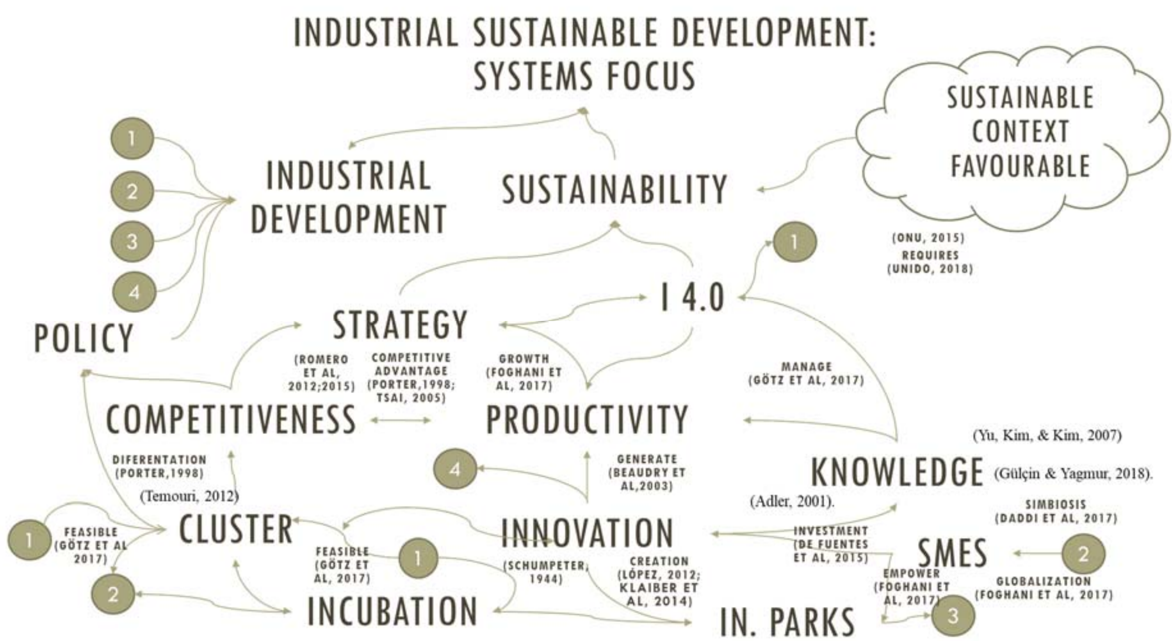


Figure II-1 Elements of the literature for a sustainable industrial development strategy

II. 1. Systems theory

II. 1. 1. Systems fields Taxonomy

François (2004), in his systems encyclopedia, summed systems taxonomy according to the founder and leader of Spain's systems movement, Rodriguez Delgado. He broke down the systemic field into the general areas of study.

Moreover, some slight marked with * have been modified and added had been introduced.

i. General approaches
    - Theory of knowledge
    - Cognitive approaches
ii. Systems philosophy
    - Systems ontology
    - Systems epistemology: (holism vs reductionism) *
    - Systems ethics *
    - General semantics *
    - Axiology
    - Aesthetics
iii. General systems Theory
    - Transdisciplinary approach
    - Generalization of main scientific principles
    - In monodisciplinary sciences *
    - In interdisciplinary sciences *
iv. Theories of general systemics use
    - Communication and information theories
    - Cybernetics (1st, 2nd and 3th order)
    - Taxonomy of living systems
    - Thermodynamics of near and far – from equilibrium system
    - Theory of catastrophes
    - Theory of deterministic chaos
    - Theory of fractals
    - Theory of games
    - Theory of networks and automata
    - Theory of autopoiesis and autonomy
    - Theory of artificial intelligence and life
    - Theory of hierarchical levels
    - Topology *
v. Systems methodologies
    - General methods (metaphors, analogies, linkages, isomorphisms *)
    - Co-participative design *
    - Formal and special languages *
    - Operational research
    - Reconstructability *
    - Systems analysis
    - Systems dynamics
    - Specific models based on above theories *

vi. Applied systems areas *
  - Biological systems *
  - Ecosystems *
  - Economic systems *
  - Familiar therapy *
  - Man-machine systems *
  - Political science *
  - Praxeology
  - Socio-technical systems *
  - Sociosystems (including animal ones) *
  - Systems education
  - Systems engineering
  - Systems management

vii. Systemic instruments
  - Simulation models
  - Electronics
  - Graphics
  - Informatics (i. e. Computer sciences)

II. 1. 2. Systems thinking

It is necessary to use systemic tools to understand the problem and the different components that compose it, such as the input and output elements. Besides, the agents in charge of monitoring, controlling, and operating the system's process and feeding it back. It also considers the interaction that the components have within the system and how it affects both the system that contains it (supra system) and the subsystems embedded (see **Figure II-2**).

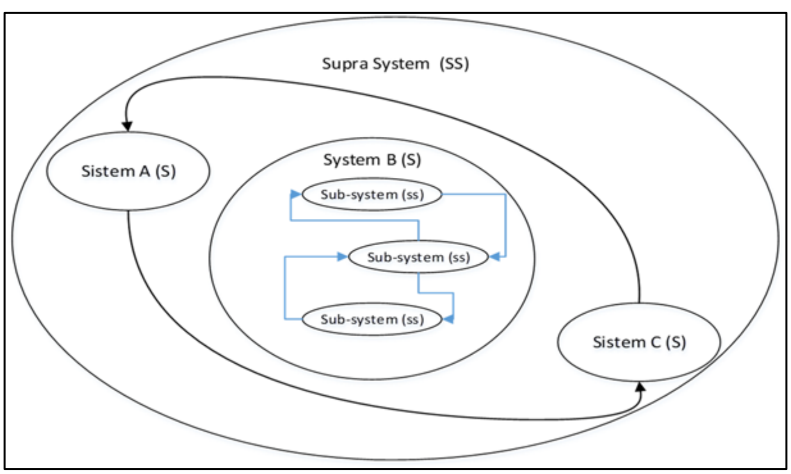


Figure II-2 Open systems general model (Aceves, 2015)

II. 1. 3. Total intervention systems

Flood & Jackson (1991) published their work Total Systems Intervention: A Practical Face to Critical Systems Thinking in 1991. They developed a meta-methodology named: Total Systems Intervention (TSI), which consists of three phases: creativity to depict the problem situation, choose the appropriate systemic intervention methodology, and implementation. Creativity, the first phase, describes the problem situation by systems metaphors to get an organized structure. Then, choosing the appropriate systemic intervention methodology is the second phase, where it is the selection of the method that fits better with the system in focus. Selecting the proper tool phase regards two main aspects. On one side, the type of problem, whether it is simple or complex; on the other side, the context of the problem bears in mind the nature of the participants' relation, if it is: unitary, or pluralist, or coercive. Finally, the implementation phase employs the particular system methodology chosen before getting a change proposal for the solution.

In summary, the matrix in **Table II-1** A System of Systems Methodologies *(Flood & Jackson, 1991)* shows the different classifications of problem situations. On the one hand, the first classification, the type of systems problem. It divides into simple and complex systems; the first one generally refers to a reduced number of elements, with few interactions and highly organized. On the contrary, the second type of complex systems. Among the characteristics involved is a large number of participants, who interact continuously and weakly organized.

Table II-1 A System of Systems Methodologies (Flood & Jackson, 1991)

Problem /Context	Unitary	Pluralist	Coercive
Simple	Simple-Unitary	Simple-Pluralist	Simple-Coercive
Complex	Complex-Unitary	Complex-Pluralist	Complex-Coercive

On the other hand, the second category classified the types of participants into three categories. Unitary participants, who share common interests, values, and beliefs, are very compatible with a high agreement degree; they act based on the agreed objectives. Pluralistic participants have essential compatibility of interests; they don't need to have deals of purpose and meaning, but a compromise is possible, they can also act according to agreed objectives. Finally, the coercive participants have no common interests; their values and beliefs seem to conflict with each other; their commitment is not possible since their character is coercive to accept decisions.

Likewise, from the treatment of each of the classifications included in the previous matrix, Jackson recommends the systemic tools that would support the problematic situation solution. Thus, this suggests the total intervention systems to represent an approach in designing the planning of the problem solution and its evaluation. Beforehand, social conditions must be considered a vision of knowledge in the context and human well-being and emancipation. Furthermore, some principles for creative problem solving should be taken into account, such as:

- Organizations are complicated to understand when using a single management model, and their problems are very complex to repair immediately.
- The strategies and difficulties of the organization require investigation through the use of systematic metaphors.
- Systemic metaphors appear to be appropriate for organizational strategy and problem-solving; they can link an adequate systems methodology to guide your intervention.
- The methodology can be complementary to solve different organizational aspects.
- Total systems intervention has an interaction in its three stages, both forward and backward.
- Stakeholders are engaged in the three stages of the total systems intervention process.

Total systems intervention Phases

i. Creativity:

During this phase, systemic metaphors such as organizational structures help management think creatively about the business problem. The metaphors currently reflect the organization's strategy, which alternatives can best be captured to achieve the organization's desired situation, and which metaphors make sense in the organization's difficulties.

ii. Selection

The appropriate methodology is chosen for the intervention based on systems (or the different methodologies) that adjust to the organizational situation's particular characteristics. **Table II-2** Matrix of Selection systemic tools of total intervention systems Matrix of Selection systemic tools of total intervention systems describes systems science's most representative systemic tools.

Table II-2 Matrix of Selection systemic tools of total intervention systems

	Unitary	Pluralist	Coercive
Simple	Operations Research Systems Analysis Systems Engineering Dynamic Systems	Social Systems Design Strategies Assuming Trial and Error	Eurytic Critical Systems
Complex	Viable Systems Mode General Systems Theory Socio-Technical Systems Contingency Theory	Interactive planning Soft Systems Methodology	???

iii. Implementation

The particular methodology of systems is used to have a complete domain of the organization, structure, and the adoption of a general orientation to the problems concerning specific proposals for change.

II. 1. 4. Soft Systems Methodology

The soft system methodology was developed by Peter Checkland in the 1960s, initially as a modeling tool. However, it was later used more as a development and learning tool. This methodology makes use of rules and principles allows to structure of a representation of the real world. To expand the systems thinking about a solution by comparing understanding through the investigation of the natural world to improve the problem situation of the system in focus (research - action). Then, context models are developed, especially the problem situation's essential systems with its multiple goals and stakeholders' perspectives.

Soft systems methodology by Peter Checkland (1999) is a suitable option for leading with a proposal with further clarification in a pluralistic context based on the system in focus (Flood & Jackson, 1991) since it tries to solve problems that involve social and natural aspects. The methodology consists of 7 steps (see **Figure II-3**), according to the author, they are not applied strictly in order. Additionally, there are two types of system activities in the methodology: the real world's activities, such as the problem's perception. While the activities that address the abstract world refer to those relevant systems models of the problem situation expressed.

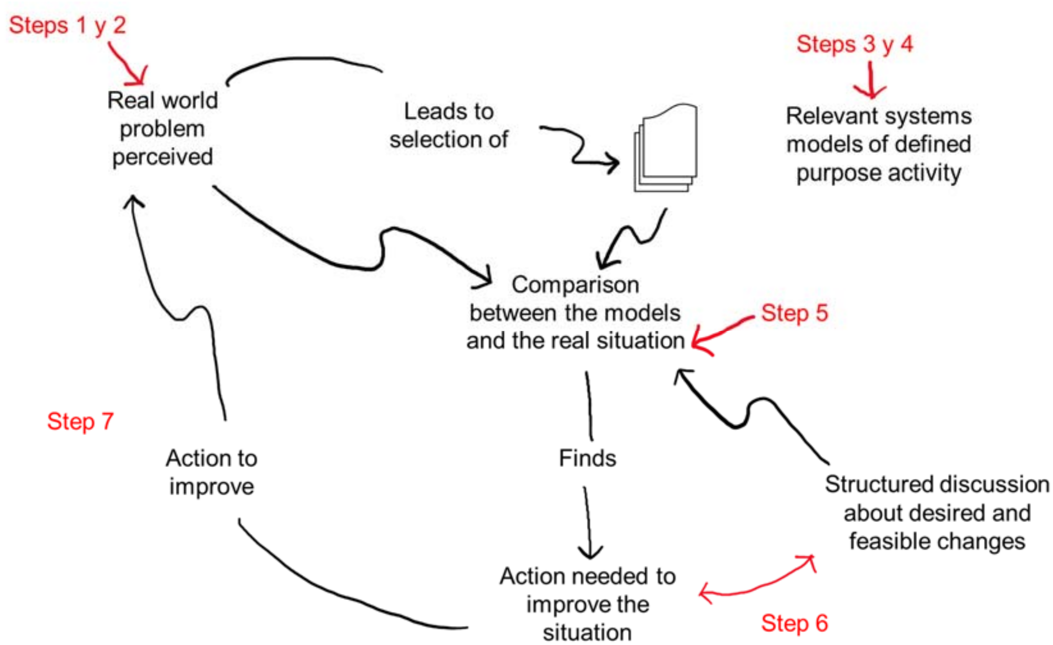


Figure II-3 Soft Systems Methodology

1. The problem situation (unstructured)
2. The problem situation expressed
3. Root definition of relevant systems
4. Conceptual models
    a. Concepts of the formal system
    b. Other systemic thinking
5. Comparison of 4 and 2
6. Feasible, desirable changes
7. Action to improve the problem situation

Figure II-3 depicts the soft systems methodology; the first two steps seek an evaluation of the general context, without the tangible objective of defining the problem collecting as much information as it is available, either by observation or questionnaire. The root definitions of the relevant systems are then built, basically moving from the real world to the systems' world. The construction process of root definitions takes different stakeholders' perspectives to create a rich vision of the problem situation. Furthermore, these perspectives are called holons with plausible relevant purpose perspectives that enable them to describe real-world activities. Each holon provides a basis for evaluating the situation separately. For this, Checkland developed the mnemonic CATWOE to see as a whole from the starting point of Transformation (T), which transforms inputs into products; once this element is depicted, then the others are defined.

- Customers: those clients who benefit from the transformed product
- Actors: Those who facilitate this transformation for those clients
- Transformation: From start to finish
- Weltenschauung - Cosmovision: which gives meaning to transformation, this transformation is essential because…
- Owner: who responds to the system and can stop it
- Environment: what influences but does not control the system.

Also, Checkland recommends structuring the relevant systems based on a system that makes X, through Y, obtain z. The fourth step is related to the definition of conceptual systems depicted in **Figure II-4**, in which it consists of + - 7 activities expressed in imperative verb to define the Transformation process (T). Then, step five, compare the conceptual model with the real world, highlighting the activities to improve the problem situation. Desirable interventions and changes are performed as the sixth step. Finally, the improvement activities are carried out in the seventh step, where the cycle closes again with the first step.

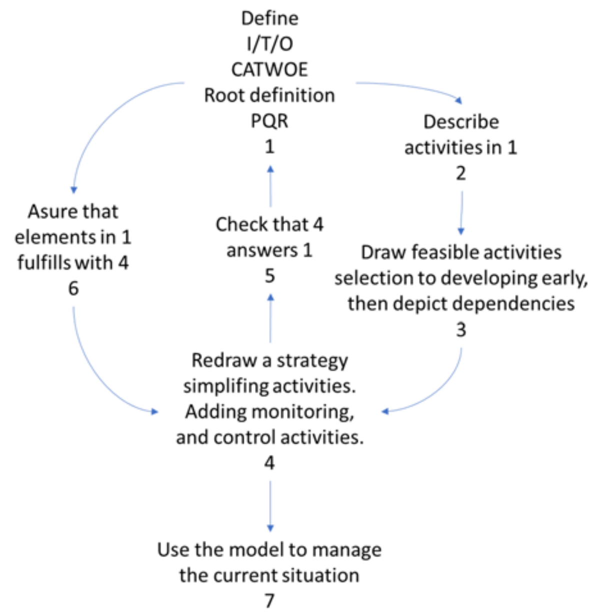


Figure II-4 SSM Model process

II. 1. 5. Viable Systems Model

On the other hand, Beer's viable systems model is useful for diagnosing organizations at different system levels to better structure the problem situation. An organization is feasible as long as it can survive in a particular type of environment. Capable of maintaining its separate existence (Beer, 1985; François, 2004), so it can enjoy some autonomy, which cannot survive in a vacuum. In a general way, the viable systems model consists of three essential components; the operation represented in a circle. It encloses the relevant processes that produce the (total) viable system-in-focus (François, 2004). Management is presented with a square, which integrates all the managerial activity needed to 'run' (François, 2004), such as models, norms, and procedures that dictate the proper development process. Context as an amoeboid shape represents its whole environment, where the operations' system occurs, which – until now – has been kept in the background (François, 2004).

The viable systems model nests five systems that operate as a whole and govern the entire system and inflows and outflows. The first system, the viable system, as mentioned before, can maintain its separable existence and with a sustainable identity and delimited. This system attends a specific related to the system's particular environment (François, 2004), like those in charge of producing goods and services. The system two coordinates system one's metasystems damping oscillation effects, acting as input attenuators for the communication between the control system (three) and the viable systems embedded in the system in focus. Therefore, system three concerns with the general coordination and coherence between systems one and two (François, 2004) of the current context named the "inside and now" of the day to day system management (Beer, 1985). However, it also needs monitoring assistance to audit such performance, also called system three*. For a Response to the need to cope with a broader environment and unknown future, System four aims at giving a wider space (context) and time (planning) frame to systems three to one (François, 2004). It also needs to have access to the full variety available in system one to three for its proper operation (François, 2004) of the future context named "outside and then." System four analyzes the forecast market demands and develops strategies to mitigate threats and weaknesses or boost strengths and opportunities.

Notwithstanding, system five, as a "general boss" (individual or collective), is always in danger to become an autocratic power "that will sooner or later make a global mistake" (François, 2004). Then, it should regard policy development, which shapes both perspectives throughout the whole viable model system. According to Ashby's Law of requisite variety, must contain general models of system three and four to control through general closure, if possible unexpected external variety (François, 2004). Therefore, it has to balance the policy implementation's general performance through the algedonic channel if the current strategy works properly by a non-analytical mode. The viable system model shown in **Figure II-5** summarizes what is mentioned above.

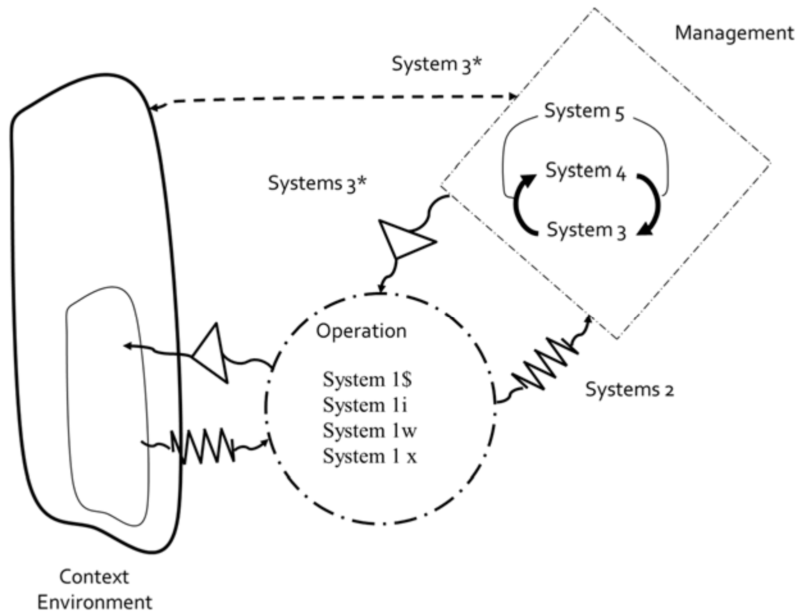


Figure II-5 Viable System Model (Modified from Beer, 1985)

II. 2. Innovation & Knowledge management

Today, knowledge management has become something important in the industrial sector; Germany launched in 2012 the I4.0, it has developed a large labor market, not just employment in the manufacturing industry. Due to its multiplier effect on industrial manufacturing jobs (UN, 2019b), the service sector has been growing for knowledge-intensive services (Götz & Jankowska, 2017). This sector is more substantial than the high-tech manufacturing services groups (Temouri, 2012).

II. 2. 1. Knowledge management

Knowledge is one of the most significant resources and an endless one, identified as an asset, the same as earth, productive infrastructure, and capital (Yu et al., 2007). The difference between them is that knowledge is an endless resource that leads to the knowledge economy (Adler, 2001). However, knowledge needs a suitable environment and a regional scope delimited for the organizations. Innovation leads to productivity, so the focus is on exploiting this innovation for sustainability under the perspective of who creates it. According to Schumpeter (1944), an innovator can be anyone who actives the business cycle in services or products in the market, such as an entrepreneur or even an industrial unit manager who exploits core competition. For instance, a cluster manager creates and implements cluster policies based on its life cycle (Pacheco-Vega, 2007).

It is of utmost importance to remove barriers for achieving a better knowledge's stakeholders sharing place (Nonaka & Konno, 1998) into the sustainable industrial development context (Mendoza-del Villar et al., 2020). Thereby, if innovation complies with knowledge transfer coordination and specialization (Hayek, 1945) about the sustainable industrial field, so that knowledge can be exploited (Adler, 2001) by an intensive knowledge environment (Powell & Snellman, 2004). Therefore, for sustaining a competitive advantage, knowledge transfer among stakeholders must be coordinated according to the productive structure's education requirements.

Although productivity increases through labor division, its specialization increases communication and coordination costs (Adler, 2001). Knowledge influences productivity, competitiveness, and profitability in an organization. Together with quality, these three elements represent gears when interacting with each other, show the degree of harmony of the system or conflict of a company (see **Figure II-6**). Competitiveness looking outward is to know the product or service situation offered to the market concerning other producers belonging to the same business line. While productivity is looking inward, it focuses on improving production processes, producing more with less production cost resulting in profitability. Therefore, this would obtain better profits with less investment and finally. Quality is the variable that allows to rotate in harmony and provides an adequate functioning or dynamics in the company and its context (Mendoza-del Villar, 2014; Pacheco, 2002).

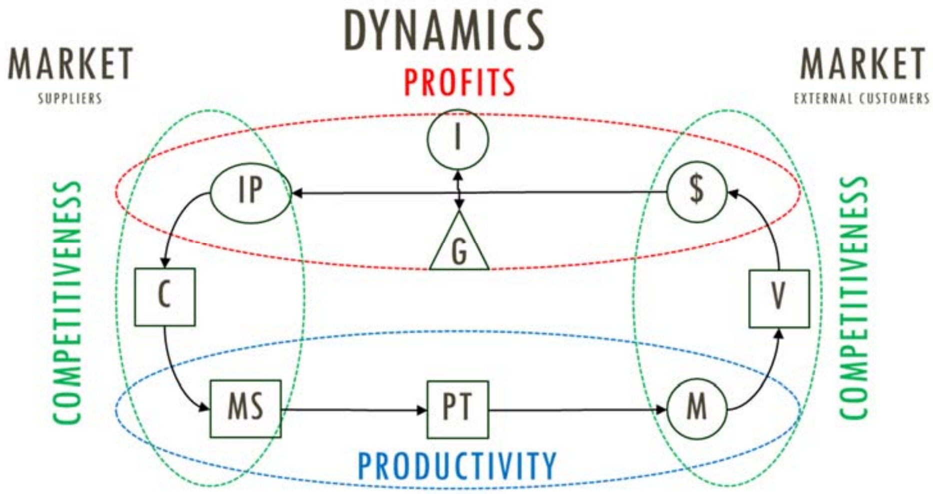


Figure II-6 Enterprise dynamics (Pacheco, 2002)

II. 2. 1. Innovation

On the one hand, the Organisation for Economic Co-operation and Development is a unique forum where around 30 countries' governments face economic, social, and environmental global issues. The OECD & Eurostat (2007) define innovation as introducing a new, or significantly improved, product (good or service), process, an original marketing method, or a new organizational method, internal practices of the company, workplace organization, or external relations. Through the OSLO manual, they classified innovation, as aforementioned, into four types of innovation. Product innovation is the introduction of a new or significantly improved good or service. Process innovation introduces a new or improved production or distribution process considerably; this implies significant changes in techniques, materials, or computer programs. Innovation in marketing is applying an original marketing method that involves substantial changes in the design or packaging of a product, positioning, promotion, or pricing. Finally, the organization's innovation introduces a new organizational method in the practices, workplace, or external relations.

On the other hand, Flynn (2008) developed the topic of technological innovation. He defined it as the process in which the industrialist conceives and develops new products or production processes, similar to what the OECD defines as product innovation and process innovation. Technological innovation includes a wide range of activities, from the first conception of an idea to the dispersion of innovative products, processes, and services throughout the economy. Significant technological innovation refers to the diffusion process or diffusion of trade innovation.

Technological innovation classifies into three types of innovation; radical innovation, which is a new technology and its first introduction to the market, opens a new market structure with a potential application, and often begins a creative destruction process. Incremental innovation refers to that one that introduces relatively small changes to the existing product by exploiting the established design's potential. Finally, disruptive innovation refers to the innovation that takes advantage of products or services by using a new combination of existing technologies or new technologies. Likewise, innovation is a development process that unfolds the business cycle's specific waveform (Schumpeter, 2010). The causal factor of change, according to Schumpeter, is "innovation," which he defines as "doing things differently in the field of economic life" (Schumpeter, 1944). Therefore, innovation is the activity or function of a particular set of individuals called innovators who introduce an idea into the circular flow and be analyzed. Thus, the innovator becomes the core factor for the success of incremental technological innovation, also considered the improvement of productivity as a result of these changes. Moreover, one of the characteristics of innovation is that it must result in social wealth and be directed either to a stratum of the population or their need satisfaction through supplying goods or services.

Likewise, Pacheco-Vega (2007) related innovation to the cluster's origin and emphasizes the innovator's role based on the cluster's life cycle. On the one hand, as the industrial cluster's origin of life, it divides it into two main ones, natural or forced originality. On the other hand, as the type of innovator who makes decisions, he divided them according to their role of government and private agents' role and life cycle, as birth or in formation, maturity, and decay. **Table II-3** shows that forced clusters might get a positive evolution from the consolidation process to the mature stage, as long as it fulfills a requirement, the promoter agent. This innovator as an individual or institution does not necessarily have to be a government agent. According to the cluster's life cycle stages, this is crucial for the cluster's survival (see **Figure II-7**). Moreover, to catalyze the cluster's activities for the cluster existence, it requires strengthening the links between member companies of either natural or forced clusters, such as the link between academic and governmental institutions, but above all, the financial connection that the cluster requires (Pacheco-Vega, 2007).

Table II-3 Government and external agents' role in nature, and forced clusters.

Phase / Origin	Nature	Forced
In formation	Not relevant	It requires the cluster formation process.
Mature	It may be relevant if the cluster has problems	Less relevant, once the cluster has started operations. Greater monitoring
Decadent	If the government wants to keep the cluster requires its intervention	It depends on the governmental vision. It may or may not be relevant. It depends on whether the government wants to keep the cluster

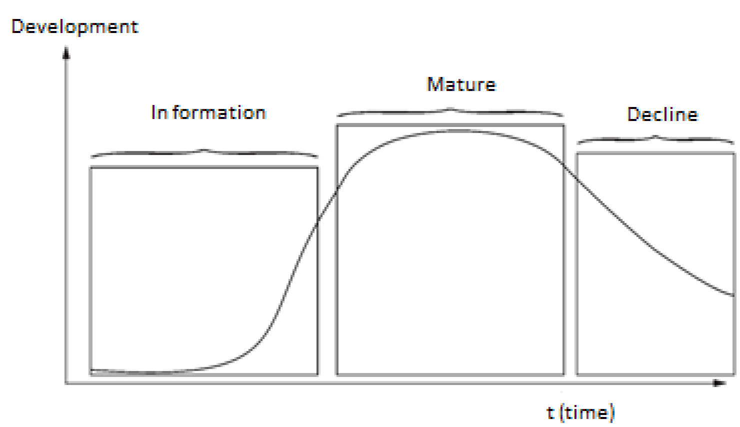


Figure II-7 Cluster's lifecycle

II. 3. Industrial management for sustainable development

According to how the industrial unit systems coordinate, knowledge management can be deployed to fulfill the demands market. **Figure II-8** shows the evolution of the market benefit based on industrial management capacity. Beginning with the most straightforward unit management, the SME firm focuses on the local market; then, on the one hand, scaling up an informal arrangement of local firms linked where there is complex market demand. On the other hand, industrial management's formal structure fulfills minimal infrastructure requirements, such as industrial parks and their different faces, to consider the local comparative advantages for their establishment. The next level is where the cluster system takes place. However, its formality could be questionable in the Mexican context; this unit management leads to scale regionally and get in touch with stakeholders with a broader scope for market demands. Finally, the most complex industrial-scale management unit is the national innovation system. Its range reaches whole regions to build the nation's competitive advantage and fit it to the worldwide market.

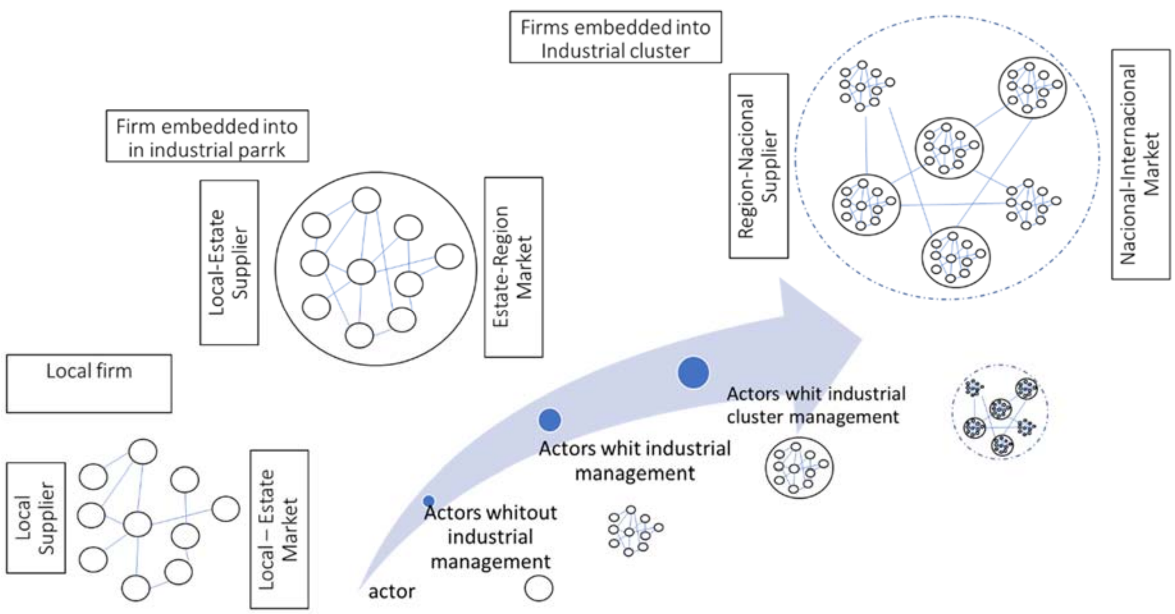


Figure II-8 Evolution of the benefit of industrial management (Own elaboration)

Notwithstanding, the Mexican industrial strategy is more likely to offer a comparative advantage of the nation, where weak differentiation is the main feature of the demand market; this differentiation consists of cheap raw material, labor cost, and land. Conversely, a national competitive advantage differentiates to offer strong differentiation employing innovation capacity for sustainable goods and services. **Figure II-9** graphically shows the industrial development process from the national value chain perspective and its global comparative advantage as an operational approach of differentiation for an industrial cluster, such as geographical position and free trade agreements. Towards the national value chain's strategic focus, as a tactical approach to industrial development for industrial parks as the leading state sectors. To finally reach the local value chain and achieve a regional comparative advantage, SMEs' differentiation in the manufacturing industry including costs, inputs, labor, and energy. These are initial elements of weakly sustainable advantage, differentiated by competition in sales prices, which creates a pattern of predatory behaviour among competitors where the product's lowest price or service generally wins. However, with deficient profit levels generating companies' closure due to a low-income margin, SMEs are the most affected.

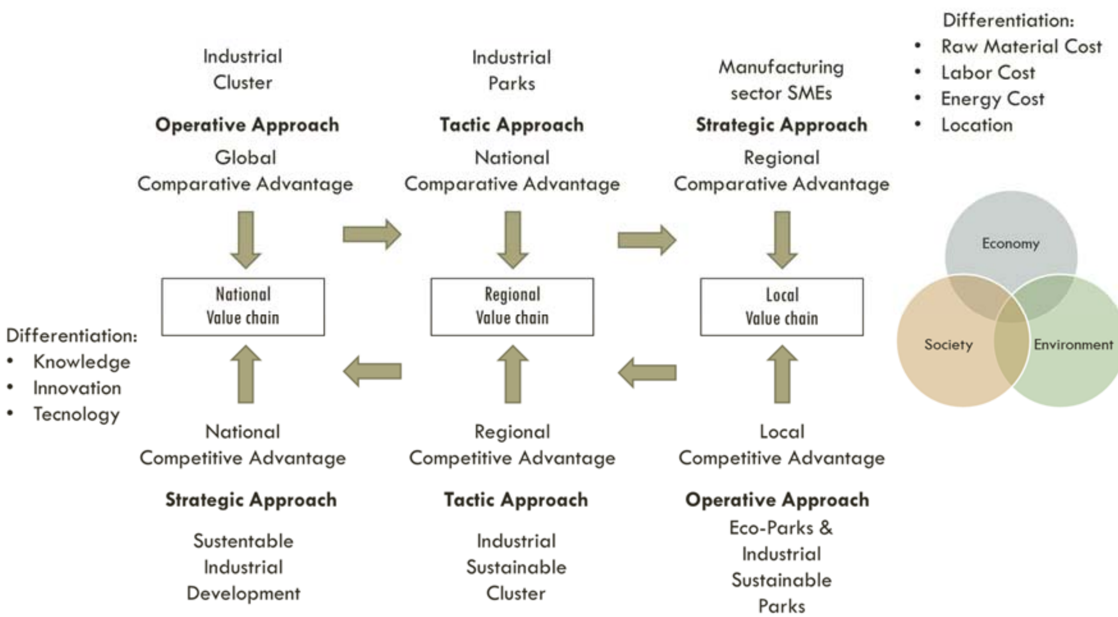


Figure II-9 Relationship between comparative and competitive advantage for sustainable industrial development

Then, to strengthen sustainability, the value chain approach for the focal system of any of the three levels must be based on achieving a sustainable and robust positioning in the market through the strategy of strategic differentiation of innovative products and services aligned with the competitive advantage (Porter, 1996). This strategy is the seed for developing a competitive advantage for any company, exploiting what creates a greater added value than the competition (Campbell & Alexander, 1997). This added value is not necessarily limited to the firm level but is also recursive; such is the example of a sustainable industrial park, in which the concept of strategy is taken into account in the region's value chain. Finally, in the same way previously mentioned, sustainable industrial development is to scale for a sustainable industrial cluster taking a level of strategy of the value chain at the national level with a national competitive advantage.

II. 3. 1. Types of Industrial management for industrial development

As aforementioned about how companies are established, the industrial conglomeration results from the territorial management of the manufacturing company's location and the market's scope. In the first instance, the company installed in an area without an industrial management unit generally perceives a local-state market with local suppliers. Then, the next type of industrial management is the manufacturing company that embeds in an industrial park. Typically, these companies are no longer micro-firms; they are at least SMEs, where their primary market is at the state-regional level with local-state suppliers. The different units for configuration in sustainable industrial development are explained below. From a sustainable perspective, some industrial units such as parks have relevant characteristics to be considered sustainable parks.

II. 3. 2. Industrial Cluster

The cluster should encompass an array of industry linkages and other leading competing entities, including government and other institutions such as universities, regulatory agencies, government advisers, vocational training providers, and trade associates (Porter, 1998). The configuration of an industrial cluster has the advantage of creating an environment conducive to industrial organization. The interrelation of the competitive advantage of supply chain value reflects a robust regional economy abroad after the development of value networks. That each of the firms that make up the industrial cluster (Barkley & Henry, 1997) efficiently taking advantage of public resources and creating labor networks between organizations. On the other hand, it requires establishing an objective to take advantage of its configuration's shared resource. For instance, the support institutions establishment, such as financial, government, environmental, and civil law institutions, among others, which complicates the selection of industrial firms, in addition to the fact that market behaviour is dynamic, creating new obstacles that are difficult to control (Barkley & Henry, 1997). They defined a cluster as companies conglomeration engaged in producing similar goods and services. Cluster has a vertical interrelation in the supply of primary products, linked to dependence on specialized services such as financial services, banks, education, training, and research and development facilities providing support in the cluster companies. On the one hand, (Hernandez et al., 2003) defined it as industrial organizations belonging to similar industrial branches as an agglomeration of productive plants located at a specific time and geographical space. On the other hand, Porter (1998), from the previous definition, added that the cluster must encompass an arrangement of industrial links and other entities that stand out in the competition, including government and other institutions such as universities, regulatory agencies, government advisers, vocational training providers, and trade associations. **Figure II-10** depicts a broader meaning of a cluster; however, identifying components in a cluster is not a crucial issue in its adequate performance. Instead, its proper performance between the different agents' links in the industrial cluster is its primary focus.

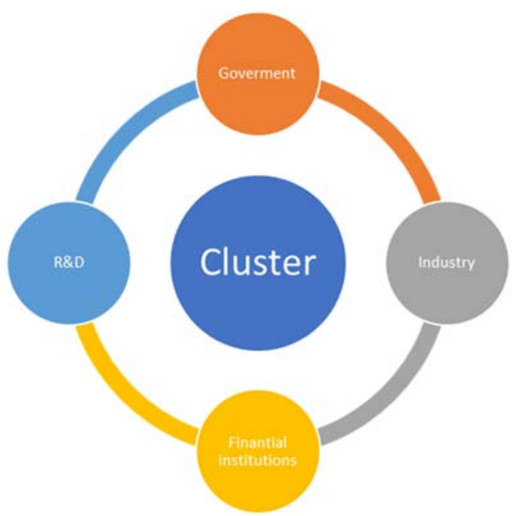


Figure II-10 Cluster's elements

Based on the core industrial sector, each cluster shows differences according to its core product and other variables that help classify industrial clusters, such as the link of sale, cooperation, and collaboration between cluster firm members and industrial cluster size. **Table II-4** denotes the classification into four different clusters:

Marshallians, Hub & Spoke, Satellite platform, and State anchored (Barkley & Henry, 1997; Boja, 2011). Depending on the firms' characteristics embedded, cluster's interdependency, labor growth, and the kind of clusters mentioned earlier, Pacheco-Vega (2007) sorted what type of firm fits better in it.

Table II-4 Types of clusters (Barkley & Henry, 1997)

Type of Cluster	Characteristics of member firms	Intra-cluster interdependence	Labor growth
Marshallian	Small and medium-sized enterprises, local companies	Substantial trade between enterprises, strong institutional support collaboration and synergy	Dependence firms, the local economy depends on the industrial cluster
Hub & Spoke	One or more companies with numerous small suppliers and service companies	Cooperation between large companies, small companies in terms of large companies	Dependence on the growth of the prospect of large companies
Satellite platforms	Large and medium industrial branches	Minimal trade exchange between enterprises, Networking	Dependence on regional skill recruitment, branches of company retention
State – Anchored	Government or non-profit entities	Restriction in sales relationships between government entities, suppliers	Total dependence on regional expansionary political ability and support for public infrastructure

Figure II-11 shows each kind of clusters models sorted in the table. In general, industrial management units found in the models are small and medium-sized enterprises (SMEs), symbolized with small circles; Large firms (BF) denoted with larger circles or government institutions. Lastly, large companies that only require services as inputs are symbolized with oval rectangles. On the other hand, Sölvell (2015) stated that clusters represent a type of agglomeration consisting of companies related to a kind of industry (competitors, buyers, suppliers, related technology companies, etc.) and a range of other organizations and supporting actors. In order to separate the different types of agglomeration economies, a simple classification is done throughout a scheme that outlines the advantages of efficiency (economies of scale) against the agglomeration's innovation advantage and actors of related technology.

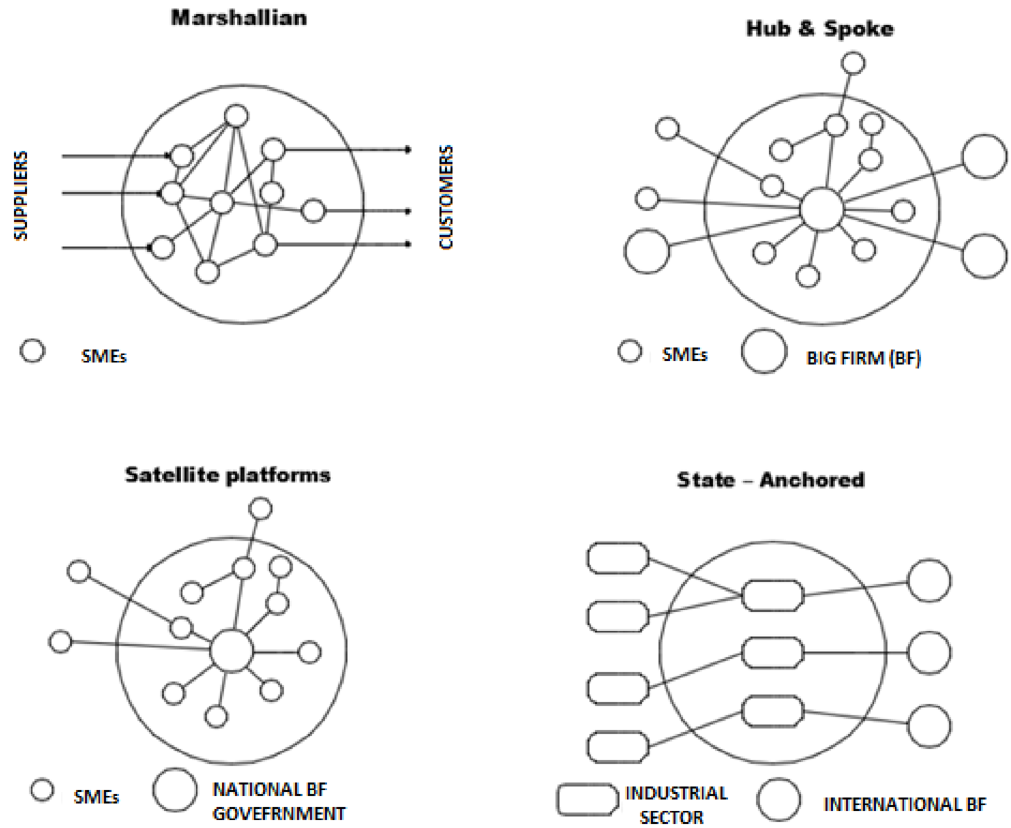


Figure II-11 Types of clusters' arrangement (Boja, 2011)

Table II-5 presents the divisions that lead to four different types of aggregations (Sölvell, 2015); they are similar to the ones published by Boja (2011) in his article "Clusters Models, Factors and Characteristics." With minimal modifications to those exposed by the previous author but with the same classification objective.

Table II-5 Types of agglomerations (Boja, 2011; Sölvell, 2015)

	Different firms' type	**Same firms' type**
Economy efficiency & flexibility	Urban agglomerations	Industrial district
Innovation	Innovation agglomerations	Cluster

II. 3. 3. Industrial Parks

An industrial park is delimited in a land, directed for industrial use, and that offers all the urban infrastructure and the legal permits necessary for efficient industrial installation (ProMéxico, 2019). The industrial park also contributes to the region's economic development strategies (NMX-R-046-SCFI-2015 PARQUES INDUSTRIALES – ESPECIFICACIONES, 2015) and generates confidence certainty to investors and users. The Mexican standard NMX-R-046-SCFI-2015 Industrial Parks - Specifications is a document that establishes clear and uniform criteria for evaluating industrial parks in Mexico. The document developed with the different most representative actors in economic and environmental development: the SE, the AMPIP, the UNAM, CONCAMIN, the PROFEPA, and the CTMNNPI. Among the essential aspects that an industrial park must comply with are:

- General requirements of the Industrial Park
- Technical requirements of the Industrial Park
    - Water
    - Energy
    - Telecommunications
    - Residual discharges
    - Infrastructure and urbanization
- Particular requirements for each Lot
    - Building density
    - Construction restrictions
    - Green areas
    - Parking
- Rules of Procedure
- Environmental impact

i. Eco-Industrial Parks

An eco-industrial park (PEI), unlike an industrial park, guarantees sustainability through the integration of social, economic, and environmental quality aspects in its location, planning, operation, management, and dismantling. UNIDO is an international unit of the UN, dedicated primarily to industrial promotion and acceleration in developing countries. In 2018, besides the World Bank and the German Agency for Cooperation (GIZ) developed a manual for practitioners related to eco-industrial parks, “implementation and international framework.” The manual displays the international guidelines to be able to implement or transform industrial parks into eco-industrial parks (The World Bank Group, 2019).

The manual consists of three main phases; the national approach for PEI; the framework implementation of the PEI in industrial parks, and PEI's symbiosis in the industry. **Figure II-12** shows this methodology, emphasizing the collaboration of a representative team of the stakeholders to execute activities.

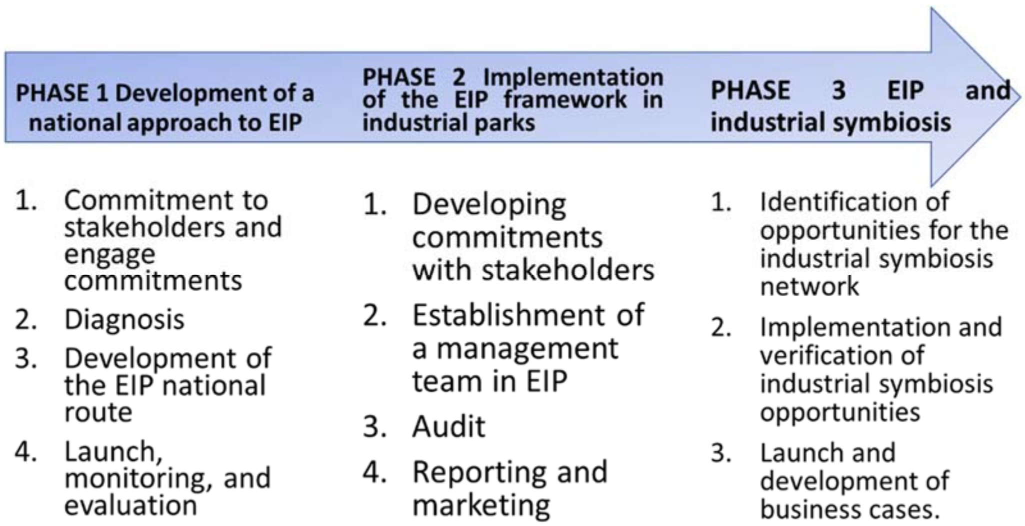


Figure II-12 Framework for Eco-Industrial Parks (The World Bank Group, 2019)

ii. Sustainable Industrial Parks

Likewise, the sustainable industrial park (SIPa) is a variant of the eco-industrial park. In 2017, UNIDO developed a practical guide for sustainable industrial parks. The difference concerning the eco-industrial park is that the SIPa is a strategy to comply with the Sustainable Development Goals. As mentioned in the Sustainable Development section in the first chapter, the UN developed the 2030 agenda SDGs. This guide is aligned with SDG-9 to build resilient infrastructure, promote inclusive and sustainable industrialization, and foster innovation. Based on production patterns implementation with the efficient use of resources and following the circular economy principles. UNIDO (2017) defined Sustainable Industrial Park as a group of productive companies located in a delimited area collaborating. Under a joint strategy, they aim to achieve economic, environmental, and social benefits. Taking advantage of both collectively and individually and integrating sustainable development for the entire park and its companies.

The guiding model for converting industrial parks to sustainable industrial parks consists of 8 phases: It begins with the formation of the work team, followed by the addition of the actors' alliances. Subsequently, with all the actors involved, the diagnosis development identifies collaboration between companies and complies with sustainable development. Then, carrying on to formulate an action plan of the activities identified priority in diagnosing the firm and the park level. In the fifth phase, the planned activities are executed and articulated with the different actors and managers. As it is an issue, the communication of results is essential to transmit to the various actors and the benefits of collaborative work with private companies and the public sector. It must be emphasized that spreading the benefits and marketing activities also attracts more allies in the future. Likewise, an evaluation of the results is required to make the corrections to the action plan. Finally, industrial symbiosis seeks to multiply the results. **Figure II-13** depicts a graphic summary of the model of conversion from industrial parks to sustainable industrial parks. Similarly, it is key to success to form a work team, such as in the eco-industrial park. However, this model seeks a circular economy; therefore, the industrial symbiosis develops this function based on the companies' waste's derivative products and makes the most of all the resources.

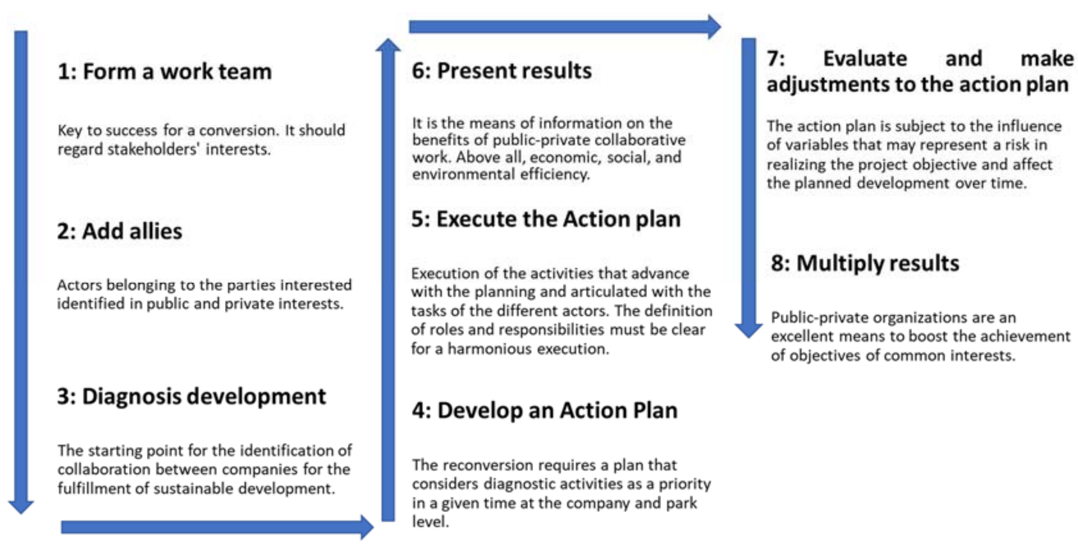


Figure II-13 Model for the conversion of an Industrial Park to a Sustainable Industrial Park (UNIDO, 2017) *iii. Competitiveness of Industrial Areas through Sustainability Program (proCAIS)*

proCAIS is a program that seeks to strengthen industrial areas and resident companies through the implementation of action plans and measures aligned with compliance with the criteria for sustainable development (GIZ, 2016). The proCAIS is a product of the teamwork of the German cooperation of GIZ. The process begins with an introduction and contextualization of the industrial park to be evaluated. Secondly, the diagnosis is executed to assess the three spheres' sustainability criteria for sustainable development, plus the organizational standards (**Figure II-14**). The phase that continues is implementing measures based on the diagnosis and, lastly, the documentation.

Figure II-14 ProCAIS Industrial Park Sustainability Diagnosis (GIZ, 2016)

As an example of the evaluation of a model industrial park in Mexico's state, in 2016, metrics measured and denoted in **Table II-6** about the different spheres of the Industrial area. These variables relate to the environment (A), economy (E), society (S), and the organization (O). At the end of the evaluation, a pentagon graph like the one shown in the previous picture.

Table II-6 Variables evaluated with the proCAIS method (GIZ, 2016)

Code	Concept
A1	Responsible oversight of compliance with environmental laws and regulations
A2	Promotion of resource efficiency and industrial symbiosis
A3	Emissions monitoring and control
A4	Protection of natural water and soil systems
A5	Promotion of biodiversity

Code	Concept
A6	Efficient land use
A7	Climate change mitigation and adaptation
E1	Economic feasibility of the management and concept of the place
E2	Fiscal effects for the municipality
E3	Supply of infrastructure and logistics in general
E4	Power generation and distribution
E5	Waste management
E6	Water and wastewater management
E7	Transport system
S1	Social infrastructure
S2	Promotion of quality housing
S3	Safety concept
S4	Promotion of labor and occupational health regulations
S5	Promotion of gender equity
S6	Participation with unions and civil society organizations
S7	Biodiversity management
O1	Master planning of the area
O2	Administrative structure
O3	Service culture
O4	Networking
O5	Participation in planning and operation
O6	Maintenance, cleaning, Retrofitting
O7	Disaster risk management

iv. Techno & Scientific Parks

A technology park is a physical space with adequate infrastructure for the installation of productive companies. Technological research and development activities occupy a suitable place in their operation and require the means to obtain technical inputs (López, 2012). In comparison, the scientific park is an organization managed by specialized professionals whose fundamental objective is to increase its community's wealth by promoting the culture of innovation and competitiveness of the knowledge-generating companies and institutions installed in the park or associated with the park (López, 2012).

v. Research Parks & Innovation centres

A research park is a physical space with the correct infrastructure for establishing units that mainly carry out research and development activities. Likewise, it offers services to obtain technological inputs, high-level human resources, infrastructure use in research centres, access to libraries and specialized documentation services, and contracting of technical projects (López, 2012). Likewise, López (2012) defined an innovation centre as a facility that supports people who venture into creating a technology-based company through a favorable environment, including technical evaluation, advice on management, commercial and industrial strategy, and banking financial contacts.

vi. Technopole

The concept of technopole involves the concertation of a more significant number of regional actors related to promoting economic and political activities. Technopole aims at fostering by performing regional development based on the technology objective. Therefore, in a technopole, the installation and strengthening of study and research centres are promoted and planned that contribute to the training of human resources and generate business opportunities based on technology (López, 2012).

II. 3. 4. Business Incubators

Bosques-brugada et al. (2020) mentioned that one of the strategies for facing a weak business is business incubators (BI). Since they commonly offer services that satisfy new firms' requirements (Aerts et al., 2007; Grimaldi & Grandi, 2005; Vanderstraeten et al., 2016). Besides, this entity could pave the way for the implementation of emerging implementing industry 4.0 technologies too. However, this sort of business incubator promotes technology for tenants' firms is known as Specialized Business Incubator (SBI) (Bosques-brugada et al., 2020).

Business incubator born in 1959, in USA Batavia, New York; it aimed to create a business building for business support, about the procedure to become an independent firm tenant (Mancuso Business Development Group, 2020). It has been identified three business incubators generations. Bruneel et al. (2012), in their study related to business incubators evolution, reported their differentiation, which is determined basically with the services that BI offered. The first generation comprehends from the '50s to '80s; during this time, it caught international attention and started to spread out in the foreign market. BI offered shared office only space.

Then, the second generation appeared in the 1990'd decade; it added the training support service. Finally, the third generation, which began in this millennium, is characterized by offering complement services of network access such as information and communication technologies, professional networks, and financial services (Bosques-brugada et al., 2020).

i. Diversified Business Incubators

The type of collaboration among tenants, where an administrator represents the BI, is determined by the characteristics of the service relationship of diversified business incubators with them. This link aims to explore business support and the barriers that affect it (Rice, 2002), the significant successful drivers in university incubators (Somsuk & Laosirihongthong, 2014). Incubators were evaluated by a qualitative analysis of the impact factors that influence business survival into a BI; It regarded innovation level, size, and international trade activity (Mas-Verdú et al., 2015); the simulation of knowledge transfer service and network efficiency (Zhao et al., 2017). The tenant's BI profile and those prospective tenants resulted positively during the selection process and throughout the incubation process (Albort-Morant & Oghazi, 2016), and the social capital located in the BI (Redondo & Camarero, 2019).

ii. Specialized Business Incubators

The relevant literature about specialized business incubators (SBI) wrote by the same authors (Schwartz & Hornych, 2008, 2010). Respectively, the first research settled the benefits and deficiencies of SBI, while in the second document, they proposed the internal network creation and stressed the links between academy-industry. On the other hand, although the authors did not explicitly express a specialized business incubator, they aimed to close the gap between a diversified and specialized business incubator. In their research, Aerts et al. (2007), "Critical role and screening practices of European business incubators," related the specialization in business incubators. They established that the survival rate is related to the selection process of tenant prospects other characteristics. The specialty involves a set of variables that characterized incubators (Grimaldi & Grandi, 2005); such a feature is a source of competitive advantage against diversified incubators (Vanderstraeten et al., 2016). Barbero et al. (2014) matched the type of business incubator base on the innovation sort. Rubin et al. (2015) evidenced how the innovation source comes from a successful collaboration between the incubates and the incubator management in Australia and Israel.

iii. Specialized and diversified business incubators characteristics.

This section, developed in the research *"Specialized Business Incubators as a strategy for Small and Medium-sized Enterprises in the Industry 4.0 era – A systemic approach"* (Bosques-brugada et al., 2020), aims to contextualize business incubators' characteristics according to the researcher's leaders' different focuses. Although business incubators are mainly classified in the innovation origin (Barbero et al., 2014), there is also the specialization focus the type of innovation falls into diversified or specialized incubators (Schwartz & Hornych, 2008, 2010). **Table II-7** shows the main characteristics of both business incubators found in the literature review. Therefore, this section aims to explain the main aspects of an incubator business framework regarding both focuses on a rich vision of a business incubator specialized for tackling the imminent arrival of Industry 4.0.

Table II-7 Specialized and diversified business incubators characteristics (Bosques-brugada et al., 2020)

Characteristics	Diversified		Specialized	
	Author	Point	Author	Point
Sectorial	(Zhao et al., 2017)	BI performance improvement.	(Grimaldi & Grandi, 2005)	Scope delimited per-sector
			(Rubin et al., 2015)	
			(Schwartz & Hornych, 2008)	Sectors should be complementary.
			(Aerts et al., 2007)	Competitive advantage development by focusing on one sector.
Selection	(Albort-Morant & Oghazi, 2016)	Features tenant's profile analysis: age, education, training, entrepreneurship background.	(Aerts et al., 2007)	Depends on a set of characteristics such as focus on determined sectors; innovation promote and venture capital.
	(Redondo & Camarero, 2019)	Social capital based on the trust level among tenants and incubator managers.	(Schwartz & Hornych, 2010)	Tenant's values evaluation reliability, honesty and loyalty.
External networks	(Somsuk & Laosirihongthong, 2014)	Strong relationship among suppliers for complementary resources.	(Vanderstraeten et al., 2016)	Promote cooperation between tenants and suppliers about central business areas.

			(Schwartz, 2013)	Network business are integrated with financial institutions and private and public research institutions.
			(Schwartz & Hornych, 2010)	Universities as a vehicle for technological independence.
	(Redondo & Camarero, 2019)	Access to external resources for tenants.	(Bruneel et al., 2012)	Specialized knowledge and resources acquisition.
			(Barbero et al., 2014)	High specialization level of technological innovation.
Survival rate	(Mas-Verdú et al., 2015)	Depends on business innovation.	(Aerts et al., 2007)	Depends on selection process.
			(Schwartz, 2013)	Suggest survival studies.
Infrastructure	(Rice, 2002)	Promote the critical resources to tenants such as infrastructure.	(Schwartz & Hornych, 2008)	Offer facilities and equipment specialized based on needs
			(Schwartz, 2011)	Specialization costly

a) Focus on a single sector

SBI focus on a single sector as how Grimaldi & Grandi (2005) and Rubin et al. (2015) proposed in their researches or as Schwartz & Hornych (2008) also included complementary sectors. Furthermore, knowledge limitation does not mean demeaning knowledge value. Conversely, Aerts et al. (2007) proposed the specialization where we regard it as differentiation, which seeks to be at the edge of the knowledge, thus create a competitive scenario (Jacobs & Chase, 2021; Prahalad & Hamel, 1990), where tenants could harness with emerging technologies.

b) Selection

Among characteristics to be evaluated in the selection process of the SBI tenants are knowledge and background experience. Although they are part of diversified features, as Albort-Morant & Oghazi (2016) pointed out, they have to fulfill the specialized area's knowledge and experience for the prospect selection. Therefore, candidate selection is of utmost importance in the sectorial project of the SBI process. Moreover, soft skills such as trust, honesty, and loyalty, proposed by Redondo & Camarero (2019) and Schwartz & Hornych (2010), are the bedrock to remove internal cooperation barriers and promote venture capital innovation among stakeholders, actors, and customers. Aerts et al. (2007) suggested it with the incubator manager's innovative support as to how a social champion with the role of trust (Hewes & Lyons, 2008), and foster a hub for the connection of I4.0 technologies among them.

c) External networks

External networks foster customers' and suppliers' cooperation (Vanderstraeten et al., 2016) and strengthen the relationship between complementary services suppliers (Somsuk & Laosirihongthong, 2014). For instance, Redondo & Camarero (2019) supported their research on external resource access to tenants, such as Bruneel et al. (2012) mentioned specialized knowledge and resources acquisition. Furthermore, such cooperation links foreign actors, likewise Schwartz (2013) proposed financial and research institutions. Both institutions are necessary for innovation development to boost technology transfer and specialized knowledge (Barbero et al., 2014) like I4.0 technologies, where universities play a role as a vehicle for technological innovation (Schwartz & Hornych, 2010).

d) Survival rate

Due to the results' relevance, the survival rate is a research opportunity (Schwartz, 2013). Neither evidence in the literature that survival rate is an SBI characteristic, nor is it a source of competitive advantage against diversified incubators. Therefore, there are no studies that support the survival hypothesis of firms incubated by SBI. On the one hand, an improvement in the survival rate comes from secondary characteristics. For instance, Mas-Verdú et al. (2015) related it with business innovation, which can come from a competitive advantage, such as a sustainable differentiation source in the firm's core competence (Porter, 1996). On the other hand, Aerts et al. (2007) reported that the survival rate depends on an appropriate selection procedure.

e) Infrastructure

As one of the differentiation sources is the differentiation of the locality, region, or even nation's core competence is the concept of the business incubator's specialization. Furthermore, due to the significance of investment in facilities and technological equipment (Schwartz, 2011), the specialization concept should fit the sector needs, such as Schwartz & Hornych (2008) suggested. Therefore, promoting the critical infrastructure as a marketing strategy of the SBI to tenants (Rice, 2002) or new prospects would harness cost externalities.

