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# IMPACT OF INDUSTRY 4.0

## ON THE DEVELOPMENT PROCESSES OF THE MANUFACTURING INDUSTRY IN ZONE 9 OF ECUADOR

## IMPACTO DE LA INDUSTRIA 4.0 EN LOS PROCESOS DE DESARROLLO DE LA INDUSTRIA MANUFACTURERA DE LA ZONA 9 DEL ECUADOR

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ABSTRACT

This study has been carried out with the aim that companies know in depth the advantages that the implementation of innovative techniques can have. Based on the general methodology for the analysis of trends, the challenges, postures, trends and technologies of industry 4.0 have been investigated and identified today, in order to promote the growth of the manufacturing sector, from the education and training of professionals. The use of new technologies in the production process, training in cutting-edge knowledge as well as investment in research and development hand in hand with academia make it possible to increase the quality of the sector, improving the way products are conceived, and making them increasingly adaptable to consumer requirements.

Keywords: Industry 4.0, Manufacturing, Innovation, Competitiveness, Productivity.

RESUMEN

Se ha realizado este estudio con el objetivo de que las empresas conozcan a profundidad las ventajas que puede tener la implementación de técnicas innovadoras. Sustentado en la metodología general para el análisis de tendencias, se ha investigado e identificado los retos, posturas, tendencias y tecnologías de la industria 4.0 en la actualidad, con el fin de impulsar el crecimiento del sector manufacturero, desde la educación y la formación de profesionales. El uso de nuevas tecnologías en el proceso productivo, capacitación en conocimientos de vanguardia, así como inversión en investigación y desarrollo de la mano con la academia hacen factible aumentar la calidad del sector, mejorando la forma de concebir los productos, y haciéndolos cada vez más adaptables a los requerimientos de los consumidores.

Palabras clave: Industria 4.0, Manufactura, Innovación, Competitividad, Productividad

## INTRODUCTION

The implementation of new technologies encourages change in manufacturing and marketing processes, the relationship with the client, and permanence on the market (Bartram et al., 2018). Encouraging the study of new technological trends is essential to ensure industrial development. The implementation of these trends will help establish a disruptive environment in the Ecuadorian industrial sector, thus changing the paradigm that it is only necessary to redesign the processes and their operations in order to repower the industry. Otherwise, the industry must have intelligent tools both for the manufacturing of products and their commercialization and conception. For this, it is necessary to have a clear picture of the country's position in relation to the implementation of new technologies.

Hermenean (2013) explains that the future of the manufacturing industry is being repowered thanks to the digital transformation, which directly influences quality assurance, product design, and cost stabilization. The use of new technologies in the last ten years has led to the calling of this new era as Industry 4.0, a term born in Germany, where all existing technological transformations have been conceptualized with a new level of organization and control over the entire value chain of the life cycle of products (Vaidyaa et al., 2018; Angreania, et al., 2020).

Labor and natural resources are fundamental pillars in the manufacturing sector in Ecuador, while in other countries engineering activities are a fundamental pillar. This complicates development in the market, making it challenging to establish competitive trade with neighboring countries. For this reason, Ecuador has the 2030 plan, in which it is stated that academia must play a vital role in the development of the manufacturing sector. New research must promote the implementation of new technologies that benefit the competitiveness and productivity of the manufacturing industry. It must also be supported by other disciplines to change the elaboration and development of quality products as well as management models (Arroyo et al., 2017