II. 4. Strategy & Competitiveness

The strategy is conceived as a determinant for survival through evolution; as Darwin mentioned in evolution's theory, those who do not adapt to their environment disappear. While in business, the same model pattern happens (Henderson, 1989). Tzu (2015) compared the strategy with war battles. However, today it has radically changed to the business sense, in which the real weapons for the trade war have become the context knowledge of the market and its trend behaviour over time.

Based on the principle of exclusion of competitiveness, two species cannot coexist by making both live in the same environment. Likewise, in the absence of a force that balances, when two species compete for some essential resource, they will displace one another sooner or later. Thereby, by giving each species an advantage, only one of the two will survive. Therefore, to stay alive, at least a given species must have an advantage in its territory, this Henderson (1989) called strategy.

On the one hand, Mintzberg (1987) considered the strategy to formulate two plans; there is a plan for the future. While the other plan is prepared based on past behaviour. On the other hand, the strategy has been misunderstood or wrongly perceived. Hence, it is necessary to know what the strategy is and what it is not. Firstly, the incorrect use of the objectives and the error in distinguishing between purpose and restriction are frequent. Secondly, the confusion in the process of declaring goals interconnected with the strategy and with its implementation, such a way that it makes it complicated for an organization to define where to start (Mintzberg, 1987). Third, the expectation that the planning process will lead to a new and improved strategy, but the essential ingredient for a good strategy is to see how value is created from the inside. Hence, in response to a good strategy, it is not a new planning process or a redesigned plan improved. It lies in managers' understanding of two fundamental points: the benefit of a well-articulated purpose and the importance of discovering, comprehend, document, and boost insights about how to create more value than other firms do (Campbell & Alexander, 1997).

Although operational efficiency is an excellent plan to get higher economic returns, such efficiency is not a strategy; it would rather be regarded as operational efficiency; also known as a competitive advantage or core competence (Prahalad & Hamel, 1990). Then, which could better characterize strategy into businesses, according to Porter (1996), in his article *"What is Strategy,"* is the positioning that the differentiation of its product gives the company. Thus, the strategy's essence is fostered in activities that differ or better expressed that are carried out differently by rival firms. Furthermore, strategy and competitiveness's purpose are to establish a profitable and sustainable position in the face of the forces that govern competition in the industry. Porter (2008b) analyzed the firm competition throughout the five forces that shape industrial competition (see **Figure II-15**).

However, if the strategy goes beyond, thus a broader sense requires the sector analysis. Similarly, Porter (2008a) denoted a useful competition analysis tool for a particular sector, based on national competitive advantage determinants shown in **Figure II-16**. It emphasizes how these elements combined produce a dynamic, stimulating, and intensely competitive business environment (Porter, 1998). Therefore, a company needs to formulate strategies to survive. Consequently, it requires structuring the competitive base that an SME firm or a corporate, or a conglomerate enjoys as strengths or better known in the business environment as a competitive advantage

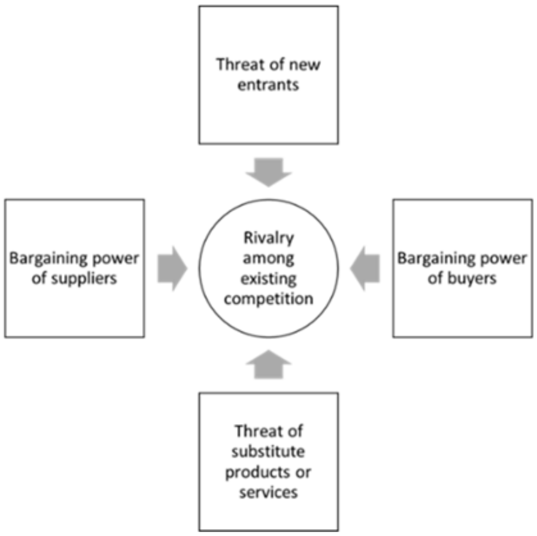


Figure II-15 The Five Forces That Shape Industry Competition (Porter, 2008b)

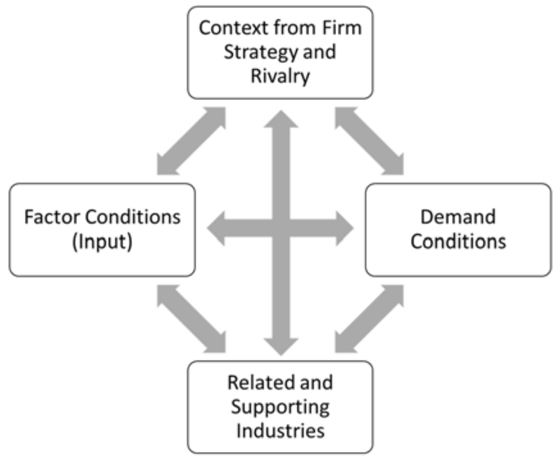


Figure II-16 Porter diamond model (Porter, 2008a)

II. 5. Industrial sustainability

Sustainability drives sustainable operational performance through different focuses, from the green approach such as sustainable manufacturing, lean practices such as lean manufacturing, and the supply chain management focus such as sustainable supply chain. **Figure II-17** denotes keywords linked with industrial sustainability, such as industry 4.0, lean manufacturing, supply chain management, operational performance, and literature review. Moreover, as fields of studies in conjunction, these keywords are of utmost importance for a holistic model. In the broader sense, sustainability makes the appropriate strategy for meeting the needs of at least the next generation without putting at risk any of the three dimensions (TLB). Besides, lean manufacturing comprises a set of tools for maturing industrial processes by optimizing them. Relatedly, supply chain management integrates industrial processes. Still, its horizontal focus from raw materials suppliers to customers as end-users gives the firm a competitive overview of its focal location. Meanwhile, as long as Industry 4.0 technologies fit with the firm's core competence, it would boost its operational performance benefits. Therefore, operational performance aligns sustainability, lean manufacturing, and I4.0 into the supply chain. A favorable outcome does not limit the whole alignment since each study's field drives to it. However, a holistic operational performance should regard them.

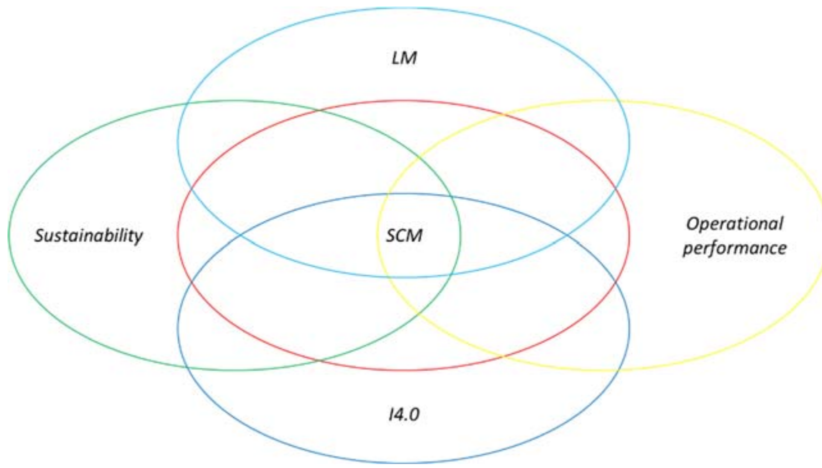


Figure II-17 Industrial sustainability components

II. 5. 1. Sustainable manufacturing

Sustainability makes sense as long as the firm's strategy maintains its long-term survival with a strong differentiation. Thus, sustainability enables the firm to differentiate the firm by a strong differentiation (Porter, 1996). Porter Defined strong differentiation based on sustainable differentiation. This focus aims not only to create a competitive advantage by boosting innovation of core business processes (Mendoza-del Villar et al., 2019; Porter & van del Linde, 1995), where innovation significantly leads to sustainable performance in all its dimension (Kuzma et al., 2020). It also does structural changes in how goods and services are produced (Hussain & Malik, 2020). The dynamics of technological innovation focused on improving processes that take part in specialization (Barbero et al., 2014).

Notwithstanding, the sole technology focus will not obtain sustainable outputs even it can result in negative ones (Kamble et al., 2020; Papetti et al., 2018), the degradation of human life and the Earth’s life (Wojtkowiak & Cyplik, 2018) by the environment depletion (Savaget et al., 2019). Thereby, a broader focus makes sense with general sustainability; for instance, technology in information and communication is necessary for green operation practices. Jabbour et al. (2016) determined that green operation practices improve green and operational performances. Internal barriers significantly influenced green and operational performance, regardless of their size and external obstacles. In the study developed by L. A. Mendoza-del Villar et al. (2020) for measuring general and industrial sustainability, decision-makers in medium-size companies mostly focused on implementing technological improvements. However, they leave behind a holistic perspective since environmental issues are ignored or even misunderstood.

Sustainable manufacturing, defined as the integrated transformation system of sustainable inputs, such as social and environmental concerns, is regarded to mitigate their impacts through sustainable outputs, maintaining a high-quality focus throughout its whole life cycle (Machado et al., 2019). The human factor is the crucial determinant for long-term success and societal flourish (Pinzone et al., 2018). Therefore, sustainable manufacturing is part of the whole productive system. The process focus (see **Figure II-18**), consists of four main components: inputs, processes, outputs, and feedback activities. Sustainable manufacturing aims to cover them by optimizing the use of every resource. Inputs refer to those raw resources, such as natural resources (Stock et al., 2018), materials, energy, (Machado et al., 2019), and human beings (Machado et al., 2019; Pinzone et al., 2018). The process mainly regards life cycle activities from a different perspective; for instance, the product gathers its method, systems, services, and product per se (Machado et al., 2019); While the economic view considers performing 6'R activities related to reuse, recycle, reduce, refused, rethink, and repair throughout the whole system (Yadav et al., 2020). Seemingly, Dey et al. (2020) with the circular economy approach, considers: take, make, use, distribute, and recover activities to enhance SMEs' sustainability. Outputs focus on minimizing wastes in their different matter states, such as wastewater, emissions, solid wastes, and noise (Stock et al., 2018). Lastly, feedback aims to get sustainable equilibrium with the TBL (Machado et al., 2019).

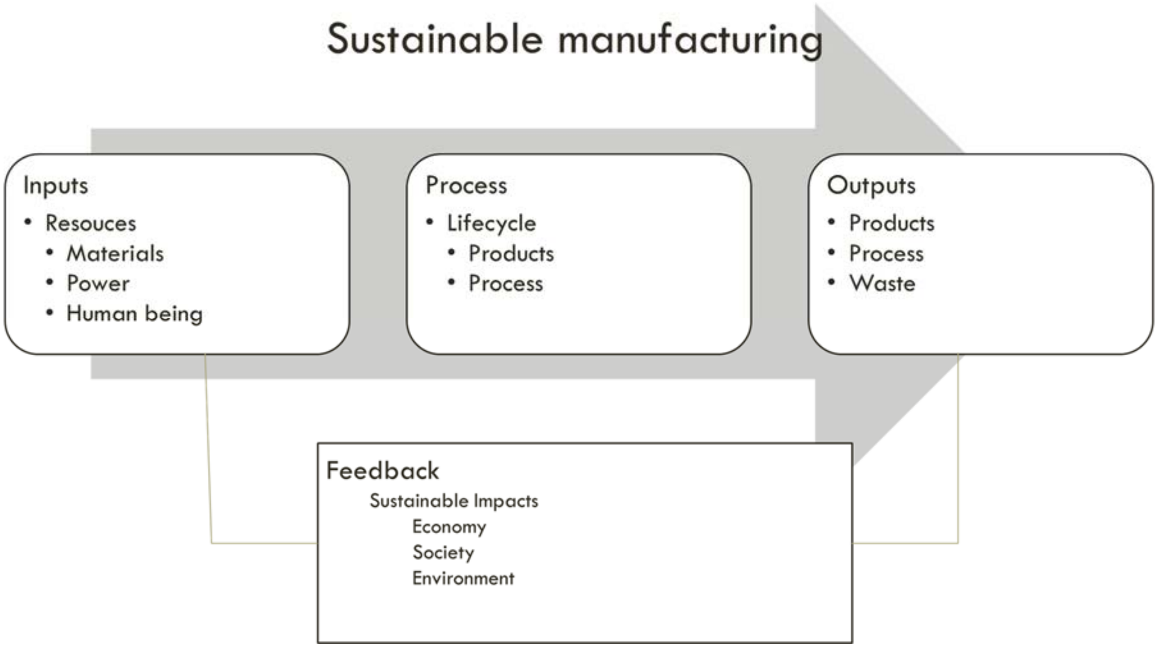


Figure II-18 Sustainable manufacturing based on the process focus

II. 5. 2. Lean manufacturing and supply chain management

It is of utmost importance the role that lean manufacturing plays to get sustainable performance. Thus, it mediates to achieve operational performance (Ben Ruben et al., 2020; Kamble et al., 2020; Ramirez-Peña et al., 2020). Besides, sustainable operations should align with the business strategy (Ben Ruben et al., 2020). Furthermore, lean practices not only improve operational performance but also enhances the supply chain (Kamble et al., 2020; Tortorella et al., 2018), process factors (Dombrowski et al., 2017; Kamble et al., 2020; Tortorella et al., 2019), control & human factors (Kamble et al., 2020; Sahoo, 2019). In comparison, Belhadi et al. (2020) conditioned operational performance through improving the environment with green manufacturing, lean six sigma efforts, and the technological capability to use big data analytic.

Therefore, technology supports lean practices and improves sustainable performance (Ben Ruben et al., 2020; Dombrowski et al., 2017; Haddud & Khare, 2020; Kamble et al., 2020). The lean practices which are part of such support mainly predominates Just in Time (JIT) (Chen & Lin, 2017; Kamble et al., 2020; Rosin et al., 2020; Tortorella & Fettermann, 2018), Visual Management (VM) (Haddud & Khare, 2020), Total Productive Maintenance (TPM) (Haddud & Khare, 2020; Kamble et al., 2020; Rosin et al., 2020), Continuous Improvement (CI) (Haddud & Khare, 2020; Rosin et al., 2020), and the Poka-Yoke approach (Haddud & Khare, 2020).

Tovar & Mayagoitia (2018) developed a continuous improvement cube (CI-Cube) model for lean management. It consists of the integration of the six faces for continuous improvement of the firm. Each face of the cube focuses on a topic, in which their methodology follows a mature process for proper firm development. It begins with the primary face, bases, or fundaments; it aims to develop its bedrock strategy. Culture, the second cube's side, seeks to engage employees to achieve firms' goals harnessing communication among employees and management engagement. Thirdly, the approach part advocates avoiding focusing on trivial activities since the business supports the environment, health & safety, quality, as long as the previous cube's faces are developed. The fourth phase, the system, is the base of the CI-Cube model, in which it deploys a set of lean tools sorted into three action phases: deployment, development, and consolidation. Based on Deming's improvement cycle, lean tools in each action phase are classified (see **Figure II-19**), where each action phase evolves according to the firm's maturity.

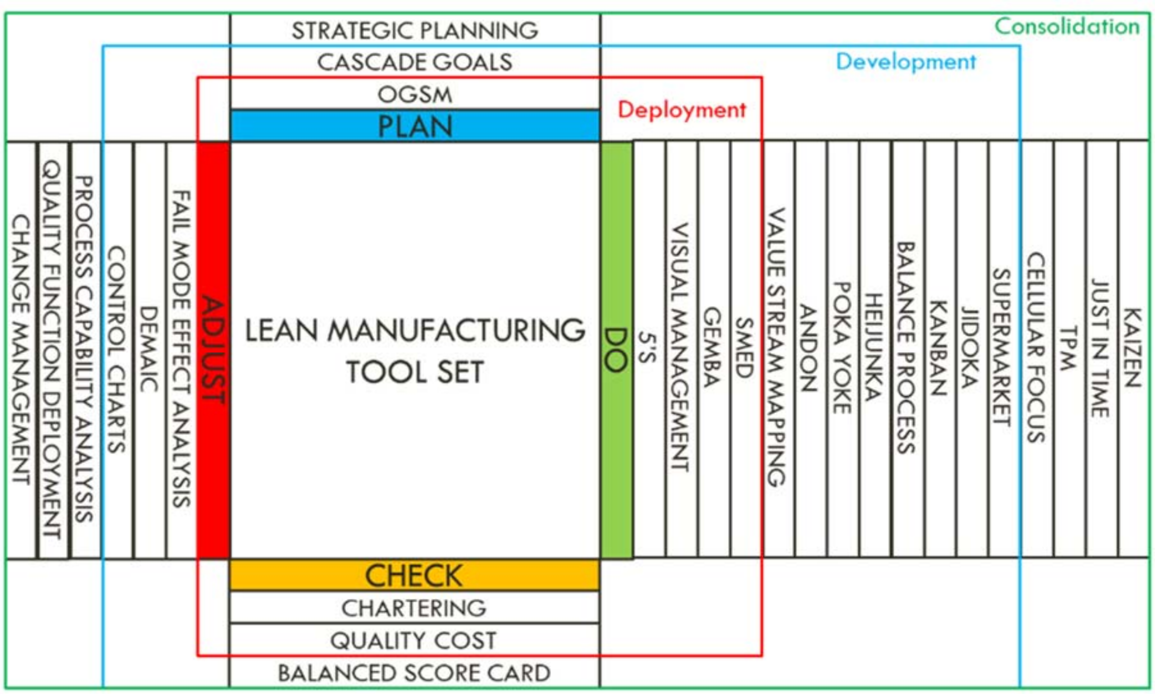


Figure II-19 Lean manufacturing tool set

Sustainability, the fifth face of the CI-Cube, offers the durable firm's continuous improvement; it integrates two activities. Organizational practices related to the ARMAR acronym in Spanish;

- A Ensures update of documentation and standardization after improvement
- R Perform effective visual management
- M Business health monitoring
- A Apply pilot test
- R Processes improvement redefinition

On the other hand, transformation, the second activity, consists of the CRECE acronym in Spanish, where:

- C Purpose confirmation
- R Challenge the people
- E Hubs establishment
- C Agile processes creation
- E Spread knowledge

Lastly, the sixth face of the CI-Cube is Promotion. It involves how to boost innovative continuous improvement throughout the organization. For instance, the initiative's identity campaign and the material communication for campaign promotion, such as campaign understanding and communication, are based on change management, team management, and local campaigns.

II. 5. 3. Industry 4.0

The Latest Industrial revolution coined as industry 4.0 (I4.0), Industrie 4.0 in Germany (Grube et al., 2017), advance manufacturing partnership in the USA (Culot et al., 2020; Grube et al., 2017), advanced manufacturing 3.0 in the Republic of Korea (Culot et al., 2020; Grube et al., 2017), the Chinese "Made in chine 2025" (Culot et al., 2020), the Japanese "Society 5.0", the French "Factories of the Future"; "Fourth industrial revolution" in the UK (Culot et al., 2020). The smart factory has shown that technologies, combined with lean practices, have innovated the industrial activity by optimizing processes involved in value creation. Thereby, to face global issues, I4.0 can be a bridge to achieve SDG from the TLB perspective.

These technologies tackle problems such as the above mentioned, reducing pollutant emissions, responsible production, energy consumption in the environmental dimension. In the social aspect, a strategy against poverty, optimal working conditions, and appropriate social development. Profits growth by minimizing all sorts of waste involved in every activity as the economic effect. Nevertheless, the conditions in emerging economies are the opposite of implementing I4.0 technologies due to mainly financial aspects. Meanwhile, developed economies' firms face trade-offs between still having operations in developing countries or stop relying only on reducing labor costs and adopting the back-shoring strategy by implementing industry 4.0 technologies (Ancarani et al., 2019; Brennan et al., 2015).

I4.0 technologies have the potential to unlock sustainable practices from the outcome performance point of view. From the firm's focus, de Sousa Jabbour et al. (2018) proposed a careful analysis of the critical success factors for a productive synergy of I4.0 and sustainability in the environmental dimension of manufacturing, where innovation capacity and culture play an essential role. In comparison, Stock et al. (2018) began their analysis from the business model and the value creation network & life cycle product as macro potentials. Their study also includes: the micro potentials involved in the value creation, the performance of the critical aspect of sustainable outputs such as energy and material consumption, and the working conditions. In sum, I4.0 technologies improve sustainable outcomes in general terms from the value creation and ecological and social dimension, being only the primary energy consumption reported as the weak point of the technological implementation.

Although economic growth is crucial, its quality fountain would transform it into economic development that aims to get a sustainable strategy (WEF, 2018). In that way, Bosques-brugada et al. (2020) stated that emerging markets should promote capital streams to foreign investment (FMI, 2017), for reducing a global downturn risk (Thomson, 2017), which aims its activity to the 12 emerging technologies in the fourth industrial revolution. These are critical drivers for sustainable economic development that will face technological aspects and pave the way to achieve sustainability (Sinha & Matharu, 2019). Such emerging technologies, listed below, involve a high specialization level (WEF, 2017).

- Additive manufacturing (3D printers)
- Advance materials and nanomaterials
- Artificial intelligence and robotics
- Biotechnology
- Energy capture, storage and transmission
- Blockchain and distributed ledge
- Geoengineering
- Internet of Things device technologies
- Neurotechnology
- New computing technologies
- Space technologies
- Virtual and augmented technologies

Besides the 12 emerging technologies considered before, its imminent implementation of the fourth industrial revolution involves techniques for the integration of horizontal and vertical firm's processes, additionally, the end-to-end engineering that the life product cycle implies (Götz & Jankowska, 2017). Although Industry 4.0 is an excellent opportunity for all stakeholders in the goods and services production, it also represents a threat to lagged economies in technology development (Rüßmann et al., 2015). Rüßmann (2015), as a pioneer of the I4.0, established related technologies that make possible such interconnection: horizontal and vertical integration, the Industrial Internet of Things (IIoT), Cybersecurity, the cloud, additive manufacturing, augmented reality, Big data analysis, autonomous robots, and simulation. There are in common 6 of 12 emerging technologies with I4.0 technologies denoted in **Table II-8**.

Table II-8 Common Emerging and I4.0 technologies (is not part of I4.0 listed, but it is an I4.0 technology)*

Emerging technologies	**I4.0 technologies**
Additive manufacturing (3D printers)	Additive manufacturing
Artificial intelligence and robotics	Autonomous robots
Blockchain and distributed ledge	Blockchain*
Internet of Things device technologies	Industrial Internet of Things (IIoT)
New computing technologies	The cloud, Big Data analysis & Simulation
Virtual and augmented technologies	Augmented reality

I4.0 technologies have different classifications; as aforementioned, Götz & Jankowska (2017) and Leyh & Martin (2017) regard them in horizontal, vertical firm's processes technologies, the technologies from engineering to engineering that the life product cycle implies. Furthermore, human focus technologies are part of this view (Leyh & Martin, 2017). Tortorella et al. (2019) sorted I4-0 technologies into three categories, product, process, and development technologies. Notwithstanding, technologies are categorized based on the latest technological language. In this sense, likely to Tortorella et al. (2019), Dombrowski et al. (2017) classified I4.0 technologies for process-related characteristics, systems, and technologies of industry 4.0. In comparison, Culot et al. (2020) grouped technologies in Physical / Digital interphase and process, data processing, and network technologies. Kamble et al. (2020) on the other hand, listed technologies for smart data collection, storage, analysis, and sharing technologies; shop floor and integration technologies. Lastly, technologies are seen based on their mature use. In this case, Núñez-Merino et al. (2020) began their classification with obsolete technologies. Mature technologies regard most of the industry 4.0 technologies that have been largely innovated in the supply tech market. Conversely, those technologies which are not boosted in the market due to recent launch are emerging technologies. Moreover, they also consider the general approach of the Information systems and technology derived in systems networks, such as control systems, execution systems, and enterprise resources planning systems (Qu et al., 2019) integrated throughout horizontal and vertical processes (Núñez-Merino et al., 2020).

Table II-9 Summarizes the life cycle technology classification per each I4-0 technology. The technology arrangement is built based on the Núñez-Merino et al. (2020), they classified most of the I4.0 technologies. Notwithstanding, to get a state of technology development, industrial unit management should use I4.0 technologies maturity. The first category, physical sensors, is an obsolete technology electronic data interchange where physical sensors transduce this kind of information. Mature technologies encompass most of the widespread technologies, so they are essential but still far to achieve a competitive advantage.

Conversely, those technologies that support the competitive advantage are emerging technologies (Núñez-Merino et al., 2020). On the one hand, Barcode systems, RFID, Social media, Information systems, Simulation, and robotic systems are mature technologies. While emerging technologies aim to drive up efficiency and competitiveness. For instance, the industrial, service, and internet of things and how big data stored by the cloud can analyze high data volume through artificial intelligence and cybersecurity managing processes such as the blockchain to reduce cyber-attack risks. The virtual and augmented reality, additive manufacturing, and their integration with manufacturing systems by cyber-physics systems support the future factory without leaving behind information systems that mention through visualization technologies what is happening in the factory in life. Moreover, digital twins and shadows as a simulation upper level, auto-guide vehicles, and GPS are part of these technologies.

Table II-9 I4.0 Technologies classification based on Life Cycle

Obsolate	Mature						Emerging																	Information Systems			
Physical sensors	Barcode Systems	RFID	Social Media	Information Systems	Simulation	Robotic systems	Cloud Computing	Inernet of things	industrial internet of things	internet of services	Artificial Intelligence	Virtual reality	Autoguide vehicle	Cyber-physic Systems	Big Data	3d Printer	Cybersec	BlockChain	Augmented reality	Visualization technologies	GPS	Digital twins	Digital shadows	Electronic data interchange	SCADA	MES	ERP

Today academics, politicians, and industry leaders are talking about the fourth industrial revolution (I4.0), which will raise manufacturing productivity to unprecedented levels (Grube et al., 2017). According to the roadmap of the Secretaria de Economía (2016) “crafting the future: a roadmap for industry 4.0 in Mexico” quoted Siegfried Dais, leader of this initiative in Germany, “the world of production will likely become more and more linked until everything interconnects as a whole.” A single factory will no longer connect with Networks and processes, but through Industry 4.0, individual factories will eliminate boundaries with the interconnection of multiple factors or regions. The structuring of Industry 4.0 varies according to the different exponents, the consulting firm PWC in its work “Industry 4.0: Building you digital Enterprise,” mentioned that the critical points of I 4.0 are (Reinhard et al., 2016):

1. The digitization and integration of the horizontal and vertical value chain
2. Digitization of the offer of products and services
3. Digitization of business models and customer access

Likewise, three types of systems integration, vertical, horizontal, and end to end engineering. Vertical integration concerns integrating several systems at different hierarchical levels within the factory. It emphasizes the essence of verticality by integrating sensors and actuators in the automation pyramid levels. It would then scale to the manufacturing execution system and reach the enterprise resource planning (ERP), allowing the reconfiguration in the manufacturing system. Horizontal integration goes through the value network inter-company collaboration of the flow of materials between companies. The integration of end-to-end engineering is present throughout the entire value chain, supporting the increase in production customization requirements. Such integration includes linking stakeholders, products, and equipment throughout the product life cycle, from raw material acquisition to the end of the product life (Götz & Jankowska, 2017; Strandhagen et al., 2017).

Therefore, the information system integration throughout the firm is essential, such as the horizontal, encompassing from suppliers to customers data; the vertical one contains the information from the firm's upper levels to the workshop. The table above depicts different information systems, beginning with electronic data interchange, which is the communication level in the manufacturing cell that operates with PLC systems. Then, the Supervisory Control And Data Acquisition (SCADA) as a smart control layer for complex control of the business support (Qu et al., 2019), which provides closed-loop feedback to and for engineering automation (PLC and CNC controllers) (Dutta et al., 2020). As a smarter execution layer (Qu et al., 2019), the manufacturing execution system transmits flow data in process-related (Tortorella et al., 2019) in the vertical dimension (Dutta et al., 2020). Thereby, SCADA and MES enable more efficient manufacturing processes since both can increase the process and product connectivity and interaction (Tortorella et al., 2019). Lastly, the smartest layer for planning is the Enterprise Resources Planning (ERP) (Qu et al., 2019), designed to eliminate wastage in the information management process throughout the supply chain management (Núñez-Merino et al., 2020).

Results

Chapter III. Result

III. 1. -General model for sustainable industrial development

Based on the research developed by titled "Towards sustainable industrial development - a systems thinking-based approach" and "Systemic model for sustainable industrial development in the manufacturing sector," I considered different theoretical methodologies for the framework proposal for a sustainable industrial development model with a system thinking approach. First, systemic tools are essential to understand the problem and all the different components involved in the framework (Kruger et al., 2018; Virapongse et al., 2016). Besides, a system is a process that contains input, output, agents that act as monitoring, control, operation, and feedback interrelated for a common purpose. It also contemplates the interaction of the system's components and how it affects both the system that contains it (supra system) and the subsystems embedded into it. Three systems are involved as a general sense of systems thinking. As a superior system, the supra systems can see the system in focus performance (Aceves, 2015). As aforementioned, the supra system is also the environment in which the focus system is embedded (Virapongse et al., 2016).

Then, industrial clusters have been mentioned as a strategic option for industrial development because they provide a strong competitive advantage and create innovative differentiation into the region, state, or nation. **Figure III-1** depicts a sustainable industrial development strategy delineated as part of the model as the system in focus—moreover, the framework for industrial sustainable development couples to the socially inclusive approach. As explained before, the general framework proposes to be the industrial cluster model, as an industrial unit management organization that establishes a differentiation strategy with its core competence. The cluster strategy must highlight a competitive advantage to get a strong and healthy, sustainable competitive business context strategy. In this regard, the supra-system is where the system in focus must evaluate its context. This asset of the triple line bottom is what determines the context of the system in focus embedded. Although the three spheres are separate in the framework, it does not mean that they are independent of each other. Hence, sustainability is the basis of the industrial strategy to balance the three dimensions for suitable development.

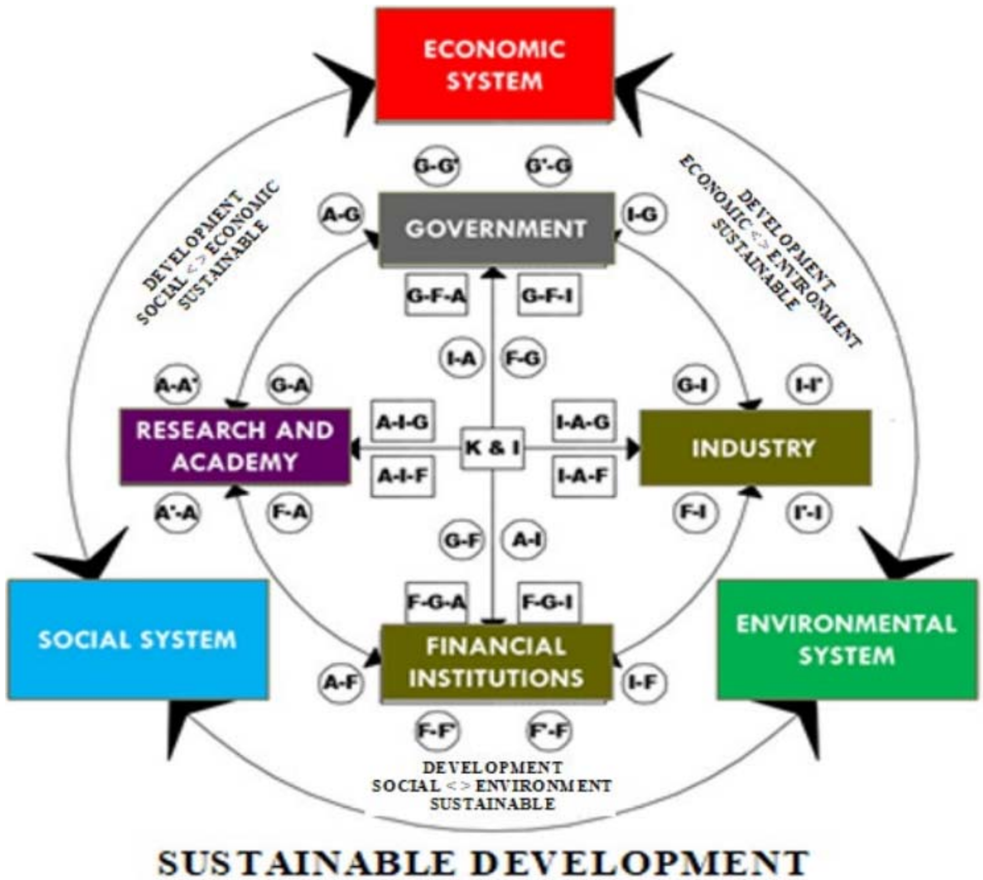


Figure III-1 Model for sustainable industrial development

For that reason, the industrial cluster as the system in focus is the way to properly balance the triple bottom line development and achieve affordable industrial development. Therefore, the sustainable industrial frame is built based on the clusters theory and the systems thinking theory. The framework shows how the parts of the triple helix are also interconnected with the financial sector as it is a component that exploits innovation. The cluster proposal framework is embedded in the sustainability context. Thus, when a subsystem establishes into the cluster, it previously developed context analysis about main variables, such as how the region is wealthy or the average education grade of the people, or if row suppliers are close to the establishment. However, the cluster organization is on the duty of monitoring the sustainable context with sustainable metrics used by the UN is 17 SDGs and create policies that could balance sustainability.

III. 2. Dependencies for sustainable development

The elements involved by each of the systems based on sustainable development dimensions classified according to the triple bottom line, such as mentioned in the previous unit; the Economic, Social and Environmental dimensions. Likewise, international organizations such as the UN and its co-dependencies and UNIDO add the organizational sphere in the documents they have released for sustainable industrial development (GIZ, 2016; UNIDO, 2016, 2017, 2018).

III. 2. 1. Dependencies related to the environmental dimension

The environmental dimension encompasses many actors since it is the system that contains the social and ecological systems in the system in focus. According to the model for sustainable industrial development, there are several links to them. **Table III-1** they are shown the most representative dependencies at the environmental pillar's supra-system level. The supra-system is not only limited in contemplating agencies of a regional nature, but also of a federal nature. Such is the example of state secretariats such as SEMARNAT, SENER, POFEPA, etc. In general, these agencies control and protect against the exploitation of natural resources. Likewise, these agencies act as auditors and monitors of emissions of solids, liquids, and gases that damage the environment.

Table III-1 Actors in the Environmental System and their Links (Own elaboration)

Dependence	Acronym	Icon	System in focus	Link
Secretariat of Environment and Natural Resources	SEMARNAT	SEMARNAT	Environmental System	Environment-Government
Secretariat of Energy	SENER	SENER SECRETARÍA DE ENERGÍA	Environment-Government	Government-Society
Federal Attorney for Environmental Protection	PROFEPA	PROFEPA PROCURADURÍA FEDERAL DE PROTECCIÓN AL AMBIENTE	Environment-Government	Government-Industry
National Institute for Ecology and Climate Change	INECC	INECC INSTITUTO NACIONAL DE ECOLOGÍA Y CAMBIO CLIMÁTICO	Environment-Academy	Government-Society
Air Quality National Information System	SINAICA	SINAICA	Environment-Academy	Government-Society

Dependence	Acronym	Icon	System in focus	Link
National Water Commission	CONAGUA		Government-Society	Environment-Society
National Forestry Commission	CONAFOR		Government-Society	Environment-Society
National Commission of Natural Protected Areas	CONANP		Government-Environment	Environment-Society
Energy and Environment Security Agency	ASEA		Government-Environment	Environment-Society
National System of Environmental Information and Natural Resources	SNIARN		Environment-Government	Government-Society
Mexican Institute of Water Technology	IMTA		Environment-Academy	Government-Society
Protect Our Planet	POP		Foreign-Government	Foreign-Environment
Research Institutions for the Environment			Environment-Academy	Academy-Society

III. 2. 2. Dependencies related to the social dimension

The social dimension is the system nested in the environmental system, also known as the environment or the ecosystem, where the component and the dependencies of social focus develop. **Table III-2** shows the leading agencies dedicated to the monitoring and evaluation of the social dimension. Similarly, as in the previous sphere, it is divided into federal agencies such as SEGOB or SEP, to mention a few examples. Although some levels are national dependencies, they also have a regional connotation such as SEDESOL and CONAPO. However, their effects focus on local development for the social approach. Furthermore, institutions mentioned in the table are for social development, such as the IMSS and ISSSTE for care in social services and the CONACyT as a unit focused on developing human resources with a high degree of quality for innovation and technological development.

Table III-2 Actors in the Social System and their Links (Own elaboration)

Dependence	Acronym	Icon	System in focus	Link
Secretariat of Welfare	SEDESOL		Society	Social-Government
Secretariat of the Interior	SEGOB		Government	Government-Society
Secretariat of Public Education	SEP		Academy	Academy-Society
Secretary of Health	SALUD		Society	Government-Society
Social Security Dependencies	IMSS, ISSSTE		Society	Government-Society
National Population Council	CONAPO		Government	Government-Society
National Council for the Evaluation of Social Development Policy	CONEVAL		Government	Government-Society
National Council for Science and Technology	CONACyT		Academy	Government-Academy

III. 2. 3. Dependencies related to the economic dimension

The economic dimension is the one that is nested within the social and environmental pillar. However, it is the sphere that contains the most significant element for development, "innovation." As discussed in the previous chapter, innovation is crucial for strong sustainability by innovating designs that significantly improve products, processes, organizations, and marketing. Activating the economic circle and increasing productivity makes products more competitive by pursuing a strategy that supports differentiation. Among the more significant financial system agencies are the Ministry of Economic (SE) and the SHCP as elements for developing industrial and monetary policy. Likewise, Mexico is a country with many movements abroad, such as remittances, exports, and imports. The Ministry of Foreign Relations is a dependency of great importance to channel such efforts and support direct foreign investment that also has a significant impact at the regional level within the nation (see **Table III-3**).

Table III-3 Actors in the Economic System and their Links (Own elaboration)

Dependence	Acronym	Icon	System in focus	Link
Secretariat of Economy	SE		Economy	Economy-Society
Ministry of Foreign Affairs	SRE		Foreign	Foreign-Society
Secretariat of Finance and Public Credit	SHCP		Economy	Government-Economy
ProMéxico	ProMéxico		Foreign	Foreign-Economy
Chambers of the Manufacturing industry			Economy	Economy-Industry
Industrial Clusters			Industry	Industry-Academy-Government
Industrial Park Development Companies			Industry	Industry-Government
Economic Commission for Latin America and the Caribbean	CEPAL		Foreign	Foreign-Economy

III. 2. 4. Dependencies related to the sustainability

Agencies that focus on sustainable development mentioned generally have a transcendental approach to nations and overseas. Such is the UN's example with Sustainable Development objectives, or the United Nations Development Program (UNDP), which have an external connotation. However, they seek to support the design of strategies for sustainable development. For this purpose, the National Institute of Statistics, Geography, and Information (INEGI) reports monitoring the 2030 agenda's sustainable development indicators. **Table III-4** shows the main dependencies that cover the three areas for sustainable development.

Table III-4 Actors in the Sustainable system and their Links (Own elaboration)

Dependency	Acronym	Icon	System in focus	Vinculo
Sustainable Development Goals	SDG		Foreign-Government	Foreign-Economy, Society, Environment
United Nations Development Programme	PNUD		Foreign	Foreign-Society
United Nations Environment Programme	PNUMA		Foreign-Government	Foreign-Environment
National Institute of Statistics and Geography	INEGI		Society-Government	Government-Industry

III. 3. Total intervention systems

III. 3. 1. Creativity

The development of systemic metaphors is followed by identifying the problem under study from a sustainable industrial development strategy perspective. Therefore, such as systemic metaphor, the previous model identified a strategy for sustainable and inclusive industrial development devising the system in focus, where the problem situation, explained in the justification section, performs. The industrial cluster found in the literature review as a mechanism for industrial and sustainable development leads to a strategy for industrial development with a sustainable approach. Likewise, according to the previous section, many institutions are involved in the problem situation model rich picture (see **Figure III-2**). Hence, to get an organized structure, these elements integrate a creative strategy in TIS's first stage (Mendoza-del Villar et al., 2020)

Figure III-2 World rich vision of system in focus

III. 3. 2. Selection

In the phase selection, the type of system under study and the problem situation members approach are analyzed to choose the appropriate systemic tool which fits better (Flood & Jackson, 1991). Thereby, for selecting the systemic tool, which matches the type of problem, it regards two characteristics, the number of members and the kind of objective of the agents involved in the issue. Since there are several members of the problem, then the type of situation is complex. In addition to the fact that the objective pursued is sustainable and inclusive industrial development, according to **Table II-2**, there is a problem with the members' pluralistic approach. Therefore, Jackson mentioned that one of the tools for these systemic problems is Peter Checkland's soft systems methodology.

III. 3. 3. Implementation

Indeed, as implementation, the soft systems methodology is used to develop a systemic solution for transforming a sustainable and socially inclusive industrial development. However, it seeks a more limited approach with a unitary objective to establish as a premise the sustainable and inclusive development for the systemic model. Hence, a tool that deals with complex problems and a unitary approach is the Staford Beer viable systems model. Therefore, the approaches are delimited based on the soft systems methodology to use the viable systems model later and thus have a strategy that supports industrial development with a comprehensive, sustainable, and socially inclusive approach.

III. 4. Soft systems methodology

III. 4. 1. The problem situation (unstructured)

Foremost, to establish the problem situation considered problematic in the real world of sustainable industrial development in the manufacturing sector strategy, it should acknowledge, explore, and define the situation to assess the entire interest system (Checkland, 1999). Therefore, as aforementioned, it showed a general evaluation of an unsustainable industrial strategy and its struggles during the context section of the current investigation. Information is obtained through secondary sources such as national government databases of the three sustainable pillars to assess a general overview of the problem situation.

In brief, by adopting weak sustainability through the NAFTA treaty and analyzing the leading sustainability indicators' performance, such as GDP, pollution emissions, and unemployment. It can be inferred that the Mexican strategy is not providing the expected results, a phenomenon that can be explained for many reasons. On the one hand, in the case of the environment dimension, data obtained from the National Institute of Ecology and Global Warming (INEEC) on greenhouse gas emissions shows a high possibility, i.e., 98.3%, of continuing with the same growth rate (see **Figure I-33**). On the other hand, data information collected from the National Institute of Statistics, Geography, and Information (INEGI) indicates that the index of secondary sector GDP, which involves manufacturing activity, is compared with the labor productivity index and occupied population index (see **Figure I-32**). Labor productivity decreased in 2012, even though GDP and occupied population indexes are correlated, but negatively. Moreover, although there is a significant increase in employment, which reduces the gap between formal and informal jobs, there are more informal jobs than formal ones (see **Figure I-35**).

Notwithstanding, the Mexican government, as pointed out before, has made a low effort to stabilize this situation. On the one side, according to data from INEGI, it was reported that albeit there is 4.32% of GDP as an investment for ecological accounts, only 13.13% is for environmental protection. It means that 86.87% of the expenses address the depletion and degradation of the environment (INEGI, 2018). This amount is superior to 0.51% of GDP for research and experimental development, a science expense. Additionally, a decoupling tendency between economy and environmental depletion, as the GDP proportion went from 8.4% in 2003 to 4.6% in 2016 (INEGI, 2018). On the other side, there is a contradiction in the main social variables' performance. Despite GDP per capita and the human development index showing a growing performance, the GINI index maintained its performance, resulting in inequality and a lack of social well-being (see **Figure I-34**).

Therefore, the lack of an aligned approach to the sustainability of the industrial strategy leads to weak sustainability, which has achieved poorly performance in any dimension. Hence, it puts at risk the achievement of sustainable development objectives. In terms of the economic sphere, the labor productivity indicator in the short-medium term has an inefficient performance; it reaffirms the labor increase. Notwithstanding, such rise does not make sense with low productivity inferring a deficient industrial strategy, confirming our above arguments. The social dimension shows an inequity of welfare, any sense of remunerations while growing unemployment.

Last but not least important, the environmental measurement, with high chances of growth rate in greenhouse gas emissions and the inadequate focus of investing in depletion and degradation of the environment instead of protecting it. In short, this neoliberal framework has not given Mexico a favorable competitive position. From a theoretical point of view, this kind of unsustainable development would not flourish in any dimension, and it would not offer a competitive advantage against neoliberal markets (Porter & van del Linde, 1995).

III. 4. 2. The problem situation expressed

In the second stage, the issue is expressed somehow; Checkland called this a rich picture for two reasons. Firstly, the situation needs to be expressed in all its richness. Secondly, Checkland suggested that the best way of depicting it is in a picture. The rich picture provides structures, processes, context, people, issues, and conflicts. In this way, the problem situation was shaped before with the focus system for sustainable industrial development in the manufacturing sector. Afterward, the industrial unit management bedrock integrates enterprises, such as SMEs or Large companies, from the systemic thinking perspective. Then, assuming they are part of a local management unit. In that case, firms embedded in industrial parks and several approaches, like sustainable, eco-industrial, techno, scientific, and green parks. Moreover, superior industrial management is through conglomerate management based on innovation and product flexibility (Cluster or industrial district). Additionally, industrial management provides market benefits based on industrial management capacity **Figure II-8**; and its role in the value chain **Figure II-9**.

The strategy of industrial development is a viable choice for tackling issues. However, its lack leads to inefficient productivity performance (Porter, 1998). It pointed out a negative tendency of labor productivity in the Mexican manufacturing industry, despite small and medium-sized enterprises (SMEs) being the primary employment source in Mexico, providing 78% of employment, representing 99.8% of established firms, and contributing to 42% of GDP (Arana, 2018). This sector is very vulnerable (Marcelo, 2015), as most SMEs die during the first three years after being established (see **Figure I-36**). The tendency is that as long as fewer employees are in the firm, the weak it is, whereas robust firms are alive in the fifth year, tend to have many employees (Mendoza-del Villar et al., 2019, 2020).

Foremost, to establish the problem situation for sustainable industrial development in the manufacturing sector strategy, it should be structured to identify the actors who are part of the entire system. The sustainable industrial development actors and elements are pointed out based on the sustainable industrial development model.

To do this, **Table III-1** to **Table III-4** showed the different actors involved in industrial development. Although the rich vision not represented all institutions indicated without an adequate structure problematic of the elements that intervene in the focus system; indeed, the most representative institutions in terms of economic, social, and environmental development are mentioned. Likewise, the actors are grouped based on the links of the dimensions for sustainable development. So, the first approximation of the rich vision's structuring, although disordered, was presented in **Figure III-2**.

However, **Figure III-3** depicts the focus system embedded in a sustainable development cluster scheme. Where actors with industrial agglomeration management presented in the focus system. They take advantage of the endogenous and exogenous benefits generated by industrialization (spillovers effects). In addition to the industrial management benefits mentioned above, it is essential to position itself operationally in the comparative advantage in the global approach towards the comparative local strategy. Based on the differentiation in material, energy, and geospatial inputs, the main differentiators are taken into account by which of the comparative advantage of the system in focus. Subsequently, the competitive advantage takes place from the opposite direction from the value chain's local operational approach with the capacity in innovation, science, and technology of the system approach towards the strategic view of the national competitive advantage.

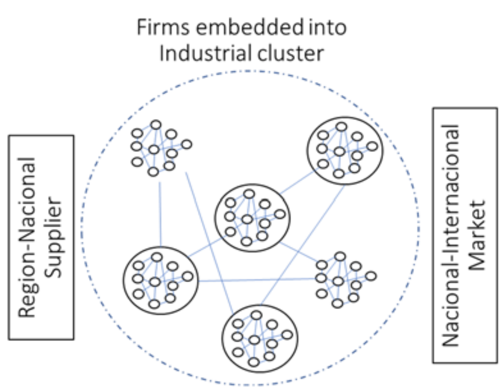


Figure III-3 System in focus for the sustainable industrial development

III. 4. 3. Root definition of relevant systems

Afterward, stage three moves out of the real world and into the world of systems; this is the stage where the system's world defines the problem situation regarding a holistic approach by understanding the concept of different perspectives that can draw out of the rich picture. That is why Checkland called it the root definition stage and is the unique and most challenging part of the methodology (Checkland, 1999). A root definition describes a notional system chosen for its relevance to what the investigator and the people in the problem situation perceive as matters of contention" (François, 2004). It concisely a tightly constructed description of a human activity system that states what the system is" "what it does then is elaborated in a conceptual model built based on the definition. Every element reported in the definition must be reflected in the model derived. A well-formulated root definition will make explicit each of the CATWOE elements. An utterly general root definition embodying CATWOE might take the following form: "An (O) owned system which, under the following environmental constraints which it takes as given (E) transform this input (I) into that output (O) through the following major activities, among others (T), the transformation is carried out by these actors (A) and directly affecting the following beneficiaries and victims (C). The world-image makes this transformation meaningful (W)" (François, 2004).

Therefore, for an adequate conceptualization of managing sustainable industrial development in the manufacturing sector, identifying the relevant systems is continued based on the root definition's critical problem systems. Each holon provides a separate value base by which to evaluate the situation. The basis of SSM is that trying to address all types of perspectives as a whole is too complex an endeavour. Clarity is gained by addressing essential perspectives separately, understanding their implications, and then using those understandings when seeking to reintegrate these perspectives into a set of evaluative conclusions and suggestions for future actions (Checkland, 1999). Based on economic, environmental, and social indicators measurements, there is a lack of strategy for achieving sustainability in the Mexican industrial development context. For instance, the SMEs' death rate as a social driver of poverty deploys other social unwanted issues. Then, there is a lack of a strategy in the Mexican context for achieving sustainability in industrial development Even though TSI's was used initially with the metaphor system depicted in the sustainable industrial development model (Mendoza-del Villar et al., 2019); each critical system's root definition criterion needs to be aligned and coordinated under a sustainable industrial and inclusive development strategy (Mendoza-del Villar et al., 2020).

Critical systems identified in the system in focus that need to be examined from several perspectives for the sustainable and inclusive development transformation are systems involved in environmental institutions, social and foreign actors. Environmental institutions' system works as monitoring and auditor element of the system in focus, meanwhile social ad foreign actors trace the path for inclusiveness and the supra-system route for sustainability. Although environmental institutions, social and foreign actors are part of the strategy, their performance as a whole has not achieved expected sustainable outputs since any of the TBL targets have not been conducted under a sustainable development goal commitment (Mendoza-del Villar et al., 2020).

For critical root systems identification, the focus system would help delimit the scope according to the transformation activity. Once the system in focus for sustainable industrial development has been defined, its structured approach of industrial unit management and the main dependencies involved in the supra system into focus makes it time to formulate the root systems for sustainable industrial development. In that way, based on the cluster theory and the methodology for converting and installing an industrial park to an eco-industrial park and a sustainable industrial park to structure the problem situation's roots to highlight stakeholders for sustainable development. The research focus system is sustainable industrial development; thus, it identifies the interested parties (Stakeholders) for sustainable industrial development.

The Cluster strategy must highlight a competitive advantage to get a robust and sustainable strategy for a competitive business context. In this regard, the supra-system is where the system in focus must evaluate its context. This assess of the Triple Bottom Line is what determines the context of the system in focus embedded. Although the three spheres are separate in the framework, it does not mean that they are independent of each other. Hence, sustainability is the basis of the industrial strategy to balance the three dimensions for suitable development. For that reason, industrial unit management, like the industrial cluster as the system in focus, is the way to properly balance the Triple Bottom Line's development and achieve affordable industrial development (Mendoza-del Villar et al., 2019).

Notwithstanding, the model would complement sustainability by strengthening the missing link of inclusiveness in the sustainable industrial development model. For that reason, stakeholders are the critical drivers for inclusiveness into the system in focus. According to the World Bank and UNIDO in the Eco-industrial park manual (The World Bank Group, 2019) and sustainable industrial park guidelines (ONUDI, 2017), it is necessary to strengthen the strategy by forming a group of members and adding allies to represent stakeholder's interests. Even the Mexican industrial park norm NMX-R-046-SCFI-2015 was developed by significant economic development actors and environment actors (NMX-R-046-SCFI-2015 PARQUES INDUSTRIALES – ESPECIFICACIONES, 2015). Moreover, Martín-Gómez et al. (2019) indexed triple helix stakeholders, like users and audit units, into the green energy framework. Finally, **Table III-5** mentions critical Stakeholders systems of industrial development for transformation to sustainable & inclusive industrial development roles: The State, Cluster, Industrial Products and services system, Academy, Environmental institutions and, Foreign & Local actors (Mendoza-del Villar et al., 2019, 2020).

Table III-5 Stakeholder and their role in the system in focus

Stakeholders	Role	Description
State	Policy	Legislate industrial policy and regulations.
Cluster	Link	Promote links between actors in the sector.
Industry	Goods and service production	Produce satisfiers for a specific market.
Academy	R&D + i	R&D and innovation for the production of goods and services.
Environmental institutions	Auditing	Regulate actors for ecological balance.
Foreign actors	Advising	Advise efforts in industrial development.
Local actors	Beneficiaries or Victims	Beneficiaries or Victims of system's performance

Thereby, to achieve a feasible strategy that involves the pluralist stakeholders' focus and the complexity of the problem, soft systems methodology is chosen for tackling these issues (Checkland, 1999; Flood & Jackson, 1991). Hence, the roots' definitions of the holons system in focus transformation are the relevant systems: Customers, Actors, Transformation, Weltanschauung, Owners, & Environment (CATWOE). For strong sustainability, the strategy for sustainable and inclusiveness of the industrial development transformation should align with an innovative core business of the firm, industrial park, or industrial cluster (industrial management unit) (Bosques-brugada et al., 2020; Luis-Pineda, 2008; Mendoza-del Villar et al., 2019; Roome, 2012). Each company embedded in the industrial management unit would only focus on its core business activity regarding sustainability products and processes (Mendoza-del Villar et al., 2020).

The root definition for transforming the industry [T] focuses on sustainable and inclusive industrial development in industrial development. Transformation is defined as "to develop a strategic and sustainable industry that meets not only the needs of the environmental, social and economic dimensions of the present generation but also the future generation ones" (Mendoza-del Villar et al., 2019). In that way, customers of the system in focus [C] are products and services industry solutions systems that [W] produce goods and services sustainably to satisfy the TBL of the market's demands. Actors [A], who are also part of the systems, can get such industrial transformation easier. Moreover, [A] and [C] are formed by industrial entities, which means firms can be customers or suppliers of a core product or service. Sustainable management can scale up by management systems as industrial parks or even industrial clusters. In that way, those superior systems that oversee performance development would advise systems embedded for correcting local to global issues, such as global warming. The dynamics of the sustainable and inclusive transformation process is performed by a different unit of industrial management in the manufacturing sector [E], where the state [O], most of the cases, roles the policy for economic development, which is the case of a peripheral economy as Mexico (Luis-Pineda, 2008; Mendoza-del Villar et al., 2020).

The root definition of sustainable and inclusive industrial development depicted in **Figure III-4** shows the critical systems involved: industrial solutions systems. They play active roles in sustainable and inclusive development in the industry. Then, the essential actors for sustainable and inclusive industrial development who facilitate the transformation from industrial development strategy to sustainable and inclusive industrial development strategy are the academia for R&D, as well as financial institutions that enable the innovation with other systems into the economic cycle. Industrial management institutions are in charge of playing the innovative active role to approve and boost the cycle by linking critical systems for healthy and sustainable industrial development. Local social actors must be considered for the strategy inclusiveness and being part of the labor force since industrial development is embedded in society. Otherwise, the algedonic channel would negatively impact local social actors and complicate the performance or even collapse the system. Thereby, the state recognized as the ruler and owner of the social system should pay attention to this channel. Additionally, foreign actors suggest goals and economic, environmental, and social policies to get global equilibrium.

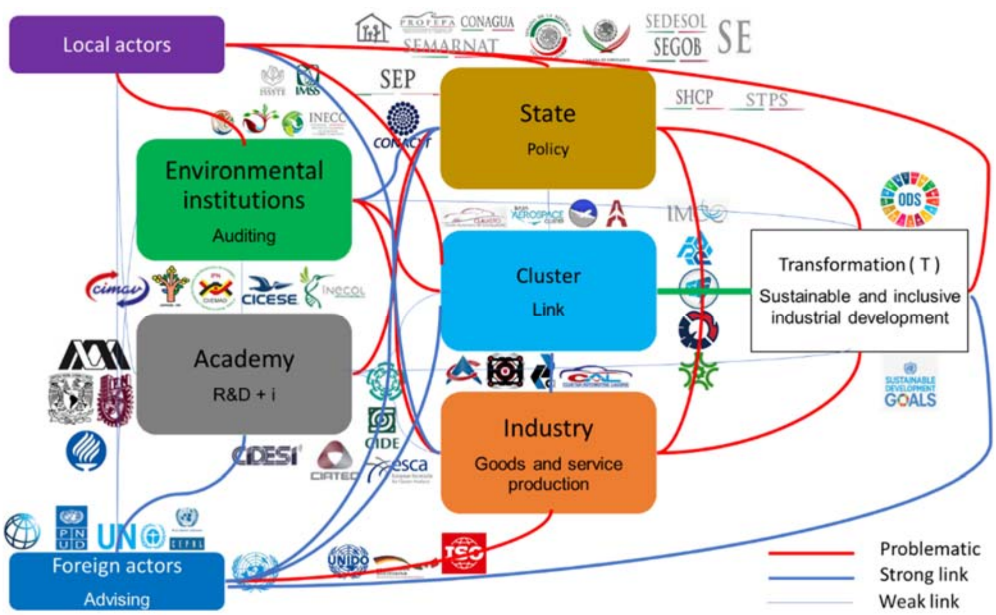


Figure III-4 Root definition of the Critical Systems for sustainable and inclusive industrial development

The figure above shows the relevant systems mentioned before, which conglomerate the problem's rich vision and actors. For its proper interpretation, it is a vehicle to achieve sustainable and inclusive industrial development. Furthermore, it shows the system's relationships in focus for sustainable development, in which connections are bidirectional. **Table III-6**. denotes whether there is a conflicted relationship, according to the colour; blue colour shows a relationship without conflict, but with a strong relationship with a thick line, while a thin line represents a weak connection. On the other hand, in red, the links identify present failures for sustainable industrial development. The transformation system depicts conflicts with the critical systems: social actors, the state, and services and goods solutions systems. As explained before, the algedonic channel reflects the behaviour of suitable or unsuitable decisions by mainly social actors. Therefore, for a better understanding, the root definition for each of these relevant systems is developed.

Table III-6 Relations of relevant systems for Sustainable Industrial Development

Element	Relationship	Element
Sustainable and Inclusive Industrial Development	Policy design for sustainable and socially inclusive strategic industrial development.	State
Sustainable and Inclusive Industrial Development	Transformation of inputs into products and services under the circular approach, sustainable and socially inclusive economy.	Industrial and Service Solutions
Sustainable and Inclusive Industrial Development	Contribution of society in terms of sustainability to improve regional conditions (culture, society, cleanliness, awareness).	Social actors
Sustainable and Inclusive Industrial Development	The mechanism for the transformation of sustainable industrial strategic development by linking stakeholders.	Cluster
Sustainable and Inclusive Industrial Development	Research and development and innovation of the processes of the value chain in its different modalities for sustainable development.	Academy
Sustainable and Inclusive Industrial Development	Mechanisms for monitoring and regulating the agents involved in sustainable industrial development.	Environmental Institutions
Sustainable and Inclusive Industrial Development	Support for the formulation of policies for sustainable and inclusive industrial development based on experiences from other countries.	Foreign Actors
Cluster	Link partners belonging to the industrial cluster for business development and link problems with academia and solutions with the state.	Industrial and Service Solutions
Cluster	Propose solutions to state problems, link human resource requirements based on industrial expectations.	State
Cluster	Regional development supports the region's society and improves the quality of life for everyone without leaving anyone behind.	Social actors
Cluster	Design of programs for the care and protection of ecosystems and the use of natural resources for sustainable consumption.	Environmental Institutions
Industrial and Service Solutions	Advice on the design and development of sustainable products and services or minimize the deterioration of ecosystems and improve production processes.	Foreign Actors

Industrial and Service Solutions	Contribution of taxes based on business activity, design of policies to protect free competition, eliminating monopoly practices.	State
Industrial and Service Solutions	Industrial practices that are friendly to the environment or minimize its damage, monitoring, and regulatory auditing compliance regarding environmental protection in industrial activity.	Environmental Institutions
State	Provide the facilities and social services that the community requires for integral development, the contribution of taxes for the payment of services such as security and social services.	Social actors
State	Promote science and technology and innovation in problems of a national, regional, or local nature. Contribute to scientific and technological research to improve the conditions of sustainable development.	Academy
Environmental Institutions	Regulating and monitoring compliance with safety and environmental protection in the maintenance of sustainable ecosystems.	Social actors

i. Relevant system: Industrial Cluster

The purpose of the relevant cluster system is to link the industrial actors to meet the partners' requirements that make up the industrial cluster (see **Figure III-5**). The link is with academia, government institutions, with other industries, among others. **Table III-7** lists each of the elements for the root definition of the relevant cluster system.

Table III-7 Relations of relevant systems for Sustainable Industrial Development

Root definition	Relevant system	Industrial Cluster
I	Inputs	Industrial Partners Request for requirements: Technicians-Industry HR-Academy training Politics-Government
T	Transformation	Link strategic innovation among stakeholders
O	Outputs	New element development consolidation. Requirements' issuance for the sector to interested Institutions.
P)	What?	Link industry with other industries, academia, and government
Q)	How?	By linking industry sector requirements to industrial, academic and government institutions
R)	Why?	To promote the productivity of sectors development
C	Customer	Cluster Partners, Industry
A	Actor	Industry, Academy, Government
W	Weltanschauung	Boost industrial development through the actors involved
O	Owner	Cluster Director
E	Environment	Cluster Industrial Sector

Weltanschauung: According to the 2012-2018 national development plan, one of the five structural components is prosperous Mexico; its main objective is to increase and democratize the productivity of our economy (República, 2013). Advice and support with a value of 120 million delivered by the secretariat of the economy and the world bank to 37 productive clusters in Mexico under three segments: cluster governance, certifications, and human capital training.

Likewise, through interviews with decision-makers in the metal-mechanical industry cluster system (CLAUTMEX and ECAL) and the cluster accreditation organization, the following arguments were made. Clusters are not physical figures as they are in European countries. They are formed based on sector requirements (Tentlix, 2019). They are an acceptable way of landing the sector requirements to the different institutions interested in the sector. The main contribution is the accumulation of knowledge for specialized training for human resources in the sector. Their training depends on the organization of the private actors in the industry. From this point, the requirements of all types of productivity factors are deployed: Human Resources, Material Resources, Financial Resources, Technological Resources (Clautedomex, 2019). Moreover, the academy would be an excellent means to request technological requirements; however, the costs leave them out of the competition (ECAL, 2017).

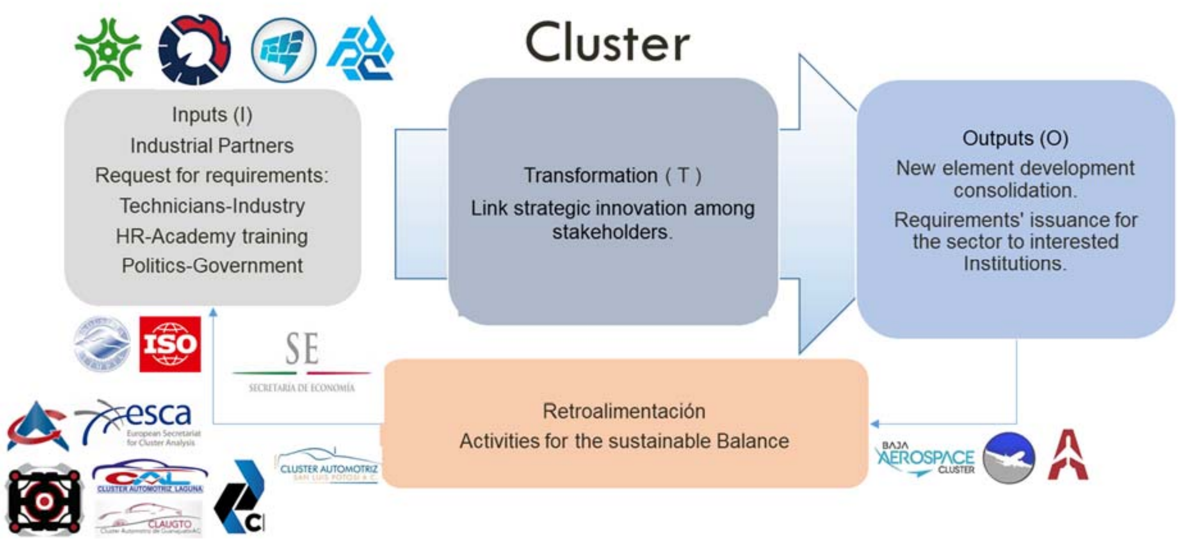


Figure III-5 Root definition: Cluster (Own elaboration)

Issues that cluster involves are the lack of support for the regional development for everyone's quality of life without leaving anyone behind. Likewise, the low effort for plan design for ecosystems cares and protects and uses natural resources for sustainable consumption. On the other hand, Cluster efforts focus on industrial support based on foreign experience by linking partners' clusters with academia, industry, and the State. However, solutions proposal with the State for industrial policies is weak; instead, it limits on linking human resource requirements based on industrial expectations.

ii. Relevant system: industrial and service solutions

Similarly, for the industrial and service solutions system's root definition, its transformation process (T) is defined. It produces tangible (products) and intangible (services) satisfiers through the transformation of inputs (materials, energy, information, and human resources). The industrial and service solutions system adds value to satisfy the market's needs and obtain an economic remuneration. **Table III-8** lists the elements for the root definition of the industrial solutions and services system and the conceptual system in **Figure III-6**.

Table III-8 Root definition relevant system: industrial and service solutions

Root definition	Relevant system	Industrial and service solutions
I	Inputs	Capital, Raw material, Energy Human Resources information
T	Transformation	Produce Satisfiers
O	Outputs	Economic development Formal employment Goods and Wastes (Solids, Liquids, Gases)
P)	What?	Produce tangible (products) and intangible (services) satisfiers.
Q)	How?	Transform material, energy, and information resources with human resources by means of technological resources.
R)	Why?	Satisfy the market's needs and obtain economic gains through the production of satisfiers.
C	Customer	Industrial customers and society's end users.
A	Actor	Industrial Chambers, Partners, Industry, Society
W	Weltanschauung	Generate profits by transforming inputs into the added value of products and services for a market.
O	Owner	Partners
E	Environment	Manufacturing industry

Weltanschauung: The economic, Social, and Environmental systems, being neoliberal, have evolved under the economic growth approach. This scheme is unsustainable because its approach fosters a resource depredation scheme (Human H, Natural N, Capital K, Knowledge k and Technology, T). Competitiveness is based on local consumption of the cheapest, skimping on costs that even affect productive investment resource quality; hence, this is the base factor of Productivity. It is also a factor that affects other factors such as motivation and training, thereby reducing labor productivity in the sector. One of the leading industries that allow the adequate development of science and technology in any country is capital goods production to manufacture production means. However, we only consume 23% at the national level (Calderón & Sánchez, 2012).

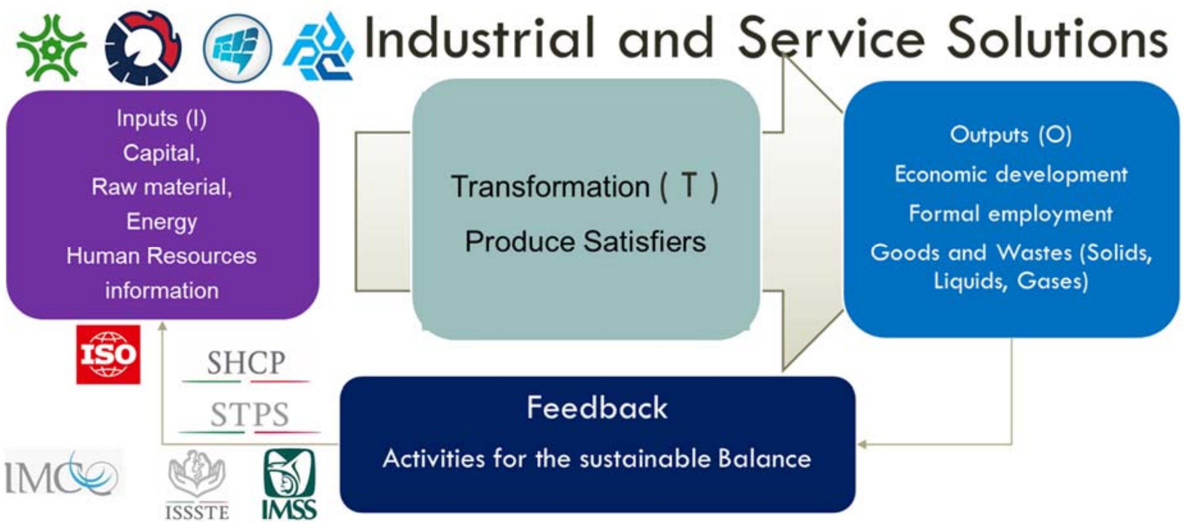


Figure III-6 Root definition: Industrial and Service Solutions (Own elaboration)

On the one hand, industrial manufacturing, which is considered the bedrock for industrial development throughout this thesis, has shown an unsustainable approach. Thus, SMEs are far from getting foreign actors to advise them on the design of sustainable consumption, minimizing the deterioration of ecosystems, and improving production processes. Although environmental institutions aim to regulate waste and residue emissions and pollutants and monitor the emissions industry fulfillment, SMEs struggle to achieve the ecological care framework since policies and rules are out of SME affordance. It is due to the insufficient capacity to fulfill environmental costs and tax obligations accomplishment. Furthermore, policies to protect free competition and eliminate monopoly practices are not part of the state strategy; they do not support SMEs because the mortal rate shows a high likelihood of carrying on with the same performance. On the other hand, industrial manufacturing should change its approach to transforming inputs into products and services under the circular, sustainable, and socially inclusive economy.

iii. Relevant system: academy

The relevant system Academia scientifically investigates the population and industry's requirements and needs for the implementation and technical feasibility of sustainable proposals. **Table III-9** shows the different elements for the academy's root definition; likewise, it is shown graphically in **Figure III-7**.

Table III-9 Relevant root system definition: Academy

Root definition	Relevant system	Academy
I	Inputs	Requirements: Industrial, Social and Environmental Human resource
T	Transformation	Research and development of sustainable products and services.
O	Outputs	Viable Proposals in Science and Technology for: Products, services, processes, Marketing, and Organizational Planning.
P)	What?	Scientific Research for the viability and instrumentation of Sustainable techniques.
Q)	How?	Research and Development and Innovation
R)	Why?	To create, design, produce, and transport products with the optimal consumption of resources.
C	Customer	Society, Industry and Government
A	Actor	Council of Science, Research Institutions and Universities and faculties
W	Weltanschauung	Research on sustainable products and services to generate sustainable development
O	Owner	SEP, Science Council
E	Environment	Industry Sector

Weltanschauung: By interviewing SNI Researchers on sustainable and inclusive development from UNAM, IPN, CIIEMAD, CIECAS, ESE, ESIME in Forums on Sustainability and Climate Change held in the IPN and UNAM. Research on environmental impact is provided with the administrative objective, avoiding necessary sustainability recommendations (Dr. Mayagoitia, 2019). In the economic system, highly qualified human resources are not used for the region's economic development. There is an absence of a strategy for a circular economy production in the industry; industrial processes indeed improve. Notwithstanding, the approach must consider sustainable industrial development throughout the product life cycle (Dr. Pachauri, 2018). Despite the human resource does valuable and quality research in the social system for the contribution of science and technology, it is difficult to put into practice, which reduces the positive impact of the SDGs' achievement.

Figure III-7 Root definition: Academy (Own elaboration)

Research and development and innovation of the value chain processes are purposeful in its different modalities for sustainable development achievement. However, the promotion of science and technology and innovation for national, regional, or local problems, solutions are far from contributing to sustainable development scientific and technological research.

iv. Relevant system: Government institutions

In terms of industrial development, government institutions are the main actors in the formulation of policies that support industrial activity and regulate fair competition to prevent monopolies or oligopolies. Thus, legislating and formulating policies for industrial development is the main instrument for economic growth, to be able to provide social benefits by collecting taxes from legal resources like goods and services and formal employment. **Table III-10** describes the elements for the root definition for the relevant government system. Furthermore, **Figure III-8** represents the root definition of the government system.

Table III-10 Relevant root system definition: Government institutions

Root definition	Relevant system	Government institutions
I	Inputs	Laws and Rules Social Needs Financial needs Political parties
T	Transformation	Legislation and Policy for Sustainable Industrial Development

O	Outputs	Economic development Formal employment Social benefit Tax collection
P)	What?	Legislation and policy for Sustainable Industrial Development
Q)	How?	Laws and Policies
R)	Why?	For social and economic development
C	Customer	Society and Industry
A	Actor	Chambers of Senators and Deputies and Chambers of the industrial sector, Political parties
W	Weltanschauung	Legislate policies for industrial development
O	Owner	The State
E	Environment	Industry sector, territorial region

Weltanschauung: Forums of the economy commission in the Senate of the Republic, Sen. Gustavo Madero, Permanent Forum Dip. Alejandro Viedma. Legislation and policy are little dependent on industrial sustainability; 80% of SMEs die within the first 2 or 3 years of life (Marcelo, 2015), affecting the economic and social system. In the environmental system, there is a lot of work, but without cultural awareness. Therefore, a low contribution to achieving the Sustainable Development Goals and deficient public policies for social participation (Constructor Eléctrico, 2017). As a developing country, Mexico is only responsible for reporting and monitoring indicators and not meeting the SDGs.

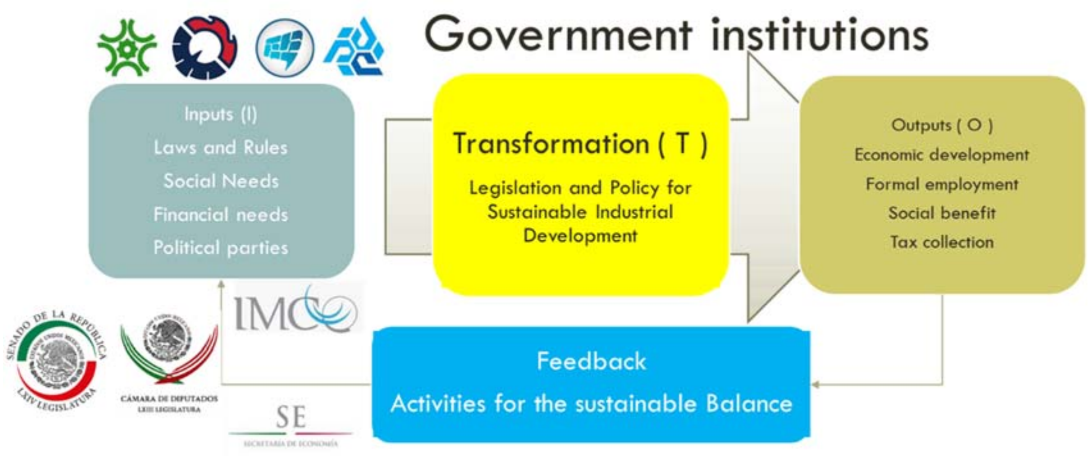


Figure III-8 Root definition: Government institutions (Own elaboration)

As aforementioned, policy-makers for sustainable and socially inclusive industrial development have not met current challenging goals since sustainable performance in any pillar reflects an unsustainable behaviour. The State should provide facilities and social services that the community requires for integral development, for instance, security and social services. Notwithstanding, to guarantee them, tax contribution based on business activity must protect free competition, eliminating monopoly practices, and develop protectionist policies for firms' survival. Furthermore, the State should land national issues by promoting science and technology for sustainable development achievement.

v. Relevant system: Environmental Institutions

There are two objectives of environmental institutions. The first is the regulation of the exploitation of resources and the environment to the industrial sector and society. Meanwhile, the second objective is to monitor and regulate the environment's degradation by industrial activity and community. Likewise, the contribution of strategies for the legislation and regulation of human activity emissions are essential outputs for environmental equilibrium. **Table III-11** explains the relevant system environmental institutions' root definition; moreover, it is depicted in **Figure III-9**.

Table III-11 Relevant root system definition: Environmental institutions

Root definition	Relevant system	Environmental institutions
I	Inputs	Capital Human resource information
T	Transformation	Regulation of actors for ecological balance
O	Outputs	Ecological preservation Waste management Process Certification Environmental policy formulation
P)	What?	Regulation and management of stakeholder emissions
Q)	How?	Through the application of the norm for the regulation of pollutants of the social and economic actors
R)	Why?	For social welfare through ecological balance
C	Customer	Society and Industry
A	Actor	Secretary, attorney, accrediting entities, external actors
W	Weltanschauung	
O	Owner	SEMARNAT
E	Environment	Industry sector, territorial region

Weltanschauung: Interviews with Sustainability representatives (Protect Our Planet Movement, Sustainability IPN) The economic, social, and environmental system, under a scheme of resource depredation (Human, Natural, Knowledge, Capital, and Land), have affected the ecological balance. In terms of greenhouse emissions, the pathway consistent not exceeding 2 degrees Celsius or 1.5 degrees Celsius above pre-industrial levels, not to cause ecological structural imbalances affecting all systems (United Nations, 2015). Extensive environmental regulations with low didactics for SMEs, hindering their development as they do not have the resources for ecological compliance. The formulation of rules is based on depletion and environmental degradation as its expense represents 4.32% of GDP (INEGI, 2018), instead of prevention and ecological protection, which means 0.57% of GDP (see Annexes). Thereby, a low contribution of the industry to the Sustainable Development Goals' achievement.

Therefore, regulation and monitoring compliance with safety and environmental protection is essential for sustainable ecosystem maintenance. That is why the program's design for the care and protection of ecosystems and natural resources for sustainable consumption needs the environmental institutions' cooperation. Thus, eco-friendly industrial practices that minimize environmental damage would regarding an environmental protection approach in industrial activity. It should make it easier to implement mechanisms for monitoring and regulating the agents involved in sustainable industrial development.

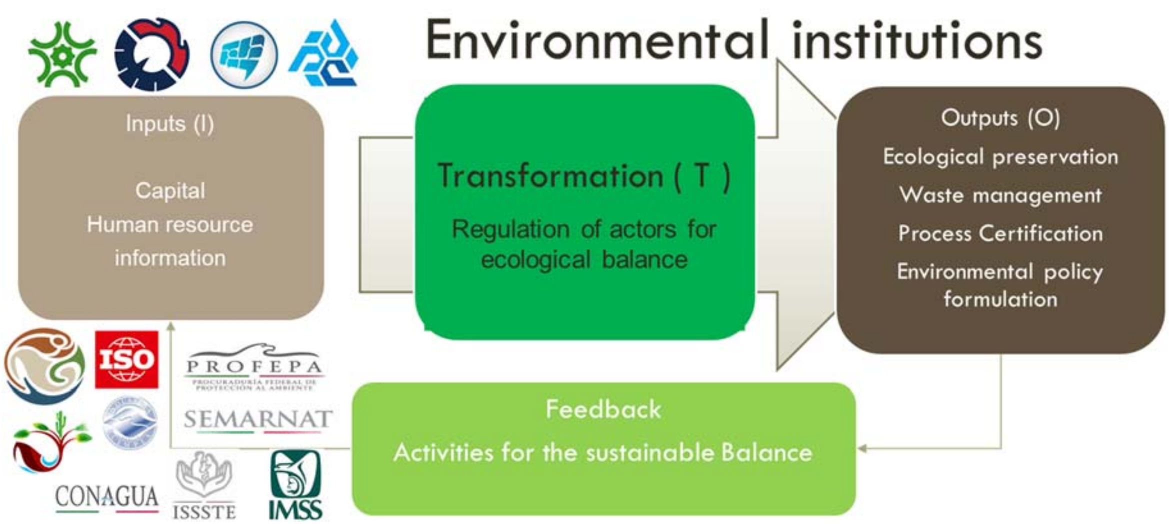


Figure III-9 Root definition: Environmental Institutions (Own elaboration)

vi. Relevant system: External Institutions

Regarding external institutions, they refer to those actors that are not directly part of the problem situation for sustainable industrial development; they are preferably external actors; who have the experience and knowledge in sustainable practices based on international context. These institutions aim to integrate Mexico into the global strategy to tackle poverty and climate change by monitoring the Sustainable Development Goals results. They aim to support the formulation of strategies and recommendations to improve the spheres of sustainable development. Moreover, they help governments at their different levels through studies and diagnoses. **Table III-12** resumes the root definition of the external institutions' system, according to the root depicted in **Figure III-10**.

Table III-12 Relevant root system definition: External Institutions

Root definition	Relevant system	External Institutions
I	Inputs	Economic, Social and Environmental Indicators Member of the UN
T	Transformation	They inspect and recommend sustainable development measures for regulatory compliance with social, economic, and environmental indicators.
O	Outputs	Recommendations on sustainable development Studies for sustainable development Diagnosis for sustainable development
P)	What?	Guide efforts in decision-making by political and industrial actors for sustainable development
Q)	How?	Through international normative recommendations for sustainability.
R)	Why?	To reduce irreversible risks such as climate change and poverty
C	Customer	Society
A	Actor	External actors, UN, UNIDO, World Bank, GIZ, SRE
W	Weltanschauung	Recommend policies for the balance of sustainable development
O	Owner	SRE
E	Environment	Industry Sector, World Territory

Weltanschauung: The risk of not complying with the 2030 agenda at the level in the national territory and at the global level is a significant risk of social imbalance but above all environmental. The most economically vulnerable people receive the most significant negative impact, losing their property, land, or even their lives after a natural disaster. Moreover, according to the SDGs, they aim to eliminate poverty and face climate change, not compromise the next generation's resources, satisfying the current generation's needs. Therefore, the SDGs break down goals that support the 17 sustainable development goals to contribute from any country and type of actor, transcending religions, nationalities, cultures, and territorial regions such as states and even countries.

Figure III-10 Root definition: External Institutions (Own elaboration)

A low contribution of advising on the design and development of a sustainable framework by foreign institutions has not minimized ecosystems' deterioration and improve production processes. Likely to the State, the lack of didactic promotion of advising only aims at big firms since they have the infrastructure to land foreign advising and improve sustainable measurements of products and services. Such advice would mostly support sustainable and inclusive industrial development policy formulation based on other countries' experiences, especially those with a high economic index.

III. 4. 4. Formal Conceptual System

Finally, after developing the root definition of the relevant systems and interconnection through the vehicle for Sustainable Industrial Development of **Figure III-4**, then the general conceptual model is devised in **Figure III-11**. In the model of nested hierarchical systems environment and circulating flows developed by E. Romero (2014), in her work "Design and modeling sustainable industrial parks based on methods of industrial ecology and complex systems." The model adapted into the figure around Hierarchical nested systems and circular flows to a general conceptual model, which shapes the different subsystems; therefore, it becomes the mentioned system's root definition.

Relevant system: Sustainable industrial development

For the relevant system's root definition of Sustainable Industrial Development, the figure mentioned above is considered. Industrial development is mainly nested in the economic sphere, where the interaction of stakeholders obtains satisfiers and benefits. However, these require the resources of the environmental dimension, raw materials, energy, and land. Then, with the social dimension factors as an approach related to the worker's culture and psychology, such as labor, knowledge, and encouragement, they would adequately develop the task of transforming the economic dimension's productive factors. It is worth mentioning that productive social factors performance modifies economic factors, such as the proper employment of capital goods, capital, and training to obtain satisfiers that impact the three spheres for sustainable development. Such satisfiers break down as follows; the economic dimension pursues financial and economic satisfiers; in the social size, economic and social benefits, while in the environmental pillar, get satisfiers' effects. Likewise, outputs of such consumption that affect the mentioned system are residues, scraps, and waste. That is why the environmental balance contribution through sustainable industrial development minimizes ecological depletion and degradation by transforming sustainable and socially inclusive industrial development. Such a system should support the reactivation of recycling and reuse of waste and residues to the economic circle through the circular economy's symbiosis for its use and proper disposal of industrial waste.

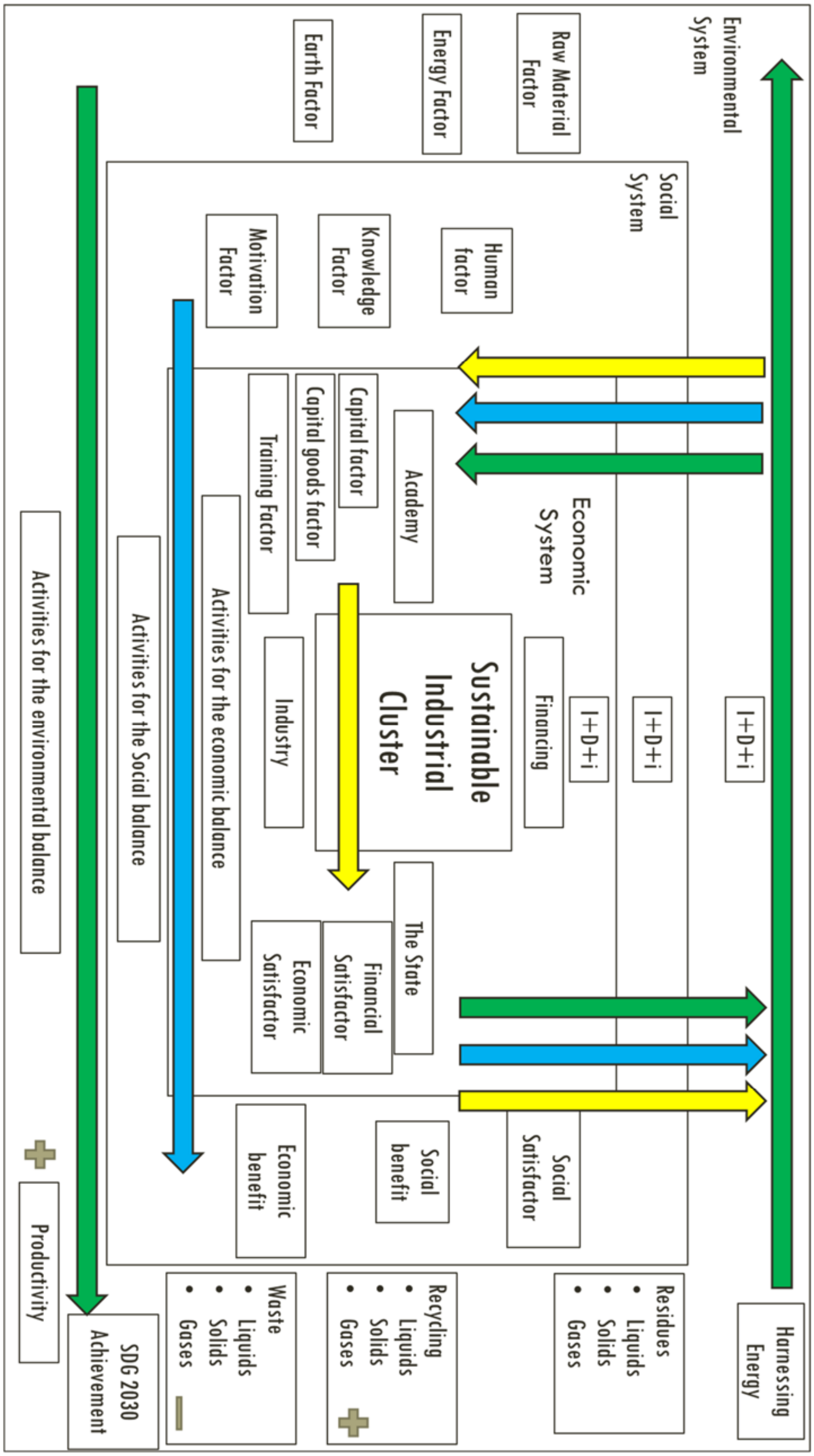


Figure III-11 System for Sustainable Industrial Development and Relevant systems (Own elaboration, based on E. Romero, 2014)

Through the participation of stakeholders in the sustainable production of innovative products and services, the industrial groups consolidate the government, academia, and industry's participation to enhance the capacity for innovation and productivity. To balance the sustainable development of the context in which economic activity takes place based on feedback activities. Hence, the Sustainable and Inclusive Industrial Development aims to produce a strong focus on sustainability, thus obtaining innovative products and services that differentiate themselves and support the different categories of industrial management. From SMEs without support to industrial unit management, companies incorporated into industrial unit management such as an industrial park, even those that reach a level of maturity and strength of being incorporated into an industrial cluster strategy. **Table III-13** describes the elements for the root definition illustrated in **Figure III-12**.

Table III-13 Root definition relevant system: Sustainable and Socially Inclusive Industrial Development.

Root definition	Relevant system	Sustainable and Inclusive Industrial Development
I	Inputs	Environmental factors: Raw material, Energy and Earth Society Factors: Employees, knowledge, soft skills Economic factors: Capital, Machinery, Technology
T	Transformation	Transform industrial development with a strong and inclusive sustainable approach
O	Outputs	Innovative Products and Services Reusable waste Re-valuable recycling Waste that minimizes the sustainable impact Circular economy Fulfillment of the SDG 2030 agenda
P)	What?	Produce goods and services with a sustainable approach
Q)	How?	Through the use of strategies that support the competitive advantage of the industrial management level, as well as making use of its comparative advantage.
R)	Why?	To balance the sustainable development of the context
C	Customer	Industry, industrial parks and clusters
A	Actor	Clusters, the State, industrial and service solutions, environmental institutions, academia and social and external actors.
W	Weltanschauung	Produce sustainable goods and services for sustainable development
O	Owner	Innovator of the balance for sustainable development for sustainable and inclusive industrial development.
E	Environment	Industrial Sector

Weltanschauung: An acceptable way to interpret sustainable industrial development implementation is by adopting sustainability with a strong focus and aligning said strategy with the stakeholders to differentiate the sectoral product through the dynamic activity of innovating derived products services. With this, supporting the installed industry, especially SMEs, who, since they do not have the necessary infrastructure to compete, from the perspective of a value chain at the level of installed industrial management, focus their efforts on the Core activity for which the company has its reason to be. To this end, among the activities that can be perceived according to Porter's value chain are the primary or support activities in which these SMEs can develop a differentiation by competing in the development of products and services. Even more in-depth as they are inbound and outbound logistics, operation, marketing, and sales or service activities for the primary activities. While for support activities, SMEs could differentiate themselves in providing services for procurement of supplies, technological development, human resources management, and infrastructure installation in the industry.

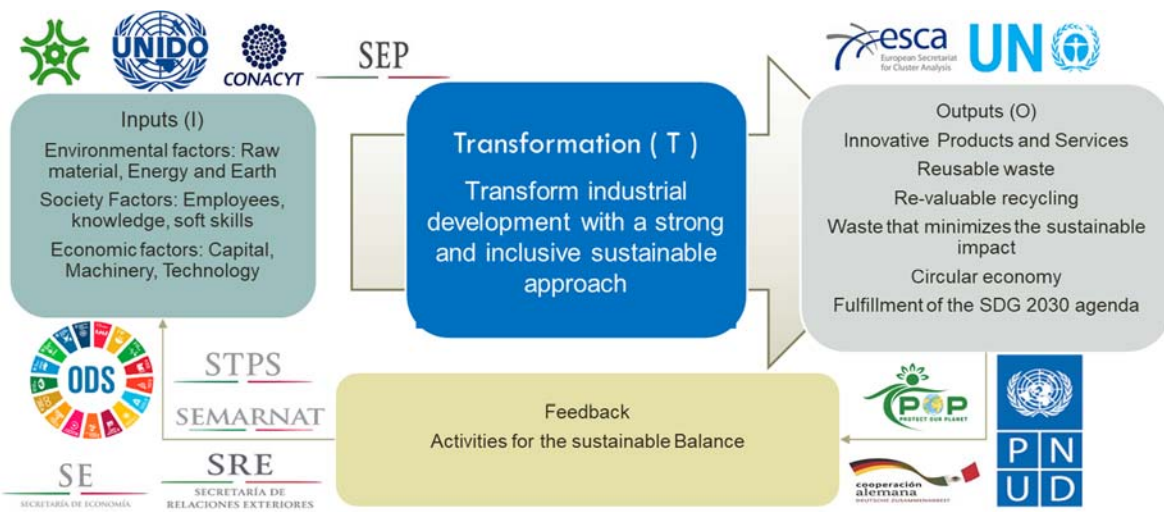


Figure III-12 Root definition: Sustainable and Inclusive Industrial Development (Own elaboration).

However, in this section, it has been possible to reduce the system's objectives for sustainable industrial development and identify the main issues between the different systems relevant to its achievement. **Table III-6** identified the problems of the relevant systems. It was found that the policy's design for sustainable and inclusive industrial development is insufficient by the State due to the lack of strategy to achieve sustainability. The current State's approaches do not support SMEs because the mortal rate shows a high likelihood of carrying on with the same performance. Thus, guidelines result in the low capacity to fulfill environmental costs and tax obligations accomplishment; SMEs struggle to achieve the ecological care framework since policies and rules from the State and foreign institutions are out of their affordance. Hence, policies to protect free competition and eliminate monopoly practices are not part of the state strategy.

Therefore, the void of leaving SMEs out of the market mainly for the innovation capacity to be competitive from the competitive advantage approach, whereas competing with an unsustainable focus, avoiding the social inclusion for the regional development. Therefore, the proposed solution must consider a holistic objective that considers a sustainable approach and an inclusive strategy by bonding transformation's stakeholders for Sustainable and Inclusive Industrial Development and implementing sustainability for inclusive development such as circular economy's symbiosis.

According to the total intervention systems mentioned in the method section, one of the systemic tools to reach a more concrete solution is the Viable Systems Model (VSM). VSM manages complex problem due to the number of actors involved in the system in focus and a defined formal objective. Therefore, the systemic tool of the viable systems model is a suitable option. Stafford Beer's VSM is used to give a conceptual structuring to the great complexity that the model for sustainable industrial development represents.

III. 4. 5. Other Systems Thinking: The Viable Systems Model

In this section, the viable systems model is structured in a theoretical and conceptual way to represent a complex system model, and the objective approached Sustainable and Inclusive Industrial Development (DISI). As part of the soft systems methodology stage is to model the system's activities required to achieve the transformation described in the definition. In addition to the model development and have already identified the relevant industrial development systems, the VSMod ® platform's latest version 2010 is used (see **Figure III-13**). The VSMod developed by Pérez Ríos to facilitate identifying every one of the components and record information corresponding to each of them constitutes a rather complex task (Pérez, 2009).

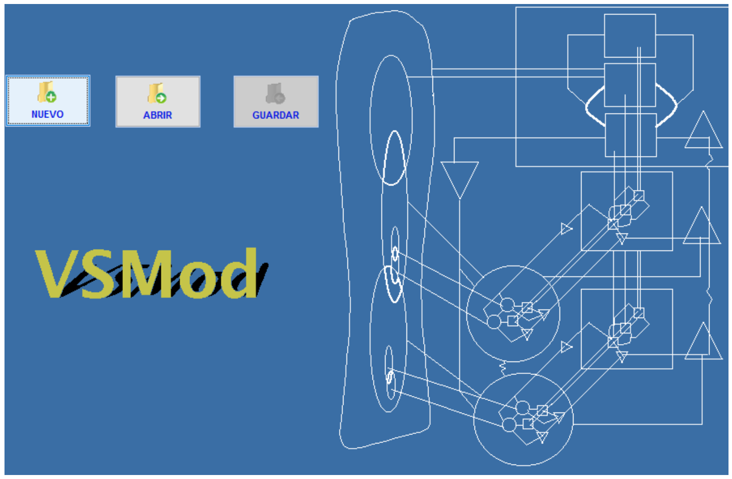


Figure III-13 VSMod ® Software

III. 5. Viable Systems Model

As the problem in context remains complex, and regarding the context of the problem situation aligned to sustainable development transformation. It is necessary to deal with a transdisciplinary approach for a holistic view to obtain practical benefits (Papetti et al., 2018). Hence, it can be considered a systemic tool for a unitary context problem. According to the previous statement, the system's problem in focus is complex with a unitary context based on the total systems intervention meta-methodology by Flood & Jackson (1991). Among the systemic models which are part of this construct is the viable system model (VSM). The VSM is characterized by cybernetics, which remains the learning system's view. Additionally, it is also useful for diagnosing the system, such as sustainability needs to do.

For an organization to be viable, it must have an identity and have the ability to survive in a particular environment. Although their existence from their viable systems is separable and independent (François, 2004), each of them enjoys a certain autonomy, but they cannot survive in the vacuum. The organization is viable as long as it can maintain a separable existence, although not necessarily independent of other organizations' existence with a tendency towards independence (Beer, 1985). Like an embryo example, it is not viable until it is born and through the parents' care, who offer the necessary homeostasis. The minor, already with an identity, become a more independent entity with sustainable stability.

Thereby, the viable system model is feasible when a system can survive in a determined context. Then, such a system is capable of maintaining its separate existence. It has the autonomous capacity with the art of complex systems governing. It has the autopoietic function with a sustainable identity that offers the self-generation by self-production of their elements and the network of their characteristic's interaction. In that way, recursively propriety, driver of the VSM, lets to scale up or scale down in the systems embedded. However, the identity capacity to maintain its separate existence obeys the second Ashly's law of variety requisite that mentions the variety absorbs variety. It means that the way to lead with complexity, at least the same variety of complex solutions, should be available.

The model consists of embedding the five systems of the viable system model into the conventions previously mentioned. The first system, the viable system, is the system that is viable with the capability to maintain its separable existence and with a sustainable identity and delimited. This sort of system is in charge of producing goods and services. Systems two coordinate the communication between the control system (three) and the viable systems embedded in the system in focus. Therefore, system three oversees the "here and now" system performance. However, it also needs monitoring assistance to audit such performance, also named as system three*. The next level is system four, which is in charge of the "then and there" strategic activity. It analyzes the forecast market demands and develops strategies to mitigate threats and weaknesses or boost strengthens and opportunities.

Notwithstanding, the policy's development should shape both perspectives throughout the whole viable model system. This is the fifth system; its duty is to balance the system's general performance by the policy implementation. The algedonic channel shows whether the current strategy is working properly by a non-analytical mode. **Figure III-14** shows the general systemic model for sustainable industrial development; it expresses the systems mentioned above.

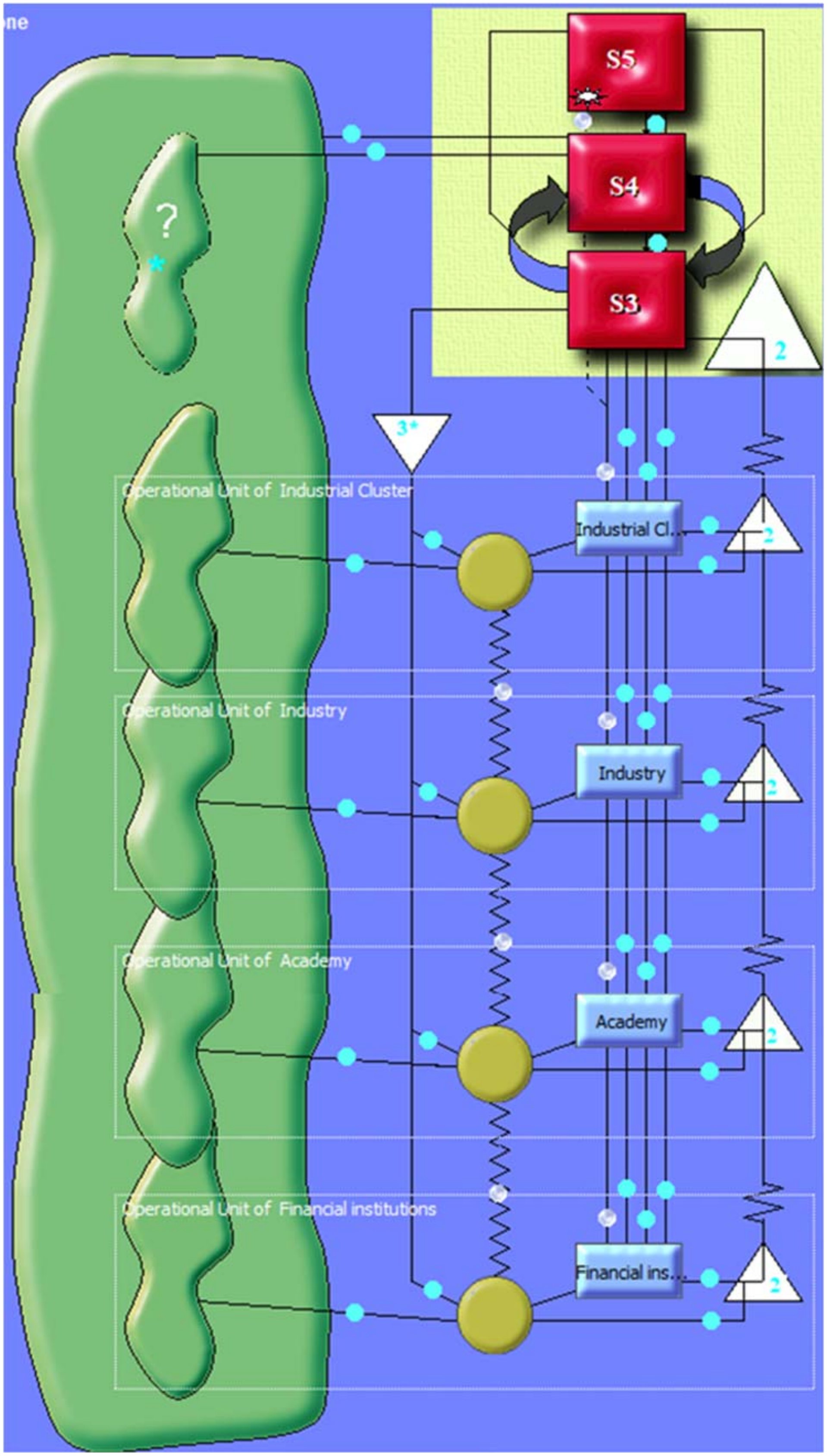


Figure III-14 Systemic Model for Sustainable and Inclusive Industrial Development (Own elaboration)

III. 5. 1. Systems One (S-1)

Systems one represents the subsystems responsible for production and delivery to the suitable environment of the organization's goods and services; they are made up of operational, organizational units. Each of them is in charge of a line of activity or product (Pérez, 2009). For instance, those that make the system work (Ramírez, 2019), for sustainable and inclusive industrial development. These are frequently numerous in a complex system since each attends a specific process related to a particular part of the system's active environment (François, 2004). Relevant systems are concrete or viable as they have a defined identity and are permanent in context. Moreover, the problem in focus was conceptualized before, as well as its links diagnosed too. However, as a proposal, the viable systems model would support contributing with a strategy to theoretically solve the problem in general for Sustainable and inclusive Industrial Development (DISI).

Thus, the viable systems model is used to diagnose and model the sustainable industrial development identified as relevant systems. Hence, the viable systems for sustainable industrial development identified as pertinent systems in the previous section are industrial cluster, academy, and Industrial and service solutions related to industry and financial institutions. Each system must have its main characteristics; the viable or operational system, the abstract or management system, and the environment where the particular system 1 operates. Additionally, it has communication mechanisms (S-2) and auditing (S-3 *) that report to system 3 (S-3).

i. System one: Industrial Cluster System

One of the most representative systems for promoting sustainable industrial development is the cluster system. As defined, the Cluster mentioned that it is a conglomerate of companies with links with other institutions such as academic, government, and financial institutions. Besides, according to the industrial unit management configuration, a subsystem gets benefits in the different ways exposed; for instance, a cluster nests subsystem like companies in the different types of parks. On the other hand, **Figure III-4** showed an enriched vision for sustainable industrial development. The links identified with current issues for sustainable industrial development are exposed in the **Table III-14** below.

Table III-14 Cluster's issues for sustainable industrial development

Element	Relationship	Element
Cluster	Legislation grounded for industrial support	Government institutions
Cluster	Lack of inclusion for the technical development of the locality-region.	Social actors
Cluster	Lack of support in the inclusion of the academy for the technical problem’s solution	Academy
Cluster	Regulation at industrial unit management level	Environmental institutions

In this section, the system one Industrial Cluster is described to solve the issues mentioned in the previous table; thus, the viable cluster system has relationships throughout the general system for sustainable Industrial Development. Hence, the cluster in abstract and its relationship with the Communication and Monitoring system are part of the industrial cluster system one (see **Figure III-15**). On the one hand, the cluster's communication system has the coordination of linkage, even with other industrial clusters, industrial synergy and symbiosis, industrial requirements, and sustainable and inclusive industrial development. On the other hand, the Monitoring system has audits where the relevant environmental system performs environmental audits and manages resources in the environment.

As mentioned in the root definition section, the cluster system links to actors such as industrial, academic, and government institutions. To identify potential opportunities for innovation among the actors and be coordinated and monitored. However, the criterion to which the context provides information is the imbalance for sustainable development. Such is the example of the 2030 agenda SDGs that face climate change and poverty and contribute from the cluster mechanisms' position to transforming sustainable industrial strategic development based on the linkages of the interested parties' innovation potential.

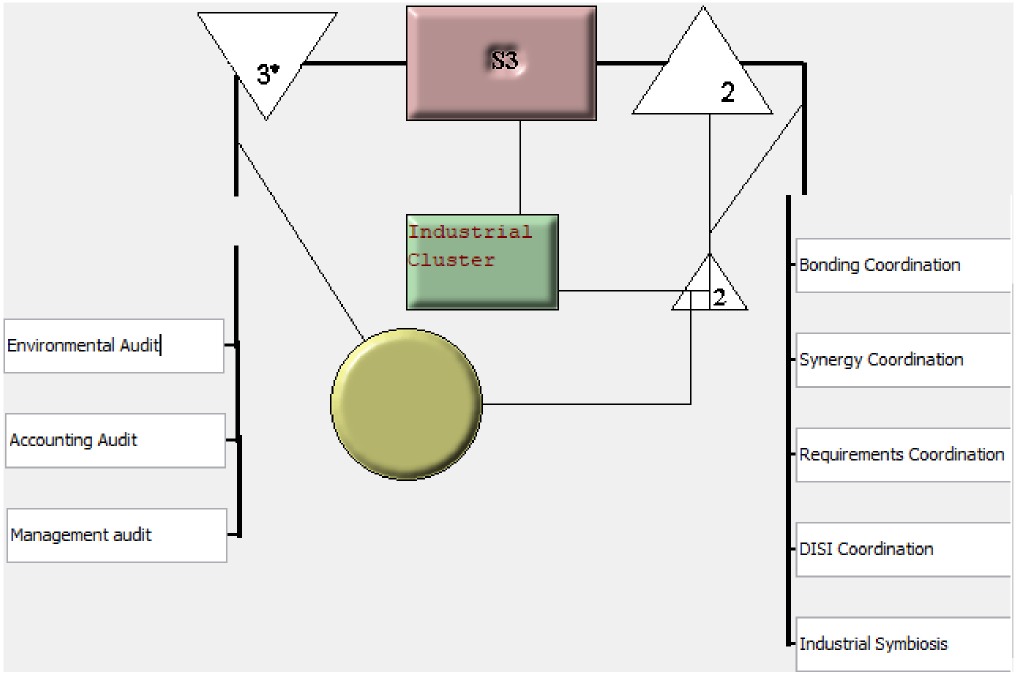


Figure III-15 System one relationship: Industrial Cluster with systems two and three

Among its communication elements is related to the coordination of the subsystem:

- Bonding coordination
- Coordination of industrial requirements
- Coordination of Synergy
- Industrial Symbiosis Coordination
- Coordination for Sustainable and Inclusive Industrial Development.

Among its Audit elements, the coordination must report to S-3 are:

- Environmental Audit
- Management audit
- Accounting Audit

ii. System one: industrial and service solutions

Throughout the soft systems methodology of the current chapter, the industrial activity was described as the industrial and service solutions relevant system, in which it includes, in addition to industrial activities, financial services. This system's root definition focuses on generating profits by transforming inputs into an added value of products and services for a market. This system activates the economic pillar; therefore, it depends on the design of its operations strategy that contributes to the success or failure of factor productivity. Its scope is directed from a local market to a global one and, similarly, the supply.

Table III-15 collects industrial and service solutions' issues for sustainable industrial development. It highlights that unsustainable policies and regulations have made SMEs struggle with exclusive practices since policies and rules are out of their affordances to accomplish environmental costs and tax obligations. Likewise, they are far from getting foreign actors to advise them on designing sustainable strategy frameworks that minimize ecosystems' deterioration and improve production processes.

Table III-15 industrial and service solutions' issues for sustainable industrial development

Element	Relationship	Element
industrial and service solutions	To transform the approach from unsustainable industrial behaviour to a strong sustainable innovation that produces inputs into products and services under the circular, sustainable, and socially inclusive economy.	Sustainable and Inclusive Industrial Development
industrial and service solutions	SMEs are far from getting foreign actors to advise them on designing sustainable consumption strategies, minimizing ecosystems' deterioration, and improving production processes.	Foreign actors
industrial and service solutions	guidelines result in the low capacity to fulfill environmental costs and tax obligations accomplishment.	Government institutions
industrial and service solutions	SMEs struggle to achieve the ecological care framework since policies and rules are out of SME affordance.	Environmental institutions
industrial and service solutions	To bond partners' clusters members belonging to the industrial cluster for business development with academia, industry, and the State.	Industrial Cluster

Therefore, its operations transcend regional borders; it was mentioned in the structured problem situation section that base on the sort of supply and market depends on the type of industrial management unit. One of the main objectives of industrial management is to add synergies for the broader competitiveness of those companies that do not have the necessary infrastructure to be competitive. For this, by not having them and taking advantage of the context of their management of other companies that offer these services, it would allow them to specialize in the Core activity and develop competitive advantages by making a product and service productively efficient. Such a competitive advantage, when aligned to a strong sustainability strategy, then the cost reduction would be made at operating cost, without sacrificing the sale price.

Hence, to support a strong sustainable development strategy, the industry must be incorporated into the model to transform sustainable and inclusive industrial development. Thus, it will align its Core competence to the general strategy for developing environmentally-friendly industrial practices or minimizing its damage, depletion, and deterioration, thereby complying with the SDGs' achievement and the sustainable development of the context. **Figure III-16** shows the elements for communication (system 2) and monitoring (system three*) to integrate the transformation model of sustainable and inclusive industrial development.

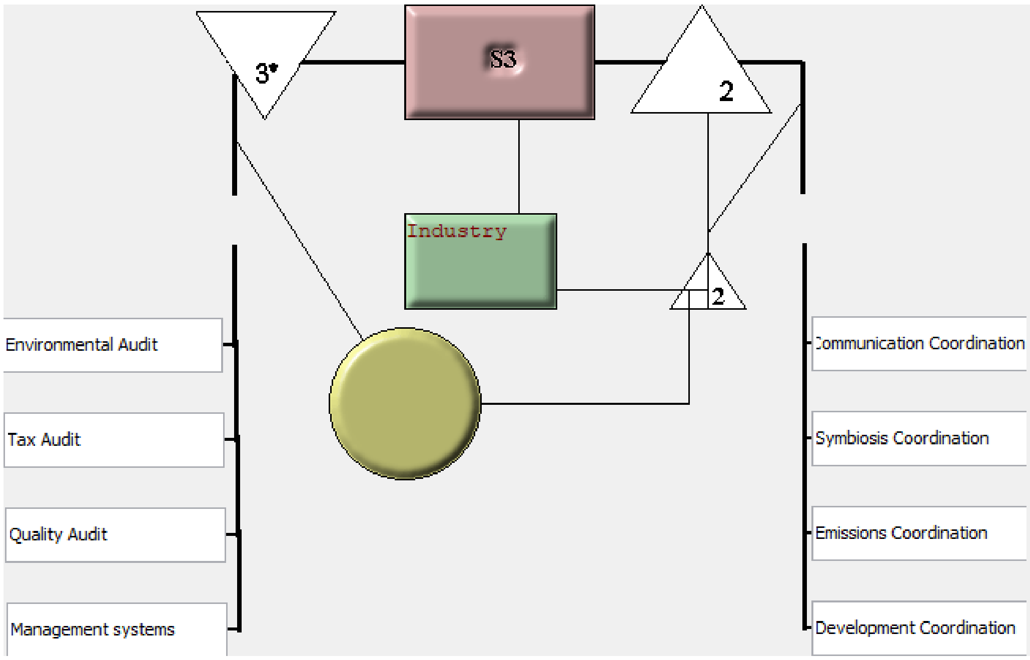


Figure III-16 System one relationship: industrial and service solutions with systems two and three

Likewise, its relations with the other elements would support the industrial sector to develop strategies that further help the strong sustainability strategy, such as implementing industrial symbiosis and synergy and circular economy for an advance in the level of established industry maturity. They should Support the Coordination and communication elements for the sustainable and inclusive industrial development transformation as well as monitoring that mentioned below:

Systems two

- Industrial communication coordination
- Symbiosis Communication
- Emissions Coordination
- Coordination of Sustainable and Inclusive Industrial Development

Systems three *

- Environmental Audit
- Management audit
- Tax audit

iii. System one: Academy

One of the relevant systems that serve as guiding determinants for innovation in sustainable industrial development is academic institutions. Although they present a good relationship throughout the Sustainable Industrial development, **Table III-16** shows its relation with stakeholders. Notwithstanding, the State shows a conflict in promoting science and technology and innovation in regional issues inadequately. In addition to displaying a risky relationship with the Industry, there is little competitiveness in solving industrial innovation problems since most efforts leave a sustainable aim away; instead, it pursues an economic benefit.

Table III-16 Academy's issues for sustainable industrial development

Element	Relationship	Element
Academy	Promote science and technology and innovation in pro of national, regional, or local issues. Contribute to scientific and technological research to improve the conditions of sustainable development.	Government institutions
Academy	Research and development and innovation of the value chain processes to develop a strong sustainable strategy.	Sustainable and Inclusive Industrial Development
Academy	Boost capability to meet industrial sector needs and exploiting innovation capacity with practical research.	Industrial Cluster
Academy	Research support to get optimal environmental results.	Environmental institutions
Academy	Innovate value chain for core business improvements and develop the industrial unit management towards sustainability.	industrial and service solutions

Hence, for a viable solution, **Figure III-17** shows the coordination and auditing actions for the problem-solving approach by training human resources linked to innovation for sustainable development coordinated by a sustainable research plan. Such a plan should meet the industrial sector needs to foster R&D + i in pro of unsustainable issues solutions. In the same way, monitoring activities for compliance with the sustainability agenda and fulfill sustainable research goals.

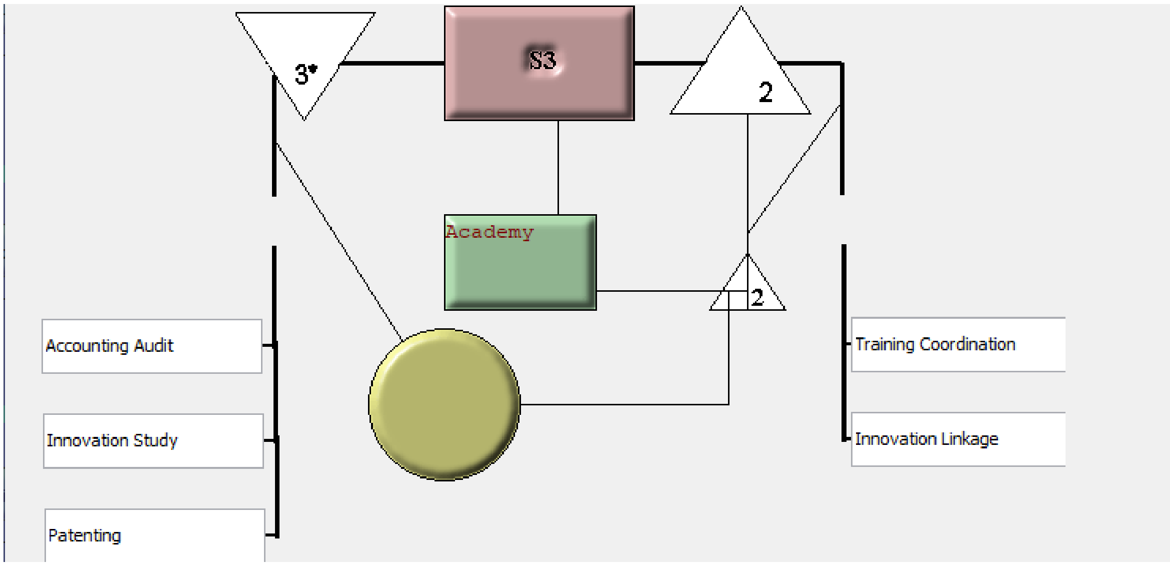


Figure III-17 System one relationship: Academy with systems two and three

Among the activities to coordinate at the Academy are:

- Coordination for the training of Human Resources
- Link in scientific and technological innovation.

While for the activities of Systems 3 *, there are:

- Accounting audit
- Innovation studies
- Patents of scientific and technological products

iv. System one: Financial Institutions

Another viable system for sustainable and inclusive industrial development, innovation is necessary; as mentioned in the section on innovation in the previous chapter, it makes economic sense where financial institutions play an essential role. According to the OECD, innovation occurs as long as an activity related to the disruptive or incremental improvement of a product, service, marketing strategy, or organization scheme is economically exploited. This activity does not come by itself, if not through an innovator, who is the agent with the ability to activate the economic circle. Then, **Table III-17** mentions the financial institutions' issues for sustainable industrial development.

Table III-17 Financial Institutions' issues for sustainable industrial development

Element	Relationship	Element
service solutions as Financial Institutions	Strong sustainability requires a robust innovation capacity to fulfill sustainable firms' goals.	Sustainable and Inclusive Industrial Development
service solutions as Financial Institutions	A sustainable strategy that meets industrial needs for responsible consumption, minimizes ecosystems' deterioration, and improves production processes demands economic resources to achieve them.	industrial and service solutions
service solutions as Financial Institutions	Grounding foreign institutions' advising should robust the sustainable strategy since national assistance would meet the sustainable challenges, and international innovation efforts could contribute to achieving goals.	Foreign actors
service solutions as Financial Institutions	Guidelines development for financial plans to innovate unsustainable issues.	Government institutions
service solutions as Financial Institutions	A lack of financial instruments to tackle SMEs struggle to achieve the ecological care framework.	Environmental institutions
service solutions as Financial Institutions	Financial frameworks for industrial unit management's development.	Industrial Cluster

Therefore, the relevant system of financial institutions requires some support systems for the communication of the strategy and monitoring of the allocated resources to be used correctly are (see **Figure III-18**):

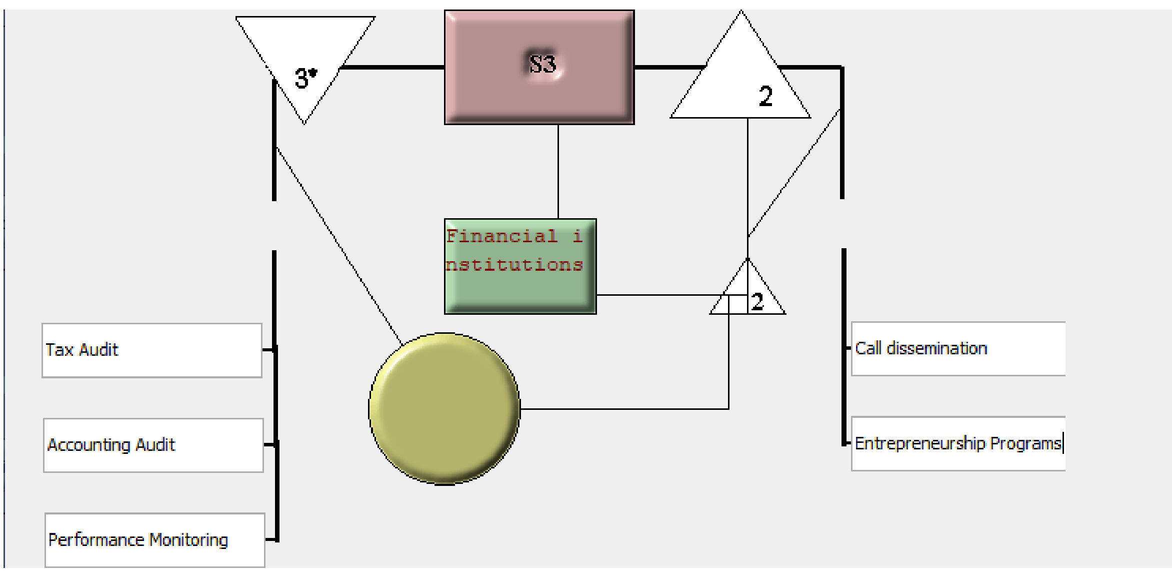


Figure III-18 System one relationship: Financial institutions with systems two and three

Coordination Activities (System 2) of the financial institutions for innovation are:

- Dissemination of calls for innovation in Sustainable and Inclusive Industrial development
- Programs for entrepreneurship include the incubation, acceleration, and development of companies for sustainable and inclusive industrial development.

3 * Systems activities for financial institutions for innovation.

- Tax audit
- Accounting Audit
- Performance monitoring in innovation and productivity

Finally, despite not being viable systems, the activities are discussed because they do not meet the requirements. Still, it is important to mention their role in sustainable and inclusive industrial development. For this, as in the enriched vision, the relevant systems that are not viable are described. Their part is in the viable model for sustainable and inclusive industrial development.

v. Government Institutions

The State is one of the essential elements for the legislative process on sustainable and inclusive industrial development. Because they are in charge of building both policies and laws for fair market competition; moreover, taking into account an algedonic agent for decision-making for the system wisdom. Industrial policies have been targeted to deal mainly with economic problems, such as job creation. Unfortunately, the State has assumed a passive role in the manufacturing industry, which correlates with low economic growth (Calderón & Sánchez, 2012). Calderón & Sánchez cited Kaldor's three laws of the importance that the manufacturing industry has with economic progress. The first, the economic growth determined by the growth of manufacturing; the second, the rapid growth of the industrial manufacturing product, leads to industrial labor productivity development. Thus, productivity and technical progress are endogenous; the third law proposes that aggregate productivity growth is positively related to the manufacturing product's change and negatively associated with non-manufacturing employment growth. Therefore, one of the input elements for industrial development is the manufacturing industry and labor productivity.

Besides, Calderón and Sánchez mentioned the leading causes of economic stagnation: neoliberal policies, which follow the statutes of the Washington Consensus, whose main pillars are the short-term anti-inflationary macroeconomic stabilization, the indiscriminate liberation of international trade, and capital flows. This model basically obeys Mexico's comparative advantage dictated in favour of the US economic cycle, avoiding the Mexican economy's real financial challenges. Likewise, it cites that the stagnation comes from the redundant industrialization by substituting imports with a considerable industrial base, which did not compete with imported products. Thus, the market for consumer, intermediate, and capital goods were replacing national products. The result was the weakening and replacement of the chains of the national manufacturing branch by manufacturing imports. Then, the Mexican economy's real economic challenges and the strengthening of the Mexican manufacturing industry's competitiveness are part of the input for the transformation.

Likewise, the signing of the North American Free Trade Agreement (NAFTA), with the Export Maquiladora Industry (IME), left havoc due to the indiscriminate opening. With it, the dismantling of the production chain, resulting in less growth in the country. The neoliberal economic model's primary failure lies in assuming a passive role on the State's part to formulate industrial policies in favour of the manufacturing industrialization of the productive chain for Mexico's economic development. Since it left it to the free market that had been displaced for the low competitiveness of manufactured products, as mentioned before. Another input for industrial development is the productive chain lack of focus by the State's role in the formulation of active industrial development policies.

A correct industrial policy model consists of strategic collaboration between the private sector and the government to discover and remove obstacles, knowing the externalities that strengthen the regional, State, or productive national chain (Calderón & Sánchez, 2012). Conversely, the Ministry of Economic in its Industrial Policy section mentions that industrial policy seeks to resolve market distortions but explicitly says that the "free market" allocations of goods and services in the economy are inefficient. Moreover, the SE aims to eradicate antitrust practices, which fosters the collaboration of the private sector and the government to develop industries with more significant economic impact for the exploitation of comparative advantages and the use of knowledge spillage (SE, 2018).

The guidelines of the programs that implement the SE have the following premises:

1. Strengthening and development of the domestic market with the same solidity as the foreign
2. Strengthening infant industries that have comparative advantages
3. Provide information to agents for the solution of distortions in the market.
4. Coordination, targeting and prioritization of joint actions between the private sector and the different levels of government.

These indeed contribute to the strengthening of comparative advantage, especially to policies to attract Foreign Direct Investment (FDI) such as policies applied to the protection, financial and fiscal incentives, policies for measures in a particular sector, policies for massive economies of scale such as electricity, telecommunications among others and last but not least the territorial policies for clusters (Calderón & Sánchez, 2012). However, it leaves aside the productive advantage necessary for economic development. **Table III-18** highlights the relationship issues among government institutions and the root systems for sustainable development. Therefore, based on these problematic relationships, the state has to transform the industrial development system regarding the following bullets:

- Development of the manufacturing industry
- Labor productivity
- Real economic challenges of the Mexican economy
- Strengthening of the Mexican manufacturing industry
- Productive chain
- Active state position
- Industrial policies fostering strong sustainable innovativeness

Table III-18 Government Institutions' issues for sustainable industrial development

Element	Relationship	Element
Government institutions	Legislate in pro of Sustainable and Inclusive Industrial Development.	Sustainable and Inclusive Industrial Development
Government institutions	Politicize policies in the industry in favour of supporting industrial manufacturing, especially SMEs.	industrial and service solutions
Government institutions	Formally employ society inclusively.	Social actors
Government institutions	To foster sustainable policies based on specialized analysis.	Academy

vi. Environmental Institutions

On the other hand, another of the relevant systems that function as an audit system in each viable system is environmental institutions, which support the state in seeking the necessary measures for monitoring and auditing compliance with responsible consumption and pollution and minimal environmental degradation.

vii. Social actors

Likewise, another of the relevant systems is the local society that is not explicitly part of the model for sustainable industrial development if they are not users of jobs and main clients as end-users of consumer goods. So, sustainable and inclusive industrial development must take local society as one of the social component actors to improve conditions, whether in labor matters or even as a beneficiary of the spillovers of sustainable and inclusive industrial development activities.

viii. Foreign actors

Finally, external actors are generous support for the strategic planning system or system four. As sustainability experts, they also have the prospects and strategies for sustainable and inclusive industrial development in developed countries. However, the Mexican context has a plurality skewed in being a low-middle income country known as a developing country. In this type of context, mainly at the international level, there is progress in sustainable development in the report of SDG indicators. However, we limit only to report them instead of propose alternatives to sustainable development. Such is the example of sustainable industrial parks by UNIDO that, in their case, only three parks have been established, and each of them is very distant; therefore, there is a lack of strategy for their establishment.

III. 5. 2. Systems Two (S-2)

Systems two, have anti-oscillatory effects or act as “input attenuators” locally and globally, are in charge of coordinating system one’s metasystems (François, 2004) Anti-oscillatory effects absorb variety throughout attenuators. These systems are essential for standard variance supply to reduce variety (Beer, 1985). This system is intended to make the set of organizational units that comprise system one function harmoniously (Pérez, 2009). Thus, such systems reduce the variability deployed from the control system or system three to systems one. Systems one, responsible for production and delivery to the organization's goods and services' suitable environment, identified previously as the industrial cluster, industrial and service solutions for the industry, academy, and financial institutions for sustainable industrial and inclusive development.

Moreover, coordination systems exposed in **Figure III-15**, **Figure III-16**, **Figure III-17,** and **Figure III-18** are in **Table III-19**, where industrial cluster requires coordination for bonding, synergic symbiosis, and requirements for sustainable and inclusive industrial development. Industrial and service solutions need a coordination system for communication and development without leaving behind the symbiosis for waste and emission planning. Likewise, academy and service solutions highlight the innovation bonding regarding training, dissemination of innovative calls for sustainable development. Although in systems one I named some of the coordination systems, they are not limited; since some systems two are working with more than a system one, for instance, sustainable and inclusive industrial development (DISI for its Spanish nomenclature) coordination. Therefore, this section aims to devise joint coordination for sustainable, inclusive industrial development.

Table III-19 Coordination systems identified in viable systems

Systems One	Systems Two
Industrial cluster	Bonding Coordination
Industrial cluster	Synergy Coordination
Industrial cluster	Requirements Coordination
Industrial cluster	DISI Coordination
Industrial cluster	Industrial Symbiosis
industrial and service solutions	Communication Coordination
industrial and service solutions	Symbiosis Coordination
industrial and service solutions	Emissions Coordination
industrial and service solutions	Development Coordination
Academy	Training Coordination
Academy	Innovation Linkage
Financial institutions	Call dissemination
Financial institutions	Entrepreneurship Programs

Therefore, as unified proposal coordination regarding sustainable and inclusive industrial development, named as DISI coordination for its acronyms in Spanish, communicates the whole system's strategy. Such coordination aims to organize proper communication and tackle relationship issues for sustainable and inclusive industrial development. For instance, with unique coordination among stakeholders, the industrial cluster should devise instruments properly for policy-makers and legislate inclusive rules and laws that boost SMEs' development, fostering green operations to all industrial management units. However, to design these instruments, the coordination must regard synergic symbiosis that gathers the firms' emissions wastes into the industrial unit management. Therefore, in that way, Academy and Financial institutions support innovation bonding. However, assistance innovation should align with the robust innovation approach that fosters core business value differentiation. Coordination interconnects with all kinds of industrial management units, mainly to the weaker ones who do not have the robustness to tackle economic issues such as SMEs to fulfill the environmental framework that exogenous improve operational efficiency. Notwithstanding, to achieve such outputs, Academy applies R&D and innovation to innovate the comparative and competitive value chain of the industrial unit management towards sustainability.

In that way, system two for industrial and inclusive industrial development is considered the regulatory centre to damp oscillations (Beer, 1985) and coordinate but not command the industrial cluster, industrial and service solutions, and academy the following activities, which is better devised in **Figure III-19**.

- Sustainable and inclusive industrial development coordination
- Bonding program for sustainability
- Synergic for industrial symbiosis
- Emissions agenda for circular economy
- Training and human resources development
- Entrepreneurship program for innovation dissemination

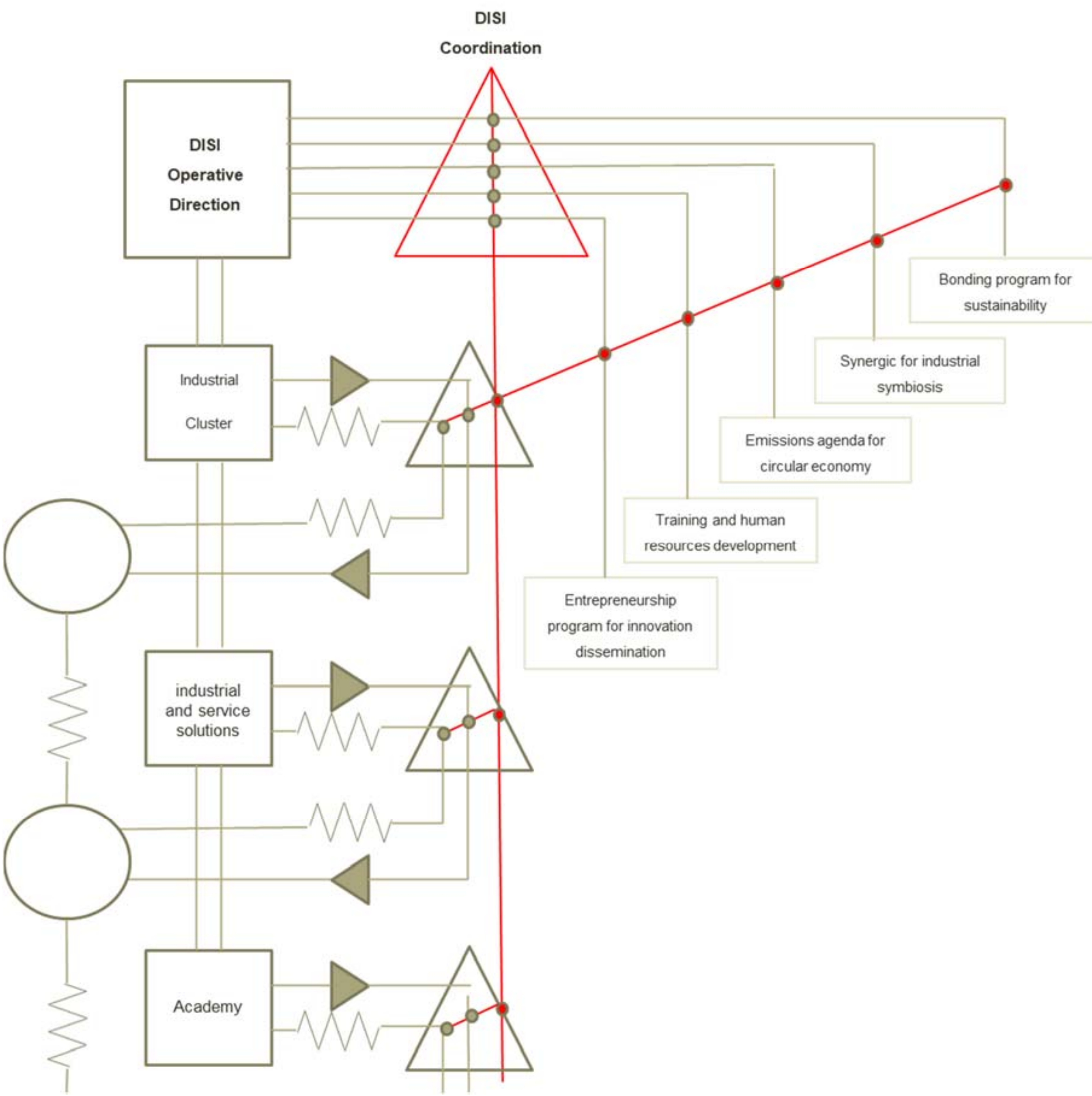


Figure III-19 Sustainable and Inclusive Industrial Development Coordination (DISI)

III. 5. 3. Systems Three * (S-3*)

System three*, also known as the audit system, obeys the first axiom of management, which says that the sum of horizontal variety disposed of by all the operational elements is equal to the sum of vertical variety disposed on the components of corporate cohesion (Beer, 1985). Thus, this type of system enjoys a wide variety to replenish its variety since audit systems are not separable from system three; it is system three*. This system supports the here and now system, aiming to get information about systems' one performance, which cannot be available to get by the communication system. Its mission is to complement the Meta-system information through the vertical system 1 – system 3 line and system 2. The qualitative difference lands to the information provided by the system three * relate to there is not a natural routine activity, but affects the whole system one. In summary, its purpose is to ensure the complete information between system one and system 3, which is achievable by employing auditing activities such as surveys, compliance with management systems procedures, and so on (Pérez, 2009).

Auditing systems mentioned in **Figure III-15**, **Figure III-16**, **Figure III-17**, and **Figure III-18** are summarized in **Table III-20**, which identifies auditing activities for viable systems. Environmental auditing and management systems auditing are part of the general system three* activities. Both are essential to determine how well systems one is working on, then communicate to system three their performances. However, it does not delimit to develop those auditing activities; it means that these essential activities only gather sustainable information, but it should also contribute with knowledge that handled highlights to amend control of the viable system. The mortality SMEs rate is acknowledgeable as one of the leading social dimension disequilibrium aspects; in that way, auditing operations might get a strict role to fulfill with a normative framework and cooperate with the control system with proper and innovative strategies to achieve such framework. Hence, Tax and accounting activities should get attached to the previous statement and collaborate with a sustainable design that develops the industrial unit management.

Table III-20 Auditing systems identified in viable systems

System One	System Three *
Industrial cluster	Environmental auditing
Industrial cluster	Accounting auditing
Industrial cluster	Management auditing
industrial and service solutions	Environmental auditing
industrial and service solutions	Tax auditing
industrial and service solutions	Quality auditing
industrial and service solutions	Management auditing
Academy	Accounting auditing
Academy	Innovation study
Academy	Patenting
Financial institutions	Financial auditing
Financial institutions	Tax auditing
Financial institutions	Innovation monitoring

The viable systems would improve their overview performance throughout proper auditing activities as long as they could increase the variety requisite. In somehow variety requisite increase makes resilient the firm responding against adversity, regarding too that such a capability should be organically developed. Although this feature is the key to achieving sustainable development, if the system in focus is compromised by corruption or interfaith records, auditing systems would be part of an unsustainable plan to maintain a vulnerable system. In that way, rather than supporting Mexico's industry by complex and strict rules for the industrial environmental framework, they have shown to be out of the Mexican context. Mortality and excessive regulations and laws with a lack of didactic implementation struggle firms. Hence, appropriate auditing support would lead the control system to be pertinent to any industrial unit management's viable system context, since an SME or big firm to the most complex industrial cluster. A didactic implementation of a sustainable normative framework would be inclusive with the industry and foster and encourage industrial unit management to participate and contribute to sustainability.

For instance, auditing industrial unit managements, such as industrial clusters, would support industrial policy development alongside policy-makers, regarding the inclusion of the social actors, the environmental context, and fostering research and development with academia. Moreover, as part of the auditing system, the framework fulfillment is of utmost importance to achieve it; nevertheless, it is not less critical its failure achievement. Feedback activities would make the system more robust to become a sustainable one. Likewise, innovation auditing by studies and patenting required to get a sustainable and inclusive industrial development is necessary for measuring the impact of innovation through financial instruments, as well as the goals achievement tendency.

Figure III-20 summarizes how system three* deploys the several auditing required for the “inside and now” system that controls the viable systems embedded in the focal system. The auditing and compliance system for sustainable and inclusive industrial development integrates as much requisite variety as the focal system embeds to audit the several viable systems. However, in general terms, system three* performs auditing activities for sustainable and inclusive development in the industry for goals compliance. For instance, auditing activities that this system overviews are management systems, accounting and tax compliance, environmental and ecological emissions, and innovation and patenting monitoring. Hence, other systems are useful for auditing and compliance achievement; that is the case of environmental institutions, which have enough requisite variety in the ecological field and give ecologically sustainable achievement guidelines. Besides, the academy would be an authority for innovation and patenting alongside financial institutions.

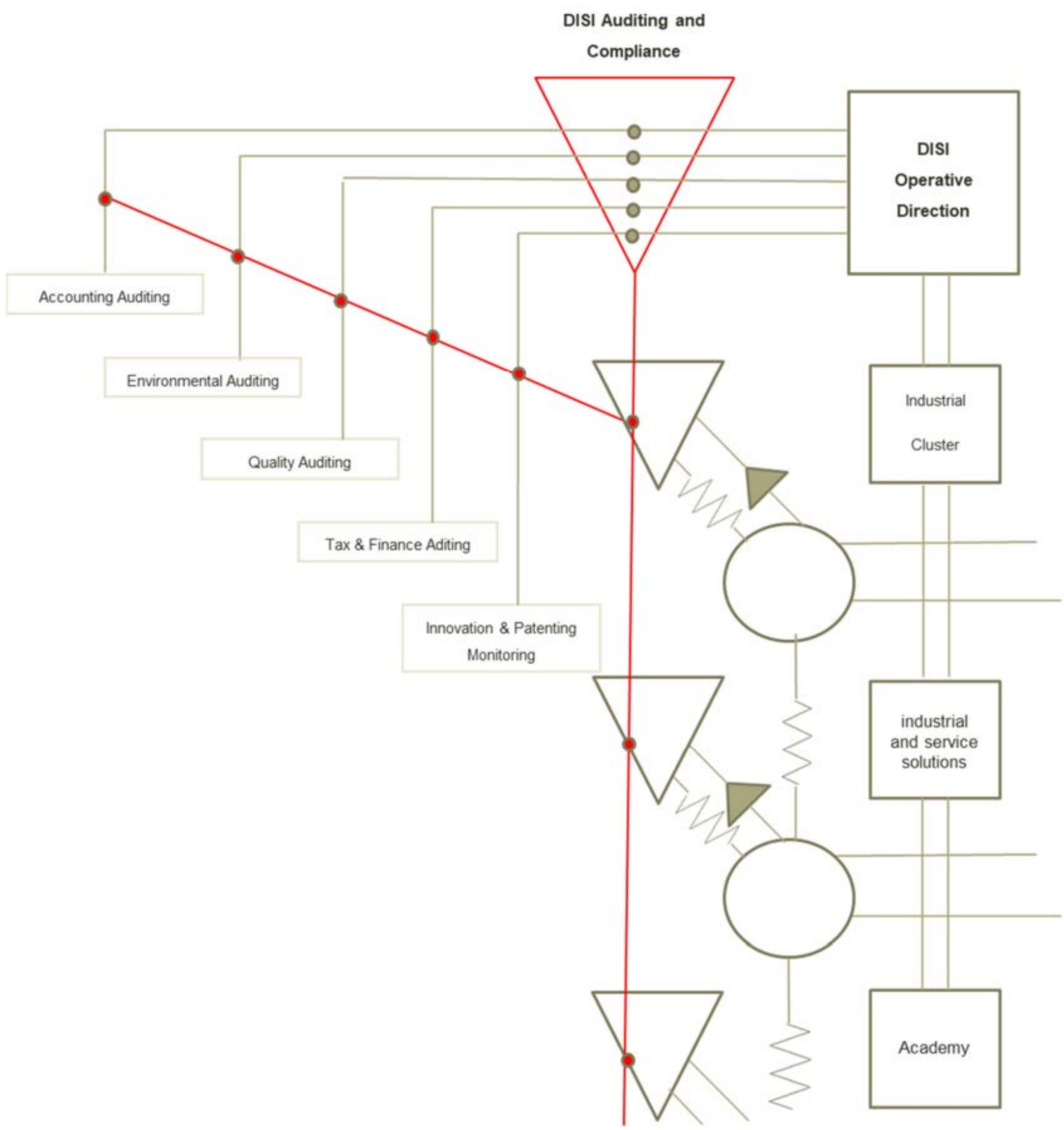


Figure III-20 Sustainable and Inclusive Industrial Development (DISI) Auditing and Compliance System

III. 5. 4. System 3 (S-3)

System three surveys the system as a totality and is responsible for the day-to-day management of internal and immediate firm's function (Beer, 1985). Hence, its task consists of managing the set of operating systems one, skewing to reach a synergic group that exploits output interaction of systems' one performance throughout assigning goals for each of them jointly with the system four and with the system five approval. Therefore, its duty lies in supplying enough available resources among units and determining the mechanisms to evaluate the proper utilization to comply with expected goals (Pérez, 2009). In that way, system three concerns the general coordination and coherence between systems one and system two (François, 2004).

System three mainly concerns two approaches; on one side, there is the command for making decisions concerning the system in focus. On the other hand, the enhancing concern is based on the capacity to absorb variety via systems Two and Three* (Beer, 1985). Likewise, establishing the rules for intervention enables the senior management to discharge its legal responsibilities; and the resources bargains between system three and system one are also part of this system's commitment. Rules determine the balance sheet and obtain the statement, whereas resources balance aims to program planning and budgeting resources through accounting activities. Therefore, these activities should align with the sustainable and inclusive industrial development control system. Planning and auditing systems have been explained before through system Two and system Three* respectively in this section (see **Figure III-21**), while bargain resources and rules have not been.

In general terms, rules for sustainable and inclusive development are those required for system stability among viable systems and clear communication for system coordination. Moreover, the consumption of resources is needed to be bargained for the focal system function. In this way, resource planning follows the rules too; besides, for planning resources, the control system should have the requisite variety for proper budget and planning of systems one. Therefore, rules and planning resources approach the essential activity per viable system.

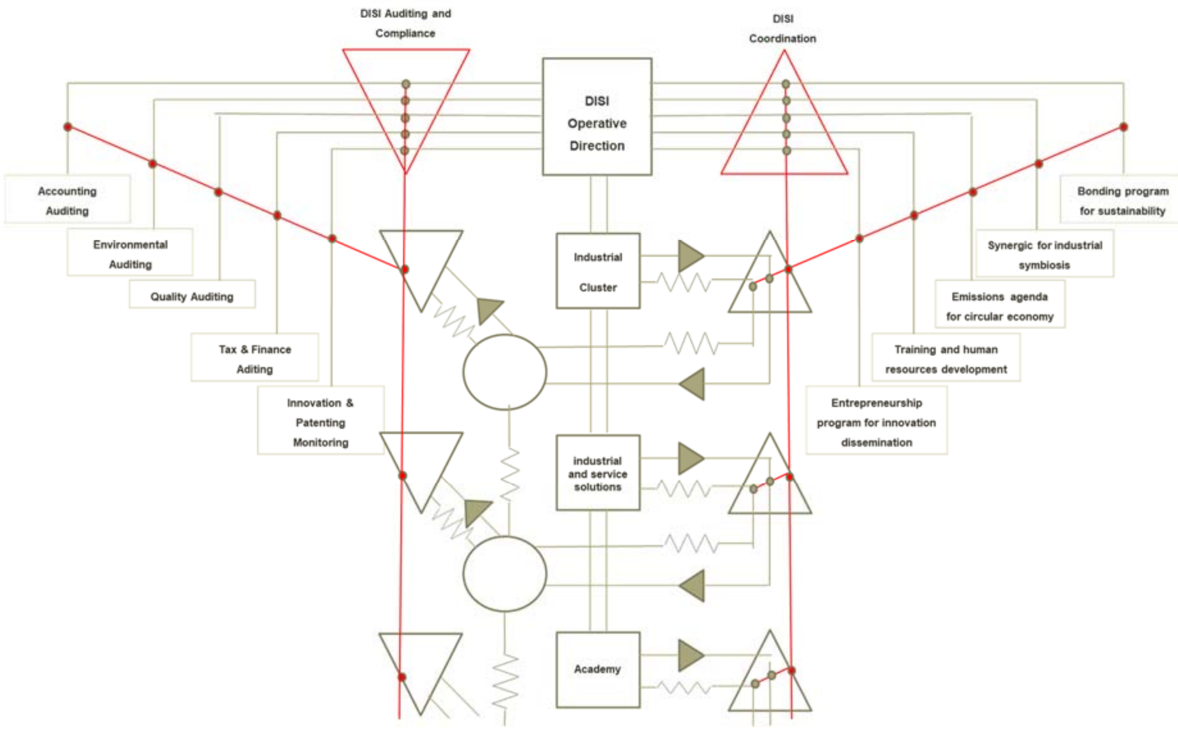


Figure III-21 Sustainable and Inclusive Industrial Development (DISI) Operative Direction

The operative direction for sustainable and inclusive industrial development oversees the activities related to development. This system embeds the industrial cluster, the product & service industrial solution system, academy, and financial institutions. All of them identified as viable systems are, in essence, the heart of the sustainable goal. Nevertheless, their afford is not enough without State assistance since it is the system's general ruler.

III. 5. 5. System 4 (S-4)

On the one hand, system three concerns the firm's functions here and now; meanwhile, system four regards the there and after operations. In other words, activities belonged to the future and external organization's environment (Pérez, 2009). Therefore, system four tackles a broader environment and unknown future employing frameworks of the conditions and time regarding system three to systems one planning. Hence, the full variety available to get access in system one to three is required for system four's convenient operation (François, 2004). However, it is concerned with managing the outside-and-then and provides self-awareness to the system in focus (Beer, 1985).

Figure III-22 depicts system four related to the Strategic Planning Direction for sustainable and inclusive industrial development; it is in charge of monitoring the focal system's foreign and external environment (Steiner, 2014). Strategic planning refers to a plan for planning, which considers the long-term horizon regarding internal and external stakeholders' interests. It requires the external or foreign actors and the social ones to deploy a strategic sustainability plan about sustainable development. Likewise, other systems like environmental institutions, industrial clusters, and the State would delimit their scope and join them to deploy such a strategy. System four of the system in focus contains a recursive model according to the focal system's common concerns, mainly those that make the system unsustainable. Remind the critical risks to get sustainable and inclusive industrial development; sustainable development goals are essential. Particularly, poverty and climate change lead to unsustainability reflected in several variables and indicators; a weak focus on sustainability conveys low differentiation reflected in cost competence. Those concerns are part of the self-awareness for system four itself, but also, they are recursive for the whole system through system three homeostasis (Beer, 1985). Thus, the awareness intersection among these affairs is continually monitored based on the broader environment and its focal system's context.

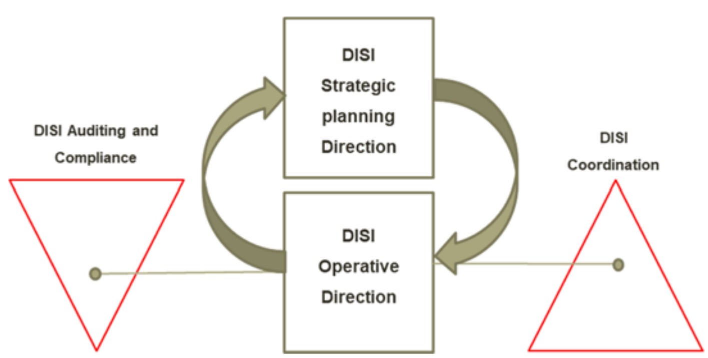


Figure III-22 Strategic Planning Direction for Sustainable and Inclusive Industrial Development (DISI)

III. 5. 6. System 5 (S-5)

This system is the maximum authority level in the organization. It can regulate system three and system four interaction since it responds to Ashby's law of requisite variety that can control through general closure and unexpected external variety. In that way, system five can absorb all the variety that they cannot afford. Its duty consists of balancing the current and future organizational frameworks, based on what affects the whole system (Pérez, 2009). It can be feasible throughout the algedonic channel, which provides the non-analytical signal to regulate the entire system (Beer, 1985). Notwithstanding, this system risks becoming an autocratic power, which leads to committing global mistakes, then, it leaves behind this type of organizational model to get a heterarchical organizational one.

As the representative of system five, the Council and Policy for Sustainable and Inclusive Industrial Development heads the focal system. This system does not State only at the summit of a hierarchical structure since it needs to be in touch with viable systems through the algedonic channel. By the way, the non-analytical indicator gives highlights for the system feedback between system four and system three. In the same way, system five requires as much requisite variety to absorb the variety that wisdom has to solve conflicts regarding homeostasis of such feedback interaction. Thus, this system aims to create politics for the whole system's sustainable development. The State plays a significant role in the industry's sustainable pillars equilibrium (Mosquera-Laverde, 2017).

For instance, regional development policy with industrial cluster support would spread benefits from other viable systems such as industrial and service industrial solutions, the academy, and financial institutions. Nevertheless, as mentioned in the fourth system, local and external indicators and sustainability variables must be part of the policy-makers' strategy to develop sustainable policies for strength and boost strong differentiation. **Figure III-23** devises the whole system regarding both the auditing and compliance activities and coordination and planning system; likewise, the viable systems that the control system as a ruler has to manage. Notwithstanding, such management requires the system four feedback to absorb requisite variety in internal and broader environments.

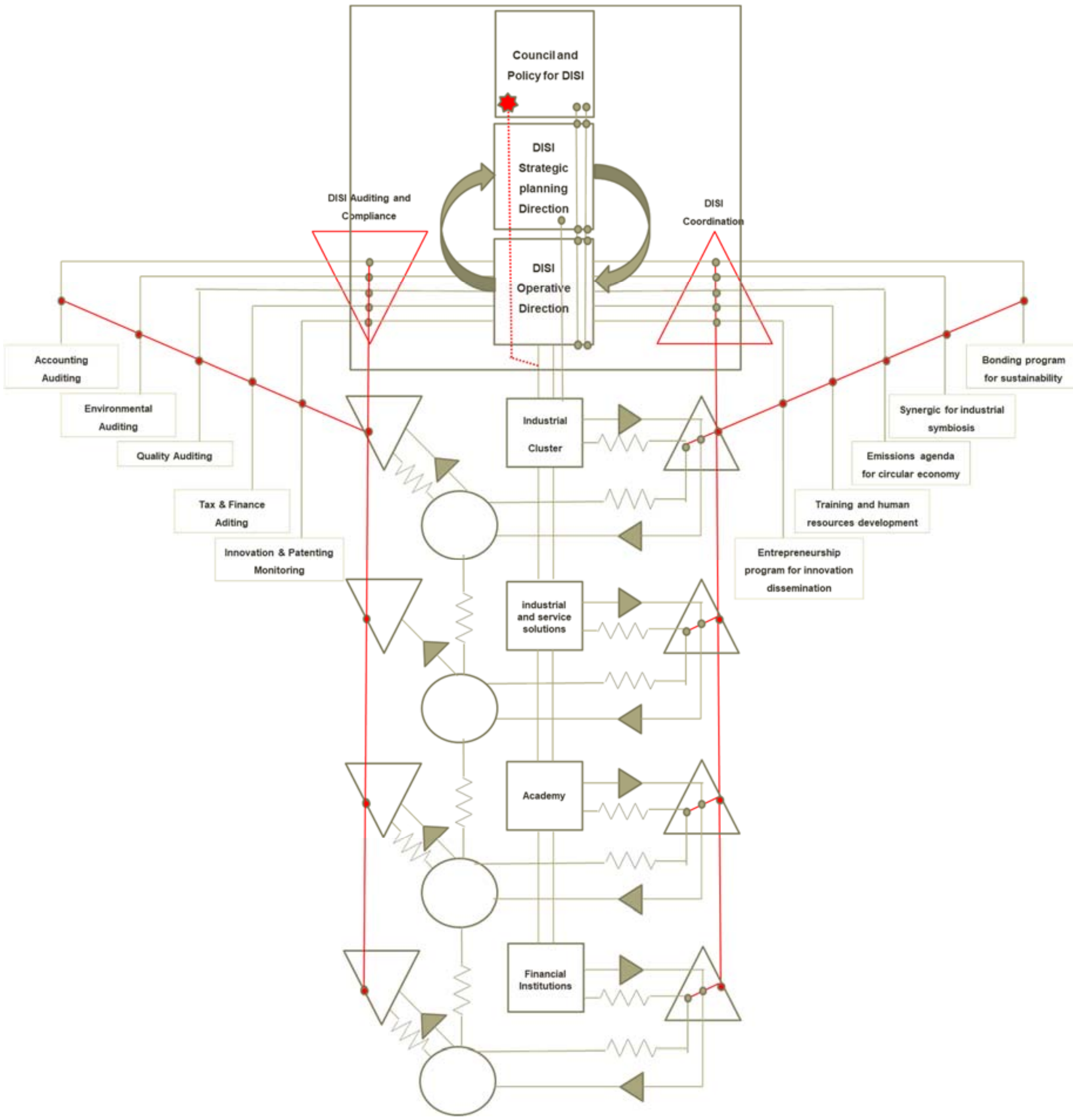


Figure III-23 Council and Policy for Sustainable and Inclusive Industrial Development (DISI)

III. 5. 7. Viable System Model for Sustainable and Inclusive Industrial Development (DISI)

Finally, **Figure III-24** depicts the model's general overview with the five systems integrated and linked with their appropriate contextual environment. Indeed, it is built based on the sub-section, as mentioned earlier, of several systems. In sum, each of them relates to:

- Systems one, or viable systems of industrial cluster, industrial and service solutions system, academy system, and financial institutions system for DISI.
- Systems two, or coordination systems for DISI.
- Systems three*, or auditing and compliance systems for DISI.
- System three, or operative direction system for DISI.
- System four, or strategic planning direction system for DISI.
- System five, or system of council and policy for DISI.

One of the primary VMS features is the recursion capability, meaning how the model is able to scale down/up based on the general concept. On the one hand, it can be applied to industrial unit management; that is how the industry is managed based on the territorial scope. For instance, as a strategy for industrial development, the industrial cluster concerns a broader sense of management than industrial parks or the different company sizes. On the other hand, as the cluster concept regards viable systems; thus, any of them performs, at least in the abstract way, such activities.

Likewise, the figure below shows the environment corresponding to each system; Although links represent a conceptual framework, they do not strictly define the contextual intersection among viable systems. Moreover, it reflects the links connections with the future context, which essentially the strategic planning direction system forecast mainly threats that would put on risk the system existence, or looks after potential benefits for boosting the system in focus. Meanwhile, the Operative Direction plays a control role that evaluates system weaknesses and strengthens for bearing in mind the focal system's core competence. Nevertheless, the viable system model aims to tackle the unsustainability that industrial development has struggled by the passing time. Under this context, sustainable indicators or variables are part of the algedonic channel assignment since they are of utmost importance to be considered for the whole system's feedback and tackle the unbalanced sustainable pillar or pillars. Likewise, the local context pear each viable system requires continuous improvement from the core competence's strong differentiation approach for sustainable outputs, minimizing ecological impact.

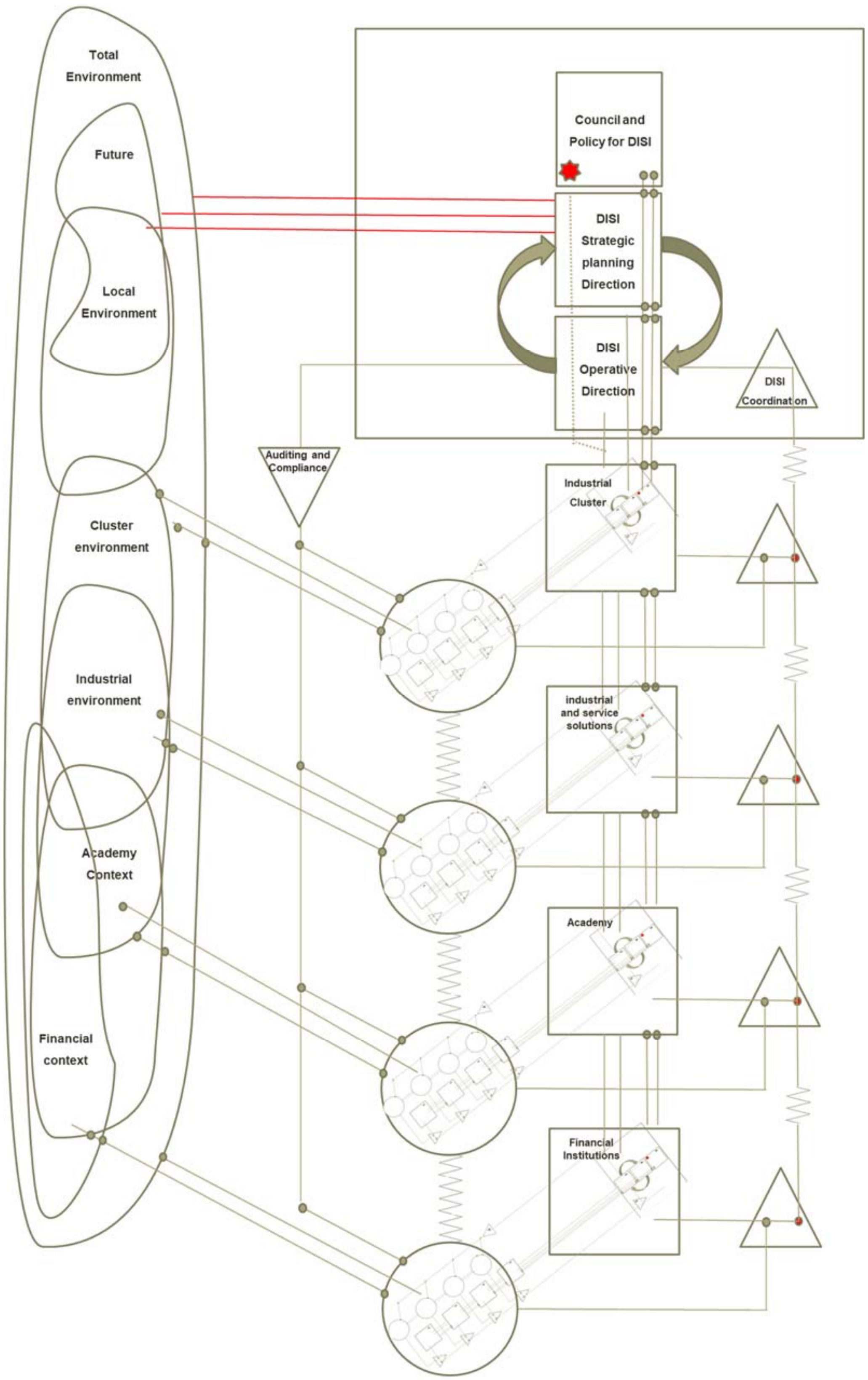


Figure III-24 Viable System Model for Sustainable and Inclusive Industrial Development

Discussion

Chapter IV. Discussion

This chapter discusses the model for sustainable industrial development; the model responds to a strategy for the industry to develop based on the sustainable and inclusive context analysis. A case study is designed based on the model explained in **Figure II-9**, related to the relationship between comparative and competitive advantage for sustainable industrial development. For analysis purposes, an SME practical case is employed, where the focal system consists of a Small Establishment JIV. The SME is a manufacturer of speed reducers with a primary market for end-users such as companies belonging to the manufacturing sector 331-333 according to the SCIAN of INEGI.

IV. 1. National value chain

IV. 1. 1. Global Comparative Advantage - Operational approach

The comparative advantage of sustainable industrial development is studied. According to PROMEXICO, the main points that give Mexico an advantage are the privileged strategic geographic position and the business facilities. We enjoy a preferential location for various reasons, not only because of our proximity with the North American economic region, since as a whole between the United States and Canada, according to data from the World Bank (see **Figure I-13**), they generate 24% of the world economy. Likewise, Mexico has commercial agreements that further facilitate trade with these countries, such as the new CANADA - United States - Mexico Agreement (CUSMA). Moreover, even having a maritime port connection in the Pacific and Atlantic Oceans positions Mexico even better in the global comparative chain with the trans-Pacific treaties (TPP) and the Pacific Alliance.

On the other hand, it highlights that the North and central Mexican regions contribute to most of the National industrial GDP as part of the Nation's comparative advantage (see **Figure IV-1**). Since they are the leaders' states with the manufacturing sector's gross domestic product contribution, they participate with 54% of the total production country. The company's economic region is in Mexico's state; it also shows to be one of the main contributors to the Manufacturing sector with 6.7% of total GDP 331-336 (see **Table I-6**).

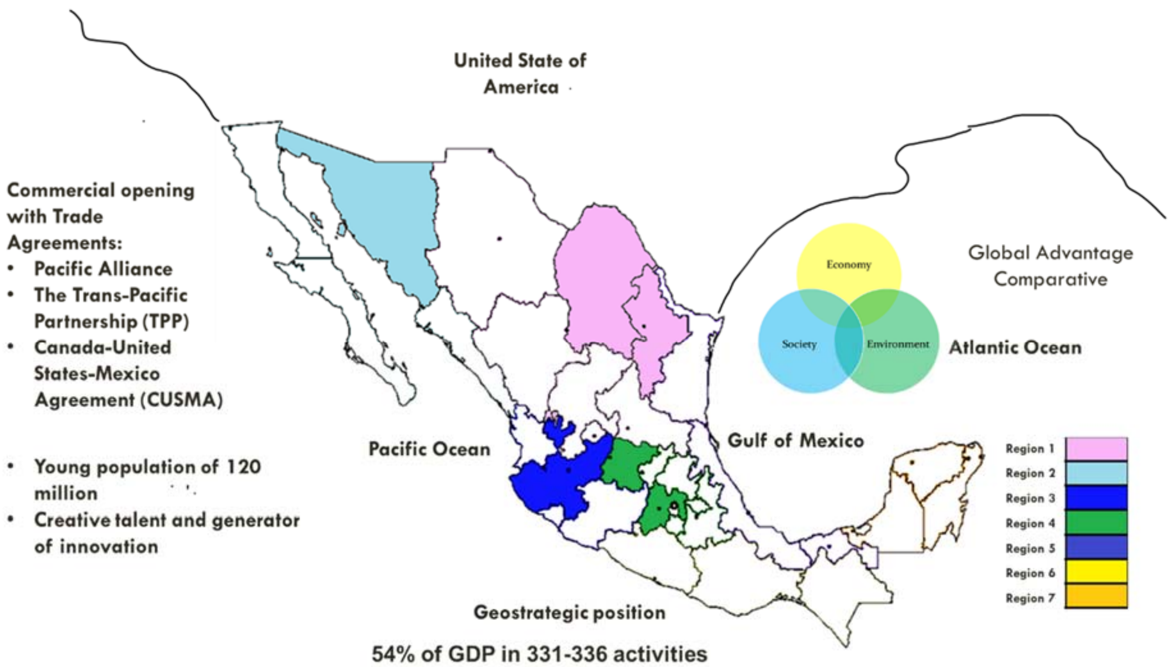


Figure IV-1 Comparative advantage of Mexico

IV. 1. 2. National Competitive Advantage - Strategic Approach

Then, in the analysis of the competitive advantage of the National-regional level, it is mentioned that in addition to economic activity, it is also how efficient resources are used; according to **Figure I-30**, the personnel employed's labor productivity in the manufacturing industry is going down since 2014. In addition to the aggregate level of this indicated, since 2012, it has shown an erratic performance because employed personnel are employed at a higher rate, while it does not correlate with returns in GDP (see **Figure I-32**). In the justification of the present investigation, a more in-depth analysis was made; however, the absence of an industrial development strategy for national competitive advantage is considered in this section.

One of the elements required to get a competitive advantage is innovation; **Figure IV-2** mentions that the central region has the largest number of researchers in any field of knowledge application. On the one hand, based on the central area's patent number as an innovation indicator, it likely seems to have a good performance.

Notwithstanding, the number of researchers in the Engineering field is not substantial; even this field of study is the manufacturing sector research & development innovation force. Although most of the human resource for this research area concentrates on the central region, there are just 170 researchers in the engineering field (see **Figure IV-3**).

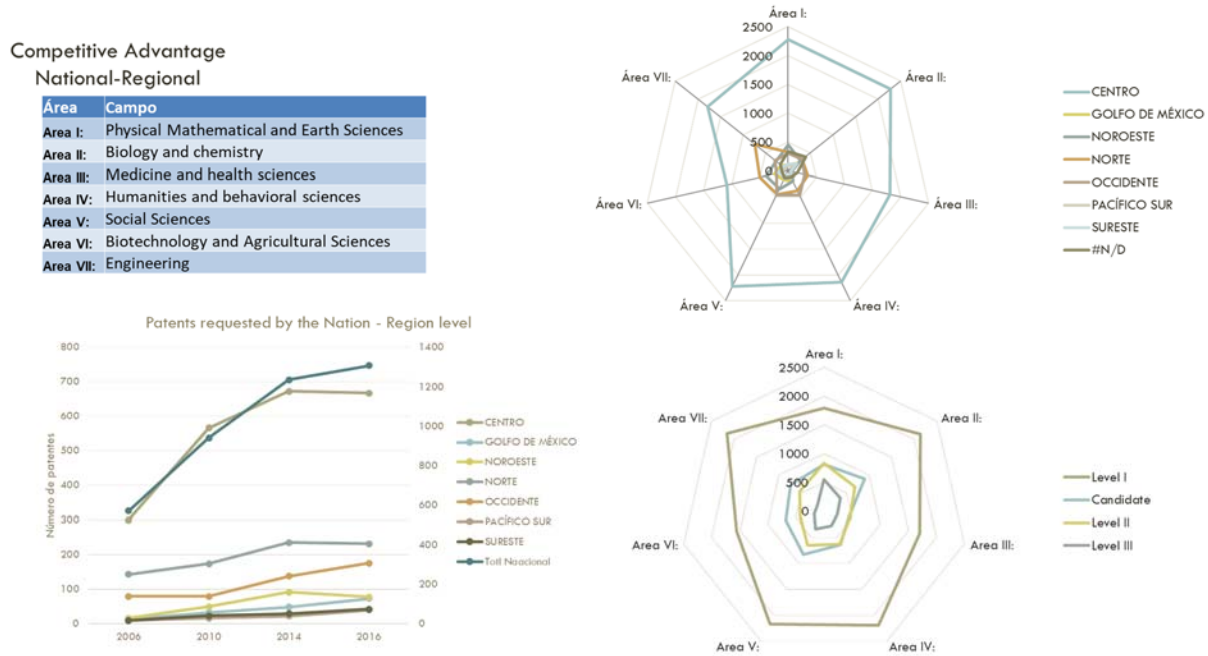


Figure IV-2 Indicators for Innovation at the National-Regional level (data obtained from CONACyT)

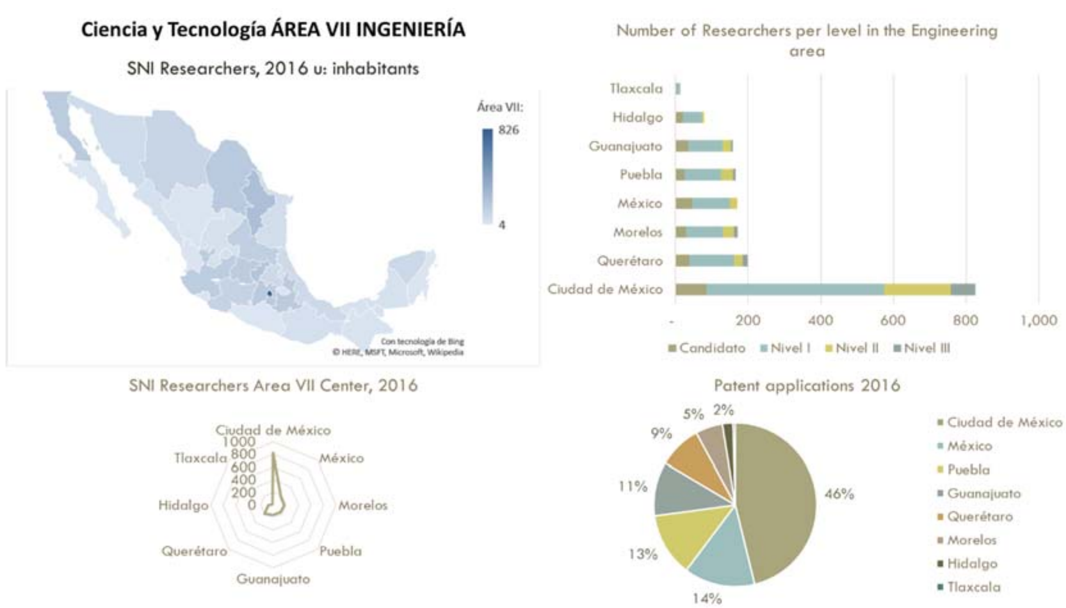


Figure IV-3 Status in Science and Technology for the Engineering area 2016

IV. 1. 3. Evaluation of sustainability at the National - Regional level

Based on the spheres for sustainable development variables records in **Appendix 2** mentioned in **Table IV-1**, the yellow variables belong to the economic dimension; in blue colour, the social ones, and green colour, the environmental sphere. By the way, they were described in chapter one in **Figure I-8**. Furthermore, the variables are presented at different levels; N-National, N-R, National-Regional; N-E, National-State; R-E, Regional-State; R-E-M, Regional-State-Municipal. However, the analysis is made for the National level and the National-Regional level, central region, because the focus is on the central area. The multiple linear analysis was performed to analyze each of the above variables, taking GDP as response functions for the economic system: Whereas, for the Social system, the Human Development Index; and finally, for the environment, the greenhouse effect emission in tons of CO_2. Hypothesis testing was done using $r^2 \geq 0.9$ and analysis of variances of each run to locate the variables that determine each of the dimensions at the national and central regions. If the P-value $\leq .0.05$, then the null hypothesis that said is not significant, the variable is rejected. Besides, to eliminate autocorrelation in the data, the Durbin-Watson statistic was used as another test, accepting the model if it meets the characteristic of being less than three. The exercise was executed using the Minitab 19 software.

Table IV-1 Variables and indicators for sustainable development

Code	Concept	Level N	N-R	N-E	R-E	R-E-M
BC	Trade balance	X				
GPD	Public debt of the Government	X	X	X	X	X
FDI	Direct Foreign Investment	X	X	X	X	
AEP	Economic Active Population	X	X	X	X	X
WP	Employed Population	X	X	X	X	X
UP	Unemployed Population	X	X	X	X	X
SEP	Salaried Employed Population	X	X	X	X	
NSEP	Non-Salaried Employed Population	X	X	X	X	
GDP	Gross domestic product	X	X	X	X	X
GDPPC	Per capita gross domestic product	X	X	X	X	X
POT	Total population	X	X	X	X	X
PCD	insured population	X	X	X	X	X
PSC	Uninsured population	X	X	X	X	X
INPU	Public investment	X	X	X	X	X
GPE	Average Grade School	X	X	X	X	X
IDH	Human development Index	X	X	X	X	X
GINI	Social Cohesion Coefficient	X	X	X	X	X
DENPO	Population Density	X	X	X	X	X
OPV	Average occupants per House	X	X	X	X	X
VCSER	Homes with all services	X	X	X	X	X
VCAG	Homes with drinking water	X	X	X	X	X
VCELE	Homes with electricity service	X	X	X	X	X
VCDRE	Homes with drainage services	X	X	X	X	X
WHAT	Energy consumption	X	X	X	X	X

PQVE	Vehicle Park	X	X	X	X	X
EGEI	Emissions of greenhouse gases	X	X	X	X	X

The report presented in **Table IV-2** indicates the significant variables and indicators' sustainable development systems; The survey with stats determined is in **Appendix 3**. Likewise, **Figure IV-4** summarizes the significant variables for each of the pillars for sustainable development. Hence, at the national level for the economic dimension, it was determined that the Employed Population and Public Debt are significant. Meanwhile, in the social size, the HDI is determined by the insured population, the average school grade, and the coefficient of social cohesion. However, in the environmental sphere, no set was obtained that explains the emissions.

On the one hand, the correlation coefficient is adequate, with a 99.32% correlation adjusted to multiple variables and not presenting autocorrelation in the data. On the other hand, when performing the analysis of variance in each of the runs for the environmental system, null hypotheses were accepted for all of them; therefore, there was no significance in the variables. Although any ecological variable resulted significant, for informational purposes, the same figure shows the best fit.

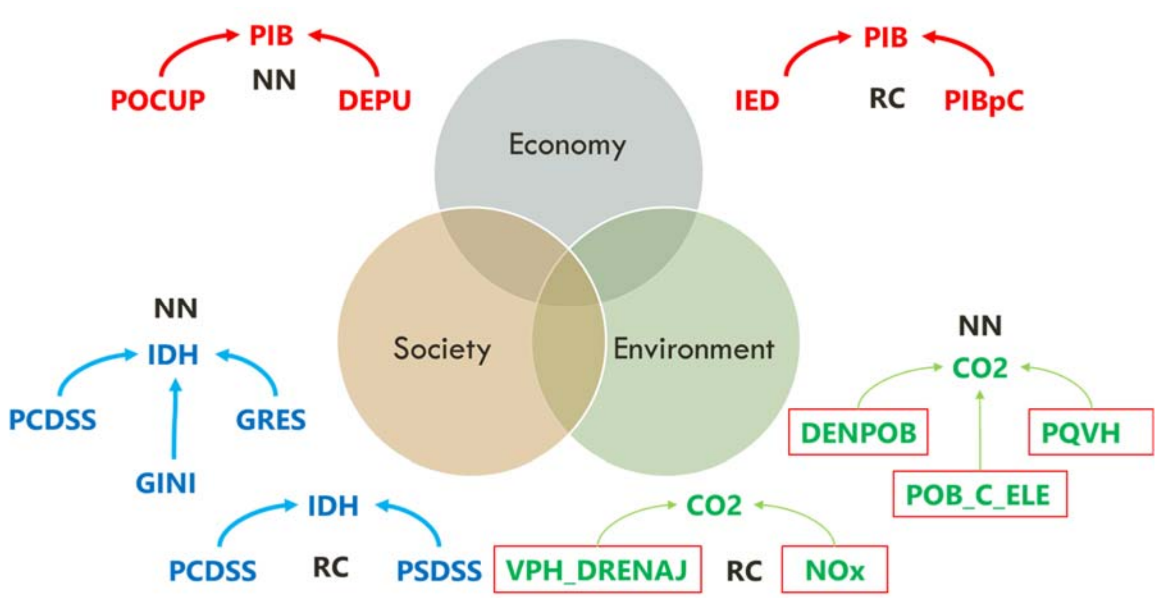


Figure IV-4 Variables and significant indicators for each of sustainable development spheres.

Table IV-2 Sustainable Development Variables Evaluation

p-value<.05	Nacional			REG-CEN			REG-GM			REG-NRE			REG-NTE			REG-OCC			REG-PSUR			REG-SURE		
r^2	99.55	98.23	99.32	99.8	97.64	99.08	99.91	99.91	99.08	99.53	97.78	99.99	99.08	97.41	99.91	99.78	99.86	98.79	99.99	94.85	99.53	99.64	96.82	99.39
DW<3	X	X	X	X	X	X	X	X	X	X	X	3.2324	X	X	X	X	X	X	X	X	X	X	X	X
Code	PIB	IDH	CO2	PIB	IDH	CO2	PIB	IDH	CO2	PIB	IDH	CO2	PIB	IDH	CO2	PIB	IDH	CO2	PIB	IDH	CO2	PIB	IDH	CO2
Year	X	X	0.265	X	X	X	X	X	X	X	X	X	0.188	X	0.126	X	X	0.08	X	X	0.096	X	0.11	0.188
DEPU	X									0.087									X			X		
IED				X			0.064									X								
PEA													X									X		
POCUP	X															X			X					
PDESOC																								
PTA													X											
PTRABNA							X															X		
PIBpC				X			X			X									X					
POT																								
PCDSS		X			X			X			X			X			X						0.156	
PSDSS					X															0.051			0.149	
INPU																								
GRES		X						X			X			X			X			X			0.13	
GINI		X						X									X						0.103	
DENPOB			0.07												0.073			0.134						0.219
PROM_OCUP																								
VPH_C_SERV																								
VPH_AGUADV															0.066			0.184						0.164
VPH_C_ELEC			0.056									X			0.069			0.152			0.144			0.165
VPH_DRENAJ						0.06			0.06			X			0.075									0.164
WHATT												X									0.398			
PQVH			0.065									X												
NOx						0.072			0.072												0.178			

On the other hand, in the central regional analysis, the following results were obtained. For the economic pillar, it was identified that Foreign Direct Investment and GDP per capita determine regional GDP factors in the central region. Besides, it was obtained that both populations explain HDI with rights and those without rights for health services in the social sphere. As mentioned before, this environmental sphere could not be explained because the analysis of variances is higher than 0.05 of the P-value, refusing to reject the null hypothesis of its tests. However, for informational purposes, for reasons of obtaining the best test result, both drivers Nitrous Oxide (NOx) emissions and household drainage systems were determined

IV. 2. Regional value chain

IV. 2. 1. Regional comparative advantage - Tactical approach

One of the main strategies for industrial development is industrial clusters' formation; the central region specializes in supplying the automotive sector, followed by the Information and Communication Technologies (ICT) industry. Finally, the broad market emerging from the aerospace industry. **Figure IV-5** the specialized clusters for these sectors are shown; automotive clusters in the state of Mexico (CLAUEDOMEX), Guanajuato, Querétaro, Morelos (CIVAC), and the central zone in Puebla (CLAUZ). The ICTs in the states of Guanajuato (ITESI), Querétaro (InteQsoft), Morelos, Puebla, Mexico, (Prosofware), and Tlaxcala. Lastly, the Aero cluster de Querétaro in the aerospace sector locates in Querétaro.

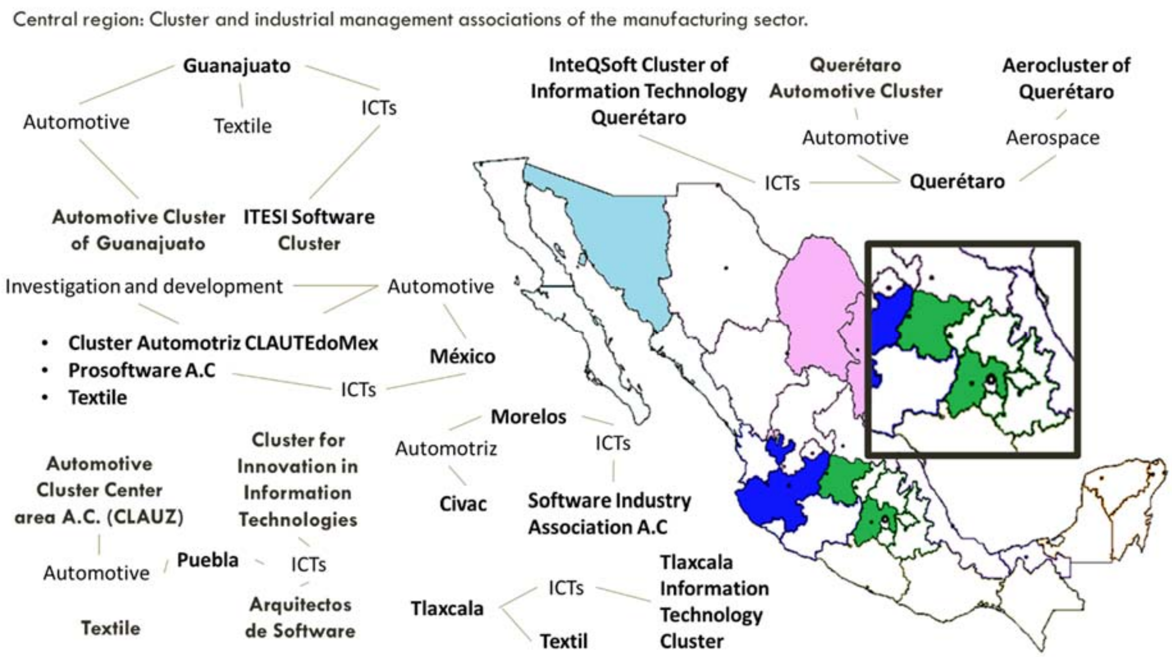


Figure IV-5 Clusters of the manufacturing sector in the central region

IV. 2. 2. Regional competitive advantage – Tactic approach

From this point, the focal system begins to be the focal study point. It is defined for discussion purpose, "JIV," an SME firm manufacturer of speed reducers and motor gears. Indeed, since the first value chain analysis phase, the SME is regarded for the study; here in this section, it is explicitly declared. In this way, the focus system analyzes its value chain based on its competitive advantage regional value chain. Hence, it starts with the breakdown of the determinants for product analysis differentiation. JIV is a company with more than 60 years of experience in the Design, Manufacture, Trading, and Repair of Reducers and Gearmotors. JIV is a Spanish-origin company with operations in Mexico, sold in 2011 to a Mexican businessman due to the eurozone economic crisis; thus, rights and patents were transferred since then. However, in 2018 management changed entirely since the owner's modification. Although the new administration is willing to do its best, its position in the market is struggling due to the latest operations mismanagement. Moreover, the current COVID-19 makes the situation more difficult for SME survival.

First, it requires the competitive advantage analysis's tactic approach for the regional value chain, and then, the core business is essential to perform such studio. Core business should declare suppliers and customers of the supply chain's focal system breakdown analysis, which consists of the general process overview of its core business. The firm's core business consists of designing, manufacturing, trading, and repair reducers and gear motors. The main products or services disposed to the customers are Gear motors and speed reducers, spares for motor gears, and maintenance and overhaul service, all of them, hereafter the focal product. Three segmented kinds of customers purchase these outputs: the final user is regarded as the customer who uses the product in their facilities; the distributor is a customer who sells the product wholesale; and also, he is the channel for end-users. Lastly, the original equipment manufacturer is that customer who integrates the focal product in his design. Then, he and distributors can sell the focal product to each other to the final user.

Mainly, the focal point transformation required two primary kinds of materials and outsourcing services. Primary materials suppliers divide into raw suppliers and integration components suppliers for the focal point. On the one side, raw material suppliers supply the following entries: foundry, steel, and bonze. On the other side, integration components suppliers are necessary for bearings, assembly components, motors, and painting. While outsourcing services of maquila are required when there is no capacity installation for special sizes; besides, it requires heat treatment service. **Figure IV-6** shows the company's general supply chain and its services to the market.

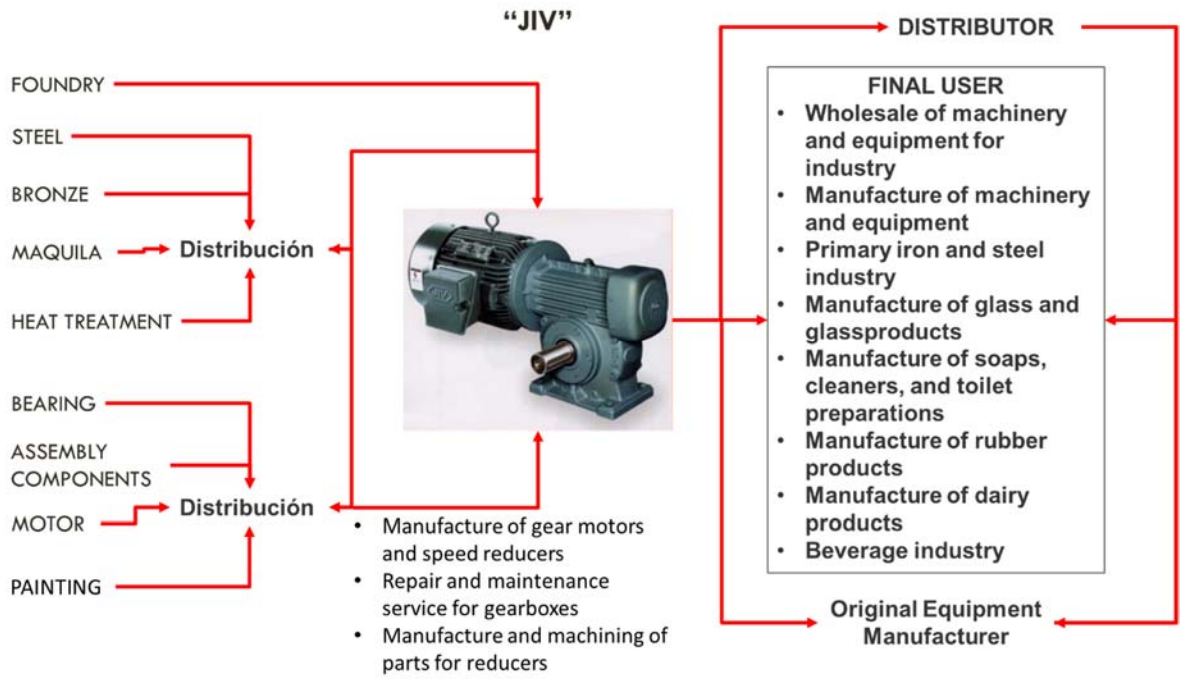


Figure IV-6 Supply Chain of the System in Focus "Transmision de Potencia JIV"

IV. 3. Local value chain

IV. 3. 1. Regional comparative advantage – Strategic approach

The comparative advantage's strategic approach at the regional level of the value chain is of utmost importance for the system's industrial support in focus; since it essentially shapes its behaviour conditions under the studio. Therefore, one tool that crafts the strategy is the five forces; however, the system's core business in focus is not regarded for DENUE as a high demand activity. On the one hand, due to I4.0 technologies, JIV's product competitors have evolved to improve the smart factory; nevertheless, they are just introducing an incremental innovation that can be substituted by electrical control systems without sacrificing the operational quality. On the other hand, with free trade treatments, like those mentioned in the first section of this chapter, new entrants' potential risk is latent. Those who can take advantage of the new CUSMA treatment since many other countries with free trade with Canada or the USA can use it to boost a potential market.

Therefore, for the analysis of the supply and demand of motor units, it is used INEGI hub, since it sorts the activity based on the SCIAN codes. Then, INEGI classifies the product in the manufacture of transmission engines of branch 3336. It belongs to the manufacturing sector of machinery and equipment 333 and the manufacturing industry 33. Demand conditions analysis is done through an input-product matrix and how to know the economic flows that this sector has. On the one hand, the manufacture of machinery and equipment, branch 333, is directed mainly to the manufacture of automobiles and transport with 26% of its consumption, followed by the manufacture of machinery and equipment (branch 333), and finally for the manufacture of computer equipment as primary markets.

On the other hand, at the 3336 sub-branch level, the manufacturing of internal combustion engines, turbines, and transmissions. **Figure IV-7** shows the leading market with 26% of its product is sub-branch 3361, belonging to cars and trucks; followed by activity 3336, related to internal combustion engines and turbine manufacturers, and transmissions. With 11% of the potential market is sub-branch 3363, dedicated to the manufacture of parts for motor vehicles.

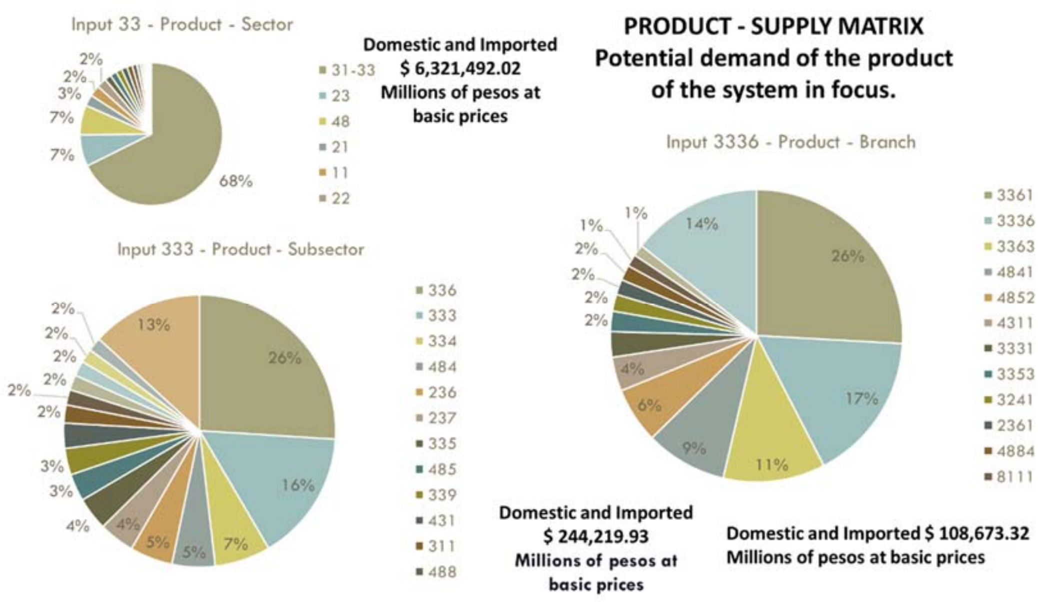


Figure IV-7 Product-Supply Matrix of manufacturing activity

Analyzing the manufacturing sector's productivity shows a correlation between labor productivity concerning GDP (see **Figure I-26**). Likewise, productivity is one of the economic determinants for the industrial sector; hence, leader States on productivity matter are mainly in Mexico's north region. Besides, the State of Mexico is part of this competitive scenario (See **Figure I-27**). This last Mexican State is where the firm's focal system locates; so, the study requires its productivity analysis for a strategic approach of a sustainable regional value chain. The State of Mexico is part of the State with lower use of personnel than other productivity states leaders, the lowest production volumes compared to the states with the highest contribution in the manufacturing sector (see **Figure I-28**). Although **Figure IV-8** shows good labor productivity performance, their production volume only shows an amount that is not significant as Mexico's northern states perform.

Likewise, the analysis of competitiveness is performed as one of the determinants of competitiveness. As mentioned earlier, the activity that the company offers to the market is the manufacture of transmission reducers. However, BIE does not regard it as a high impact activity due to the little volume in the national economy. Thus, power transmission firms of the same branch found in an upper SCIAN code where were identified **Figure IV-8** depicts the territorial triangulation of the competition that the firm faces. The triangulation was determined through the National Statistical Directory of Economic Units (DENUE), an INEGI's platform, employing this type of market's activities. An extension area from Monterrey, Nuevo León, Guadalajara, Jalisco, and Puebla shows a potential region of competitiveness among the organizations identified. It highlights that only one of the firm's sectors is from Mexican capital origins, while the others of foreign origin. But nowadays, the system in focus is part of national competitiveness.

Figure IV-8 Productivity and Competitiveness of the sector

IV. 3. 2. Local competitive advantage – Operational approach

The company's products' supply chain analysis narrows the study to obtain hard results; in this way, **Figure IV-9** depicts the main customers' company classification; end-users, with 41% of its market. The distributor is then positioned in the second position with 37% of sales, while the original equipment manufacturer (OEM) with 22% market participation. On the other hand, the type of SCIAN industry to which the customers belong changes the market position—since distributors represent the primary customer, followed by EOM customers. Then, customers segmented to the iron and steel industry, Glass manufacturers, and rubber products production among the most representative customers. Likewise, the figure also shows the sales company's performance in the last three years. As aforementioned, market sales have been reduced and the failure to comply with the equipment's delivery times due to management changes. On the other hand, even the attempt to carry a forecast model shows high variability in the data that does not allow to infer the organization's sustainable future.

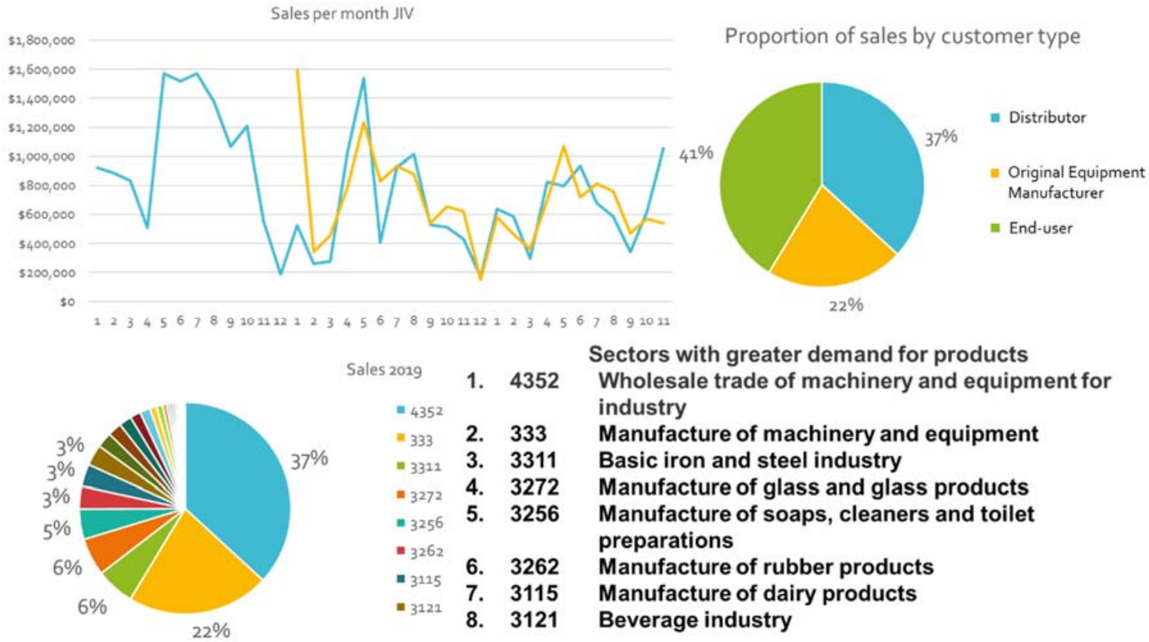


Figure IV-9 Sales and Market of the organization in focus

The products with the highest demand are shown in **Figure IV-10**, which shows that the reducers are in high demand and highlight spare parts as a potential market. According to Original Equipment Manufacturers and distributor type of customer, the equipment's main application is supplied without knowing who the end-user is. On the other hand, for the primary industry of iron and steel and the manufacture of glass and production of rubber, they are sectors of heavy machinery; then, the equipment supplied is of heavy construction. In that way, it infers that the focal company's core market relates to the robust construction industrial manufacturing market differentiation against the competition. For instance, the RT equipment model is robust equipment for heavy applications. However, this speed reducer model is not in high demand; the RT model represents the core company's product income.

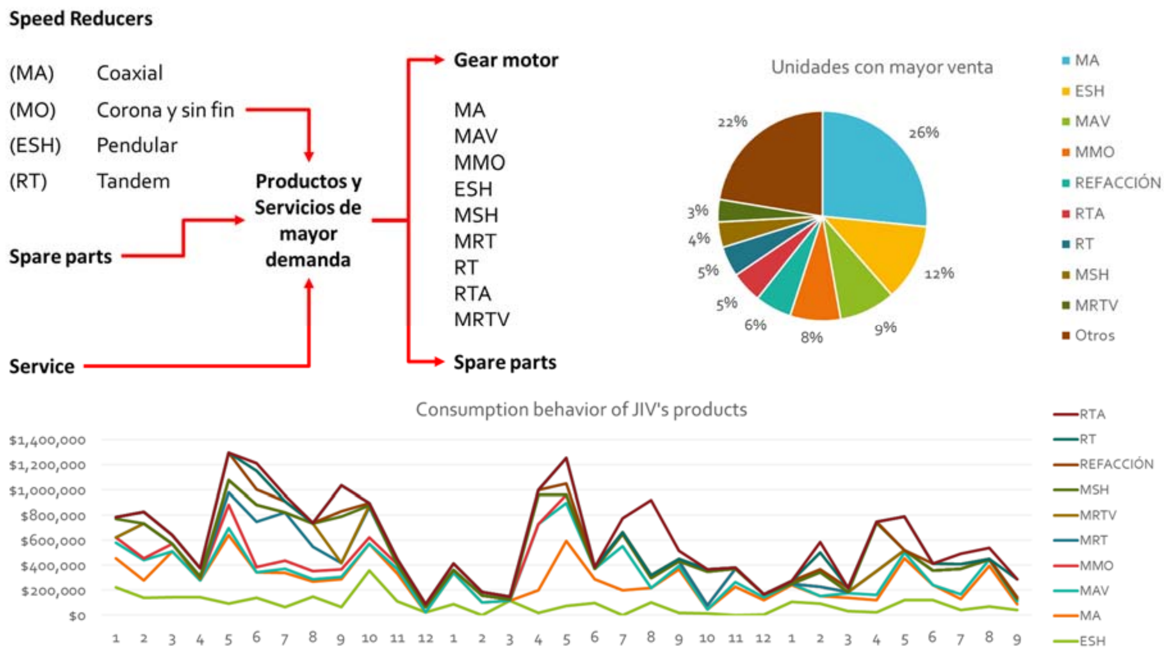


Figure IV-10 Consumption behaviour of JIV's products

On the other hand, the analysis of the expenses incurred in the organization is developed. **Figure IV-11** shows the distribution of the organization's main costs; at the moment, there are no manufacturing and energy expenses such as water, electricity, and consumables, but it is estimated that each month an approximate payment of $ 15,000 is made. Therefore, the total monthly expense is around $ 500,000 mxn. However, the main expense made according to costs is in supplies and materials since they represent 60% of the monthly expenditure, followed by labor with 30% and finally in manufacturing expenses with 10%. It is observed in the same figure that the principal materials and supplies are steel, bronze, and cast iron, while the components sort into motors and bearings. And that maquila services are also part of the production process.

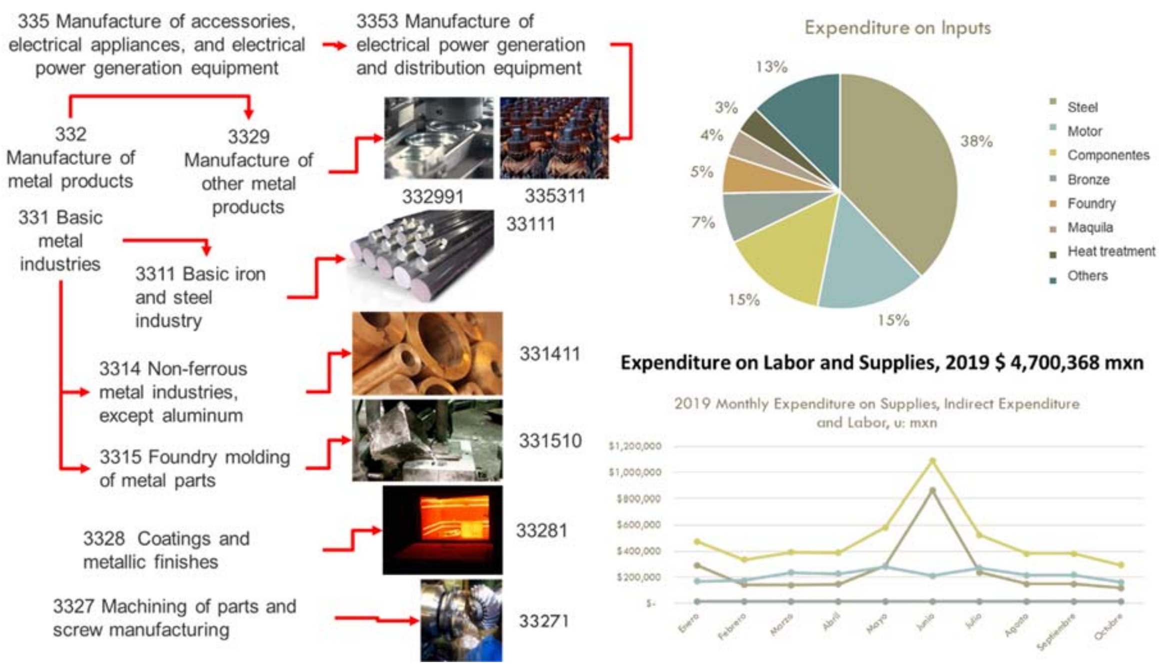
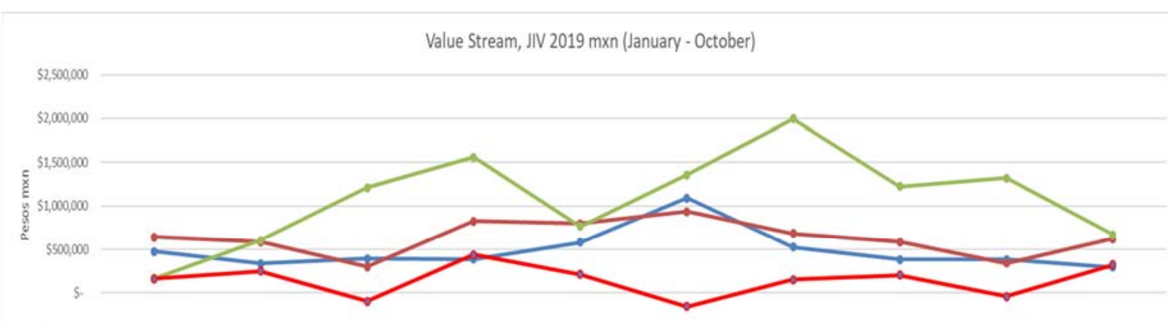


Figure IV-11 Monthly Expenditure on Supplies, Indirect Expenditure of Factory and Labor, 2019 u: mxn

The difference in sales versus costs is an issue that could be unsustainable according to the company's behaviour patterns; during this period, it has supported billing to avoid losses in its operations. Clarifying, financial information obtained has been modified and presented for discretion purposes. **Figure IV-12** shows that the economic flow between sales and expenses of the system in focus has a low or almost zero profit margin in some periods; this is the case of march, June, and September. It is then necessary to look for a strategy that supports the organization to exploit its innovative capacity both for developing strategic planning and improving the competitive advantage for optimizing costs in managing operations.



	January	February	March	April	May	June	July	Augost	September	October
EXPENSES	$475,489	$335,690	$393,367	$388,813	$582,773	$1,089,523	$525,272	$381,416	$382,386	$295,640
SALES	$639,434.14	$585,549.60	$298,905.40	$826,575.00	$796,972.00	$933,969.60	$681,026.30	$584,522.80	$342,656.50	$620,454.95
INVOICE	$166,607.61	$604,473.61	$1,211,859.73	$1,560,869.25	$765,796.10	$1,359,877.69	$1,997,647.68	$1,225,771.52	$1,320,129.05	$669,803.69
BALANCE	$163,945.11	$249,859.95	-$94,461.49	$437,762.23	$214,199.15	-$155,553.29	$155,753.82	$203,106.90	-$39,729.39	$324,815.40

Figure IV-12 Value stream 2019 of the system in focus

Likewise, the supply chain of materials inputs materials that the same organization has is shown; the objective is to recognize the system in focus' supply chain. Therefore, to efficiently identify potential suppliers and the SCIAN classification to locate the focal system's production chain, the INEGI DENUE Directory was employed. It is of utmost importance to shape the strategy based on the organization's production process once the suppliers, clients, and the competition have been identified; then, align their vision to a strong sustainability strategy. Thus, the organization's production process is analyzed; however, only its central or primary operations are declared due to discretion in the information. **Figure IV-13** shows the organization's macro process, in which it is divided into different stages, as a general process for the manufacture of reducers.

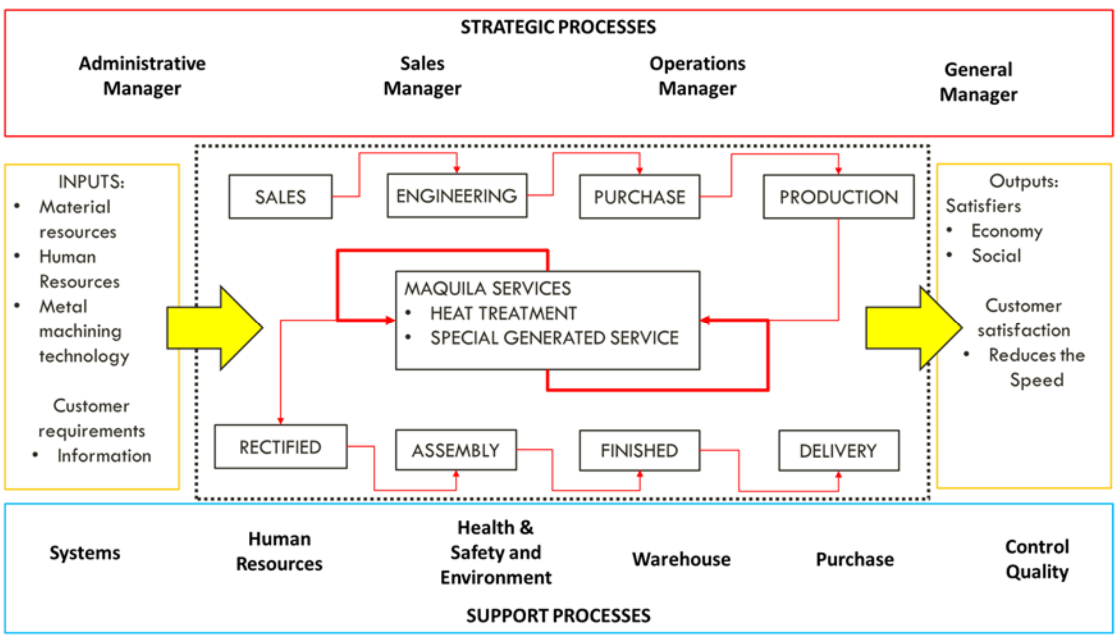


Figure IV-13 Support and strategic processes of JIV's core processes

The process starts based on the input elements described in the left part of the figure. Then, it goes through selling the equipment, followed by the equipment engineering development according to the customer requests. The procurement of materials requires the client's requirements; besides, it goes to the production process, where several production processes interact for adding value with tangible outputs. These are the core competence where the organization can differentiate itself by offering a competitive advantage. It is of utmost importance to bring back a robust and sustainable strategy as long as efforts align with its core activities. Therefore, the production process is taken as the main one, subdividing into forming and generating gears, crowns, pinions, and endless shafts such as the production process. The rectified process is another with the assembly and finishing process. All of these processes generate added value, besides obtaining the most significant utility in the controlled processes. Thereby leaving out, but not is limited to, monitoring and testing the quality of the processes belonging to the maquila: such is the case of parts generated that the same company cannot process it and the heat treatment.

The organizational system is indirectly related to the organization presented in **Figure IV-14**. Three main areas are distinguished; in the first area is the workshop area, which controls the operative system. On the other hand, the administrative department oversees the general structure, mainly with the customers, who are the most critical element, and the organization's human resources. Finally, engineering with purchase departments work alongside the workshop area; they are the organization's heart. On the one side, productive areas are viable systems; meanwhile, administrative areas manage the system organization. However, a lack of systems that seek to regulate both areas in parallel through monitoring, coordination, and communication mechanisms is absent.

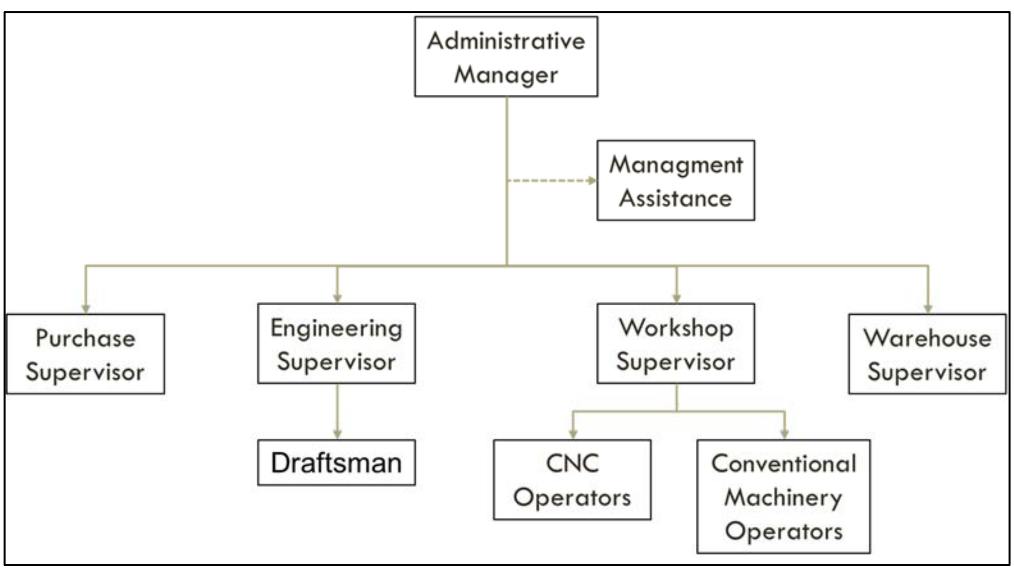


Figure IV-14 JIV's structure hierarchy

The diagnosis of the organization's current situation is made based on the porter chain value of the activities previously identified that add value to the organization. They were then organized in the Michael Porter value chain format and analyzed each of the segments (see **Figure IV-15**). In such a way, it deploys two kinds of activities primary and support. Indeed, both relate to the core activities competence of the organization. Moreover, by defining its core competence and highlighting its differentiation, JIV's speed reducers are more robust than the product competition market. Nevertheless, it is not synonymous with a bad design because there are records of the right quality equipment that even its useful life is over 20 years.

However, recently there are records that delivery times exceed those offered by the competition, even though the equipment already has a promised delivery date from the equipment's acquisition in the quote. It is worth mentioning that delivery times are already stipulated to be competitive in the market. Therefore, this problem causes a risk of unsustainability over time, putting business continuity in doubt. Analyzing the system in focus proposes a solution that entails employing a strong sustainability criterion, making the organization's strategy more robust from a holistic perspective.

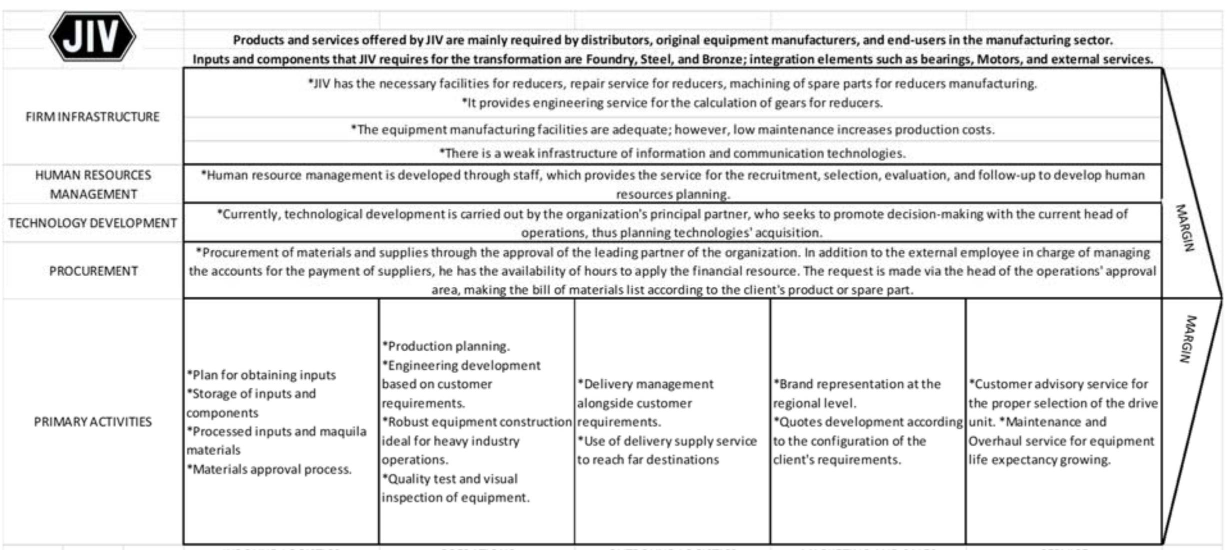


Figure IV-15 Porter's value chain of the system in focus.

IV. 3. 3. Evaluation of sustainability at the Regional – Local level

The discussion section compares the theoretical model of the root definition of critical systems to transform sustainable and inclusive industrial development against the main actors' point of view in the sustainable context. Based on the essential root systems links identified in the Root definition of relevant systems. On the one hand, the algedonic channel reflects the behaviour of suitable or unsuitable decisions by mainly social actors. Therefore, questionnaires were elaborated by google forms for discussing the sustainable context with academicians, people, and decision-makers in SMEs at the regional-local level. Each questionary is divided into five sections, two of them based on Garbei's questionnaire (Garbie, 2016); the first section is related to General Sustainability, while the second one, in the Industrial sustainability evaluation (only for the firm's managers). Section II of the questionnaire is an own development based on the developed questionnaires. Lastly, the third section, based on Benesova's questionnaire (Benesova et al., 2018), is related to "Industry 4.0 and Education 4.0" (only for the firm's managers too). The general questionnaire is available in the **Appendix 4** section.

The questionnaire was developed with Google forms to be answered in 20 minutes for an industrial while taking 5 minutes for other stakeholders. As previously mentioned, the questionnaire consists of 5 sections, each evaluating different aspects of sustainable industrial development. Section 0: these are general questions, which classify whether the applicator is an agent in the industry; otherwise, the applicator leads directly to the first part of the questionnaire: Sustainability. The next three sections, II, III, and IV, are pertinent questions for entrepreneurs and industry partners to share their perspective of the industry; section II, sustainability in the sector, section III, and its view of Industry 4.0 in the section IV. Nevertheless, the questionnaire application had 27 applicators, of which 33.33% were industrial, 22.22% are academics with postgraduate degrees, and 44.44% general public and the government's involvement being null. **Figure IV-16** shows a general overview of statistics where 44% say they belong to Mexico City and 22% from the State of Mexico. 44% belong to the female gender, while 56% are male. Finally, the educational level divides to graduate and undergraduate education, with 41.7% and 16.7% belonging to upper secondary education.

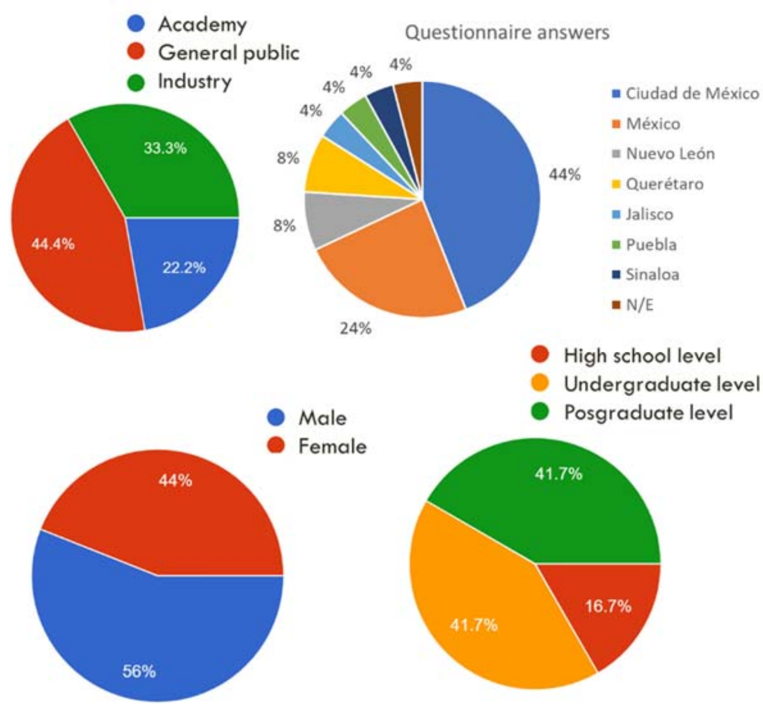


Figure IV-16 Section I: general answers statistics

i. General Sustainability Evaluation

Firstly, the questionnaires revealed in the sustainability evaluation section that the main concerns of people, academicians, and managers in general sustainability are social factors (see **Figure IV-17**). **Table IV-3** provides the overview scores per each sustainability section for general sustainability. Social factors refer to a lack of commitment from the State since there is a failed strategy to tackle corruption, an absence of trust, and inadequate public security service. It affects not only the trustworthiness of the linked system but also the overall state components. Moreover, the answers to the environmental sustainability part also reveal a weak environment field since the answers denoted a void in the academic people formation. Likely, it would be the absence of people's environmental culture reason, as the sustainability field is not appropriately disseminated, as it happens in developed countries. However, some answers to the three sectors also mention a big concern of them with the country's economic future as responses denote that they do not find an optimistic scenario.

Table IV-3 Sustainability overview scores

S	Sustainability: General	3.48
S1	Have you heard about sustainability?	3.96
S2	Are you interested in sustainability?	4.37
S3	Have you completed or taken training in sustainability?	2.59
S4	Do you know the meaning of sustainability?	3.85
S5	Could you explain in your words what sustainability is?	3.70
S6	Do you know what the three pillars of sustainability are?	2.70
S7	Do you know what the biggest problem for sustainability is?	3.04
S8	Do you know what the barriers to sustainability are?	3.04
S9	Do you know what the value of sustainability is?	3.44
S10	Do you know how sustainability affects your daily life?	3.48
S11	Do you agree that sustainability is not an option but the only way?	4.15
SE	**Sustainability: Economy**	**3.79**
SE1	Are you worried about the global economy?	4.22
SE2	Are you worried about the National economy?	4.70
SE3	How optimistic do you find the economic future of your country?	2.78
SE4	Do you consider that the economic dimension is the main pillar for sustainable development?	3.59
SE5	How satisfied are you financially at home?	3.67
SS	**Sustainability: Society**	**2.78**
SS1	Are you satisfied to be part of your community?	3.48
SS2	Are you satisfied with the balance between work and social life?	3.15
SS3	Are you satisfied with the safety of your community?	1.67
SS4	Do you consider freedom of expression adequate in your community?	2.93
SS5	Are you satisfied with the health services in your community?	2.44
SS6	In a typical week, how much do you feel stressed?	3.44
SS7	How satisfied are you with your personal relationships?	3.96
SS8	How comfortable are you with people outside the culture of the community?	3.93
SS9	Do you trust government institutions that provide health services?	2.15
SS10	Do you trust government institutions that provide security services?	1.67
SS11	Do you trust the institutions that provide government services?	1.81
SA	**Sustainability: Environment**	**3.10**
SA1	Are you satisfied with the environment of your community?	2.41
SA2	Are the products you consume environmentally friendly?	3.00
SA3	Do you recycle or reuse plastic, paper, glass?	3.19
SA4	Are you satisfied with the environmental care and protection services in your community?	1.85
SA5	Do you consider that climate change is one of the most relevant issues for sustainability?	4.44
SA6	Have you studied, or are you aware of global climate change?	3.70

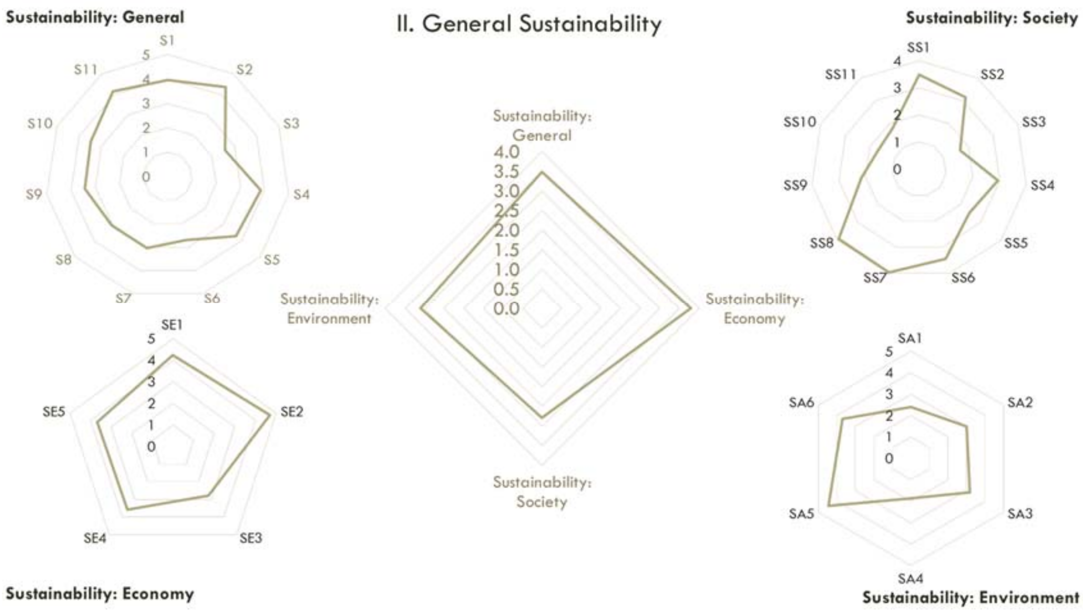


Figure IV-17 Overall Sustainability Assessment

ii. Industrial Perspective Evaluation

On the other hand, in section II for the industry analysis, it is observed that the majority responded to work in the state of Mexico. Their primary business is the manufacture of machinery and equipment, with a 37% participation, while the metallic products are 25% and raw metallic industrial with 12%. The sample mainly belongs to the branches of the metal manufacturing sector with 74% representation. It is worth mentioning that the majority are part of the SME segment because 66.7% report an income of fewer than 100 million Mexican pesos, and the employed personnel do not exceed 50 people (see **Figure IV-18**).

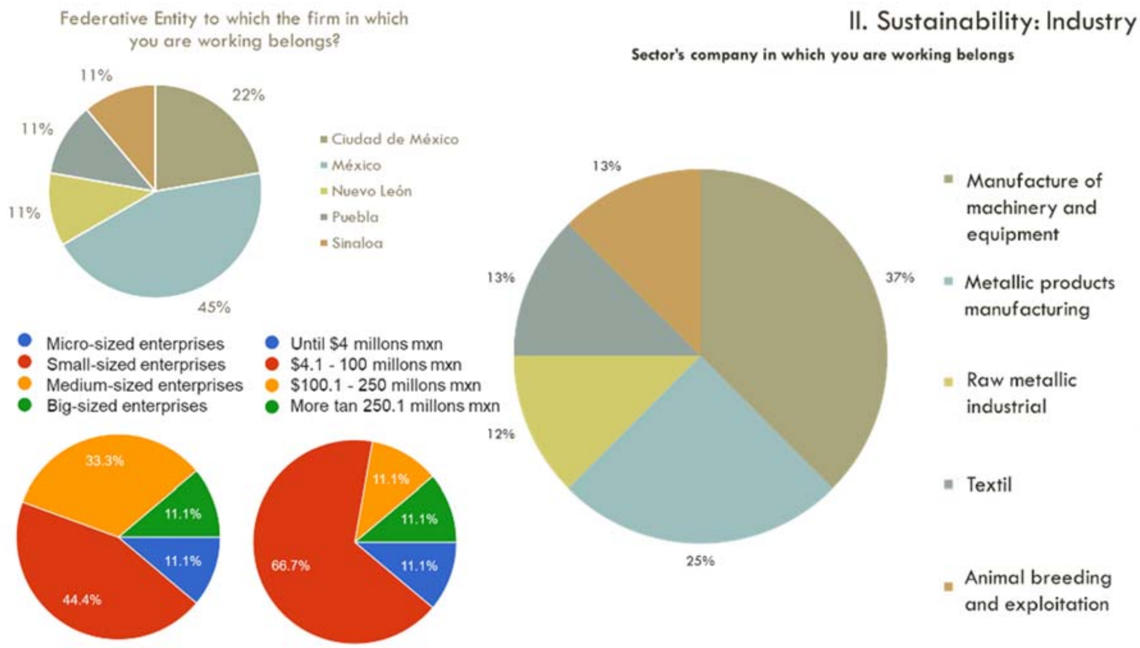


Figure IV-18 Industry section answer summary part 1

Likewise, the surveys report having most of the operational departments for the development of their day-to-day activities. The surveys' interesting point is that productive investment mainly focuses on acquiring technological equipment, with training being the least productive investment. So, entrepreneurs' perspective for technology investment focuses on three aspects; improving product quality and reducing production time and cost, which are strategic points in a competitive market. However, even though productive investment does not focus on eliminating labor, there is a lack of interest in investing in improving working conditions and the environment. Finally, the central perspective for the technology investment approach is on the economic viability approach, and they show a particular interest in sustainability. At the same time, in the questionnaire, they revealed insufficient knowledge of sustainability matters. The points of less interest for technological investment are directed to the environment, development, and social sustainability efforts (see **Figure IV-19**).

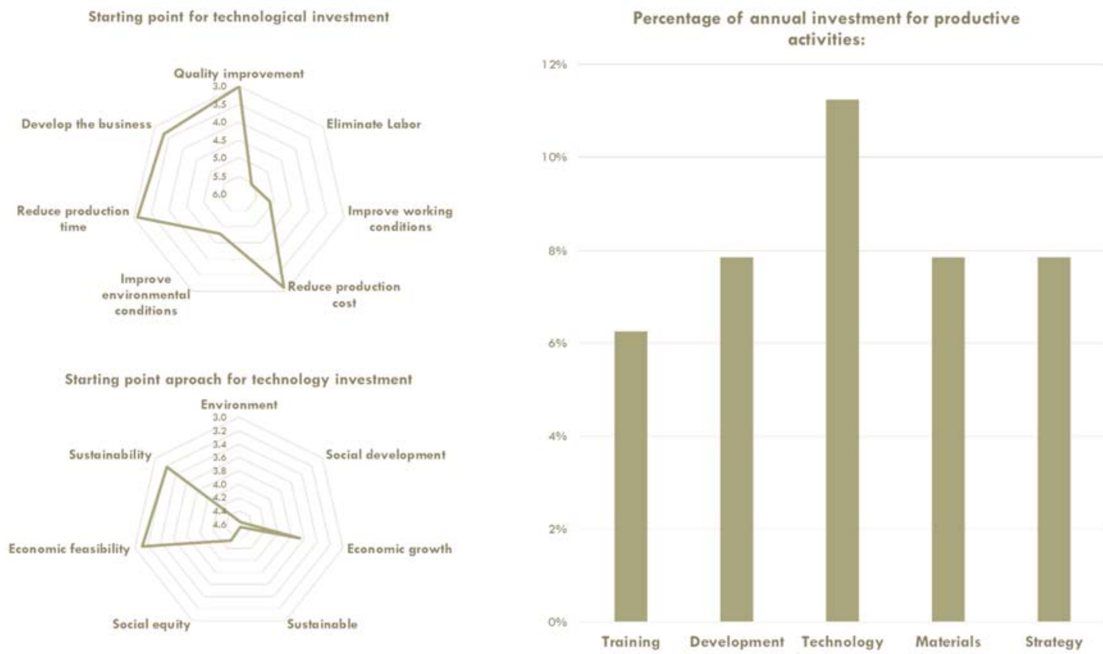


Figure IV-19 Industry section answer summary part 2

iii. Industrial Sustainability Evaluation

Secondly, the services and industrial solutions system presents a conflict with the state and environmental institutions and foreign actors. Seemingly, this pattern of answers is like a general sustainability section. There are weaknesses in social and environmental factors, as they mainly report, according to entrepreneurs, that sustainability is not part of their firms' strategy. They find an uncertain economic scenario for their growth; it would be the lack of strategy that reflects an unsteady market position (Mendoza-del Villar et al., 2020). In the third section, the industry's sustainability is analyzed in the four areas, general sustainability, economy, society, and environment; **Table IV-4** denotes scores to review for the four areas.

In summary, in the same way, they are the most lagging for sustainable balance in environmental sustainability and society. In general, the ecological dimension presents a shallow perspective because it does not have an environmental policy and, therefore, how to mitigate the effects of climate change. Likewise, efforts to optimize resources such as energy, fuel, and water minimize greenhouse gas reduction. On the other hand, in the social dimension, it is observed that SS09 listening to employees is one of the activities with the most significant degree of lag. Likewise, workplace accidents and the absence of personnel are more prevalent issues since there is a risk of paying large amounts to social security institutions (see **Figure IV-20**).

Table IV-4 Industrial Sustainability Scores

SI	Industrial Sustainability	3.22
SI1	Is sustainability integrated into the research and development strategy in your business?	2.22
SI2	Do you know the main drivers of sustainability?	2.56
SI3	Does your business have a clear future vision of its growth?	2.89
SI4	Does your business have innovation development strategies?	2.67
SI5	Is customer satisfaction important?	4.44
SI6	Do you think sustainable development is important in the industry?	3.89
SI7	Do you think it is the responsibility of the industry to promote sustainable development?	3.89
SEI	**Economic Sustainability**	**3.06**
SEI1	Does your business have a strategy to sustain itself in the market?	2.78
SEI2	Do you know the main problems that affect the manufacturing industry?	3.89
SEI4	How optimistic do you find the economic future of your company?	3.00
SEI5	Are you happy with the position of the company in the market?	2.67
SEI6	How do you consider the performance of the company in the market?	2.78
SEI7	Is there growth in the profitability of the company in the previous five years?	3.44
SEI8	Have you recently introduced new technologies?	2.78
SEI9	How often do you invest in new projects?	2.89
SEI10	Do you think the company's market position will improve in the next two years?	3.44
SEI11	Have you expanded the company recently?	2.33
SEI12	Do you think that the economic problems of a company in the sector could impact the manufacturing industry?	3.67
SEI13	Do you consider that the evaluation of the company's products obeys compliance with sustainability?	3.00
SEI3	Could you mention which one or which ones?	
SSI	**Social Sustainability**	**2.75**
SSI5	How often are employees absent?	2.11
SSI7	How often is the staff trained in the company?	2.22
SSI10	Are there policies in the company to motivate employees?	2.22
SSI4	How often do accidents at work happen in your company?	2.44
SSI6	Are there any gender preferences for the selection of personnel?	2.44
SSI8	Is there feedback from superiors to workers?	2.89
SSI2	How much is the company related to the social life of the employees?	3.00
SSI9	How often are the opinions of employees heard for decision-making?	3.00
SSI11	Are there adequate support processes for staff in the company?	3.00
SSI12	Does your company have a positive relationship with society?	3.44
SSI13	Does the company know the basic needs and promote a good quality of life for the workers (home, health, education, security)?	3.44
SAI	**Environmental Sustainability**	**2.58**
SAI8	Does the company have a strategy to face climate change?	1.67
SAI1	Does your business have an environmental policy?	2.11
SAI7	Does the company have a strategy to reduce greenhouse gas emissions and pollutants?	2.11

SAI3	Does the company have energy efficiency improvement systems?	2.22
SAI4	Does the company have a strategy to reduce water consumption?	2.22
SAI6	Does the company have a strategy to reduce the consumption of fossil fuel (gas, fuel)?	2.22
SAI5	Does the company have a strategy to reduce waste?	2.33
SAI2	Does the company have reuse or recycling systems for plastic, paper, glass?	2.67
SAI9	Does the company have a strategy to reduce toxic waste?	2.67
SAI12	Do you consider that the manufacturing industry does not distinguish between green, sustainable, and environmental?	3.11
SAI10	Do you consider that climate change is in the hands of the manufacturing industry?	3.75
SAI11	Is minimizing the negative impact of processes and operations a form of environmental awareness?	3.89

Additionally, the current economic context does not encourage further productive investment, such as I4.0 technologies and new projects. On the one hand, managers are concerned about social aspects, such as the absence of workers, mainly for medical reasons. According to accident rate records of their companies, managers must pay a higher amount for popular insurance. That is at least what the survey reports with a high labor accident rate. Notwithstanding, the training is absent, which entails technical and social issues such as professional illnesses development as an inference of health cause (Mendoza-del Villar et al., 2020).

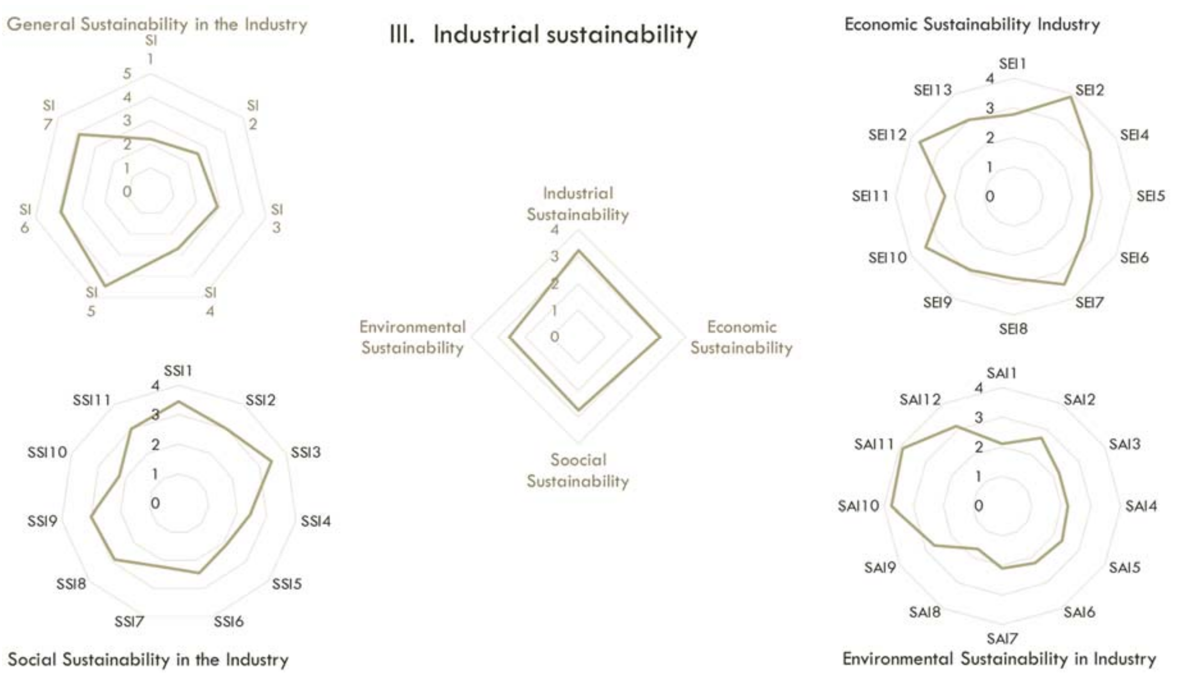


Figure IV-20 Evaluation of Sustainability in the Industry

On the other hand, the environmental field is not included in the companies' strategy since most of them do not regard an ecological management department. It means that neither eco-friendly activities (such as recycling waste) or proper toxic waste disposal procedures are not part of the product process development. Therefore, the conflict (link) between industry and environmental institutions is mainly due to improper industrial activities. The survey also highlights that investment aims to acquire economic growth and a faster return on investment or an economic feasibility pathway. In contrast, the last investment decision factor is greener production technology (Mendoza-del Villar et al., 2020).

Moreover, some interviews developed with two automotive, industrial cluster managers, and one cluster certification manager. They expressed their concerns—highlighting that Cluster is one of the drivers for sustainable industrial development (Mendoza-del Villar et al., 2019). The director of the industrial cluster certification said that "there is an identity absence of clusters. It is because they are mainly not as physical entities as to how a European cluster is. Conversely, clusters are only generated by industry demands; for instance, workforce, technology, and material demands". The Automotive Mexican Cluster's technical manager of the State of Mexico and the manager Director of la Laguna Automotive Cluster (CAL) confirmed it. For instance, despite the CAL has asked for support from the Academy, he answered that Academic services of engineering development have offered overpriced. Thereby, cluster demands have been rather supplied by the private sector instead of the Academical one, where prices are even around one-third of the Academy cost.

iv. Evaluation of the Future Industrial Trend

Finally, the last section of the questionnaire related to I4.0 answered by industrial managers shows their concerns about implementing I4.0 in the company. Despite what has been said about their economic scenario concerns, managers are willing to invest in I4.0 technology and training workers to achieve the knowledge and skills necessary for working with these technologies. Although their focus on improving manufacturing processes' efficiency could improve green practices, their answers revealed that saving money is by far the leading choice from the SME decision-makers' point of view. The productive improvement investment centres mainly on technological processes, digitalization, and automation, avoiding environmental and working conditions into the investment scope. Notwithstanding, as aforementioned, their economic concerns are more related to the current economic context, which is not favorable for a risky investment, so it would be the reason that they aim to get profits as soon as possible. Although I4.0 dates back to 2011 in the Hannover Fair in Germany (Zheng et al., 2019), as a developing country, Mexico is not still working on this kind of technology; since there is a lack of industrial policy that could help the industrial development (Riquelme, 2019).

Moreover, SMEs even stalled in the first or second productive model generations (Secretaria de Economía, 2016). The questionnaires answerers showed that just 22% of the firms surveyed are working with an ERP for digital representation of the company in real-time, as one of the beginner's steps towards I4.0 (Benešová & Tupa, 2017). Meanwhile, remaining firms are struggling to manage paper data systems, or at least that is what managers answered (Mendoza-del Villar et al., 2020).

From the managers' point of view, there are two main concerns for launching I4.0: the problematic implementation and threats & risks. On the one hand, there are some problems involving I4.0 technologies, i.e., managers mentioned that I4.0 technologies are unaffordable. Furthermore, also it affects the technological compatibility of different suppliers of new and actual I4.0 technologies. Moreover, the implementation costs of hiring high-tech and skilful workers, mainly for operating I4.0 technologies in the production line, would be considerable. Thereby, it involves risks since it takes investment on time, money, and training on them. Another riskier option can be to hire and train new workers who have recently graduated from I4.0 university careers.

On the other hand, the questionnaire responses showed threats & risks of implementing I4.0 and the previous risks mentioned. They felt into the cultural barrier, which is one of the mains social concerns of managers. They reported that the cultural barrier is generated by not regarding the workers from business development; unchaining that workers could intentionally spoil business operations. Even external threats are also subjected to technology with cyber-attacks, then it requires more skilled workers to manage these threats. Furthermore, low sales in the market represent a threat to a firm's bankruptcy. It comes when there is an uncertain economic market context with low income and high expenditure; besides, bearing in mind expenditure of I4.0 technologies investment is expensive too (Aguilar Rascón & Velázquez, 2019).

Finally, the questionnaire asked about the industry's latest generation to determine the main limitations to start up Industry 4.0 in their businesses. First of all, it seems to be a fashionable topic because 80% of the respondents answered to know the term I4.0. However, 10% of the participants said that they deal with the concept in their businesses. Likely, 25% have a vision of managing the concept implementation; however, 77.7% of digitization level is limited to operating only with a documented management system, while 22.2% carries it through an ERP (see **Table IV-5**). The questionnaire asks which would be the priority for acquiring 4.0 technologies, and the most widely accepted are cyber-physical and communication systems.

Table IV-5 Industry 4.0 SME's Scores

Qs	Industry 4.0 SME's approach	Sc
14.01	Have you heard about I 4.0?	4.00
14.02	Does your company deal with the concept of I4.0?	2.22
14.03	Do you have a vision of how I4.0 can be implemented in the business?	2.78
14.04	Do you think that the implementation of I 4.0 would modify the organizational structure of the company?	3.22
14.05	Would your staff train for the acquisition of knowledge for the implementation of I 4.0?	3.22
14.06	Would you invest in I4.0 technologies?	3.44

Likewise, there is a series of open questions, in which those questioned answered that the main problem for carrying out the I 4.0 focuses on the economic investment and the lack of capacity of the personnel to operate them and, if they do, the compatibility of the technologies do not make it feasible. On the other hand, the main threats they respond to are the lack of preparation in the personnel's attitude and aptitude to handle technologies, and an economic crisis puts a large investment at risk. Above all, cyberattacks lately are putting on risk security systems. Among the identified risks are hacking of industrial servers, a low educational level that collides with technological systems management. Moreover, a level of technical training that does not allow optimizing the benefits of implementing I4.0 and a sector crisis in the sector manufacturing triggers SMEs' bankruptcy. Finally, according to the respondents' criteria, qualified personnel at the engineering level are required to deal with the technologies of the I 4.0. Such as systems and process engineers, software development engineers, and information and communication technologies, mainly focus on an innovator as a business engineer (see **Figure IV-21**).

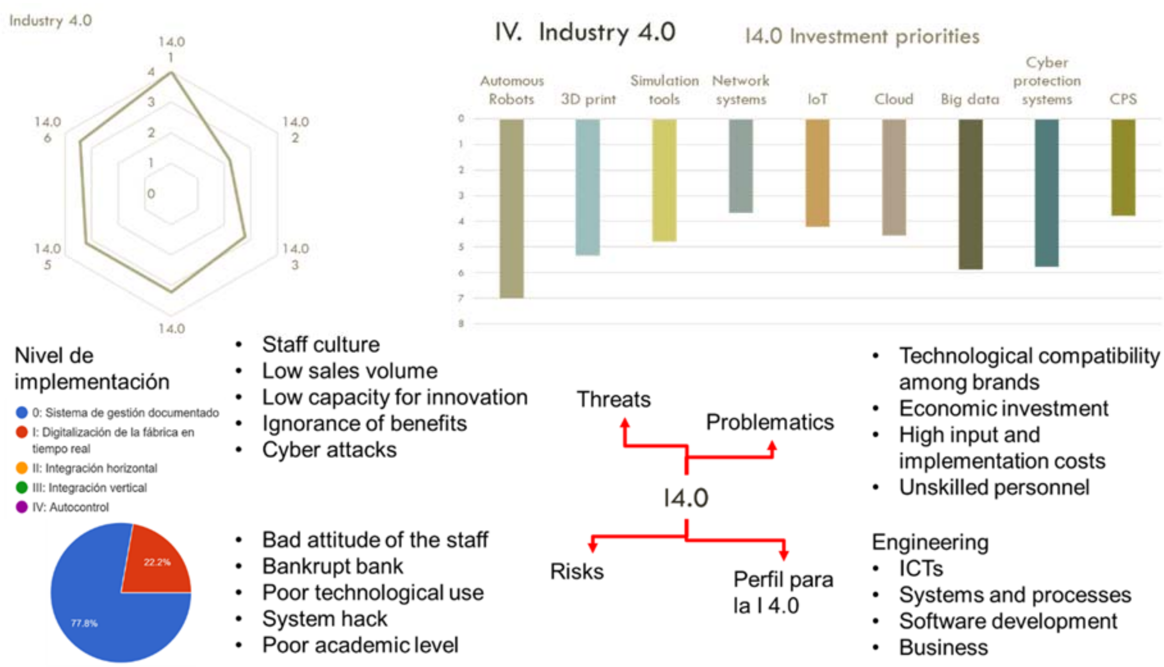


Figure IV-21 Response Summary section Industry 4.0

Relatedly with human resources, managers reported that most functional skills profiles are related to technical professions. However, no manager mentioned strengthening their strategy with social or environmental professional profiles. The suitable jobs, which the questionnaire reported, could face problematic implementation and risks & threats of I4.0 previously mentioned are systems and processes engineering, software development engineering, ICT's engineering, and business. Due to the I4.0 technology investment being high, business and systems engineering must align the core business with I4.0 technologies and maximize them throughout horizontal and vertical processes. Moreover, ICT and software development engineering tackle technological issues like I4.0 devices integration with the enterprise system and improve the system robustness against external attacks. Therefore, in this way, the workforce should be ready to meet current needs and future ones by forming human resources both in the academy and in the industry (Pinzone et al., 2018).

Most likely, **Figure IV-21** shows the decision-makers' priorities to invest in I4.0 technologies in the short term. Seemingly, managers want to begin the transition to incorporate I4.0 technologies by the interconnection of enterprise resources. Likely, they primarily invest in systems network communication such as an ERP. Furthermore, the 2nd priority, Cyber-physic systems (CPS), and in the 3rd place, the Internet of Things (IoT), the decision-makers are also keen on implementing these technologies. Then investment in I4.0 hardware tools, such as 3D printers in the 6th position and Autonomous Robots 9th position, are not priorities. Whereas, managers would invest preferably in software than hardware I4.0 tools, because the Cloud is in the 4th place, simulation tools in the 5th priority, Cyber-Protection Systems in the 7th, and finally the 8th place the Big Data.

Lastly, the cluster system's conflicted links are the social actors and environmental institutions. At the moment, it has not found so much about these initiatives linking social responsibility and eco-friendly systems with clusters organizations. There are certain exceptions in the Mexican central region context, i.e., eco-industrial or sustainable parks initiatives by AMPIP (AMPIP, 2020) and the sustainable activities by Querétaro Automotive Cluster (Automotive Cluster of Querétaro, 2020), which works with the cluster's members actions within a sustainable framework. Therefore, the central aim cluster is to gather industrial demands and offer them a supportive solution with Academia, Government, and other industrial solutions. However, adopting a holistic and innovative upper solution strategy would tackle the sustainable local challenge led by an innovator such as a sustainable industrial management system.

IV. 3. 4. Systemic model for the system in focus’s sustainable development

Based on the system in focus stated as JIV, the proposal sustainable systemic model is discussed by implementing it. Regarding the gathered information of the value's chain context in its several approaches and the firm's context, too; then, the diagnosis of the organization sustainability takes place.

As an overview of the focal system's value chain, foreign competitiveness is latent to reach the national economy through international trade treatments in the global market. Although the focal system can also take advantage of them, the firm should foster its strategy based on its core competence for a sustainable approach. On the one hand, the regional research and development innovation engineering area is clustered into the central region, led by Mexico City, the state of Mexico, and Puebla.

On the other hand, Mexico's state's productivity seems to align with the occupied personal index. Still, its efficiency does not compare to the volume production of the northern states. Regional sustainability evaluation result that Foreign Direct Investment and the Gross Domestic Profit per capita are significant for economic development, while people with and without social insurance determine social development. However, there is not any determinant that can explain the ecological sphere in the central region. In other words, the regional economy fosters its trustworthiness on foreign capital investing here and how it is aggregate distributed throughout the population. However, in the central region, both insured and not insured people shape the social sphere. Therefore, the central region's polarized population contributes to the general index aggregated, such as the gross domestic profit and the human development index obtained by the pass of time.

Moreover, the central region enjoys industrial clusters for the automotive, aerospace, and Information and Communication Technologies sectors. In which the State of Mexico gathers the automotive CLAUTEdoMex, Pro software A.C., and Textile clusters. Although these sectors are not part of the system in focus suppliers, they are valuable customers sector in the regional supply value chain where Original Equipment Manufacturers and End-Users are established. However, competitiveness is also part of such a supply chain.

The focal system is a firm that manufactures gear motors, speed reducers, spare parts, and it also offers maintenance service and overhaul of speed reducers.

Hereafter, the firm's core business activities mentioned earlier are stated to establish a sustainable strategy. Indeed, the purpose is to boost the core competence by highlighting the firm's identity while fostering them instead of spending valuable time on those that do not add value. JIV's core competence centres on heavy applications for industrial manufacturing activities, for instance, original equipment manufacturing, the Iron and steel industry, and the glass sector. Main inputs for gear motors and speed reducers transformation are steel, foundry, motors, bronze, and assembly components like bearings.

Notwithstanding, the firm’s behaviour showed that its value stream balance in several periods is negative. Thereby, a change in its sustainable strategy is required to get a transformation on an unsustainable pattern. Later, a meeting with stakeholders of the focal system took place, in which it gathered strategic position employees and the owner of the focal system. The meeting purpose was to establish the firm’s strategic goals and rules; thus, the owners’ vision is of utmost importance to structure it without leaving behind a viable strategy. As an SME firm, it was clear that it aims to make profits in the short-term since, as mentioned above, its value stream does not align with an affordable survival. Thus, the focal system’s aim goal is stated as the economic insurance profits return by selling motor gears and speed reducers, spare parts, and services that cover firms’ expenses and fulfill stakeholders’ expectancies.

In that way, the planning tool for the firm’s strategy OGSM is useful for stakeholders’ strategy deployment throughout the company’s horizontal and vertical processes. Thus, the focal system objective states as the economic insurance profits return by achieving competitive advantage from the market’s products. The primary financial goal that pursues achieving such an objective is to reach the sales goals per month. In that way, the strategies to achieve the firm’s goals obey the lean management principles that make it feasible to reach them. Thereby, to get that sales amount level, **Table IV-6** resumes the OGSM activities for the general objective achievement, where the firm’s variety should at least fulfill its capability to reach it.

Thus, the firm should meet financially and operative its operations in time, quality, and terms of customers' demands.

Table IV-6 OGSM activities for the general objective achievement

Strategy for Goals Achievement			
Business Activities	**Goal**	**Strategy**	**Metrics**
Sales	Sale 1'000,000 mxn	Market segment and sales empowerment	Sales per amount quoted by segment
Invoice	Invoice 1'000,000 mxn	Master project program	Collection effectiveness per amount expected
Purchase	Purchase 1'000,000 mxn	Purchase comparative	Money saved by budget per contract
Delivery	Delivery 1'000,000 mxn	Master project program	Delivery on time

However, why the objective mentioned above has not reached yet? A general overview through 5'whys is performed to answers it, where it claimed to not achieve the aim since a deployed reason stated as follows. Even the sales department submits an exceeded the number of quotations to fulfill customer's demands; its salesman reported that foreign competition used to gain them. According to customers' feedback, they used to choose other brands because lead time is shorter than what JIV offered, mostly because JIV competes with standardized products. The competence usually has batch existence in its stock. By the way, the recent JIV's ownership and management change have modified its suppliers' financial perception, which hardens the supply terms as new accounts.

Furthermore, the customer's relationship has been struggling with the current management since it did not fulfill stakeholders' demands. For instance, human resources did not get their salary with a promise to received them once the situation succeeded, suppliers did not receive payment, and customers, products. Therefore, **Figure IV-22** shows an analysis of the root cause related to the absence of a sustainable strategy, which should be the company's main concern. The study unfolds in evaluating people, methods, infrastructure, materials, and the environmental perspective. Among the main issues that the firm involves in the method section, they are.

Figure IV-22 Unsustainable performance elements of the system in focus

Employing a sustainable strategic approach by the viable inclusive and sustainable industrial development model would address the current business context's lack of sustainability. Therefore, concerning the background context information from the company's internal and external perspective, **Figure IV-23** devises the root cause analysis of the sustainable strategy absence as the firm's main concern based on people, methods, infrastructure, materials, and environmental perspective. It was found that among the main issues that the firm involves in the methods section are:

- The lack of planning.
- Procedures for communication and coordination.
- Absence of auditing dependence for quality and health and safety.

While in the people section, the current organizational chart does not fulfill the managerial system structure, turnover and employment discouragement are also part of the social issues and the role importance of the employees' contribution. Moreover, the infrastructure requires a transformation for improving the firm's competitiveness since the communication and coordination activities are performed mainly by the paper documented system. Indeed, the paper system is not a problem; the main concern is the lack of an established system declared that makes the system vulnerable. Besides, the workshop and warehouse are not organized, waste and obsolete parts are throughout these areas. As a consequence, potential risks involved in such disorganization affect the environmental section of the root analysis.

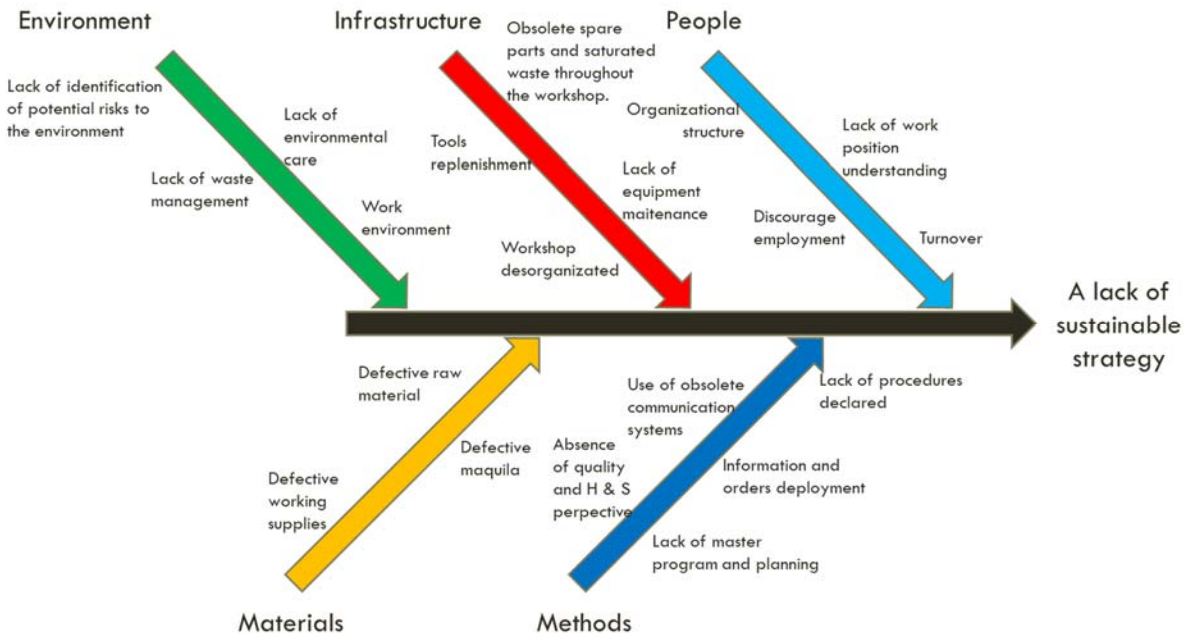


Figure IV-23 Root cause analysis of the unsustainable current JIV's situation

Therefore, it is of utmost importance to design a system that faces the lack of sustainable strategy; such a system should align to the core activities that the system in focus possesses. In that way, based on the support and strategic processes of JIV’s core processes presented in **Figure IV-13** and the organizational chart, the lack of managerial procedures determined is done by comparing the systemic model for sustainable development with the current JIV’s structure. The result depicted in **Figure IV-24** contains the minimum required systems to manage the system in focus towards sustainable development. Thus, based on it, the organizational chart is adapted to get at least the minimal systems needed for the proper management. **Figure IV-25** devises such adaption, where the organizational chart identifies the systems required for viability and sustainable development.

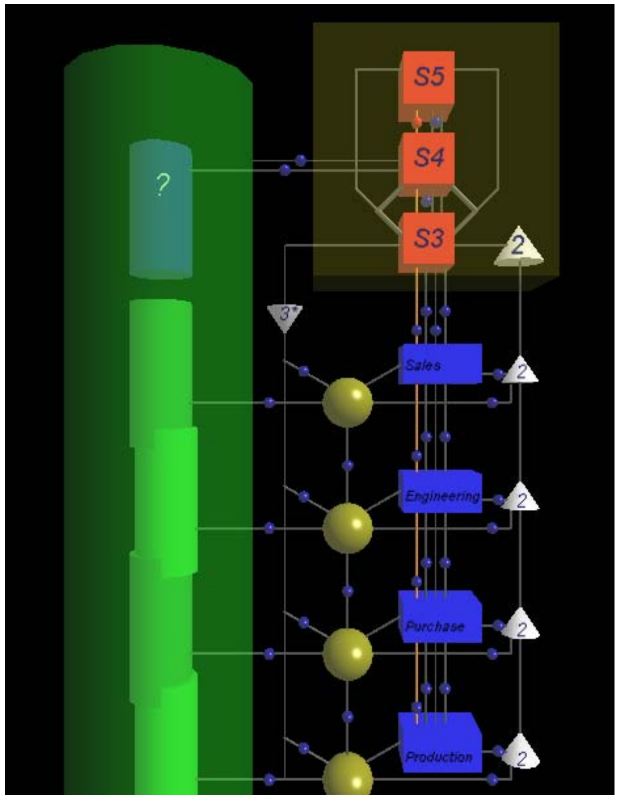


Figure IV-24 Viable system model for JIV's sustainability

The above figure shows the different viable systems that the firm contains aligned them to its core business. A Viable system is sustainable; thus, each of them adds value to the company; In which sales, engineering, purchase, and production departments devise the viability for the whole system. However, the lack of a coordination area has struggled with the proper performance for delivery on time. Thus, the introduction of a coordination area would support communication among each system one aforementioned. On the one hand, there are records of customers complaining about equipment without quality, and then, they return for warranty fulfillment. On the other hand, it translates to a waste of resources, but the most important is the likely loss of trust with customers' brand. Thereby, quality auditory should prevent and improve the production process and quality assurance to comply with customer satisfaction, without leaving behind preserving the environment by minimizing its impact and optimizing resources.

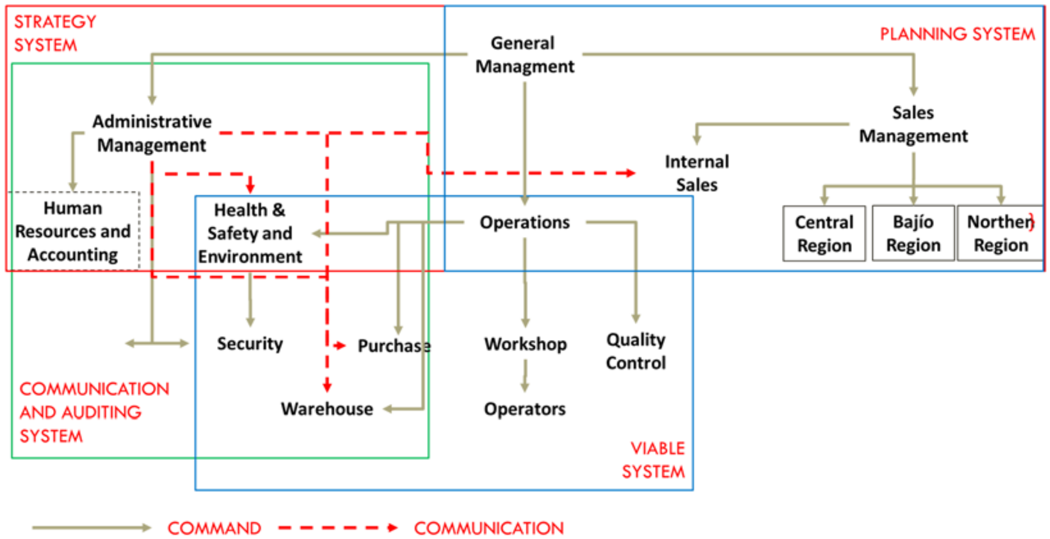


Figure IV-25 Organizational chart adapted based on the viable systems model

Indeed, coordination and auditing, and monitoring of viable systems activities should be deployed by a control and planning system. However, JIV's management scarce of these skills; neither the control system nor the planning system is performing correctly, otherways the firm should not have had an unsustainable performance. Likewise, the firm's policies have shown that customers, suppliers, and employees' demands convey an unsustainable strategy.

Moreover, based on Deming’s improvement cycle, as part of the planning activities that the firm should consolidate, a master planning program is developed according to the general process company mentioned in the JIV’s core processes. It fosters a formal structure for the overall firm activities. **Figure IV-26** exemplifies the whiteboard containing such activities to settle such master program; it is in a shared space that communicates the status per contract and supports planning activities. It makes new and works in process (WIP) available for every employee in the operations area. The program aligned logically with general procedures performed at JIV with each operational area’s aim forwards their following activities and be aware of what is coming. For instance, activities performed outside of the firm are a source of delayed time since the lack of declared procedures aligned to achieve common goals made JIV out of vision focus. Mainly maquila activities used to delay; or at least, that is what personnel complained about what affects delivery to customers on time.

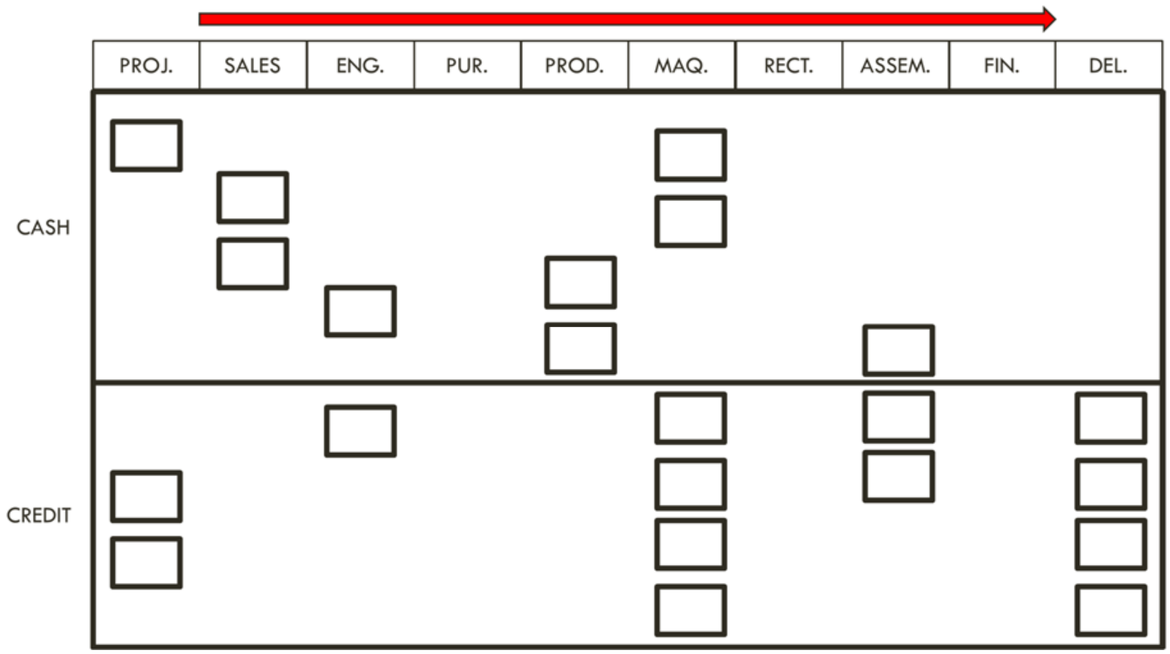


Figure IV-26 Master program for Operations Department

Once the general procedure is known and acknowledged by every operative employee, the foreground mapping deploys the background process mapping. Each mapping activity fosters its essence based on the knowledge management process of making implicit knowledge of JIV's procedures to explicit ones. The improvement team transferred knowledge of background procedures composed with the process expert, the quality inspector, and health & safety and environment assistant. They detailed each of the core activities without leaving aside quality, health & safety, and ecologically acceptable practices. Later, the do phase activities of Deming's improvement cycle, and to reach established goals, were performed according to what was planned and diagnosed, starting with the deployment phase visual management with the master program aforementioned.

Moreover, throughout Gemba tours, as a procedure of the do activities to follow the general process and during the tour, identify potential risks that could affect the operation, health and safety, and the environment. **Figure IV-27** depicts the JIV's workshop layout improved, where the workshop manager, quality control, and health and safety inspectors took the tour. They deployed several risky points to improve handling materials and reduce potential injure and accidents for employees. In that way, to handle materials efficiently, the improvement team implemented a couple of pallets, one for feeding work to operators. On the other hand, operators place work in process (WIP) for inspection and quality control approval. In this sense, the workshop and the assembly line have established a stated area where raw material, WIP, and spares are safely stocked. Furthermore, they located a space to store raw material and maquila entries; thus, the quality inspector checks and releases them to carry on in the workshop procedures.

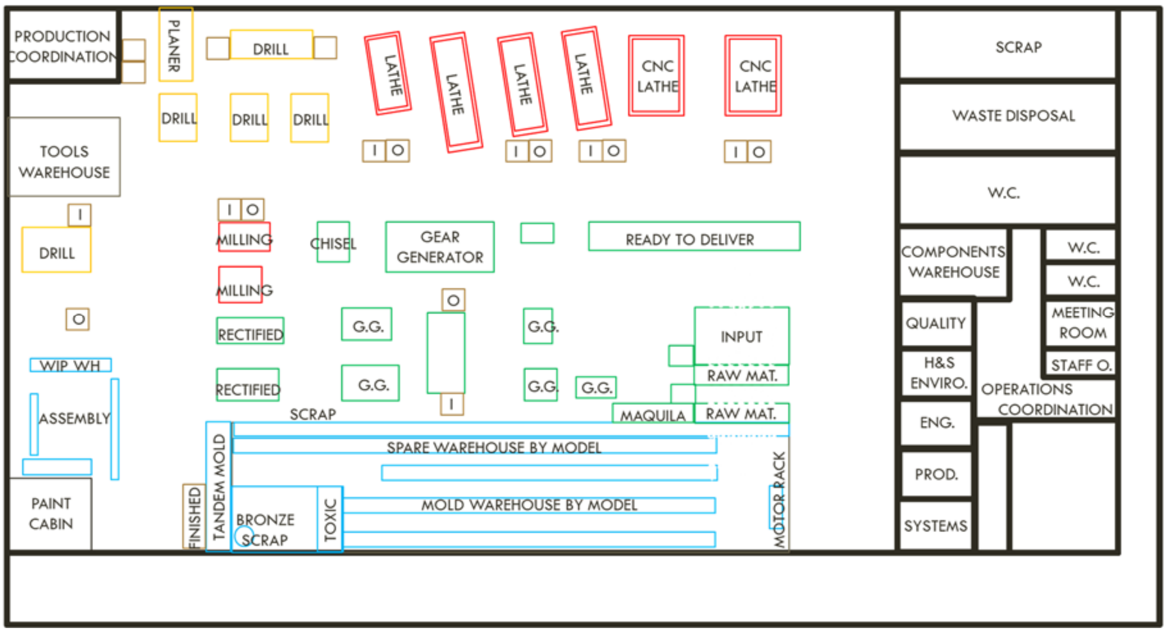


Figure IV-27 JIV's workshop layout

Likewise, other conflicted areas with potential contamination risks are material mixing scrap of steel and bronze and waste disposal, and toxic wastes. The health & safety and ecological supervisor sorted waste as valuable, valueless, and hazardous waste, mainly to avoid soil degradation, such as leaking toxic substances. Thus, he located dangerous materials in a confined area and handling them according to hazardous waste management. Valuable waste was placed in the scrap area to reduce the purchase of new materials; these materials can be recovered by applying lifecycle economy activities such as reusing, recycling, or even renewing. Notwithstanding, materials in bad conditions like bronze or steel chips are sold to waste dealers and get some refunds for the organization's financial support. On the other hand, the firm is regarded as a small generator since the solid emissions are low.

The project started in early January 2020; Gemba tour identified changes made later in February. However, a structural shift in the organization conveys a higher afford that involves strategy deployment actions. Furthermore, organizational transformation to reach a sustainable organization demands to align with a viable and sustainable system. Therefore, the operations area creation that coordinates viable systems to solve the lack of communication was proposed as the coordination and communication system. Notwithstanding, it has mentioned that quality control and health & safety, and ecological inspector were in the knowledge transfer process by mapping core business activities. Both employees are part of the auditing and monitoring system. As mentioned earlier, in any of the employees' profiles, the employees were not part of the organization until the current research's suggestions. However, these profiles' responsibility level suggested that core business mapping required auditing and monitoring profiles and processes owner perspectives to first reach a robust and detailed procedure before getting an upper and costly coordinator.

Thereby, auditing and monitoring employees were acquired in the firm before the operations coordinator hiring. Finally, after six months of carrying on working with an implicit structure of a viable system and fostering communication efforts for coordination among viable systems declared in **Figure IV-24** through the whiteboard visual management tool represented in **Figure IV-26** containing customer contracts. Hiring a profile that satisfies coordination and communication skills and fits with the overall system requirements made it easier to coordinate viable systems. It was then not improved the delivery of the outputs as finished products until the coordination and communication system implementation; it can be seen later in the improvement cycle's checking process. The productivity between total expenditure vs. the percentage of finished products grew even 260% in the following month after system two implementation. Indeed, to structure the overall system mentioned in **Figure IV-24** has already been made since the year's beginning.

The lean thinking that I referred to in this section related mainly to the firm's management, which means that meeting objectives requires the minimum variety needed to achieve them. The aim of getting financial survival indeed needs input resources and productive investment; in this sense, **Figure IV-28** mentions the system's general business processes in focus. On the one hand, activities that contribute to the firm's financial support are Sales, invoices, and Income; on the other hand, those involving financial spending for transformation are mainly materials, such as raw material or assembly components, power, and workforce. Therefore, it should take measurements of these activities for sustainable business evaluation of improvement decisions taken.

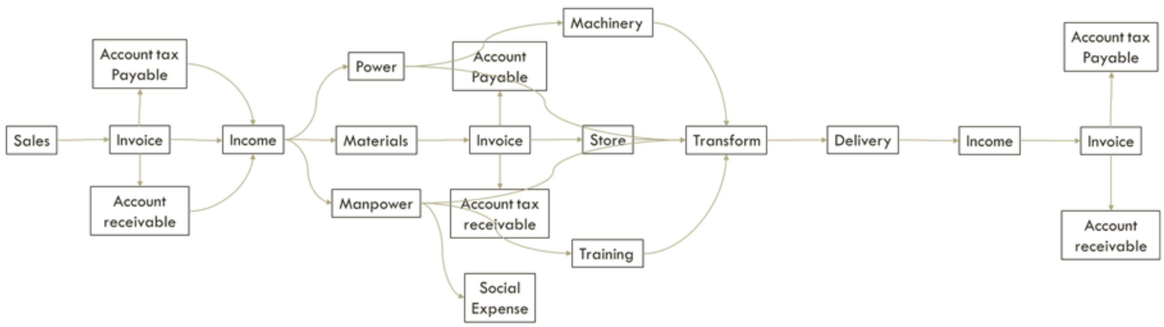
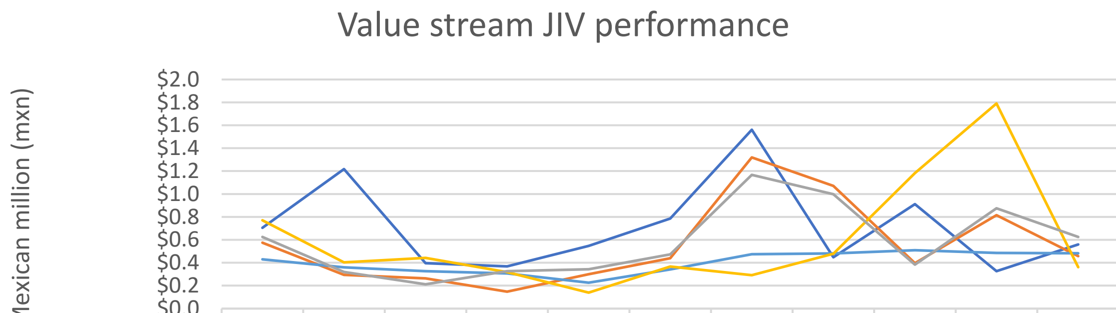


Figure IV-28 General JIV's business process

Once these activities are part of the day to day, Chartering operations occur to check how the firm reacts based on the changes mentioned above and general objectives deployed since OGSM. Employing lean thinking, then the balance of inputs and outputs requires measuring business performance indicators, such as sales, income, invoices, production, and expenses. The ratio between inputs and outputs determines JIV's productivity performance; for instance, income vs. remissions or invoices highlight how earnings are productively used. Indeed, chartering depicts the measurement of the current state of the process and records past scores; likewise, it shows how measures impact the chart behaviour. **Figure IV-29** mentions how JIV's value stream performs based on what has been said before; it regards sales, income (I), expenses (E), outputs (O), invoice (O2).



	January	February	March	April	May	June	July	August	September	October	November
Sales	0.704	1.218	0.395	0.368	0.546	0.786	1.562	0.447	0.911	0.327	0.559
Income (I)	0.574	0.294	0.263	0.147	0.299	0.439	1.320	1.071	0.395	0.815	0.457
Expenses (E)	0.430	0.360	0.326	0.306	0.226	0.341	0.474	0.481	0.510	0.485	0.482
Outputs (O)	0.770	0.403	0.442	0.318	0.139	0.366	0.290	0.478	1.183	1.791	0.360
Invoice (O) 2	0.624	0.319	0.212	0.326	0.342	0.472	1.167	0.998	0.384	0.876	0.624

Figure IV-29 Value stream JIV performance

Concerning the measurements mentioned in the Figure's table discussed above, underpin to describe the business performance utilizing the general JIV's business process. Each variable's function behaviour depends on decisions taken during the study period from January to November 2020. Indeed, it shows the business state regarding the sustainable strategy model, which comprehends strategic level measures and operative ones split from the Deming cycle phases. However, what is the relationship between business indicators? For this purpose, as an adjust activity of the Deming cycle, a multivariable analysis that responds to how outputs behave based on the general JIV's business process is performed. Sales, income, finished product delivery, invoices, and expenses split on purchase, power, payroll, taxes, and social expense were taken for such analysis. The significance p-value regarded with .05 and 0.95 regression coefficient adjusted for regression acceptance. I ran various sets with Minitab statistical software to find out how the variables are related to themselves. Based on the fulfilling statistic criteria mentioned above, it determined what explains income, finished product delivery, Invoicing, and the balance between income and expenses.

Table IV-7 summarizes the data set of multivariate models that can respond to income, outputs such as finished product delivery, invoice, and the balance between income and the sum of expenses. The next column mentions the adjusted R^2 of the indicator modelled and, finally, the significant variables (p-value<.05) that shape the indicator. Yet, significant variables (p-value<.05) that shape the indicator are denoted with capital X to those that mainly contribute to the model, whereas x variables are part of the model, but their contribution is not significant.

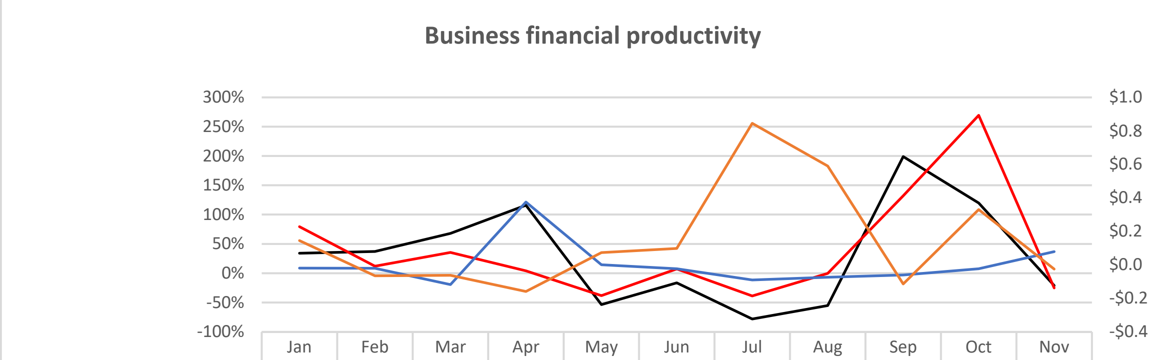
Table IV-7 Business indicators multivariance analysis

Indicator	R^2 (adj)	Income (I)	Expenses (E)	Outputs	Invoice	Purchase	Energy	Social Expense	Taxes	Payroll
Income	98.60%		X	x	X	x	x	x	x	
Outputs	97.31%	x	X		x	X	x	X	x	
Invoice	99.00%	X	x	x		x	x	x	x	
Balance (I-E)	98.12%			x	X	x	x	x	x	x

According to the multivariate analysis, on the one hand, income is determined mainly with expenses and invoicing; finished products as outputs, by the sum of costs and purchase, and curiously by social expenditure, even this is a sole output. Invoice shaped by income and the balance between income and the sum of expenses is determined mainly by invoicing. On the other hand, significant variables in the general business system are financial entry, invoicing, total expenditure, purchases, and the social expenditure remotely.

The business's financial productivity requires to be determined based on its productivity. Therefore, based on the significant variables, income, outputs, invoicing, and the economic balance, financial productivity is analyzed. In this way, the operative and financial efficiency and revenue, and total expenditure are calculated regarding invoicing and production delivered by the income obtained per month. Respectively, the resource utilization efficiency is the ratio between the value in outputs against the total cost generated in the firm; then, indicators in **Figure IV-30** translate business efficiency.

Business financial productivity and the relationship of the variables mentioned above are divided into three phases. The first one started at the beginning of the year; then the second one, when the formal system was implemented in September; and the third phase came after such an implementation. Although the first phase began with the activities implemented at the end of the year, such as the announcement of a viable system structure and most of the Gemba tour actions already performed; just operational efficiency and financial efficiency improved, while balance and resource utilization decayed till the fourth period. Conversely, after April, these indicators change their behaviour until September, where for instance, the balance has a significant measurement for good sales in the previous month. Later, in the second phase, during September, the operations coordinator figure starts working formally in the structure; the difference is that employees performed this activity implicitly before.



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov
Operative efficiency	34.08%	37.09%	67.97%	116.03%	-53.46%	-16.57%	-78.01%	-55.32%	199.21%	119.81%	-21.09%
Resources utilization	79.25%	12.00%	35.48%	3.91%	-38.34%	7.33%	-38.81%	-0.44%	131.94%	269.61%	-25.28%
Financial efficiency	8.73%	8.51%	-19.37%	121.67%	14.28%	7.56%	-11.60%	-6.79%	-2.94%	7.44%	36.72%
Balance (I - E)	0.145	-0.066	-0.063	-0.159	0.073	0.098	0.846	0.590	-0.115	0.330	-0.026

Figure IV-30 Business financial productivity

Thereby, the business mapping made it easy to transfer implicit knowledge to him and other employees; otherways, this figure should not have been useful to improve the utilization of resources and the operative efficiency in 269% and 199%, respectively. So, this phase makes the third part of the analysis, where also financial efficiency and the revenue improved. However, there is an abrupt decay in the last period since an unbalance of other indicators. For instance, general expenditure involves several expenses, including purchase; during October, even the income, invoicing, and output had good measurement. This month, sales and purchases did not align proportionally against previous indicators. Without sales and materials, then the income, production, and invoicing are not possible to obtain. Therefore, there is a lack of effort in sales and marketing activities to achieve sustained performance.

However, to face the unsustained sales and marketing performance, the focus aims to the strategic system. This system oversees how the environment is out of the focal system regarding the there and after operations. Notwithstanding, the global economy has collapsed due to a severe virus SARS COV-2, which has currently closed around 10,000 SMEs in Mexico (Téllez, 2020) and has struggled with its unemployment effect (Martínez, 2021). Furthermore, according to the type of activity, companies are allowed to operate in essential activity cases; otherwise, the firm should remain closed. Whatever the firm's activity, the value stream decays since the lack of circularity for all segments. In other words, due to the latest essential activity government update, manufacturing is an essential one, but most of the remainder firm are working remotely; thus, the sales department struggles to find customers. In that way, the firm should find ways to face the current environment without leaving aside healthy national measurements, for instance, boosting networking to find sales by all the possible networks like social or business media.

Finally, the policy system can balance the outside and inside effects of the firm and vice-versa. Also, it regards forecasting plans to adjust current operations; conversely, it reshapes current production for delivery time. Nevertheless, policy formulation is heavy to fall the responsibility in a lone figure; thus, a council representing the firm's stakeholder interest would absorb such variety involved in the organization. **Table IV-8** identifies each of the systems for JIV'S sustainable development.

Table IV-8 Viable system declared for JIV

System	Responsible Department
One of Sales	Sales department
One of Engineering	Department of operations, engineering and production
One of Purchase	Purchase department and administration
One of Production	Production department
Two of Coordination	Operations coordinator
Three * of Auditing	Departments of Health & safety, and Environment, Quality assurance, and Accounting
Three of Operative Control	General manager, Operation coordinator and Production department
Four of strategic planning	General manager and Sales department and Administration.
Five of policy council	General manager, Operation coordinator, Sales and Production department

Conclusion

Chapter V. Conclusion

V. 1. Conclusions

This section concludes with the investigation to achieve the general objective of building a systemic model for sustainable and inclusive industrial development in the manufacturing sector. Moreover, it regards how sustainable development relates to industrial development, identifying drivers that shape sustainability in the central region manufacturing context. Besides, the sustainability transformation's root systems and its relationship identification are particular objectives. They are all devising a strategical industrial development framework sustained with a sustainable industrial development literature review that employs the innovator's figure to support sustainable industrial development and represent the stakeholders' position. **Table V-1** resumes the general and particular objectives outputs obtained.

Table V-1 Objectives and outputs of the investigation

Objectives	Outputs
Relate sustainable development with industrial development	The theoretical relationship between SDG and industrial development coincides with 74 of 163 total goals equivalent to 52.4%.
Identify and represent the systems and relationships of the manufacturing industry with the different actors for sustainable industrial development.	Based on the systemic theory, relevant critical systems are Cluster, Industrial solution systems, the State, Environmental institutions, Academy, local and foreign actors.
Formulate a sustainably inclusive strategy for industrial development	The strategy fostered its approach based on the strategic competitiveness and the chain value from two perspectives, the industrial unit management and the comparative & competitive approach.

Identify and characterize the indicators that determine the sustainability of a region for the manufacturing sector	The sustainable evaluation is analyzed with two instruments; The first instrument with secondary records evaluation. On the one hand, it was determined that the working population and public debt drove the economic sphere at the national level, foreign investment, and GDP per capita at the regional level. On the other hand, the Insured population, social cohesion, and academic degree determine the national level's social sphere, while the insured and not insured population at the regional level. However, it was not found any significant driven for the ecological sphere at both levels. On the other hand, the second instrument to measure sustainability at the regional-local level was the questionnaire application applied to stakeholders of sustainable development. Answers aim that the social sphere is one of the main concerns. Likewise, there is a lack of formation and interest in the ecological pillar.
Build a systemic model for sustainable and socially inclusive industrial development in the manufacturing sector	Finally, the systemic model, built based on Beer's viable model, relates stakeholders involved in the industrial unit management. They are organized in the cybernetical structure of five central systems for sustainable and inclusive industrial development.

The model configures an industrial-organizational structure that complies with a sustainable and inclusive industrial development strategy based on the systemic theory. The model, delineated with the focal system, regards sustainable frameworks and a socially inclusive approach. Thus, the industrial cluster strategy proposed for sustainable industrial development establishes core competence differentiation that must highlight a competitive advantage to sustain a robust plan for a competitive business context. In this regard, the supra-system is where the system in focus must evaluate its context. The triple line bottom assessment determines the supra-system, or the focal system's context embedded; hence, sustainability fosters the industrial strategy to balance the TBL's dimensions algedonic channel. For that reason, the industrial cluster as the system in focus is the way to balance sustainability aligned to industrial growth adequately. Therefore, the sustainable industrial framework fosters its strategy based on the clusters and systems thinking theory. The systemic model for sustainable development contains the subsystems embedded that can analyze sustainable variables, such as how the region is wealthy or the average education grade of the people, or if raw material suppliers are close to the location system. Likewise, the strategy considers monitoring and auditing activities that stems frameworks to create sustainable policies such as the UN's 17 SDGs sustainable metrics that foster sustainability equilibrium.

Notwithstanding, the model's inclusiveness approach contemplates the innovator figure who acts as an entrepreneur for industrial development by regarding the value chain's critical root systems stakeholder's engagement and approval. It contains several system levels of the systemic model for regional industrial development to balance the triple line bottom with sustainable guidelines tools. Here, some decision-maker tools were mentioned, such as the value chain combined with sustainable guidelines and the firm's scope focus level. This proposal is a regional tool for improving the region's environment aimed at industrial policymakers as team innovators representing stakeholders' interests and society's welfare, and an adequate growth economy. Besides, according to industrial development impact, each recursive level analysis should be performed, such as at the firm, industrial parks, and industrial clusters levels. Thus, it depends on how stakeholders have defined their scope and the local sustainable region's maturity that the industrial management will manage.

The present research work presented a theoretical framework that would help develop an inclusive industrial development strategy. It supports sustainability and inclusiveness for industrial development. The viable structured model for industrial sustainable development details each of the systems involved and how critical root systems adequately distributed throughout the model transform industrial growth towards sustainable and inclusive industrial development act in the system. Such critical systems shape a framework that mainly links different stakeholders involved in the sustainable and inclusive industrial development transformation in the manufacturing sector, where the State plays a significant role in the industry's sustainable pillars equilibrium. An influential stakeholders' agreement level for Sustainable and inclusive industrial development would foster inclusiveness and reshape desirable sustainable outputs (Savaget et al., 2019; Virapongse et al., 2016). Moreover, the literature review mentioned promoting sustainability and inclusiveness into industrial development with I4.0 technologies linking ergonomics with socio-technical systems as the social sustainability bases (Pinzone et al., 2018; Steenkamp, 2019). Furthermore, social issues unchained by the cultural barrier of excluding inclusive social strategy and what it would trigger if workers' well-being is not taken into account for the development of the business and I4.0.

The analysis of context sustainability consists of two assessments; the first analysis involves sustainable variables of the value chain's system in focus context of the national and regional level; then, the second sustainability evaluation regards a survey analysis of critical roots systems approaches for sustainable development. On the one hand, the first assessment consists of analyzing the TBL variables at the national and Central regions to identify and characterize the variables that determine a region's sustainability for the manufacturing sector for sustainable development. They were selected employing multiple linear regression, analysis of variance, and the Durbin-Watson statistic. Social and economic indicators were found determinants at both levels, whereas the ecological sphere was not possible to identify indicators drivers that shape this sphere statistically.

On the other hand, the survey was done by employing questionnaires to get Stakeholders' perspectives. Both have in common that the social sphere is the primary concern for sustainable development; simultaneously, the ecological pillar presents a lack of interest. Later, based on the manufacturing sector's sustainability diagnosis stemming from the strategic-tactic-operational approaches' value chain, there is a significant lag in social sustainability for industrial development, mainly due to institutional corruption issues. It should consider social issues attention for a proper sustainable development into the industry that faces mainly those potential risks that make vulnerable SMEs and boost innovation programs that foster their integration in the value chain regarding SMEs core competence. Here, a case study illustrates the application model in a small firm located in Mexico's central region. Implementing partially the model since the lack of stakeholder's integration with a superior industrial unit management system shows improved operational efficiency. Such improvement fostered with lean management tools; the firm deployed its sustainable development. However, the current context has struggled with JIV's sales, but more than one million of the employed population has been unemployed. Moreover, more than 10,000 companies have suffered bankruptcy in Mexico due to the collapse of the world economy by COVID-19.

Thereby answering the hypothesis of adopting a strong sustainability model would support industrial development sustainably and inclusively for the manufacturing sector. Each of the particular objectives and the general one has given industrial development support elements and sustainable ones. The model relates to SDG as the most representative field of sustainability globally; besides, it is strategical since it regards a plan for planning industrial development based on the industrial unit's management. Likewise, its inclusive approach considers the system's stakeholders in order to achieve a feasible scope synergically into the values chain.

Last but not least, for developing and lagging developed economies, the task should gradually implement long-term sustainable industrial development through lean activities to build core operational advantages and obtain green products through the implementation of technologies. Under the stakeholder framework, it should be a key component for sustainable and inclusive industrial development oriented to balance economic growth with social well-being and the regional environment. Thereby, the industry would develop at the maturity level through lean sigma practices by implementing I4.0 technologies without leaving aside boosting their current role in the global market and improving their internal equilibrium.

V. 2. Need for more research

Due to its extensive scope, I should strengthen some areas at the end of this research. In that way, based on the evolution of industrial management's benefit and the relationship between comparative and competitive advantage for sustainable industrial development presented in the second chapter. **Figure II-8** and **Figure II-9** give useful highlights of what I mean; Therefore, a research project path depicted in **Figure V-1** devised the strategy to achieve sustainable and inclusive industrial development. There are squares in different colours announcing research already done and published in red and more investigation of the boxes in green. Their position relates to the research scope; notwithstanding, this research's contribution traces the path to achieving sustainable industrial development for the manufacturing sector where the cluster cooperation could reach innovation systems.

Therefore, the path identifies three remained research pieces that are still in a void of knowledge. According to an in-depth search, they are not available at the moment; thus, they require attention for a further state of the art on Industrial sustainable development. Currently, the investigation titled “Sustainable Business Model 4.0: Systemic model for sustainable industrial development" is carried out with the present research as a guideline; however, it is not still in the submission journal process. Furthermore, it suggests a practical approach as a consultancy methodology regarding strong sustainability as the firm strategy. Lastly, the design of sustainable industrial development policies for policymakers is another opportunity based on sustainable feasibility.

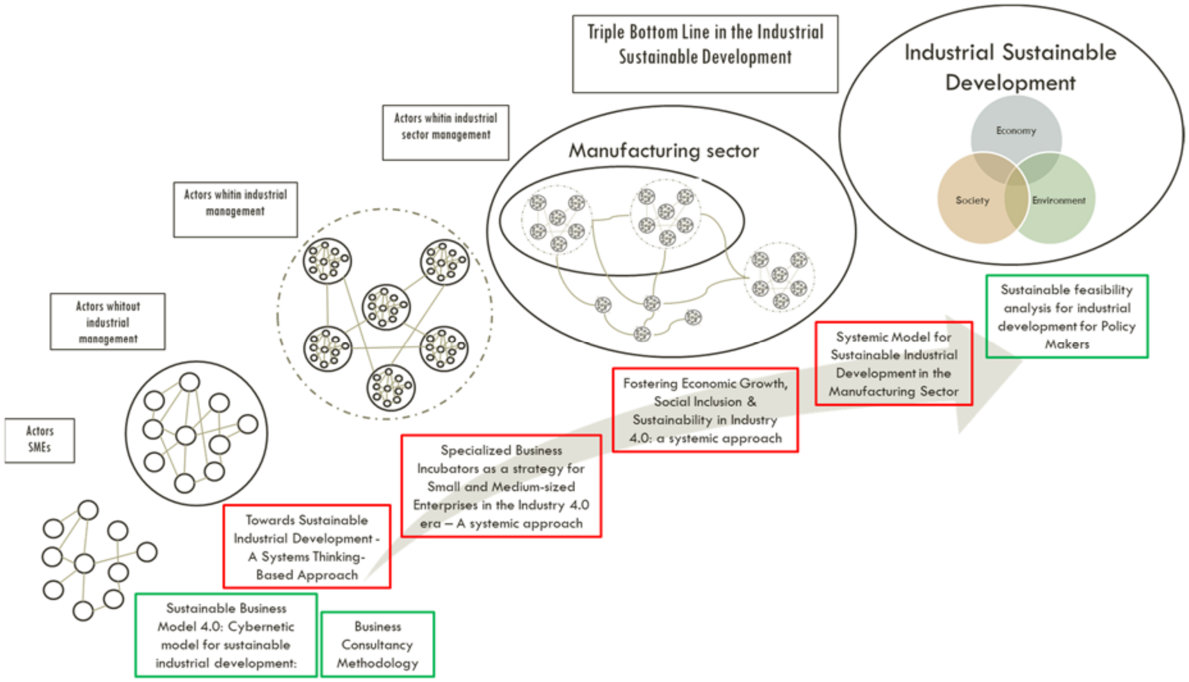


Figure V-1 Strategy for sustainable and inclusive industrial development

V. 3. Research outputs

There are four research pieces published until now (see **Appendix 6**), one at the national level and three at the international one.; the last three are indexed in Scopus for international conference proceedings.

Two of the research works were published in the proceeding presented at international conferences on Industrial Engineering and Operations Management (IEOM). The research titled "Towards Sustainable Industrial Development - A Systems Thinking-Based Approach" was published for the 3rd EU International Conference in Pilsen, The Czech Republic. My colleague Brugada and I presented the second work named "Specialized Business Incubators as a strategy for Small and Medium-sized Enterprises in the Industry 4.0 era – A systemic approach" at the 5th NA International Conference celebrated virtually in Michigan, USA.

The latest publication presented in the Journal of Procedia Manufacturing titled "Fostering Economic Growth, Social Inclusion & Sustainability in Industry 4.0: a systemic approach". This research is part of the 30th International Conference on Flexible Automation and Intelligent Manufacturing (FAIM2020).

However, any of these outputs would not have been affordable if I had not presented my first research paper, “Systemic model for sustainable industrial development in the manufacturing sector.” I presented for the XVII National Congress of Electromechanical and Systems Engineering in Mexico City.

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Appendix

Appendix 1. Glossary (François, 2004)

Autopoiesis

The condition of a system can regenerate itself by self-production of its own elements and the network of their characteristics interactions. This notion was introduced by Maturana, who wrote, “the systems that are defined as unities a network of production of components that recursively, though interactions, generate and realize the network that produces them. It also constitutes in the space in which they exist, the boundaries of this network as components that participate in the realization of the network.

Conceptual Model

A systemic account of the human activity system built based on that’s system root definition, usually in the form of a structured set of verbs in the imperative mood. “Such models should contain the minimum necessary activities for the system to be the one named in the root definition”.

Homeostasis

A system's capacity to maintain its morphology, functionality, and internal states at some definite level through fluctuations within established maxima and minima, despite external conditions.

Root definition

“A concise, tightly constructed description of a human activity system which states what the system is” “what it does is then elaborated in a conceptual model which is built on the basis of definition. Every element in the definition must be reflected in the model derived from it. A well-formulated foot definition will make explicit each of the CATWOE elements.

Subsystem

“An element or functional component of a larger system which fulfils the conditions of a system in itself; but also plays a specialized role in the operation of the system”

Suprasystem

A system of higher order in relation to some systems or subsystems or lower order. Barrier also considered that the universe could also be represented as nesting of systems, etc. Furthermore, the emergence of suprasystems corresponds to new levels of the emergence of complexity.

Sustainability

Any sustainable process and still more so any complex system depends obviously on the use of the resources to not exhaust them.

Sustainability cannot be maintained forever through a linear process; in fact, it is necessary based on the interdependence in the relationship of the process or system with its significant environment. Runaway processes are hazardous for sustainability, which can generally not be restored after such episodes.

Many current economic and ecological processes are obviously unsustainable at long and possibly even in the medium-term. If the need for permanent balanced re-equilibrated feedback with their input sources, such as recycling, is not understood in due time, collapses could become unavoidable.

Sustainable

a process' characteristic to maintain it perpetually. A systemic approach is sustainable in this sense if a regular and permanent input of needed resources is guaranteed and if the process does not end up choked by its own products.

The chances for a process to remain sustainable are low if it uses up an ever-growing quantity of critical inputs: such a situation typically leads to scarcity or exhaustion of the process's resources and asphyxia. Thus, only steady-state processes can be sustained in the long run. Generally, after a progressively slowing down growth phase. This is an essential notion for a systemic process of development "Economics in systemic terms."

Symbiosis

“An exchange between systems in which a part of each system’s autonomy is sacrificed to enhance a superordinate system relationship”. In symbiosis, “one or more systems may benefit, and none are harmed”. “The stronger superordinate relationship ultimately increases each of the original system’s resilience” and “systems are observed to be more symbiotic and more communicative with other systems in their environment after a dissipative transformation process.”

System

“A set of elements dynamically interacting and organized in relation to a common goal.”

“Systems One”

They are frequently numerous in a complex system. Each one attends a specific process related to a particular part of the active environment of the system.

“Systems Two”

Are coordinating metasystems of system one, which have anti oscillatory effects, or acts as “input attenuators” locally and globally

“Systems Three”

Are concerned with the general coordination and coherence between system one and Two

“System Four”

Responds to the need to cope with a larger environment and unknown future. It aims at giving a wider space (environment) and time (planning) frame to systems three to one. To operate correctly, any system four needs to have access to the full variety available in system one to three.

“System Five”

In accordance with Ashby’s Law of requisite variety, must contain general models of system three and four to be able to control through general closure, if possible, unexpected external variety. Unfortunately, system five, as a “general boss” (individual or collective), is always in danger in becoming an autocratic power "that will sooner or later make a global mistake" (a possible way to avoid this could be the hierarchical organization model).

Weltanschauung

A global paradigmatic worldview. Any weltanschauung "can not only serve as a guide for empirical efforts but (also) as a perceptual filter which can exclude data and causal inference which would be incompatible with the context of the paradigm itself."

Appendix 2. Sustainability indicators

$$TMAC = \left(\frac{Vt}{Vi}\right)^{\left(\frac{1}{n-1}\right)} - 1$$

Where:

TMAC Annual average growth rate
Vt value of the period t
Vi value of the period i
n number of periods between t and i

Economic dimension variables

Variable	National	Regional	State	Municipality
Balance of trade	X			
Government Public Debt	X	X	X	X
Foreign direct investment	X	X	X	
Active Economic Population	X	X	X	X
Non-Economic Active Population	X	X	X	X
Working population	X	X	X	X
Unemployed Population	X	X	X	X
Salaried Employed Population	X	X	X	
Gross domestic product	X	X	X	X
Per capita gross domestic product	X	X	X	X

a) Gross domestic product

Source: http://www.inegi.org.mx/sistemas/bie/

Table 0-1 Gross domestic product, Central Region, u: current billion USD

Region	PIB 2000	PIB 2005	PIB 2010	PIB 2015	TMAC
Centro	$217.99	$317.64	$382.11	$420.98	3.18%
Norte	$97.98	$152.31	$189.99	$215.32	3.92%
Occidente	$57.79	$82.92	$99.91	$114.50	3.65%
Noroeste	$51.68	$77.87	$90.87	$103.98	3.27%
Pacífico Sur	$30.08	$40.50	$49.91	$52.02	2.82%
Golfo de México	$53.39	$92.05	$117.43	$114.05	2.41%
Sureste	$36.60	$71.40	$76.72	$58.80	-2.13%
Total National	**$545.52**	**$834.69**	**$1,006.94**	**$1,079.66**	**2.90%**

b) Balance of trade

Source: http://www.inegi.org.mx/sistemas/bie/

Table 0-2 National trade balance u: millions of dollars

National Trade Balance	1991	1995	2000	2005	2010	2015	2018	TMAC 00-18
Total balance	**-$7279**	**$7088**	**-$8337**	**-$7587**	**-$3009**	**-$14683**	**-$13159**	**2.72%**
Petroleum products		$5985	$8151	$15495	$11482	-$10188	-$18856	-205.06%
Non-oil products		$1104	-$16488	-$23081	-$14491	-$4495	$5697	193.94%

c) Foreign Direct Investment

Source:https://www.gob.mx/se/acciones-y-programas/competitividad-y-normatividad-inversion-extranjera-directa?state=published

Table 0-3 Foreign Direct Investment u: Billions of USD at current prices

Region	IED 1990	IED 1995	IED 2000	IED 2005	IED 2010	IED 2015	IED 2017	TMAC
Centro	$2.91	$5.42	$9.30	$11.61	$10.41	$14.25	$11.83	1.51%
Norte	$0.55	$1.57	$4.94	$7.81	$9.01	$10.06	$8.70	3.60%
Occidente	$0.11	$0.10	$0.01	$0.56	$0.98	$1.20	$0.89	29.53%
Noroeste	$0.10	$0.81	$1.91	$2.82	$3.28	$2.61	$3.02	2.92%
Pacífico Sur	$0.02	$0.00	$0.37	$1.05	$0.68	$2.30	$2.15	11.66%
Golfo de México	$0.01	$0.42	$1.41	$1.61	$2.42	$3.42	$2.89	4.60%
Sureste	$0.01	$0.04	$0.31	$0.57	$0.55	$1.09	$0.87	6.70%
Total National	**$3.72**	**$8.37**	**$18.25**	**$26.02**	**$27.32**	**$34.93**	**$30.35**	**3.23%**

d) Active Economic Population

Source:

http://www3.inegi.org.mx/sistemas/iter/default.aspx?ev=1

https://www.uv.mx/apps/censos-conteos/1980/menu1980.html

http://www3.inegi.org.mx/sistemas/tabuladosbasicos/tabentidad.aspx?c=33141&s=est

http://www3.inegi.org.mx/sistemas/iter/default.aspx?ev=5

Table 0-4 Economically active population; National, u: million inhabitants

Region	PEA 1990	PEA 2000	PEA 2010	TMAC
Centro	9.45	13.46	17.42	3.27%
Norte	3.86	5.32	6.96	3.15%
Occidente	2.88	4.15	5.48	3.44%
Noroeste	1.94	2.79	3.89	3.74%
Pacífico Sur	2.29	3.19	4.21	3.26%
Golfo de México	2.91	4.02	5.03	2.92%
Sureste	0.73	1.22	1.72	4.58%
Total National	**24.06**	**34.15**	**44.70**	**3.31%**

e) Working population

Source

http://www3.inegi.org.mx/sistemas/iter/default.aspx?ev=1
https://www.uv.mx/apps/censos-conteos/1980/menu1980.html
http://www3.inegi.org.mx/sistemas/tabuladosbasicos/tabentidad.aspx?c=33141&s=est
http://www3.inegi.org.mx/sistemas/iter/default.aspx?ev=5

Table 0-5 Working population, National u: millions of inhabitants

Region	POCUP 1990	POCUP 2000	POCUP 2005	POCUP 2010	POCUP 2015	TMAC
Centro	9.188	13.259	14.783	16.559	16.976	1.78%
Norte	3.752	5.262	5.858	6.586	6.780	1.83%
Occidente	2.812	4.108	4.629	5.257	5.414	1.99%
Noroeste	1.892	2.766	3.206	3.701	3.828	2.35%
Pacífico Sur	2.220	3.161	3.580	4.080	4.187	2.03%
Golfo de México	2.820	3.964	4.376	4.819	4.912	1.54%
Sureste	0.721	1.211	1.414	1.667	1.718	2.53%
Total National	**23.403**	**33.730**	**37.846**	**42.670**	**43.813**	**1.89%**

f) Worker population insured (Worker population Salaried)

Source

https://www.gob.mx/issste/documentos/anuarios-estadisticos?idiom=es
https://public.tableau.com/profile/imss.cpe#!/vizhome/Histrico_4/Empleo_h?publish=yes
http://datos.imss.gob.mx/group/poblacion-derechohabiente-adscrita-pda

Table 0-6 Worker population insured u: millions

Region	2000	2005	2010	2015	2017	TMAC
Centro	5.95	6.10	6.82	8.26	8.87	2.52%
Norte	3.20	3.19	3.53	4.34	4.69	2.43%
Occidente	1.62	1.73	2.02	2.35	2.62	3.04%
Noroeste	1.55	1.61	1.75	2.13	2.32	2.55%
Pacífico Sur	0.62	0.67	0.76	0.86	0.91	2.39%
Golfo de México	1.39	1.45	1.61	1.78	1.78	1.56%
Sureste	0.56	0.66	0.74	0.90	0.99	3.71%
Total National	**14.89**	**15.41**	**17.24**	**20.62**	**22.18**	**2.52%**

g) Informal Working Population

Source

https://www.gob.mx/issste/documentos/anuarios-estadisticos?idiom=es
https://public.tableau.com/profile/imss.cpe#!/vizhome/Histrico_4/Empleo_h?publish=yes
http://datos.imss.gob.mx/group/poblacion-derechohabiente-adscrita-pda

Table 0-7 Informal working population, National u: million

Region	PTRABNA 2000	PTRABNA 2005	PTRABNA 2010	PTRABNA 2015	TMAC

Centro	7.410	8.385	10.004	10.016	3.39%
Norte	2.067	2.316	3.102	3.144	4.62%
Occidente	2.484	2.804	3.325	3.330	3.29%
Noroeste	1.215	1.391	1.839	2.020	4.71%
Pacífico Sur	2.539	2.876	3.329	3.408	3.05%
Golfo de México	2.572	2.838	3.242	3.265	2.61%
Sureste	0.655	0.762	0.896	0.955	3.54%
Total National	**18.942**	**21.372**	**25.738**	**26.137**	**3.47%**

h) Unemployed Population

Source

https://www.gob.mx/issste/documentos/anuarios-estadisticos?idiom=es
https://public.tableau.com/profile/imss.cpe#!/vizhome/Histrico_4/Empleo_h?publish=yes
http://datos.imss.gob.mx/group/poblacion-derechohabiente-adscrita-pda

Table 0-8 Unemployed population u: thousands of inhabitants

Region	1980	1990	2000	2010	TMAC	Proporción
Centro	249.93	266.09	204.53	860.39	17.31%	42.35%
Norte	110.54	112.84	60.32	374.29	22.49%	18.43%
Occidente	80.94	70.92	43.55	223.99	19.96%	11.03%
Noroeste	58.24	43.49	28.08	186.00	23.38%	9.16%
Pacífico Sur	81.42	66.83	33.36	129.91	16.31%	6.40%
Golfo de México	77.46	88.30	53.12	208.27	16.39%	10.25%
Sureste	14.30	11.41	10.19	48.53	18.94%	2.39%
Total National	**672.83**	**659.87**	**433.14**	**2031.37**	**18.73%**	**100%**

Social dimension variables

VARIABLE	NACIONAL	REGIONAL	ESTATAL
Total population	X	X	X
insured population	X	X	X
Uninsured population	X	X	X
Public investment	X	X	X
Average Grade School	X	X	X
Human development Index	X	X	X
Social Cohesion Coefficient	X	X	X

a) Total population

Source

https://www.uv.mx/apps/censos-conteos/1980/menu1980.html
http://www3.inegi.org.mx/sistemas/tabuladosbasicos/tabentidad.aspx?c=33141&s=est

http://www3.inegi.org.mx/sistemas/iter/default.aspx?ev=5

Table 0-9 Total population, u: million inhabitants

Region	1980	1990	1995	2000	2005	2010	2015	TMAC	Proporción
Centro	26.54	31.06	34.92	39.84	39.63	42.73	45.20	0.91%	37.89%
Norte	10.59	12.86	14.35	15.23	16.29	17.70	18.79	1.51%	15.75%
Occidente	8.31	10.10	11.25	11.77	12.24	13.44	14.32	1.41%	12.01%
Noroeste	4.76	6.01	7.00	7.67	8.36	9.22	9.84	1.80%	8.25%
Pacífico Sur	6.56	8.85	9.21	10.44	10.92	11.99	12.72	1.42%	10.66%
Golfo de México	8.38	9.98	11.01	11.55	12.12	13.15	13.95	1.35%	11.69%
Sureste	1.71	2.39	2.90	3.22	3.71	4.10	4.46	2.34%	3.74%
Total National	**66.85**	**81.25**	**90.64**	**99.72**	**103.26**	**112.34**	**119.28**	**1.29%**	**100%**

b) Beneficiary population to Health Services

Sources

http://www3.inegi.org.mx/sistemas/iter/default.aspx?ev=1

http://www3.inegi.org.mx/sistemas/tabuladosbasicos/tabentidad.aspx?c=33141&s=est

http://www3.inegi.org.mx/sistemas/iter/default.aspx?ev=5

Table 0-10 Population entitled to health services u: millions of inhabitants

Region	2000	2005	2010	TMAC	Proporción
Centro	15.22	17.56	26.07	3.92%	35.95%
Norte	8.38	9.81	13.13	3.27%	18.11%
Occidente	4.46	5.51	8.43	4.64%	11.62%
Noroeste	4.12	5.18	6.70	3.54%	9.25%
Pacífico Sur	2.09	2.39	6.66	8.61%	9.18%
Golfo de México	4.09	6.08	8.53	5.40%	11.76%
Sureste	1.42	1.92	2.99	5.48%	4.13%
Total National	**39.77**	**48.45**	**72.51**	**4.38%**	**100%**

c) Population without Right to Health Services

Sources

http://www3.inegi.org.mx/sistemas/iter/default.aspx?ev=1

http://www3.inegi.org.mx/sistemas/tabuladosbasicos/tabentidad.aspx?c=33141&s=est

http://www3.inegi.org.mx/sistemas/iter/default.aspx?ev=5

Table 0-11 Population without Right to Health Services u: millions of inhabitants

Region	2000	2005	2010	TMAC	Proporción
Centro	23.24	20.65	16.00	-4.06%	42.09%
Norte	6.47	6.03	4.21	-4.67%	11.07%
Occidente	7.07	6.33	4.83	-4.15%	12.70%

Noroeste	3.19	2.76	2.40	-3.13%	6.31%
Pacífico Sur	8.07	8.24	5.19	-4.79%	13.65%
Golfo de México	7.30	5.81	4.35	-5.60%	11.43%
Sureste	1.76	1.59	1.05	-5.61%	2.76%
Total National	**57.11**	**51.40**	**38.02**	**-4.42%**	**100%**

d) Public investment

Source: http://www.inegi.org.mx/sistemas/bie/

Table 0-12 Public investment, u: billions of dollars

Region	1990	1995	2000	2005	2010	2015	2016	TMAC	Proporción
Centro	0.95	0.81	0.88	1.44	2.60	2.44	2.55	7.34%	56.83%
Norte	0.21	0.15	0.66	1.26	2.85	0.82	0.51	-1.71%	11.38%
Occidente	0.14	0.12	0.31	0.66	0.93	0.29	0.25	-1.44%	5.51%
Noroeste	0.12	0.12	0.29	0.60	0.62	0.36	0.31	0.44%	6.83%
Pacífico Sur	0.10	0.12	0.29	0.60	1.14	0.46	0.44	2.87%	9.89%
Golfo de México	0.32	0.20	0.72	0.54	1.15	0.55	0.34	-4.95%	7.51%
Sureste	0.03	0.01	0.20	0.19	0.28	0.24	0.09	-5.09%	2.05%
Total National	**1.87**	**1.54**	**3.35**	**5.29**	**9.58**	**5.15**	**4.48**	**1.97%**	**100%**

e) Human Development Index (HDI)

Source:
http://www.mx.undp.org/content/dam/mexico/docs/Publicaciones/PublicacionesReduccionPobreza/InformesDesarrolloHumano/idhmovilidadsocial2016/PNUD%20IDH2016.pdf

Region	1950	1960	1970	1980	1990	1995	2000	2010	TMAC
Centro	0.429	0.510	0.598	0.699	0.771	0.769	0.803	0.841	0.522%
Norte	0.508	0.579	0.650	0.733	0.796	0.800	0.830	0.862	0.412%
Occidente	0.449	0.513	0.607	0.700	0.760	0.763	0.791	0.820	0.405%
Noroeste	0.562	0.632	0.690	0.764	0.823	0.820	0.842	0.863	0.274%
Pacífico Sur	0.330	0.402	0.490	0.591	0.663	0.672	0.694	0.736	0.655%
Golfo de México	0.457	0.539	0.612	0.701	0.762	0.759	0.781	0.813	0.447%
Sureste	0.488	0.529	0.591	0.692	0.785	0.790	0.814	0.844	0.408%
Total National	**0.464**	**0.535**	**0.612**	**0.704**	**0.772**	**0.773**	**0.801**	**0.833**	**0.443%**

f) Social Cohesion Coefficient (GINI Coefficient)

Sources:

https://datos.gob.mx/busca/dataset/indicadores-de-pobreza-2010-2016-nacional-y-estatal/resource/0b05c378-1a8e-49b1-8d6b-7fca61da26cc?inner_span=True

http://sedesson.gob.mx/BISS/Indicadores%20de%20cohesion%20social%20segun%20entidad%20federativa%2C%20Mexico%202008%20-%202010.xlsx
https://www.coneval.org.mx/Medicion/EDP/Paginas/Evolucion-de-las-dimensiones-de-la-pobreza-1990-2014-.aspx
https://www.coneval.org.mx/Informes/Pobreza/Cohesi%C3%B3n%20social/Indicadores%20de%20cohesi%C3%B3n%20social%20seg%C3%BAn%20municipio,%20M%C3%A9xico%202010.zip
https://www.coneval.org.mx/Medicion/Paginas/Cohesion_Social.aspx

Table 0-13 Social Cohesion Indicator (GINI)

Region	1990	2000	2010	2016	TMAC
Centro	0.53	0.53	0.46	0.46	-0.95%
Norte	0.50	0.49	0.49	0.46	-0.40%
Occidente	0.53	0.51	0.46	0.44	-1.01%
Noroeste	0.49	0.48	0.48	0.45	-0.43%
Pacífico Sur	0.53	0.55	0.52	0.49	-0.78%
Golfo de México	0.53	0.53	0.49	0.47	-0.69%
Sureste	0.52	0.56	0.48	0.45	-1.43%
National Average	**0.56**	**0.55**	**0.51**	**0.50**	**-0.68%**

g) Average school grade

Sources

http://apps1.semarnat.gob.mx/dgeia/indicadores_verdes/indicadores/archivos/01_contexto/complementarias/IC_CSE_4.1.1_A.xlsx

http://www3.inegi.org.mx/sistemas/tabuladosbasicos/tabentidad.aspx?c=33141&s=est

http://www3.inegi.org.mx/sistemas/iter/default.aspx?ev=5

http://www.beta.inegi.org.mx/proyectos/enchogares/especiales/intercensal/

http://www.beta.inegi.org.mx/temas/educacion/

http://www.beta.inegi.org.mx/proyectos/ccpv/2010/

Table 0-14 Social Cohesion Indicator (GINI)

Region	1980	1990	2000	2010	2015	TMAC
Centro	4.38	6.45	7.64	8.75	9.30	1.41%
Norte	4.66	6.60	7.71	8.87	9.42	1.44%
Occidente	4.32	6.10	7.25	8.44	8.97	1.53%
Noroeste	5.11	7.23	8.10	9.29	9.81	1.38%
Pacífico Sur	2.73	4.57	5.90	6.96	7.54	1.76%
Golfo de México	4.18	6.13	7.30	8.48	9.01	1.51%
Sureste	4.02	5.93	7.33	8.61	9.19	1.63%
National Average	**4.59**	**6.50**	**7.60**	**8.63**	**9.16**	**1.34%**

Environmental dimension variables

VARIABLE	NACIONAL	REGIONAL	ESTATAL	MUNICIPAL

Population Density	X	X	X	X
Average occupants per House	X	X	X	X
Homes with all services	X	X	X	X
Homes with drinking water services	X	X	X	X
Homes with electricity service	X	X	X	X
Homes with drainage services	X	X	X	X
Water consumption	X	X	X	X
Energy consumption	X	X	X	X
Vehicle Park	X	X	X	X
Greenhouse Gas Emissions	X	X	X	X

a) Population Density

Sources:

https://www.uv.mx/apps/censos-conteos/1980/menu1980.html

http://www3.inegi.org.mx/sistemas/tabuladosbasicos/tabentidad.aspx?c=33141&s=est

http://www3.inegi.org.mx/sistemas/iter/default.aspx?ev=5

Table 0-15 Population Density u: inhabitants / Km²

Region	1980	1990	1995	2000	2005	2010	2015	TMAC
Centro	203.92	238.61	268.28	306.07	304.49	328.33	347.30	0.91%
Norte	14.53	17.65	19.69	20.90	22.35	24.29	25.78	1.51%
Occidente	48.63	59.10	65.78	68.85	71.57	78.60	83.78	1.41%
Noroeste	12.45	15.72	18.31	20.06	21.87	24.13	25.76	1.80%
Pacífico Sur	28.58	38.53	40.10	45.45	47.52	52.19	55.37	1.42%
Golfo de México	47.39	56.47	62.32	65.37	68.60	74.41	78.93	1.35%
Sureste	12.23	17.09	20.75	23.04	26.51	29.33	31.88	2.34%
National Average	**34.13**	**41.49**	**46.28**	**50.92**	**52.73**	**57.36**	**60.91**	**1.29%**

b) Homes with all services

Sources:

https://www.uv.mx/apps/censos-conteos/1980/menu1980.html

http://www3.inegi.org.mx/sistemas/tabuladosbasicos/tabentidad.aspx?c=33141&s=est

http://www3.inegi.org.mx/sistemas/iter/default.aspx?ev=5

Table 0-16 Homes with all the services u: million homes

Region	1980	1990	2000	2010	TMAC
Centro	4.75	6.06	6.73	9.20	2.30%
Norte	1.88	2.59	2.70	3.99	2.62%
Occidente	1.47	1.95	2.00	2.94	2.43%
Noroeste	0.87	1.23	1.30	2.12	3.10%

Pacífico Sur	1.20	1.68	0.93	1.62	1.05%
Golfo de México	1.58	2.04	1.62	2.49	1.59%
Sureste	0.32	0.48	0.46	0.85	3.43%
Total National	**12.07**	**16.04**	**15.74**	**23.21**	**2.28%**

c) Homes with electricity service

Sources:

https://www.uv.mx/apps/censos-conteos/1980/menu1980.html
http://www3.inegi.org.mx/sistemas/tabuladosbasicos/tabentidad.aspx?c=33141&s=est
http://www3.inegi.org.mx/sistemas/iter/default.aspx?ev=5

Table 0-17 Homes with electricity service u: million homes

Region	1980	1990	2000	2010	TMAC
Centro	3.99	5.60	8.35	10.41	3.36%
Norte	1.43	2.30	3.30	4.40	3.96%
Occidente	1.13	1.77	2.48	3.28	3.75%
Noroeste	0.70	1.11	1.70	2.40	4.34%
Pacífico Sur	0.57	1.24	1.91	2.68	5.48%
Golfo de México	0.98	1.59	2.45	3.31	4.29%
Sureste	0.25	0.43	0.70	1.04	5.12%
Total National	**9.04**	**14.03**	**20.90**	**27.52**	**3.91%**

d) Homes with drinking water service

Sources:

https://www.uv.mx/apps/censos-conteos/1980/menu1980.html
http://www3.inegi.org.mx/sistemas/tabuladosbasicos/tabentidad.aspx?c=33141&s=est
http://www3.inegi.org.mx/sistemas/iter/default.aspx?ev=5

Table 0-18 Homes with drinking water service u: million homes

Region	1990	2000	2010	TMAC
Centro	5.05	7.63	9.65	3.47%
Norte	2.14	3.11	4.20	3.61%
Occidente	1.58	2.23	3.06	3.54%
Noroeste	1.01	1.56	2.26	4.32%
Pacífico Sur	0.88	1.40	1.93	4.26%
Golfo de México	1.26	1.95	2.73	4.15%
Sureste	0.35	0.65	0.98	5.58%
Total National	**12.26**	**18.53**	**24.81**	**3.78%**

e) Homes with drainage service

Sources:

https://www.uv.mx/apps/censos-conteos/1980/menu1980.html
http://www3.inegi.org.mx/sistemas/tabuladosbasicos/tabentidad.aspx?c=33141&s=est
http://www3.inegi.org.mx/sistemas/iter/default.aspx?ev=5

Table 0-19 Homes with drainage service u: million homes

Region	1990	2000	2010	TMAC
Centro	4.36	7.14	9.84	4.38%
Norte	1.70	2.81	4.14	4.80%
Occidente	1.39	2.19	3.15	4.40%
Noroeste	0.77	1.39	2.24	5.80%
Pacífico Sur	0.61	1.17	2.17	6.92%
Golfo de México	1.14	1.94	2.95	5.11%
Sureste	0.24	0.49	0.92	7.41%
Total National	**10.20**	**17.12**	**25.41**	**4.92%**

f) Vehicle Park

Source:
https://www.inegi.org.mx/sistemas/olap/Proyectos/bd/continuas/transporte/vehiculos.asp?s=est?c=13158

Table 0-20 Vehicular park, u: million vehicles

Region	1980	1990	2000	2010	2017	TMAC
Centro	2.72	3.90	5.82	11.00	18.89	5.53%
Norte	0.88	1.83	3.06	6.07	7.41	6.09%
Occidente	0.54	1.04	2.18	4.94	6.83	7.31%
Noroeste	0.67	1.13	1.84	3.18	4.26	5.29%
Pacífico Sur	0.17	0.35	0.75	1.89	2.83	8.07%
Golfo de México	0.50	0.93	1.53	2.89	3.72	5.75%
Sureste	0.11	0.24	0.43	1.16	1.83	8.15%
Total National	**5.59**	**9.42**	**15.61**	**31.14**	**45.77**	**6.02%**

g) Energy consumption

Source: http://datos.cfe.gob.mx/Datos/Usuariosyconsumodeelectricidadpormunicipio.csv

Table 0-21 Energy consumption u: thousands of billions of watts

Region	2010	2011	2012	2013	2014	2015	2016	2017	TMAC
Centro	44.86	50.67	58.53	60.46	60.46	62.34	64.28	116.48	17.24%
Norte	46.81	51.68	53.09	52.16	52.16	53.75	54.15	82.53	9.91%
Occidente	20.95	22.24	22.64	22.73	22.73	22.51	22.83	47.57	14.65%

Noroeste	25.44	27.65	28.66	28.52	28.52	28.18	28.74	46.89	10.73%
Pacífico Sur	7.55	7.99	8.11	8.12	8.12	8.32	8.66	13.14	9.68%
Golfo de México	21.18	22.72	23.46	22.94	22.94	22.89	23.53	43.68	12.82%
Sureste	7.56	7.98	8.18	8.47	8.47	8.76	9.34	18.20	15.76%
Total National	**174.35**	**190.93**	**202.67**	**203.40**	**203.40**	**206.74**	**211.53**	**368.49**	**13.28%**

h) Greenhouse Gas Emissions

Sources

1999 Mexico National Emissions Inventory Final, October 2006

http://sinea.semarnat.gob.mx/sinea.php?process=UkVQT1JURUFET1I=&categ=1

http://sinea.semarnat.gob.mx/sinea.php?process=UkVQT1JURUFET1I=&categ=14

Table 0-22 Greenhouse gas emissions or: million tonnes

Region	1999	2005	2008	TMAC
Centro	9.64	14.36	11.50	2.22%
Norte	7.78	13.91	10.49	3.80%
Occidente	5.79	13.51	13.03	10.66%
Noroeste	3.38	8.28	6.83	9.18%
Pacífico Sur	6.79	6.66	6.45	-0.64%
Golfo de México	3.78	7.31	6.27	6.53%
Sureste	3.29	7.17	4.35	3.56%
Total National	**40.46**	**71.19**	**58.92**	**4.81%**

Appendix 3. Evaluation report of the variables for sustainable development (Only in Spanish)

National sustainable development evaluation

A. Economic sustainable development

Regresión de los mejores subconjuntos: PIB vs. DEPU, IED, POCUP, PTA, AÑO

Variables totales	R-cuad.	R-cuad. (ajust)	R-cuad. (pred.)	Cp de Mallows	S	DEPU	IED	POCUP	PTA
2	98.1	97.2	94.4	17.1	50963545544	X			
2	96.9	95.3	90.7	28.8	65354049910				X
3	99.8	99.5	98.7	3.2	20325128513	X		X	
3	99.1	98.1	93.3	9.9	41370510333	X	X		
4	99.9	99.7	98.2	4.0	17347279470	X	X	X	
4	99.8	99.4	91.8	4.9	23220413667	X		X	X
5	99.9	99.4	88.1	6.0	23954961112	X	X	X	X

Las siguientes variables se incluyen en todos los modelos: AÑO

Análisis de regresión: PIB vs. AÑO, DEPU, POCUP

Ecuación de regresión

PIB = -96987141924254 + 49402455338 AÑO + 296.7 DEPU - 39572 POCUP

Coeficientes

Término	Coef	EE del coef.	IC de 95%	Valor T	Valor p	FIV
Constante	-9.69871E+13	1.17908E+13	(-1.34511E+14, -5.94634E+13)	-8.23	0.004	
AÑO	49402455338	6025371941	(30227032668, 68577878009)	8.20	0.004	54.29
DEPU	296.7	42.6	(161.2, 432.2)	6.97	0.006	5.73
POCUP	-39572	8409	(-66332, -12813)	-4.71	0.018	70.15

Resumen del modelo

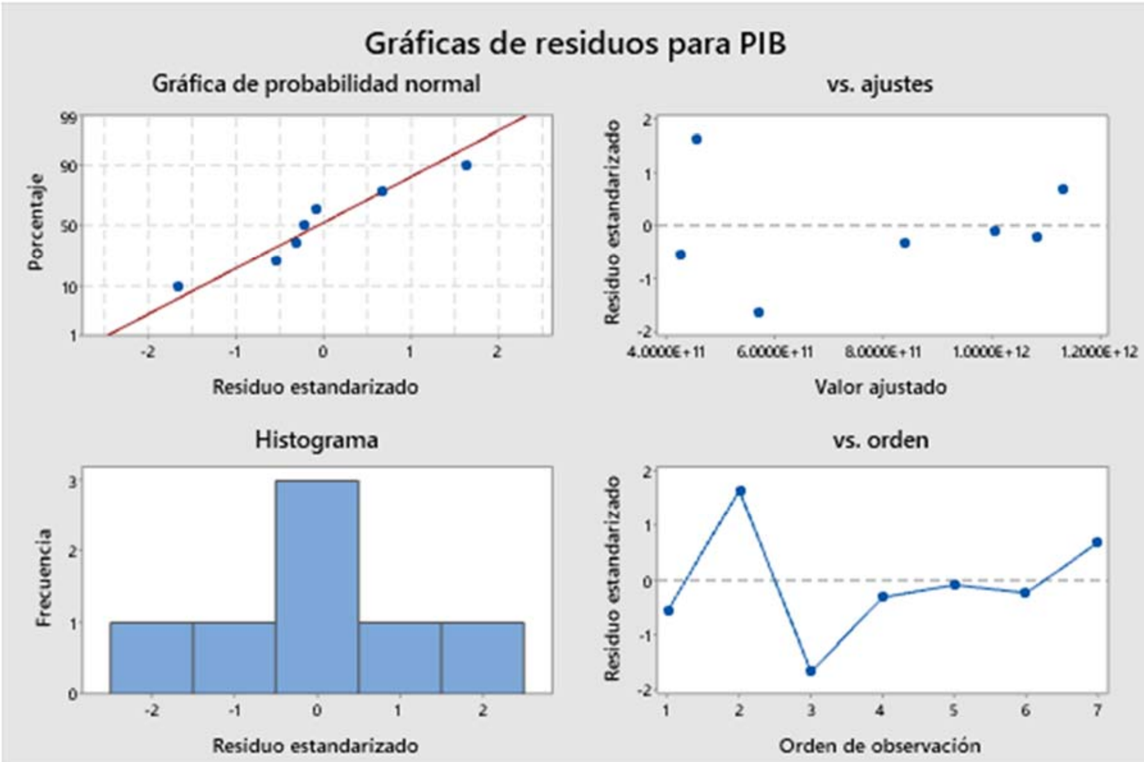
S	R-cuad.	R-cuad. (ajustado)	PRESS	R-cuad. (pred)	AICc	BIC
2.03251E+10	99.77%	99.55%	7.28768E+21	98.67%	416.23	355.96

Análisis de Varianza

Fuente	GL	SC Sec.	Contribución	SC Ajust.	MC Ajust.	Valor F	Valor p
Regresión	3	5.48649E+23	99.77%	5.48649E+23	1.82883E+23	442.70	0.000
AÑO	1	5.28288E+23	96.07%	2.77713E+22	2.77713E+22	67.22	0.004
DEPU	1	1.12118E+22	2.04%	2.00582E+22	2.00582E+22	48.55	0.006
POCUP	1	9.14980E+21	1.66%	9.14980E+21	9.14980E+21	22.15	0.018
Error	3	1.23933E+21	0.23%	1.23933E+21	4.13111E+20		
Total	6	5.49889E+23	100.00%				

Estadístico de Durbin-Watson

Estadístico de Durbin-Watson = 2.74372



B. Social sustainable development

Regresión de los mejores subconjuntos: IDH vs. PCDSS, GINI, GRES, AÑO

la respuesta es IDH

Variables totales	R-cuad.	R-cuad. (ajust)	R-cuad. (pred.)	Cp de Mallows	S	PCDSS	GINI	GRES
2	88.8	83.2	54.8	36.8	0.028882			X
2	88.3	82.5	51.5	38.5	0.029518	X		
3	90.4	80.7	33.9	33.6	0.030963		X	X
3	89.4	78.9	36.0	36.7	0.032408	X	X	
4	99.4	98.2	70.9	5.0	0.0093906	X	X	X

Las siguientes variables se incluyen en todos los modelos: AÑO

HOJA DE TRABAJO 1
Análisis de regresión: IDH vs. PCDSS, GINI, GRES, AÑO

Ecuación de regresión

IDH = -236.3 + 0.000000 PCDSS + 1.708 GINI - 1.733 GRES + 0.1222 AÑO

Coeficientes

Término	Coef	EE del coef.	IC de 95%	Valor T	Valor p	FIV
Constante	-236.3	41.5	(-414.8, -57.8)	-5.70	0.029	
PCDSS	0.000000	0.000000	(0.000000, 0.000000)	5.53	0.031	2586.47
GINI	1.708	0.287	(0.473, 2.942)	5.95	0.027	6.70
GRES	-1.733	0.298	(-3.016, -0.449)	-5.81	0.028	11095.06
AÑO	0.1222	0.0214	(0.0302, 0.2141)	5.72	0.029	3199.79

Resumen del modelo

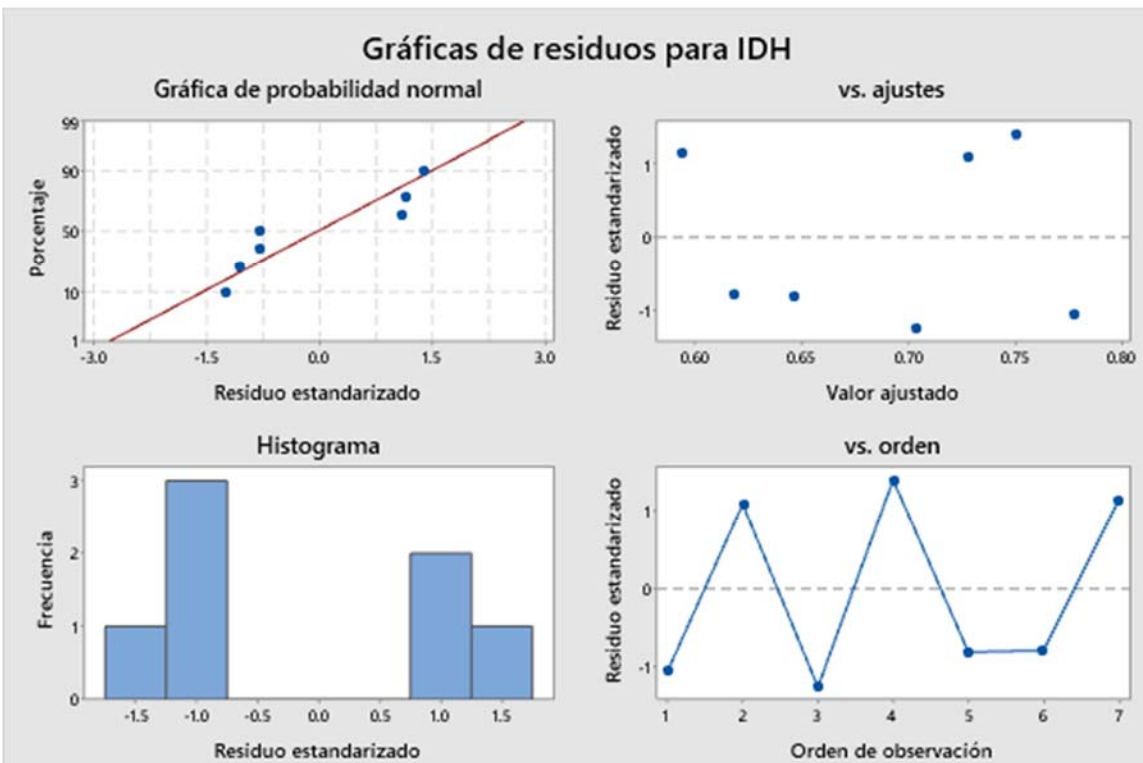
S	R-cuad.	R-cuad. (ajustado)	PRESS	R-cuad. (pred)	AICc	BIC
0.0093906	99.41%	98.23%	0.0086895	70.88%	*	-42.58

Análisis de Varianza

Fuente	GL	SC Sec.	Contribución	SC Ajust.	MC Ajust.	Valor F	Valor p
Regresión	4	0.029663	99.41%	0.029663	0.007416	84.10	0.012
PCDSS	1	0.026334	88.25%	0.002700	0.002700	30.62	0.031
GINI	1	0.000301	1.01%	0.003124	0.003124	35.43	0.027
GRES	1	0.000147	0.49%	0.002975	0.002975	33.73	0.028
AÑO	1	0.002881	9.65%	0.002881	0.002881	32.67	0.029
Error	2	0.000176	0.59%	0.000176	0.000088		
Total	6	0.029840	100.00%				

Estadístico de Durbin-Watson

Estadístico de Durbin-Watson = 2.66053



C. Environmental sustainable development

Regresión de los mejores subconjuntos: CO2 vs. WHATT, PQVH, VPH_C_ELEC, DENPOB, AÑO

la respuesta es CO2

Variables totales	R-cuad.	R-cuad. (ajust)	R-cuad. (pred.)	Cp de Mallows	S	WHAT	PQVH	VPH_C_ELEC	DENPOB
2	98.0	97.1	94.0	12.2	12658			X	
2	97.9	96.9	93.9	13.1	13098				X
3	98.3	96.6	94.2	12.4	13592		X	X	
3	98.2	96.4	0.0	13.1	14016	X		X	
4	99.8	99.3	81.6	4.5	6105.0		X	X	X
4	98.4	95.3	0.0	13.5	15969	X	X	X	
5	99.9	99.1	0.0	6.0	6965.3	X	X	X	X

Las siguientes variables se incluyen en todos los modelos: AÑO

HOJA DE TRABAJO 1

Análisis de regresión: CO2 vs. AÑO, PQVH, VPH_C_ELEC, DENPOB

Ecuación de regresión

CO2 = -15166614 + 7251 AÑO + 0.00946 PQVH - 0.0563 VPH_C_ELEC + 36005 DENPOB

Coeficientes

Término	Coef	EE del coef.	Valor T	Valor p	FIV
Constante	-15166614	9186660	-1.65	0.241	
AÑO	7251	4726	1.53	0.265	370.22
PQVH	0.00946	0.00254	3.72	0.065	219.81
VPH_C_ELEC	-0.0563	0.0140	-4.04	0.056	1731.00
DENPOB	36005	10036	3.59	0.070	998.09

Resumen del modelo

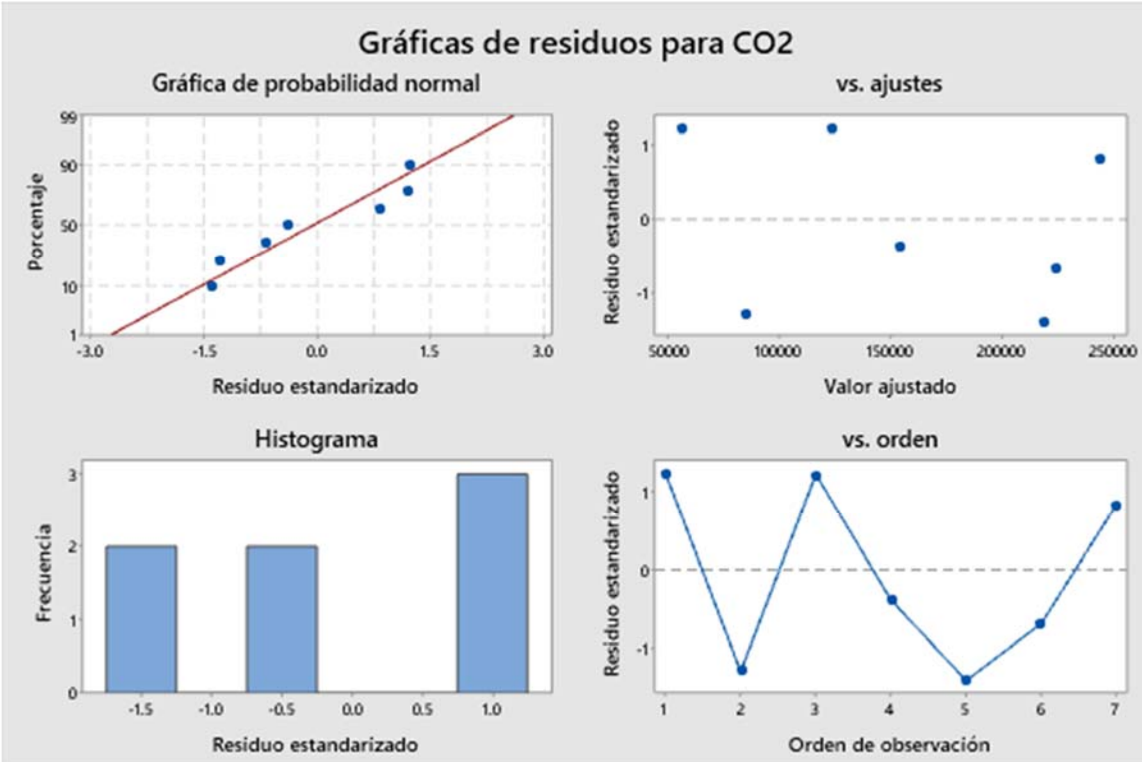
S	R-cuad.	R-cuad. (ajustado)	R-cuad. (pred)
6104.96	99.77%	99.32%	81.58%

Análisis de Varianza

Fuente	GL	SC Ajust.	MC Ajust.	Valor F	Valor p
Regresión	4	32641439715	8160359929	218.95	0.005
AÑO	1	87735803	87735803	2.35	0.265
PQVH	1	517086531	517086531	13.87	0.065
VPH_C_ELEC	1	606912237	606912237	16.28	0.056
DENPOB	1	479668031	479668031	12.87	0.070
Error	2	74540961	37270480		
Total	6	32715980675			

Estadístico de Durbin-Watson

Estadístico de Durbin-Watson = 2.84352



Center Region sustainable development evaluation

A. Economic sustainable development

HOJA DE TRABAJO 1
Regresión de los mejores subconjuntos: PIB vs. PIBpC, DEPU, IED, AÑO

la respuesta es PIB

Variables totales	R-cuad.	R-cuad. (ajust)	R-cuad. (pred.)	Cp de Mallows	S	PIBpC	DEPU	IED
2	99.5	99.2	97.9	10.3	10317638326	X		
2	99.3	99.0	97.1	13.8	11800909913		X	
3	99.9	99.8	99.5	3.2	5226618341	X		X
3	99.6	99.1	97.5	10.1	10702220610	X	X	
4	99.9	99.7	97.6	5.0	6132482224	X	X	X

Las siguientes variables se incluyen en todos los modelos: AÑO

HOJA DE TRABAJO 1
Análisis de regresión: PIB vs. AÑO, PIBpC, IED

Ecuación de regresión

PIB = -10840701597340 + 5442179386 AÑO + 37585203 PIBpC - 4.74 IED

Coeficientes

Término	Coef	EE del coef.	IC de 95%	Valor T	Valor p	FIV
Constante	-1.08407E+13	1.99637E+12	(-1.71941E+13, -4.48735E+12)	-5.43	0.012	
AÑO	5442179386	1013889776	(2215529615, 8668829157)	5.37	0.013	23.24
PIBpC	37585203	4655859	(22768181, 52402225)	8.07	0.004	19.11
IED	-4.74	1.34	(-8.99, -0.49)	-3.55	0.038	4.53

Resumen del modelo

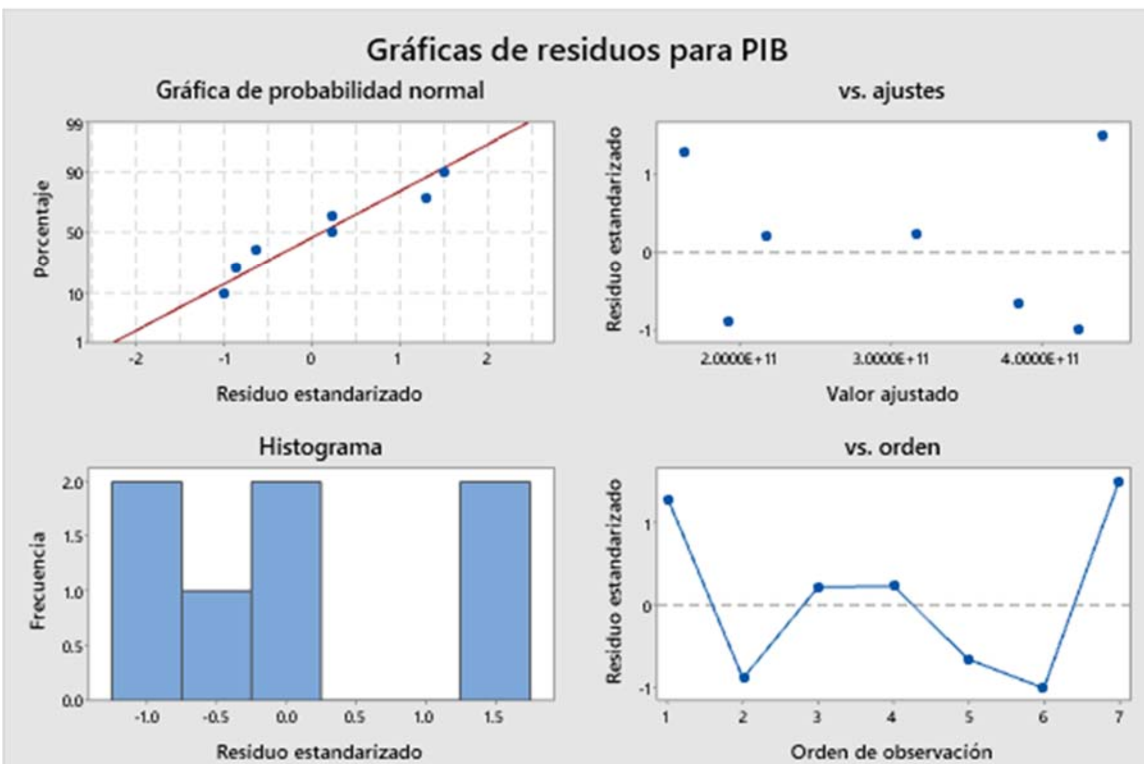
S	R-cuad.	R-cuad. (ajustado)	PRESS	R-cuad. (pred)	AICc	BIC
5226618341	99.90%	99.80%	4.11021E+20	99.49%	397.21	336.94

Análisis de Varianza

Fuente	GL	SC Sec.	Contribución	SC Ajust.	MC Ajust.	Valor F	Valor p
Regresión	3	8.05677E+22	99.90%	8.05677E+22	2.68559E+22	983.10	0.000
AÑO	1	7.83811E+22	97.19%	7.87056E+20	7.87056E+20	28.81	0.013
PIBpC	1	1.84272E+21	2.28%	1.78023E+21	1.78023E+21	65.17	0.004
IED	1	3.43862E+20	0.43%	3.43862E+20	3.43862E+20	12.59	0.038
Error	3	8.19526E+19	0.10%	8.19526E+19	2.73175E+19		
Total	6	8.06497E+22	100.00%				

Estadístico de Durbin-Watson

Estadístico de Durbin-Watson = 2.11955



B. Social sustainable development

Análisis de regresión: IDH vs. AÑO, PCDSS, PSCDSS

Ecuación de regresión

IDH = -31.88 + 0.01618 AÑO - 0.000000 PCDSS + 0.000000 PSCDSS

Coeficientes

Término	Coef	EE del coef.	IC de 95%	Valor T	Valor p	FIV
Constante	-31.88	8.93	(-60.29, -3.47)	-3.57	0.038	
AÑO	0.01618	0.00443	(0.00208, 0.03028)	3.65	0.035	93.86
PCDSS	-0.000000	0.000000	(-0.000000, -0.000000)	-5.03	0.015	22.22
PSCDSS	0.000000	0.000000	(0.000000, 0.000000)	4.17	0.025	43.98

Resumen del modelo

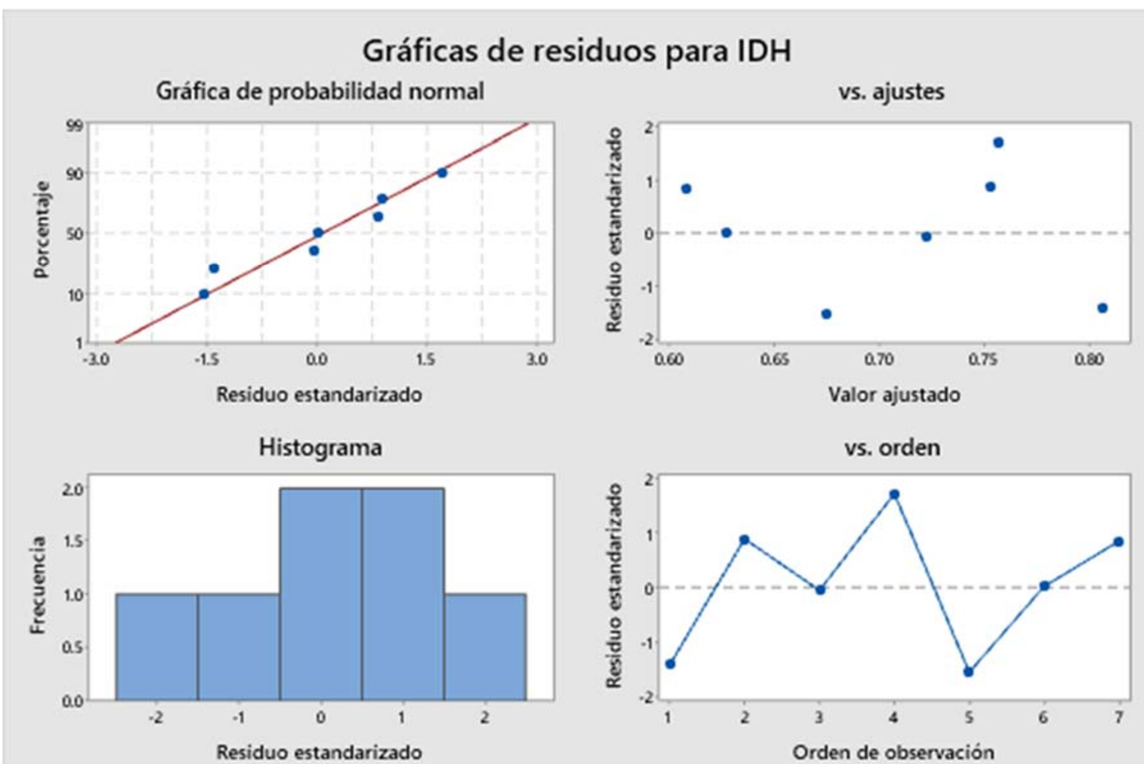
S	R-cuad.	R-cuad. (ajustado)	PRESS	R-cuad. (pred)	AICc	BIC
0.0113662	98.82%	97.64%	0.0078666	76.04%	21.25	-39.02

Análisis de Varianza

Fuente	GL	SC Sec.	Contribución	SC Ajust.	MC Ajust.	Valor F	Valor p
Regresión	3	0.032439	98.82%	0.032439	0.010813	83.70	0.002
AÑO	1	0.028671	87.34%	0.001723	0.001723	13.33	0.035
PCDSS	1	0.001518	4.62%	0.003273	0.003273	25.33	0.015
PSCDSS	1	0.002250	6.85%	0.002250	0.002250	17.42	0.025
Error	3	0.000388	1.18%	0.000388	0.000129		
Total	6	0.032826	100.00%				

Estadístico de Durbin-Watson

Estadístico de Durbin-Watson = 2.52948



C. Environmental sustainable development

Regresión de los mejores subconjuntos: CO_2 vs. DENPOB, PQVH, VPH_C_ELEC, WHATT, AÑO

la respuesta es CO2

Variables totales	R-cuad.	R-cuad. (ajust)	R-cuad. (pred.)	Cp de Mallows	S	DENPOB	PQVH	VPH_C_ELEC	WHATT
2	98.4	97.6	95.6	0.4	2879.4		X		
2	98.4	97.6	95.2	0.5	2893.6			X	
3	98.6	97.2	0.0	2.3	3107.1		X		X
3	98.6	97.1	76.3	2.3	3164.1	X		X	
4	98.8	96.4	72.5	4.1	3530.8	X	X	X	
4	98.7	96.0	0.0	4.2	3702.2	X		X	X
5	98.9	93.3	0.0	6.0	4797.7	X	X	X	X

Las siguientes variables se incluyen en todos los modelos: AÑO

Análisis de regresión: CO_2 vs. AÑO, DENPOB, PQVH, VPH_C_ELEC

Ecuación de regresión

CO2 = -7630053 + 3810 AÑO + 0.00318 PQVH - 0.0286 VPH_C_ELEC + 866 DENPOB

Coeficientes

Término	Coef	EE del coef.	IC de 95%	Valor T	Valor p	FIV
Constante	-7630053	8044471	(-42242619, 26982513)	-0.95	0.443	
AÑO	3810	4069	(-13699, 21318)	0.94	0.448	820.45
PQVH	0.00318	0.00497	(-0.01819, 0.02455)	0.64	0.588	414.14
VPH_C_ELEC	-0.0286	0.0381	(-0.1924, 0.1353)	-0.75	0.532	4876.22
DENPOB	866	1073	(-3751, 5484)	0.81	0.504	1022.25

Resumen del modelo

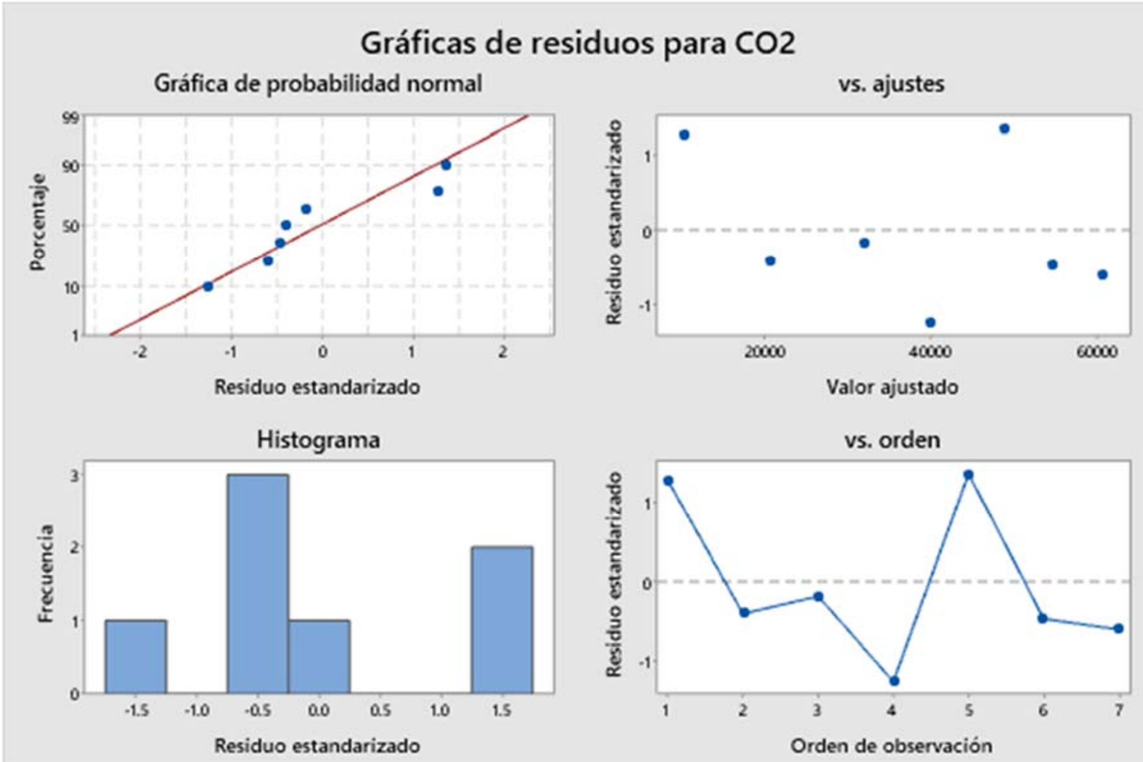
S	R-cuad.	R-cuad. (ajustado)	PRESS	R-cuad. (pred)	AICc	BIC
3530.76	98.80%	96.39%	570015736	72.52%	*	137.14

Análisis de Varianza

Fuente	GL	SC Sec.	Contribución	SC Ajust.	MC Ajust.	Valor F	Valor p
Regresión	4	2049208499	98.80%	2049208499	512302125	41.10	0.024
AÑO	1	2033876970	98.06%	10926459	10926459	0.88	0.448
PQVH	1	7099723	0.34%	5102553	5102553	0.41	0.588
VPH_C_ELEC	1	110321	0.01%	7008850	7008850	0.56	0.532
DENPOB	1	8121486	0.39%	8121486	8121486	0.65	0.504
Error	2	24932528	1.20%	24932528	12466264		
Total	6	2074141027	100.00%				

Estadístico de Durbin-Watson

Estadístico de Durbin-Watson = 2.90398


Gráficas de residuos para CO2
Gráfica de probabilidad normal
vs. ajustes
Porcentaje
Residuo estandarizado
Valor ajustado
Histograma
vs. orden
Frecuencia
Residuo estandarizado
Orden de observación

Appendix 4. Questionnaire applied for assessing sustainable development (only in Spanish)

El presente cuestionario tiene como objetivo evaluar la sustentabilidad desde la perspectiva de las partes interesadas (Gobierno, Industria, Academia y Sociedad) de los diferentes pilares que lo conforman.

El cuestionario está dividido en 5 secciones

- Sección 0: Preguntas generales
- Sección I: Sustentabilidad
- Sección II. Evaluación de la Industria
- Sección III. Sustentabilidad en la Industria
- Sección IV. Industria 4.0

Tiempo estimado de solución

Gente en la industria: 20 min

Academia, Gobierno y Público: 5 min

Nota: El cuestionario fue elaborado con base en la siguiente bibliografía

Sección 0: Elaboración propia

Sección I: I. Garbie (2016), Sustainability in Manufacturing Enterprises: Concepts, Analyses and Assessments for Industry 4.0, Springer International Publishing Switzerland 2016, 131-150.

Sección II. Elaboración propia

Sección III. I. Garbie (2016), Sustainability in Manufacturing Enterprises: Concepts, Analyses and Assessments for Industry 4.0, Springer International Publishing Switzerland 2016, 131-150.

Sección IV. Benesova et al (2018), Analysis of Education Requirements for Electronics Manufacturing within Concept Industry 4.0. Proceedings of the International Spring Seminar on Electronics Technology, 1-5

- Estado
- Municipio o Alcaldía
- Código Postal

Marque el estrato que corresponda 1. Academia 2. Público General 3. Gobierno 4. Industria

Sexo	Masculino	Femenino		
Edad	Menor de edad	19-39 años	40-54 años	>54 años
Nivel Académico	Educación Básica	Media Superior	Superior	Posgrado

Estado:	Municipio:	C.P.

Marque con una **X** según corresponda

Academia	Público	Gobierno	Industria

I. Sustentabilidad

Responder según su apreciación

1: Totalmente insatisfecho, Muy Poco, No, totalmente insuficiente
2: Insatisfecho, Poco, Insuficiente o Insatisfecho
3: Regular, con conocimiento, ni a favor ni en contra
4: Satisfecho, Bien, a favor, pero sin suficiente conocimiento
5: Totalmente satisfecho, Muy bien, totalmente a favor y con suficiente conocimiento

No	1	2	3	4	5	Campo: Sustentabilidad General
S1						¿Ha escuchado acerca de la sustentabilidad?
S2						¿Está interesado en la sustentabilidad?
S3						¿Ha cursado servicios o ha tomado capacitación en materia de sustentabilidad?
S4						¿Sabe el significado de sustentabilidad?
S5						¿Podría explicar con sus palabras qué es sustentabilidad?
S6						¿Sabe cuáles son los tres pilares de la sustentabilidad?
S7						¿Conoce cuál es el mayor problema para la sustentabilidad?
S8						¿Conoce cuáles son las barreras para la sustentabilidad?
S9						¿Conoce cuál es el valor de la sustentabilidad?
S10						¿Sabe cómo afecta la sustentabilidad en su vida diaria?
S11						¿Está de acuerdo que la sustentabilidad no es una opción sino el único camino?
No	**1**	**2**	**3**	**4**	**5**	**Campo: Sustentabilidad Económica**
E1						¿Le preocupa la economía global?
E2						¿Le preocupa la economía Nacional?
E3						¿Qué tan optimista encuentra del futuro económico de su país?
E4						¿Considera usted que la dimensión económica es el mayor pilar para el desarrollo sustentable?
E5						¿Qué tan satisfecho se encuentra financieramente en casa?
						Campo: Sustentabilidad Social
S1						¿Está satisfecho de ser parte de su comunidad?
S2						¿Está satisfecho del balance entre el trabajo y la vida social?
S3						¿Está satisfecho con la seguridad de su comunidad?
S4						¿Considera la libertad de expresión adecuada en su comunidad?
S5						¿Está satisfecho con los servicios de salubridad de su comunidad?
S6						¿En una semana normal, qué tanto se siente estresado?
S7						¿Qué tan satisfecho esta de sus relaciones personales?
S8						¿Qué tan cómodo se encuentra con gente fuera de la cultura de la comunidad?
S9						¿Confía en las instituciones gubernamentales que proporcionan servicios de salud?
S10						¿Confía en las instituciones gubernamentales que proporcionan servicios de seguridad?
S11						¿Confía en las instituciones que proporcionan servicios gubernamentales?
						Campo: Sustentabilidad Ambiental
A1						¿Está satisfecho con el ambiente de su comunidad?
A2						¿Son Los productos que consume ambientalmente amigables?
A3						¿Usted recicla o reúsa plástico, papel, vidrio?
A4						¿Está satisfecho con los servicios de salubridad de su comunidad?
A5						¿Considera usted que el cambio climático es uno de los temas más relevantes para la sustentabilidad?
A6						¿Ha estudiado o tiene conocimiento del cambio climático global?

II. Industria

Sólo para personal en la industria

A qué Estado y municipio pertenece la firma en la que se encuentra laborando

Estado:	Municipio:	C.P.

A que giro pertenece la firma en la que se encuentra laborando

- Industria alimentaria
- Industria de las bebidas y del tabaco
- Textil
- Industria química
- Fabricación de productos no metálicos
- Industrias metálicas básicas
- Fabricación de productos metálicos
- Fabricación de maquinaria y equipo
- Fabricación de equipo de computación, comunicación, componentes y accesorios electrónicos
- Fabricación de equipo de generación eléctrica y aparatos y accesorios eléctrico
- Fabricación de equipo de transporte
- Fabricación de muebles y productos relacionados
- Servicios

Tamaño de la firma en la que se encuentra laborando

Microempresa (1 – 10 empleados)	Mediana (51 – 250 empleados)
Pequeña (11 – 50 empleados)	Grande (mayor a 251 empleados)

Monto de ventas anuales de la firma en la que se encuentra laborando en millones de pesos

Hasta $4	$ 100.1- $ 250
$ 4.1 – $ 100	mayor a $ 250

Certificaciones Internacionales con las que cuenta la firma en la que se encuentra laborando

Normas ISO Gestión de Calidad 9001	Normas OHSAS Gestión de Seguridad
Normas ISO Gestión Ambiental 14001	Responsabilidad Social

En la firma que labora cuenta con las siguientes áreas funcionales.

Almacén de Materia Prima	Control de la Calidad
Almacén de Producto en Proceso	Compras
Almacén de Producto Terminado	Producción
Ventas	Servicio al Cliente
Proyectos	Gestión de la Calidad
Diseño del Producto / Ingeniería	Planeación de la Producción
Logística	Investigación y Desarrollo

En la firma que labora cuenta con las siguientes áreas de Soporte.

Recursos Humanos	Seguridad e Higiene
Contabilidad	Protección Ambiental
Finanzas	Mantenimiento
Sistemas de Comunicación	

En la firma que labora cuenta con las siguientes áreas Estratégicas.

Gerencia Operativa	Dirección
Gerencia de Ventas	Investigación de Mercados

Para la inversión productiva destinada anual, cuál es el porcentaje de acuerdo con los siguientes rubros

Inversión Productiva:
Capacitación – Mejorar la actitud del empleado;
Adiestramiento – Mejora de aptitud del empleado;
Tecnología – Mejora de los procesos productivos o medios de trabajo;

Materiales – Mejora de los recursos materiales;
Estratégicos – Mejora de los medios para la toma de decisiones

	0 – 5 %	6 – 10 %	11 – 15 %	15 – 20 %	X > 20 %
Capacitación					
Adiestramiento					
Tecnología					
Materiales					
Estratégicos					

Priorice según su criterio del más al menos importante (1, muy Importante; 7, menos importante):

Cuál es el principal punto de partida para realizar inversión tecnológica como en la inversión de los medios de producción, tal como es el ejemplo de maquinaria y herramental

Mejora de la calidad
Eliminar Mano de Obra
Mejorar las condiciones laborales
Reducir costo de producción
Mejorar las condiciones ambientales
Reducir tiempo de producción
Desarrollar el negocio

¿Qué le da mayor importancia, según su criterio, de las siguientes palabras

Medio ambiente
Desarrollo Social
Crecimiento económico
Sostenibilidad (Equilibrio Sociedad-Ambiente)
Equidad Social (Equilibrio Economía-Sociedad)
Viabilidad económica (Equilibrio Economía-Ambiente)
Sustentabilidad (Equilibrio Sociedad-Ambiental-Economía)

Responder según su apreciación:

1: Totalmente insatisfecho, Muy Poco, No, totalmente insuficiente
2: Insatisfecho, Poco, Insuficiente o Insatisfecho
3: Regular, con conocimiento, ni a favor ni en contra
4: Satisfecho, Bien, a favor, pero sin suficiente conocimiento
5: Totalmente satisfecho, Muy bien, totalmente a favor y con suficiente conocimiento

III. Sustentabilidad en la Industria

Campo: Sustentabilidad General	
SI1	¿Está la sustentabilidad integrada en la estrategia de investigación y desarrollo en su negocio?
SI2	¿Conoce los principales impulsores de la sustentabilidad?
SI3	¿Cuenta su negocio con una visión futura clara de su crecimiento?
SI4	¿Tiene su negocio estrategias de desarrollo de innovación?
SI5	¿Es importante la satisfacción del cliente?
SI6	¿Crees que el desarrollo sustentable importante en la industria?
SI7	¿Crees que es responsabilidad de la industria fomentar el desarrollo sustentable?
Campo: Sustentabilidad Económica	
EI1	¿Cuenta su negocio con una estrategia para sostenerse por sí mismo en el mercado?
EI2	¿Conoce principales problemas que afecta a las empresas manufactureras? Podría mencionar cuál o cuáles
EI3	¿Podría mencionar cuál o cuáles?

EI4		¿Qué tan optimista encuentra del futuro económico de su la empresa?
EI5		¿Está contento con la posición de la empresa en el mercado?
EI6		¿Está contento con la posición de la empresa en el mercado?
EI7		¿Cómo considera el desempeño de la empresa en el mercado?
EI8		¿Ha introducido recientemente nuevas tecnologías?
EI9		¿Con que frecuencia invierte en nuevos proyectos?
EI10		¿Crees que la posición en el mercado de la empresa mejorará en los siguientes dos años?
EI11		¿Ha expandido la Empresa recientemente?
EI12		¿Crees que los problemas económicos de una empresa del sector podrían impactar en el sector manufacturero?
SEI13		¿Consideras que la evaluación de los productos de la empresa obedece al cumplimiento de sustentabilidad?
Campo: Sustentabilidad Social		
SI1		¿Tiene su empresa una relación positiva con la sociedad?
SI2		¿Qué tanto esta la empresa relacionada con la vida social de los empleados?
SI3		¿Conoce las necesidades básicas y fomenta una buena calidad de vida la empresa hacia los trabajadores (hogar, salud, educación, seguridad)?
SI4		¿Con que frecuencia suceden accidentes laborales en su empresa?
SI5		¿Qué tan frecuente los empleados se ausentan?
SI6		¿Hay alguna preferencia de genero para la selección de personal?
SI7		¿Qué tan frecuente se capacita al personal en la empresa?
SI8		¿Hay retroalimentación de los superiores a los trabajadores?
SI9		¿Qué tan frecuente son escuchadas las opiniones de los empleados para la toma de decisiones?
SI10		¿Hay políticas en la empresa para la motivación de los empleados?
SI11		¿Hay procesos adecuados de asistencia en la empresa?
Campo: Sustentabilidad Ambiental		
AI1		¿Cuenta su negocio con una política ambiental?
AI2		¿Cuenta la empresa con sistemas de reusó o reciclaje para plástico, papel, vidrio?
AI3		¿Cuenta la empresa con sistemas de mejora de eficiencia de energía?
AI4		¿Cuenta la empresa con una estrategia para reducir el consumo de agua?
AI5		¿Cuenta la empresa con una estrategia para reducir merma?
AI6	Ya	¿Cuenta la empresa con una estrategia para reducir el consumo de combustible?
AI7		¿Cuenta la empresa con una estrategia para reducir emisiones de gases de efecto invernadero y contaminantes?
AI8		¿Cuenta la empresa con una estrategia para hacer frente al cambio climático?
AI9		¿Cuenta la empresa con una estrategia para reducir desperdicios tóxicos?
AI10		¿Considera que el cambio climático está en manos de la industria manufacturera?
AI11		¿Minimizar el impacto negativo de los procesos y operaciones son una forma de conciencia ambiental?
AI12		¿Considera que la industria manufacturera no distingue el uso entre frases como verde, sustentable y ambiente?

IV. Industria 4.0 (I 4.0)

I1	¿Ha escuchado acerca de I 4.0?
I2	¿Su empresa trata con el concepto de I 4.0?
I3	¿Cuenta con una visión de cómo I 4.0 puede ser implementada en el negocio?

I4	¿Cree usted que la implementación de I 4.0 afectaría la estructura de la empresa
I5	¿Capacitaría su personal para la adquisición de conocimientos para la implementación de I 4.0?
I6	¿Invertiría en tecnologías I4.0? ¿Cuáles?

14.07 ¿Cómo daría prioridad de implementación de las siguientes herramientas; del más importante,1 al menos importante, 9

Robots Autónomos
Impresión 3D
Herramientas de Simulación
Sistemas de Comunicación
Internet de las Cosas
Almacenamiento Nube
Big Data
Sistemas de Protección Cibernética
Sistemas Ciber-Físicos

Nivel de implementación de Industria 4.0 (marcar con X)

0: Sistema de gestión documentado	I: Digitalización de la fábrica en tiempo real	II: Integración horizontal	III: Integración vertical	IV: Autocontrol

0: La etapa cero refiere al sistema de gestión formado por medio del mapeo de procesos y que sólo se cuenta en papel.
I: La primera etapa refiere a la implementación de un ERP que permita digitalizar las operaciones de la firma en tiempo real.
II: La integración horizontal refiere a la digitalización de las operaciones del proceso productivo que permita por medio de sistemas ciber-físicos monitorear la producción.
III: La integración vertical refiere a la gestión de los datos de la cadena de suministro desde los proveedores hasta los clientes.
IV: El autocontrol refiere a un sistema de optimización que se autocontrola en función de los elementos de la etapa anterior por medio del uso de redes neuronales, machine learning.

Podría mencionar ¿cuál es la principal problemática de implementar I 4.0 en su firma?

Podría mencionar ¿cuál es la principal amenaza de implementar I 4.0 en su firma?

Podría mencionar ¿cuál es el principal riesgo de implementar I 4.0 en su firma?

¿Qué personal requeriría para la implementación de I 4.0 en su firma?

Appendix 5. Business case study statistics analysis

Income

Regression Analysis: Ingresos (I) versus Gastos (G), Salidas (O), Facturación, Compras, ...

The following terms cannot be estimated and were removed:
Nómina, Periodo

Method

Categorical predictor coding (1, 0)

Analysis of Variance

Source	DF	Seq SS	Contribution	Adj SS	Adj MS	F-Value	P-Value
Regression	7	1.34737E+12	99.58%	1.34737E+12	1.92482E+11	101.91	0.001
Gastos (G)	1	5.33123E+11	39.40%	34729805549	34729805549	18.39	0.023
Salidas (O)	1	67639488641	5.00%	44798984727	44798984727	23.72	0.017
Facturación	1	6.78108E+11	50.12%	5.70624E+11	5.70624E+11	302.10	0.000
Compras	1	17901269684	1.32%	33447070213	33447070213	17.71	0.025
Energía	1	1607960250	0.12%	33732115712	33732115712	17.86	0.024
Carga Social	1	25735631212	1.90%	42068798364	42068798364	22.27	0.018
Impuestos	1	23257130028	1.72%	23257130028	23257130028	12.31	0.039
Error	3	5666505488	0.42%	5666505488	1888835163		
Total	10	1.35304E+12	100.00%				

Model Summary

S	R-sq	R-sq(adj)	PRESS	R-sq(pred)
43460.7	99.58%	98.60%	1.25701E+11	90.71%

Coefficients

Term	Coef	SE Coef	95% CI	T-Value	P-Value	VIF
Constant	-240537	109007	(-587447, 106374)	-2.21	0.114	
Gastos (G)	-2.599	0.606	(-4.528, -0.670)	-4.29	0.023	17.23
Salidas (O)	0.513	0.105	(0.178, 0.848)	4.87	0.017	13.90
Facturación	1.3786	0.0793	(1.1262, 1.6310)	17.38	0.000	3.28
Compras	1.340	0.318	(0.327, 2.354)	4.21	0.025	3.60
Energía	72.2	17.1	(17.8, 126.6)	4.23	0.024	13.11
Carga Social	-5.18	1.10	(-8.67, -1.69)	-4.72	0.018	8.45
Impuestos	-28.16	8.02	(-53.69, -2.62)	-3.51	0.039	6.27

Regression Equation

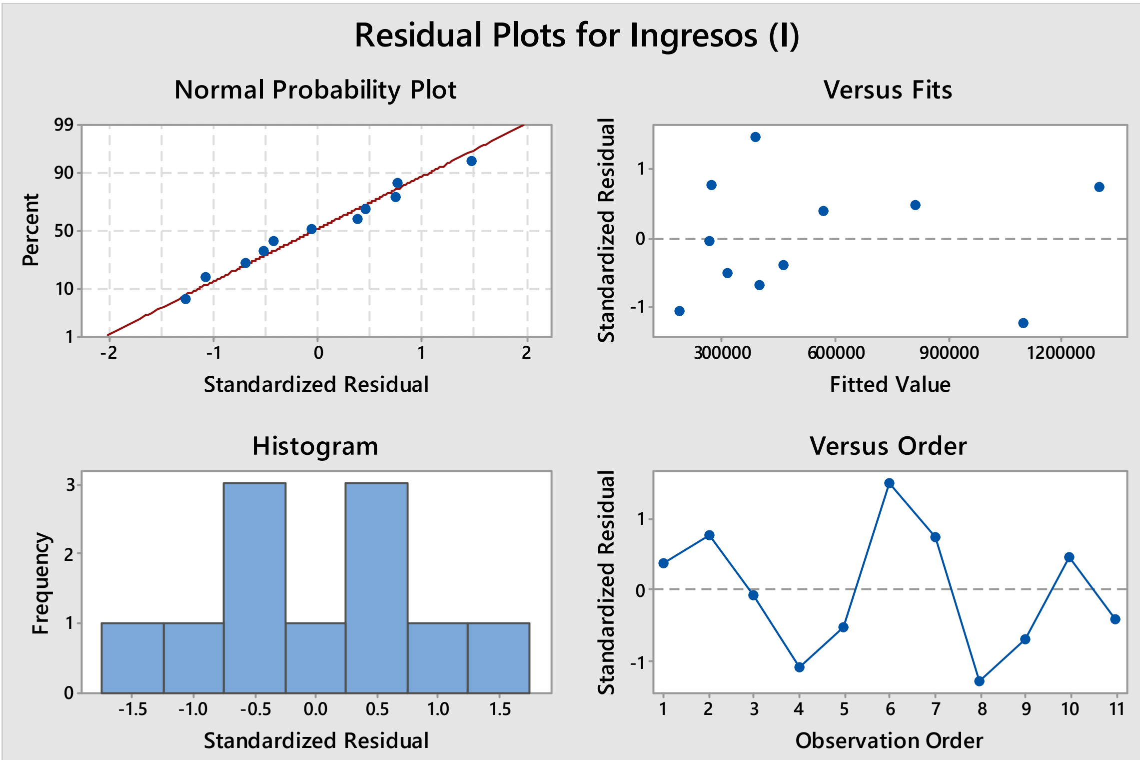
Ingresos (I) = -240537 - 2.599 Gastos (G) + 0.513 Salidas (O) + 1.3786 Facturación
+ 1.340 Compras + 72.2 Energía - 5.18 Carga Social
- 28.16 Impuestos

Fits and Diagnostics for Unusual Observations

Obs	Ingresos (I)	Fit	SE Fit	95% CI	Resid	Std Resid	Del Resid	HI	Cook's D
10	814870	813214	43313	(675373, 951054)	1656	0.46	0.39	0.993201	3.90

```
Obs    DFITS
 10  4.73246  X
X  Unusual X
```

Residual Plots for Ingresos (I)



Best Subsets Regression: Ingresos (I) versus Gastos (G), Salidas (O), ...

```
Response is Ingresos (I)

                                                            C
                                                S F         a
                                              G a a         r
                                              a l c         g I
                                              s i t         a m
                                              t d u C E       p
                                              o a r o n S u
                                              s s a m e o e
                                                  c p r c s
                                              ( ( i r g i t
                     R-Sq    R-Sq   Mallows   G O ó a í a o
Vars  R-Sq  (adj)  (pred)       Cp        S   ) ) n s a l s
   1  94.4   93.8    90.8     33.1    91771       X
   1  39.4   32.7     7.5    427.1   301831   X
   2  95.7   94.6    92.6     25.9    85483       X       X
   2  95.3   94.2    91.6     28.4    88826       X         X
   3  96.2   94.5    88.1     24.4    86002       X X     X
   3  96.1   94.5    92.3     24.7    86481     X X       X
   4  96.5   94.2    76.2     24.0    88658     X X X     X
   4  96.4   94.1    86.7     24.5    89624     X X       X X
```

5	97.0	94.0	79.7	22.5	90215	X X X X X
5	96.8	93.7	62.4	23.7	92519	X X X X X
6	97.9	94.7	18.4	18.3	85035	X X X X X X
6	97.1	92.8	21.1	23.7	98886	X X X X X X
7	99.6	98.6	90.7	8.0	43461	X X X X X X X

Outputs

Regression Analysis: Salidas (O) versus Ingresos (I), Gastos (G), Facturación, Compras, ...

The following terms cannot be estimated and were removed:
Nómina, Periodo

Method

Categorical predictor coding (1, 0)

Analysis of Variance

Source	DF	Seq SS	Contribution	Adj SS	Adj MS	F-Value	P-Value
Regression	7	2.34640E+12	99.19%	2.34640E+12	3.35200E+11	52.63	0.004
Ingresos (I)	1	67019926456	2.83%	1.51064E+11	1.51064E+11	23.72	0.017
Gastos (G)	1	8.15140E+11	34.46%	4.83636E+11	4.83636E+11	75.93	0.003
Facturación	1	1831695742	0.08%	2.19108E+11	2.19108E+11	34.40	0.010
Compras	1	3.13786E+11	13.27%	1.60648E+11	1.60648E+11	25.22	0.015
Energía	1	60459952576	2.56%	5.48190E+11	5.48190E+11	86.07	0.003
Carga Social	1	9.39022E+11	39.70%	5.13624E+11	5.13624E+11	80.64	0.003
Impuestos	1	1.49138E+11	6.30%	1.49138E+11	1.49138E+11	23.42	0.017
Error	3	19107633202	0.81%	19107633202	6369211067		
Total	10	2.36551E+12	100.00%				

Model Summary

S	R-sq	R-sq(adj)	PRESS	R-sq(pred)
79807.3	99.19%	97.31%	1.00075E+12	57.69%

Coefficients

Term	Coef	SE Coef	95% CI	T-Value	P-Value	VIF
Constant	456185	189033	(-145401, 1057771)	2.41	0.095	
Ingresos (I)	1.730	0.355	(0.600, 2.861)	4.87	0.017	26.81
Gastos (G)	5.049	0.579	(3.205, 6.893)	8.71	0.003	4.67
Facturación	-2.440	0.416	(-3.764, -1.116)	-5.87	0.010	26.77
Compras	-2.516	0.501	(-4.110, -0.922)	-5.02	0.015	2.64
Energía	-140.8	15.2	(-189.2, -92.5)	-9.28	0.003	3.07
Carga Social	9.94	1.11	(6.42, 13.47)	8.98	0.003	2.55
Impuestos	54.3	11.2	(18.6, 90.0)	4.84	0.017	3.63

Regression Equation

Salidas (O) = 456185 + 1.730 Ingresos (I) + 5.049 Gastos (G) - 2.440 Facturación
- 2.516 Compras - 140.8 Energía + 9.94 Carga Social + 54.3 Impuestos

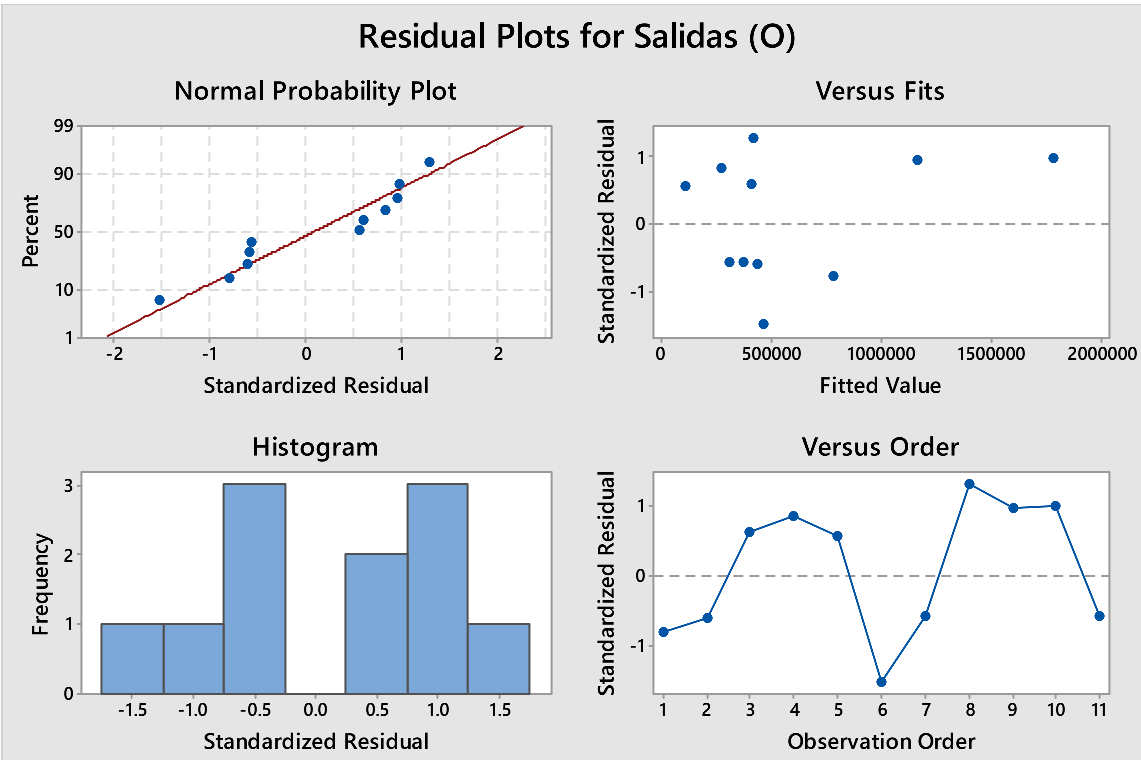
Fits and Diagnostics for Unusual Observations

Obs	Salidas (O)	Fit	SE Fit	95% CI	Resid	Std Resid	Del Resid	HI
10	1791139	1783582	79435	(1530783, 2036380)	7558	0.98	0.97	0.990696

Obs	Cook's D	DFITS	
10	12.83	10.0403	X

X Unusual X

Residual Plots for Salidas (O)



Best Subsets Regression: Salidas (O) versus Ventas, Ingresos (I), ...

Response is Salidas (O)

Vars	R-Sq	R-Sq (adj)	R-Sq (pred)	Mallows Cp	S	Ventas	Ingresos (I)	Gastos (G)	Facturación	Compras	Energía	Carga Social	Impuestos
1	53.7	48.6	0.0	184.6	348682							X	
1	51.8	46.4	0.0	192.9	356110								X
2	62.2	52.8	0.0	151.6	334298			X				X	
2	61.0	51.2	0.0	156.8	339801							X	X
3	73.7	62.4	12.3	106.0	298230			X			X	X	
3	72.4	60.6	32.8	111.2	305155						X	X	X
4	82.1	70.1	0.0	73.3	265908			X		X	X	X	
4	82.0	70.0	31.5	73.6	266511			X			X	X	X
5	89.1	78.3	0.0	46.0	226646			X	X		X	X	X
5	87.6	75.2	0.0	52.3	242070			X		X	X	X	X

6	92.9	82.2	0.0	32.5	205089		X	X	X	X	X	X	
6	92.8	82.0	0.0	32.8	206259			X	X	X	X	X	X
7	99.2	97.3	57.7	8.3	79807		X	X	X	X	X	X	X
7	93.3	77.8	0.0	32.6	229280	X	X	X	X		X	X	X
8	99.5	97.6	78.7	9.0	75561	X	X	X	X	X	X	X	X

Invoicing

Regression Analysis: Facturación versus Ingresos (I), Gastos (G), Salidas (O), Compras, ...

The following terms cannot be estimated and were removed:
Nómina, Periodo

Method

Categorical predictor coding (1, 0)

Analysis of Variance

Source	DF	Seq SS	Contribution	Adj SS	Adj MS	F-Value	P-Value
Regression	7	9.82403E+11	99.70%	9.82403E+11	1.40343E+11	142.61	0.001
Ingresos (I)	1	9.30155E+11	94.40%	2.97294E+11	2.97294E+11	302.10	0.000
Gastos (G)	1	4188619999	0.43%	26513703982	26513703982	26.94	0.014
Salidas (O)	1	62990743	0.01%	33853408678	33853408678	34.40	0.010
Compras	1	10213000494	1.04%	18921201662	18921201662	19.23	0.022
Energía	1	714714344	0.07%	23958863987	23958863987	24.35	0.016
Carga Social	1	22803741768	2.31%	30474462564	30474462564	30.97	0.011
Impuestos	1	14264560517	1.45%	14264560517	14264560517	14.50	0.032
Error	3	2952240726	0.30%	2952240726	984080242		
Total	10	9.85355E+11	100.00%				

Model Summary

S	R-sq	R-sq(adj)	PRESS	R-sq(pred)
31370.1	99.70%	99.00%	2.75767E+10	97.20%

Coefficients

Term	Coef	SE Coef	95% CI	T-Value	P-Value	VIF
Constant	174849	77770	(-72649, 422346)	2.25	0.110	
Ingresos (I)	0.7182	0.0413	(0.5867, 0.8498)	17.38	0.000	2.35
Gastos (G)	1.919	0.370	(0.743, 3.096)	5.19	0.014	12.31
Salidas (O)	-0.3770	0.0643	(-0.5815, -0.1724)	-5.87	0.010	9.93
Compras	-0.973	0.222	(-1.679, -0.267)	-4.38	0.022	3.35
Energía	-53.1	10.8	(-87.4, -18.9)	-4.93	0.016	10.00
Carga Social	3.801	0.683	(1.627, 5.974)	5.56	0.011	6.29
Impuestos	20.63	5.42	(3.39, 37.87)	3.81	0.032	5.48

Regression Equation

Facturación = 174849 + 0.7182 Ingresos (I) + 1.919 Gastos (G) - 0.3770 Salidas (O)
- 0.973 Compras - 53.1 Energía + 3.801 Carga Social
+ 20.63 Impuestos

Fits and Diagnostics for Unusual Observations

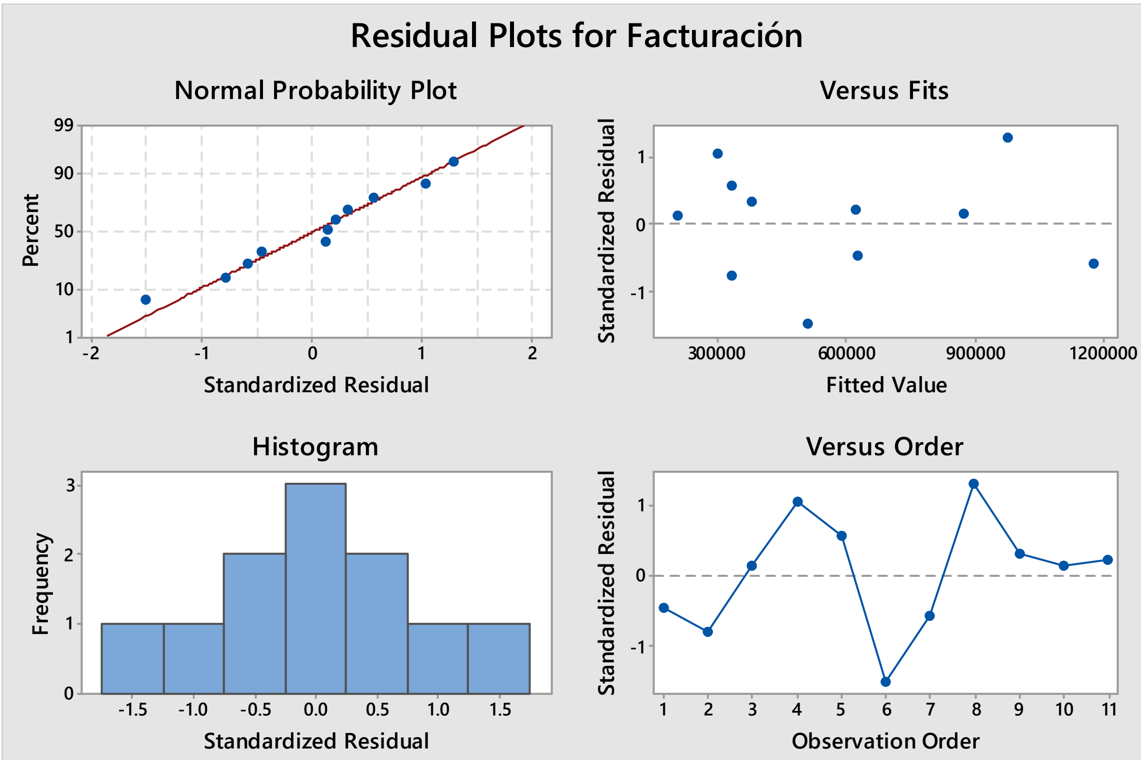
Obs	Facturación	Fit	SE Fit	95% CI	Resid	Std Resid	Del Resid	HI	Cook's D
10	875517	875133	31270	(775618, 974648)	384	0.15	0.13	0.993635	0.46

Obs DFITS

```
 10  1.57030  X

X  Unusual X
```

Residual Plots for Facturación



Best Subsets Regression: Facturación versus Ingresos (I), Gastos (G), ...

Response is Facturación

Vars	R-Sq	R-Sq (adj)	R-Sq (pred)	Mallows Cp	S	Ingresos (I)	Gastos (G)	Salidas (O)	Compras	Energía	Cargas Sociales	Impuestos
1	94.4	93.8	91.7	49.1	78316	X						
1	43.6	37.4	12.4	557.3	248399		X					
2	95.9	94.9	93.8	36.1	71108	X					X	
2	95.6	94.6	92.7	38.6	73263	X						X
3	96.3	94.7	93.4	34.1	72195	X		X			X	
3	96.0	94.4	90.1	36.6	74611	X			X		X	
4	96.7	94.5	89.3	32.2	73749	X		X			X	X

4	96.6	94.3	82.6	33.1	74768	X	X	X			X	
5	97.2	94.4	89.6	29.2	74444	X	X	X	X		X	
5	96.9	93.8	82.7	31.9	78042	X		X		X	X	X
6	98.3	95.6	19.0	20.5	65606	X	X	X	X	X	X	
6	97.8	94.5	20.0	25.2	73948	X	X	X		X	X	X
7	99.7	99.0	97.2	8.0	31370	X	X	X	X	X	X	X

Balance

Regression Analysis: Saldo (I – G) versus Salidas (O), Facturación, Compras, Energía, ...

The following terms cannot be estimated and were removed:
Periodo

Method

Categorical predictor coding (1, 0)

Analysis of Variance

Source	DF	Seq SS	Contribution	Adj SS	Adj MS	F-Value	P-Value
Regression	7	1.00135E+12	99.44%	1.00135E+12	1.43049E+11	75.73	0.002
Salidas (O)	1	803824845	0.08%	44798984727	44798984727	23.72	0.017
Facturación	1	8.99490E+11	89.32%	5.70624E+11	5.70624E+11	302.10	0.000
Compras	1	3712145	0.00%	54025398724	54025398724	28.60	0.013
Energía	1	31871158204	3.16%	32351337521	32351337521	17.13	0.026
Carga Social	1	237529007	0.02%	56820411162	56820411162	30.08	0.012
Impuestos	1	2347144653	0.23%	27667144874	27667144874	14.65	0.031
Nómina	1	66592088504	6.61%	66592088504	66592088504	35.26	0.010
Error	3	5666505488	0.56%	5666505488	1888835163		
Total	10	1.00701E+12	100.00%				

Model Summary

S	R-sq	R-sq(adj)	PRESS	R-sq(pred)
43460.7	99.44%	98.12%	1.25701E+11	87.52%

Coefficients

Term	Coef	SE Coef	95% CI	T-Value	P-Value	VIF
Constant	-240537	109007	(-587447, 106374)	-2.21	0.114	
Salidas (O)	0.513	0.105	(0.178, 0.848)	4.87	0.017	13.90
Facturación	1.3786	0.0793	(1.1262, 1.6310)	17.38	0.000	3.28
Compras	-2.259	0.422	(-3.604, -0.915)	-5.35	0.013	6.33
Energía	68.6	16.6	(15.8, 121.3)	4.14	0.026	12.34
Carga Social	-8.78	1.60	(-13.87, -3.68)	-5.48	0.012	17.98
Impuestos	-31.75	8.30	(-58.16, -5.35)	-3.83	0.031	6.70
Nómina	-3.599	0.606	(-5.528, -1.670)	-5.94	0.010	7.45

Regression Equation

Saldo (I - G) = -240537 + 0.513 Salidas (O) + 1.3786 Facturación - 2.259 Compras
+ 68.6 Energía - 8.78 Carga Social - 31.75 Impuestos
- 3.599 Nómina

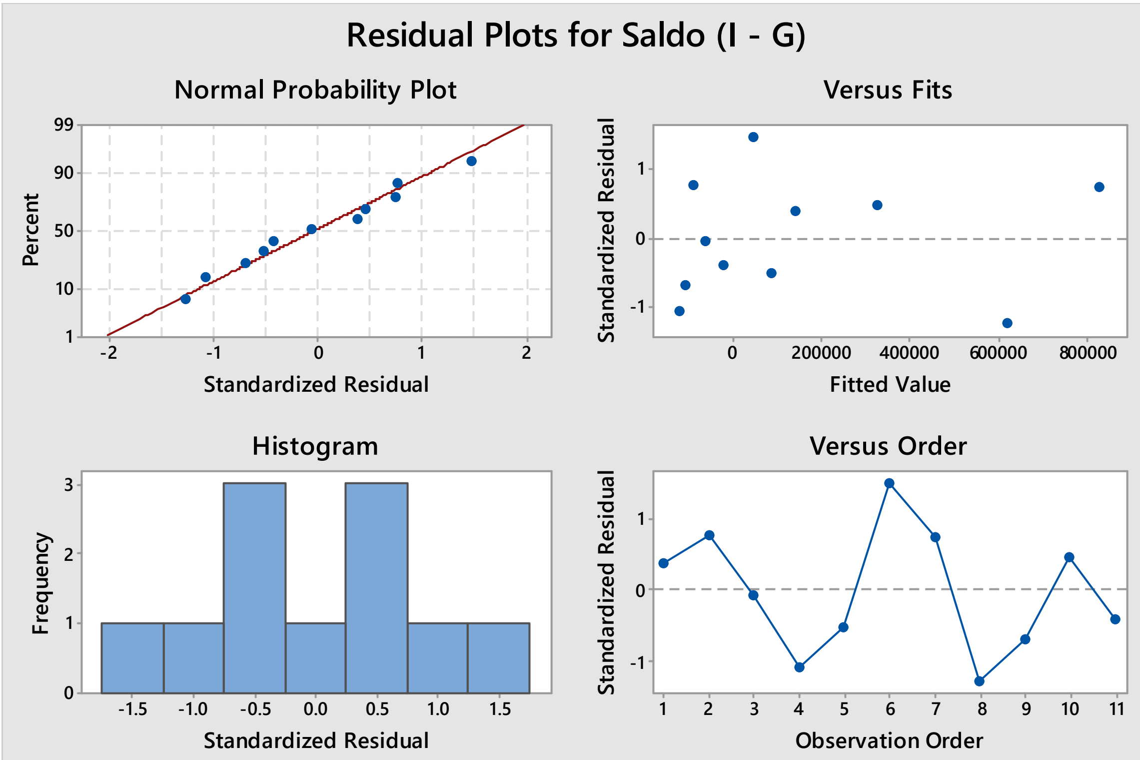
Fits and Diagnostics for Unusual Observations

Obs	Saldo (I - G)	Fit	SE Fit	95% CI	Resid	Std Resid	Del Resid	HI	Cook's D
10	330272	328616	43313	(190775, 466456)	1656	0.46	0.39	0.993201	3.90

Obs	DFITS	
10	4.73246	X

```
X  Unusual X
```

Residual Plots for Saldo (I - G)



Best Subsets Regression: Saldo (I - G versus Salidas (O), Facturación, ...

```
Response is Saldo (I - G)
```

Vars	R-Sq	R-Sq (adj)	R-Sq (pred)	Mallows Cp	S	Salidas (O)	Facturación	Compras	Energía	Carga Social	Impuestos	Nómina
1	86.5	85.0	78.0	64.7	122705		X					
1	26.2	18.0	0.0	386.5	287392			X				
2	92.1	90.1	84.0	37.4	100029		X				X	
2	91.6	89.5	82.9	39.7	102773		X		X			
3	93.2	90.2	75.7	33.5	99236		X			X		X
3	93.0	90.1	80.2	34.1	100065		X				X	X
4	94.9	91.5	82.0	26.3	92764		X	X		X		X
4	93.7	89.5	65.2	32.5	102764		X			X	X	X
5	96.0	91.9	73.8	22.5	90119	X	X	X		X		X
5	95.0	90.0	67.3	27.8	100546		X	X		X	X	X

6	96.7	91.7	0.0	20.6	91288	X	X	X	X	X		X
6	96.2	90.6	0.0	23.1	97491	X	X	X		X	X	X
7	99.4	98.1	87.5	8.0	43461	X	X	X	X	X	X	X

Appendix 6. Research Products

Research paper presented in the XVII NATIONAL CONGRESS OF ELECTROMECHANICAL AND SYSTEMS ENGINEERING (CNIES 2018)

XVII CONGRESO NACIONAL DE INGENIERÍA ELECTROMECÁNICA Y DE SISTEMAS (CNIES 2018)

Modelo sistémico para el desarrollo industrial sustentable en el sector manufacturero

M. en I. L Mendoza[1], Dr. E. Oliva[2], Dr. O. Luis[3]
[1,2] IPN, ESIME, SEPI unidad "Zacatenco", Edificio 5 2do. Piso, Col. Lindavista, C.P. 07300, CDMX
[3] IPN, ESE, Plan de Agua Prieta No. 66 Col. Plutarco Elías Calles, Unidad Adolfo López Mateos, Casco de Santo Tomás, Del. Miguel Hidalgo, C.P. 11340, CDMX
(e-mail de contacto: lmendozav1203@alumno.ipn.mx).

Resumen— La presente investigación tiene por objeto analizar el desempeño actual de la industria manufacturera en el sector metal mecánico y sus implicaciones contextuales a nivel regional, dada su relevancia y frente al hecho de que estamos inmersos en un contexto global competitivo. Con el objetivo de proponer un modelo sistémico orientado principalmente a incrementar el desarrollo industrial sustentable en el sector metal mecánico mediante clústers industriales. Tomando como punto de partida la hipótesis sobre la ausencia de una estrategia de desarrollo industrial actual en la instalación de empresas en parques industriales. Asimismo, considera la interrelación de variables en el entorno para el desarrollo sustentable con las dimensiones; económicas, sociales y ambientales en el sector referido bajo el contexto en que se encuentra inmerso en una actividad periférica como México. Por último, se describe la metodología para el desarrollo de la presente investigación.

***Palabras Clave*—desarrollo sustentable, clúster industrial, desarrollo económico, industria metalmecánica, estrategia, competitividad, análisis sistémico.**

Abstract— This paper focus on the current performance analysis of metal-mechanical manufacturing industry and its regional contextual level implications, it is according to the relevance of this sector and the fact that we are currently immersed in a highly global economic competitive environment. With the purpose of advancing a systematic model oriented to firstly Increase sustainable growth development in the metal mechanic sector by industrial clusters. Getting the starting point the hypothesis of a strategy absence in the current industrial development of the industry established in industrial parks. Furthermore, it is considered the variables interrelation of the dimensions of sustainable development context; economic, social and environment variables, bearing in mind the assumption that we are dealing with economy peripheral like Mexico. Finally, the methodology is described for the development of present research.

***Keywords*— sustainable development, industrial cluster, economic development, metal mechanic industry, strategy, competitive, systemic analysis.**

I. Introducción

Uno de los temas que en la actualidad se han convertido en ejes centrales para la Organización de las Naciones Unidas (ONU), de países en vías de desarrollo así como países desarrollados es la sustentabilidad, incluso en septiembre del año 2015 líderes mundiales acudieron a la Cumbre de las Naciones Unidas y firmaron el documento titulado *"Transformando Nuestro Mundo: la Agenda 2030 para el Desarrollo Sostenible"* en el que se incluye los 17 objetivos del Desarrollo Sostenible con el objetivo de poner fin a la pobreza, luchar contra la desigualdad y hacer frente al cambio climático, sin que nadie quede rezagado [1]. Para la presente investigación se buscar una solución holística que resuelva las necesidades actuales en materia de desarrollo sustentable y que apoye a los objetivos de la agenda 2030 con el desarrollo industrial mediante clústers industriales y la teoría de las tres dimensiones del desarrollo sustentable. El sistema está constituido por los distintos actores envueltos en la triple hélice y sus complejas interrelaciones entre ellos, además de estar inmersos en un contexto regional definido por las tres dimensiones; la dimensión económica, la social y la ambiental (ver **Figura 1**) [2]. Por otra parte, también se hace una evaluación de las condiciones actuales y se formula la hipótesis siguiente: México cuenta con una estrategia de desarrollo industrial sustentable. Para iniciar esta tesis, es menester conocer el actual desempeño de la productividad en la industria, así como su correlación en el contexto en que se desenvuelve.

Figura 1 Las dimensiones del desarrollo sustentable [2]

La ausencia de una estrategia de industrialización resulta en el desempeño ineficiente de productividad, según Porter, la productividad determina la prosperidad de cualquier estado o nación, dejando atrás las exportaciones, los recursos naturales y el turismo [3], se correlaciona con la competitividad [4], por otra parte, la productividad de los factores se expresa en el progreso técnico del proceso productivo [5]. Dada su importancia, los gobiernos deben esforzarse en crear un ambiente que apoye al aumento de la productividad ya que es una de las determinantes de la diferenciación para el bienestar social regional [6]. Asimismo, Porter en su artículo *Cluster and the New Economics of Competition* menciona que para que la productividad e innovación gobiernen con éxito la economía, se deben establecer las reglas de competitividad, por ejemplo, la protección de la propiedad intelectual y el cumplimiento de las leyes antimonopolio [3].

Research article presented and published in the Proceedings of the International Conference on Industrial Engineering and Operations Management Pilsen, Czech Republic, July 23-26, 2019

Towards Sustainable Industrial Development - A Systems Thinking-Based Approach

Luis A. Mendoza-del Villar and Eduardo Oliva-López
ESIME Zacatenco
Instituto Politécnico Nacional
Mexico City, Mexico
lmendozav1203@alumno.ipn.mx, eoliva@ipn.mx

Octavio Luis-Pineda
ESE
Instituto Politécnico Nacional
Mexico City, Mexico
oluisp@gmail.com

Jose Arturo Garza-Reyes
Centre for Supply Chain Improvement
University of Derby
Derby, UK
J.Reyes@derby.ac.uk

Abstract

Various critical global issues, including global warming and poverty, have been recognized and identified by the United Nations (UN) as drivers for unsustainability. Consequently, the UN established the Sustainable Development Goals (SDGs) with the aim of seeking universal peace and larger freedom by balancing the three dimensions of sustainable development, i.e. economic, social and environmental. A particular attention SDGs pay is in eradicating poverty as this is considered one of the greatest global challenges. Poverty is not only an economic matter as it also has an impact on the social and environmental dimensions. A strategy to tackle poverty is to foster industry development. However, a holistic point of view is necessary by also considering stakeholders otherwise, it becomes a neoliberal solution. Despite the fact that some research has been conducted, e.g. case studies and surveys of sustainable practices, there is a lack of industrial sustainable development as a framework to tackle sustainability issues. Thus, this paper proposes a framework for industrial sustainable development under a socially inclusive approach within the context of the Mexican manufacturing industry. The framework proposal is based on a state-of-the-art literature review conducted in the Web of Science and Scopus databases.

Keywords
Sustainable and social inclusive Development, Systems Thinking, Industrial Strategy, Manufacturing Cluster, SMEs.

1. Introduction

One of the issues that currently has become a central axis for the United Nations (UN) as well as for developing and developed nations is sustainability. In September 2015, world leaders attended the United Nations Summit and signed the document entitled '*Transforming Our World: the 2030 Agenda for Sustainable Development*'. It includes the 17 Sustainable Development Goals (SDGs), which have the objective of putting an end to poverty, fights against inequality and copes with climate change, without anyone falling behind (United Nations, 2015). SDGs are goals for sustainable development. Although poverty is one of the biggest world issues, there are strategies for tackling it, e.g. industrial development. Two objectives align to industrial sustainability, i.e. SDGs 8 and 9. SDGs 8 relates to decent work and economic growth, whereas SDGs 9 refers to industry innovation and infrastructure. Both goals contribute to endogenous sustainability, but they would have an exogenous effect on the 15 remaining ones.

IEOM Society International

The Third European International Conference on Industrial Engineering and Operations Management
Pilsen, Czech Republic, July 23-26, 2019

Certificate of Appreciation

This is to certify that

Luis A. Mendoza del Villar

Instituto Politécnico Nacional, Mexico

Has Presented at the Industry Solutions as a Distinguished Speaker at the 3rd European International Conference on Industrial Engineering and Operations Management at Parkhotel Congress Center Plzeň, Pilsen, Czech Republic on July 25, 2019.

Professor Donald M. Reimer
Director of IEOM Membership and Chapter Development
President, The Small Business Strategy Group
Detroit, Michigan, USA

Dr. Ahad Ali - Conference Co-Chair
Associate Professor and Director of Industrial Engineering
Lawrence Technological University, Michigan, USA
Executive Director – IEOM Society International

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Co-authorship of the research article, published in the Proceedings of the 5th NA International Conference on Industrial Engineering and Operations Management Detroit, Michigan, USA, August 9 - 11, 2020

Specialized Business Incubators as a strategy for Small and Medium-sized Enterprises in the Industry 4.0 era – A systemic approach

Guadalupe Bosques-Brugada, Luis A. Mendoza-del Villar and Eduardo Oliva-López
ESIME Zacatenco
Instituto Politécnico Nacional
Mexico City, Mexico
gbosquesb1700@alumno.ipn.mx, lmendozav1203@alumno.ipn.mx, eoliva@ipn.mx

Jose Arturo Garza-Reyes
Centre for Supply Chain Improvement
University of Derby
Derby, UK
J.Reyes@derby.ac.uk

Jiri Tupa
Department of Technologies and Measurement
University of West Bohemia in Pilsen
Univerzitni 8, Czech Republic
tupa@ket.zcu.cz

Abstract

The present research aims to get a holistic view of the characteristics of specialization in business incubators models. This paper centers on building a general framework by taking into account a holistic look at the features, profiles, advantages, and disadvantages of specialization in business incubators models. The strategy aims to impact mainly stakeholders by adopting business incubators strategies, especially to those tenant firms of the manufacturing sector related to emerging technologies such as Industry 4.0 technologies. Moreover, the framework is built based on the discussion of the leading representatives' heads of the specialization in the field of specialized business incubators' models. The strategy aims to reduce the current short-term death rate expectancy prevailing in the contemporary economic context by a robust business model for business incubation. Business incubators hold tenants into a hub with not only supportive facilities for the business without investing vital capital, which is not part of their core chain value but also harnessing the closer source of knowledge transfer and skilfully workforce-related on these technologies. Finally, remarks and recommendations are proposed for futures tenant companies' prospects, who wish to reduce the bankruptcy risk by boosting innovative goods and services with high technological development in a specific field of knowledge.

Keywords
Business Incubators, Specialization, Incubation Model, Management Units, Strategic establishment, Industry 4.0.

1. Introduction

Nowadays, poverty is one of the most significant issues in the world as well as one of the worst unwanted effects since it spread out unfortunate social scenarios that affect an appropriate development into society. The United Nations reported that there are 780 million people in poverty status. The National Council for the Evaluation of Social Development Policy, a Mexican agency that measures poverty among other social variables, indicates that 21.6 million people are living in extreme poverty, which represents 17.11% of the national population (CONEVAL, 2018). According to the World Bank (2020) for a Sustainable reduction of poverty, nations should create better employment conditions, and invest in health, education, nutrition, and sanitary conditions for people. Moreover, the network

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30th International Conference on Flexible Automation and Intelligent Manufacturing (FAIM2021) 15-18 June 2021, Athens, Greece.

Fostering economic growth, social inclusion & sustainability in Industry 4.0: a systemic approach

L. Mendoza-del Villar[a]*, E. Oliva-Lopez[a], O. Luis-Pineda[b], A. Benešová[c], J. Tupa[c], J.A. Garza-Reyes[d]

[a]Instituto Politécnico Nacional-ESIME, Adolfo López Mateos U. Zacatenco Gustavo A. Madero, Mexico City 07738, Mexico.
[b]Instituto Politécnico Nacional-ESE, Plan de Agua Prieta 66 Col. Plutarco Elías Calles U. Casco de Santo Tomás, Miguel Hidalgo, Mexico City 11340, Mexico.
[c] University of West Bohemia-Faculty of Electrical Engineering, Univerzitní 2732/8, Pilsen 301 00, Czech Republic.
[d] University of Derby-Centre for Supply Chain Improvement, Derby, DE22 1GB, UK.

* Corresponding author. Tel.: +52-553-568-3048; *E-mail address:* lmendozav1203@alumno.ipn.mx

Abstract

The most modern and mature industrial manufacturing revolution is known as Industry 4.0 (I4.0). Technological advance seeks to minimize all sorts of waste, optimizing the firm's performance operations aligning this its competitive advantage. While in developing economies often overlooked the society and environment under the current neoliberalism strategy, whose competitive approach is enforced by the State, with a detriment of local SMEs such as Mexico. Thereby, to lead I4.0 implementation for SMEs, the role of the State for a long-term strategic approach is of utmost importance. The industrial strategy should regard the imminent industrial revolution without leaving behind environmental and social dimensions to implement it, like the Scandinavian economies example. This research proposes the soft systems methodology for dealing with the sustainable complexity context and inclusive industrial development phenomena. Its holistic nature provides useful insights that devise how I4.0 and social inclusion fit into the Mexican context. The theoretical proposal builds upon the social inclusion state-of-the-art in the industry 4.0 and a survey for an affordable I4.0 initiative through a stakeholder system's network communication approach. The inclusive strategy is an effort to align root systems for sustainable development with stakeholders for Mexican SMEs in the manufacturing sector.

Keywords: Sustainable development; social inclusion approach; soft systems methodology; industry 4.0; smes strategy; manufacturing sector

1. Introduction

Being the most mature and modern manufacturing revolution, Industry 4.0 (I4.0) represents a breaking point for innovation on knowledge management digitalization [1]. This maturity revolution stems from the three previous stages, namely industrial revolutions. The first industrial revolution, which became with the first mechanical loom in 1784 with the crafting production paradigm; then, the second revolution, it was launched in 1870 with the innovative technology developed with electricity for mass production. Later, the third one, with the development of the automated devices due to Programmable Logic Controller (PLC) and IT systems.

Eventually, the fourth industrial revolution, mainly characterized by the introduction of cyber-physical systems, interconnects vertically and horizontally throughout the firm's processes [2, 3]. Such interconnection of the firm links internal processes and external ones that associate procedures involving suppliers and customers' instances. Therefore, these links begin with the horizontal operations of the firm, for example, the supply of raw material until the delivery of the final product to

10.1016/j.promfg.2020.10.244

Appendix 7. Research reports of Doctoral research stays

Alongside Professor José Arturo Garza Reyes in the University of Derby, UK

UNIVERSITY OF DERBY

United Kingdom, Derby

30 sep. 19

Instituto Politécnico Nacional
Escuela Superior de Ingeniería Mecánica y Eléctrica Unidad Zac.
Doctorado en Ingeniería de Sistemas
Alumno: M en I Luis Angel Mendoza del Villar

Reporte de Investigación

Artículo de Investigación:

Towards Sustainable Industrial Development - A Systems Thinking-Based Approach

El principal objetivo de la estancia de investigación en el College of Business, Law and Social Science, de la *University of Derby*, en *Derby* Reino Unido, fue el desarrollo de un artículo de Investigación Científica en una revista indizada en SCOPUS. Junto con el Profesor Jose Arturo Garza-Reyes, quien es uno de los principales exponentes en materia de Gestión de Operaciones y de la Cadena de Suministro.

Con un cronograma de trabajo para el desarrollo del escrito, en dicho documento se especifican fechas las principales actividades a desarrollar. Entre los principales apartados para el desarrollo del documento que sobresalen se encuentran; La investigación de publicaciones, en el cual se buscaron, identificaron y obtuvieron publicaciones; El estado del arte, en el que se seleccionaron, examinaron y reportaron las publicaciones más representativas; Obtención de resultados, en este apartado de identificó la brecha del conocimiento, así como una identificación y definición de los resultados; Por último, la discusión, en la cual se realizó una evaluación interna y externa del resultado propuesto del modelo.

El artículo se elaboró en 6 secciones, las cuales comprenden los siguientes apartados:1 Introduction, en éste se hace referencia la importancia de un cambio de estrategia para el desarrollo industrial. Luego, en la sección 2 Analysis the sustainable context, se dimensiona la problemática de desarrollo insostenible y socialmente no incluyente. En la sección 3 Literature Review, se identificaron las principales publicaciones en las principales bases de datos científicas SCOPUS y JCR, por medio de un análisis bibliométrico, se dimensionó el tamaño del alcance en los motores de búsqueda en función de las palabras clave Desarrollo Industrial Sustentable con un enfoque sistémico. En la sección 4, State of the Art literature, se hace la evaluación de la literatura más representativa en calidad de la investigación en función del *Academic Journal Guide 2018* del *Chartered Association of Business*

derby.ac.uk

College of Business, Law & Social Sciences, Kedleston Road, Derby, DE22 1GB, UK
01332 590500

School, en el reporte se determinó la brecha del conocimiento. Después, en la sección 5 Methods, Hace referencia a los métodos utilizados para un modelo teórico para el desarrollo industrial sustentable. Finalmente, en la sección 6 Results and Discussion, se obtiene el modelo y se hace una descripción, así como una discusión del modelo para el desarrollo industrial sustentable.

El artículo fue sometido al *Proceedings of the 3th European International Conference on Industrial Engineering and Operations Management,* el cual fue aceptado y con mínimos cambios para su publicación. Por lo tanto, se presentó el artículo de investigación en el congreso internacional Europeo de Investigación científica, en Pilsen, Czech Republic, July 23-26, 2019. Se obtuvo la constancia de asistencia, así como de distinguido presentador de la investigación.

3rd EU International Conference on Industrial Engineering & Operations Management
Pilsen, Czech Republic, July 23-26, 2019
IEOM Society Venue: Park Hotel Pilsen, Czech Republic

July 11, 2019

Luis A. Mendoza-del Villar
Posgrado en Ingeniería de Sistemas
Instituto Politécnico Nacional
Mexico City, Mexico

ID 559: Towards Sustainable Industrial Development - A Systems Thinking-Based Approach

Subject: Acceptance Letter for ORAL PRESENTATION at the 2019 IEOM Pilsen Conference

Dear Authors,
On behalf of the IEOM Society International's organizing and program committee, it is our pleasure to inform you that your paper for the above title has been accepted for Oral Presentation and publication for the 3rd IEOM European International Conference on Industrial Engineering and Operations Management in Pilsen, Czech Republic during July 23-26, 2019. Each paper was subject to anonymously peer reviewed by at least two referees. Accepted papers will be published in the Proceedings and indexed in SCOPUS. Attending the conference and presentation of the paper is required.

We look forward to seeing you in Pilsen, Czech Republic.

Regards,

Dr. Jiří Tupa – Conference Co-Chair and Chairman of the Organizing Committee
Vice Dean for Strategy and Development
Faculty of Electrical Engineering
University of West Bohemia, Pilsen, Czech Republic
Email: tupa@ket.zcu.cz Phone +420 377 634 008

Dr. Ahad Ali - Conference Co-Chair
Associate Professor and Director of Industrial Engineering
Lawrence Technological University, Michigan, USA
Executive Director – IEOM Society International
ahad@ieomsociety.org

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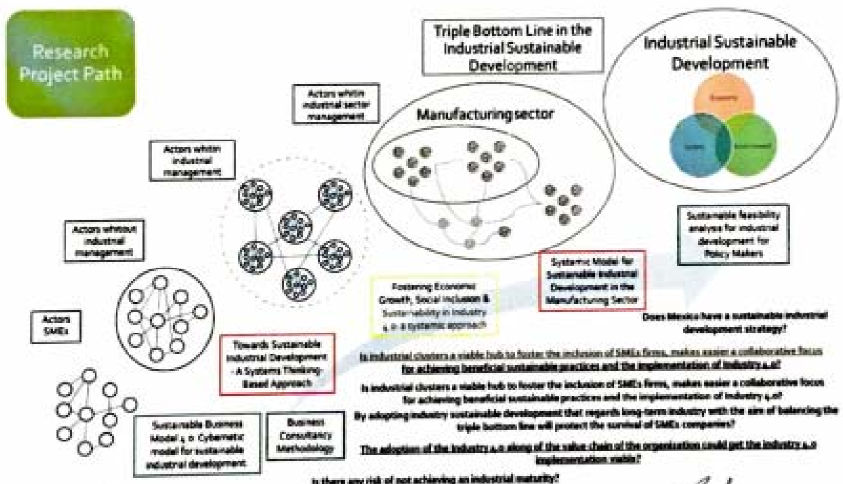
Asimismo, se atendieron a conferencias de investigación científica locales en la Universidad de Derby, como la *Annual Research & Knowledge Exchange*

UNIVERSITY OF DERBY

conference 2019 el día 21 de mayo 2019 y el *Posgraduate Research Conference* el día 14 de junio 2019.

Finalmente, se comenzaron actividades para el desarrollo de una red de Investigación para el desarrollo Industrial 4.0 sustentable entre las Universidades de *University of Derby, en* Derby, Reino Unido, *Západočeská Univerzita v Plzni*, en Pilsen, República Checa *y el Instituto Politécnico Nacional*, en Ciudad de México, México. Para ello, se realizó una estancia en la universidad de república checa, con el objetivo de hacer una propuesta de cooperación para el desarrollo de un modelo para la industria manufacturera que cumpla con la integración de las tecnologías 4.0 con un enfoque estratégico al desarrollo sustentable. Para ello, se muestra en la siguiente figura la ruta de investigación, la cual fue discutida para el desarrollo y logro de objetivos previamente mencionados, con las diferentes investigaciones que se han llevado a cabo (rojo), que están en proceso (amarillo) y que aún se encuentran en propuesta (verde), así como las que se lleguen a desarrollar.



Dr. Eduardo Oliva López
Supervisor SEPI-ESIME Zac.

Prof. José Arturo Garza-Reyes
Supervisor University of Derby

M en I Luis Ángel Mendoza del Villar
Alumno

Alongside doc. Jiri Tupa in the University of West Bohemia in Pilsen, the Czech Republic

FACULTY OF ELECTRICAL ENGINEERING
UNIVERSITY OF WEST BOHEMIA

The Czech Republic, Pilsen
27th July, 2020
The University of West Bohemia
Faculty of Electrical Engineering

Instituto Politécnico Nacional
Escuela Superior de Ingeniería Mecánica y Eléctrica Unidad Zac.
PhD. Program Systems Engineering
Student: M en I Luis Angel Mendoza del Villar

Research report

The aim of the research internship in the West Bohemia University in the Czech Republic is to develop a research paper indexed in a SCOPUS journal alongside doc. Jiri Tupa, who is a research leader in the Industry 4.0.

Despite the current situation about coronavirus, it was possible to work remotely. Based on the approved scheduled, where it consists of the activities developed during the internship

1. Research publications related to the I 4.0 in the sustainability context for the industrial development
2. Depict the state-of-the-art report for Industry 4.0 sustainable development.
3. Build a methodological framework for Industry 4.0 into the sustainable development context.
4. Discuss the framework and compare with the most representative researcher in the field of sustainable frameworks for sustainable development

The development of each activity listed is reported in a couple of research papers accepted in SCOPUS proceedings indexed journals. The first publication accepted in a SCOPUS ELSEVIER journal, Procedia Manufacturing, for the 30th International Conference on Flexible Automation and Intelligent Manufacturing (FAIM2020), "Fostering Economic Growth, Social Inclusion & Sustainability in Industry 4.0: a systemic approach" includes in each structure's section the points mentioned from the socially sustainable approach of the I4.0. The second publication accepted in a SCOPUS proceeding conference for the Proceedings of the 5th NA International Conference on Industrial Engineering and Operations Management "Specialized Business Incubators as a strategy for Small and Medium-sized Enterprises in the Industry 4.0 era – A systemic approach" includes as well each structure's section the points with the management unit specialized business incubator focus.

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1. Research publications related to the I 4.0

I performed the research of publications for both research papers with the literature review methodology shown in Figure 1. In this way, I used for the search of publications SCOPUS and Web of Science as scientific research papers browsers. The keywords searched were based on titles of both investigations that described them with support of Boolean connectors to get accurate outputs. Afterward, a bibliometric analysis was performed to find information clusters like fields of studies in the investigation. However, outputs obtained did not have a standard terminology. Therefore, I purged the information intending to get an accurate bibliometric analysis of the research field of study.

Figure 1 Literature review methodology

2. state-of-the-art report

The state-of-the-art report is the latest step mentioned in the literature review methodology. Hence, it takes the bibliometric analysis purged from the information classification step. Its aim pursues to get the gap of the edge´s knowledge of the most relevant research in terms of top journals. An evaluation of the journals was then performed regarding the *Academic Journal Guide 2018* del *Chartered Association of Business Schools.*

3. methodological framework

In both cases, it was built a methodological framework where Industry 4.0 is not only its ultimate purpose but also a strategy in which sustainable development context is essential to pave the way for its affordable arrival. Figure 2 shows the first methodological framework; it studies the critical root systems for stakeholders' common goals. While Figure 3, derived from the second research, devises a specialized business incubator model for those business incubators managers who aim to establish I4.0 as their business model.

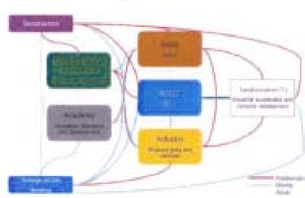

Figure 2 Root definition of the Critical Systems for SID

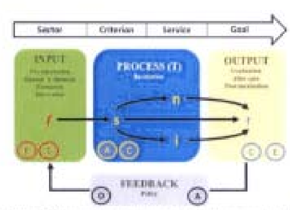

Figure 3 Specialized business incubator model SBI

4. Framework discussion

There is a discussion section for both research cases. Here, there is a comparison with the most representative researcher in the field of sustainable frameworks for sustainable development. In the first case, it carried out an empirical discussion with the sustainable development of industrial development. On the one side, it considers interviews with them

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to pursue a system's shape for industrial and inclusive sustainable development. On the other side, questionnaires were applied to firms' managers in the manufacturing sector. Both studies support the theoretical framework depicted below. Whereas in the other research, it holds an internal and external discussion. The internal discussion describes the implications that the conceptual framework bears in mind; the external one discusses the model with heath leaders of specialized and diversified business incubators.

Acceptance letter of the research papers

"Fostering Economic Growth, Social Inclusion & Sustainability in Industry 4.0: a systemic approach"

Published in the 30th International Conference on Flexible Automation and Intelligent Manufacturing (FAIM2020).

Review Results

Contribution Details

Fostering economic growth, social inclusion & sustainability in industry 4.0: a systemic approach

31222

[illegible]

Review Result of the Program Committee

This contribution has been accepted for inclusion in PROCEDIA MANUFACTURING and presentation at the Conference.

[illegible]

Overview of Reviews

Questions		Review 1	Review 2
Relevance and significance of the topic and of the defined research scope to FAIM2020 scope	[illegible]	[illegible] Excellent	[illegible] Average
Appropriate presentation/ referencing of previous work with respect to the size of the article	[illegible]	[illegible] Good	[illegible] Average
Clarity, correctness and innovativeness of methodology for the stated objectives and scope	[illegible]	[illegible] Good	[illegible] Average
Significance and clarity of results with respect to the defined research scope	[illegible]	[illegible] Good	[illegible] Average
Organization, expression, grammar, syntax, compliance to template	[illegible]	[illegible] Average	[illegible] Good
Appropriate representation of paper contents by the title		[illegible] Good	[illegible] Good
Existence of similar previous publications by the same authors or indication of plagiarism		[illegible]	[illegible]
Overall merit		[illegible]	[illegible]

Review 1

Evaluation of the Contribution

[illegible]

Reviewer's Comments on the Contribution

Comments for the Authors:

[illegible]

Review 2

Evaluation of the Contribution

[illegible]

Reviewer's Comments on the Contribution

Comments for the Authors:

[illegible]

FACULTY OF ELECTRICAL ENGINEERING
UNIVERSITY OF WEST BOHEMIA

"Specialized Business Incubators as a strategy for Small and Medium-sized Enterprises in the Industry 4.0 era – A systemic approach"

Published in the Proceedings of the 5th NA International Conference on Industrial Engineering and Operations Management

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IEOM Society

5th NA International Conference on
Industrial Engineering and Operations Management
August 10-14, 2020
Detroit, Michigan, USA

July 09, 2020

Luis Angel Mendoza del Villar
Instituto Politécnico Nacional ESIME Zacatenco
Avenida Instituto Politécnico Nacional 2023, Lindavista, 07300 Gustavo A. Madero, CDMX, Mexico

ID 354: Specialized Business Incubators as a strategy for Small and Medium-sized Enterprises in the Industry 4.0 era – A systemic approach

Subject: Acceptance Letter for ORAL PRESENTATION at the 5th North American Conference, Detroit, USA

Dear Luis:
On behalf of the IEOM Society International's organizing and program committee, it is our pleasure to inform you that your paper for the above title has been accepted for Oral Presentation and publication for the 5th North American International Conference on Industrial Engineering and Operations Management in Detroit, Michigan, USA during August 10-14, 2020. Each paper was subject to anonymously peer reviewed by at least two referees. Accepted full papers will be published in the Proceedings and indexed in SCOPUS. Conference is planned with virtual mode due to current COVID-19 global pandemic.

IEOM Society International, a 501(c)(3) nonprofit organization has become a premier international platform and forum for academics, researchers, scientists and practitioners to exchange ideas and provide insights into the latest developments and advancements in the fields of Industrial Engineering and Operations Management. After having successfully organized previous international conferences in Bangladesh (2010), Malaysia (2011), Turkey (2012), Indonesia (2014), UAE (2015), Orlando (2015), Malaysia (2016), Detroit (2016), Morocco (2017), UK (2017), Bogota (2017), Bandung (2018), Paris (2018), Washington DC (2018), Pretoria (2018), Bangkok (2019), Toronto (2019) and Riyadh (2019) and Dubai (2020) is now organizing the 5th North American International Conference in Detroit, USA.

Minimum one author must register to include the paper in the program and proceedings. Presentation mode will be Virtual / Online using Zoom and necessary link and program will be published in due course. You can visit http://ieomsociety.org/detroit2020/ for conference details and registration payment.

IEOM is expecting another exciting event in Detroit. Some of the events and activities that are planned include: outstanding keynote speakers, global engineering education track, industry solutions track, more than 400 technical presentations, women in industry and academia track, undergraduate and graduate student paper competitions, panel sessions, recognition and awards, and exhibition. More than 400 participants are expected to join from more than 50 countries with a diverse background.

You will see the Detroit Conference as a great value-added event. Your participation is highly appreciated. If you have any question, please contact info@ieomsociety.org

We look forward to seeing you in Detroit Conference, USA.

Regards,

Professor Donald M. Reimer – Conference Sponsors Chair
Director of IEOM Membership and Chapter Development
President, The Small Business Strategy Group
Detroit, Michigan, USA

Dr. Ahad Ali - Conference Co-Chair
Associate Professor and Director of Industrial Engineering
Lawrence Technological University, Michigan, USA
Executive Director – IEOM Society International

Sponsors and Partners

IEOM Society International, 21415 Civic Center Dr., Suite # 217, Southfield, Michigan 48076, p. 1-248-450-5660, Email: info@ieomsociety.org

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Additional research activities

Even lockdown, I took several research courses from MENDELEY, ScienceDirect, Scival, Scopus, ELSEVIER, ACM, Turniting, Cambridge, Wiley, and Gruyter, even the lockdown. Moreover, short term courses such as how to write English articles and Lean Six Sigma 4.0 Black Belt updates were taken. Besides, in any courses, I received certifications and certificates of attendance as evidence. Furthermore, there is still research in the process titled "Sustainable Business Model 4.0: Systemic model for sustainable industrial development" where the research's methodological base is devised in Figure 4. Although the research is in progress, each section of the study's advance progress status is as Table 1 mentioned.

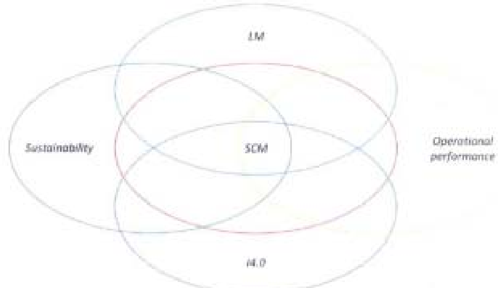

Figure 4 Sustainable lean 4.0 manufacturing bases for systemic 4.0 model

Table 1 Advance progress status

Research part	Status	Comments
Abstract	100%	Finished
Introduction	100%	Finished
Literature Review	85%	In progress, only Supply chain is on process
State of the Art	50%	In progress, the comparative information has done, thus it is written on the research.
Methods	75%	In progress, methodology is developed and written in the document.
Results	50%	In progress, results are developed but not still reported in the research
Discussion	25%	In progress, internal discussion is done but not still finished the external one.
Conclusion	0%	Not started

Finally, the research is part of the sustainable and inclusive sustainable development. Figure 5 depicts that both research papers and the study in progress are part of the strategy. Articles framed in red are those accepted in indexed journals and proceedings, while those in yellow are papers with in-progress status.

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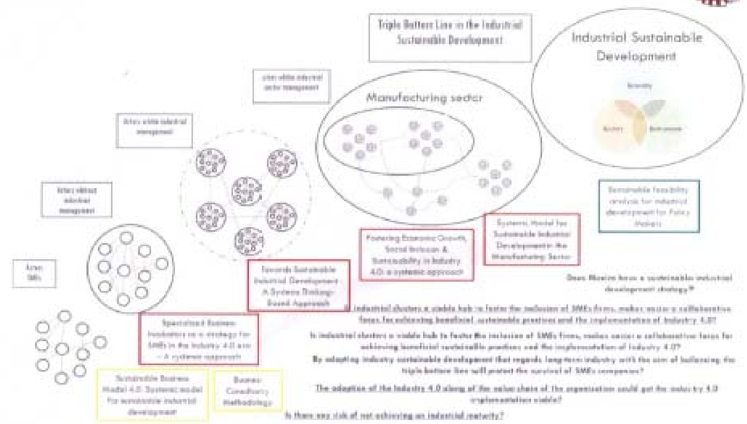

Figure 5 Strategy for sustainable and inclusive industrial development

Dr. Eduardo Oliva López
Supervisor SEPI-ESIME Zac.

doc. Jiri Tupa
West Bohemia University supervisor

M en I Luis Angel Mendoza del Villar
Alumno

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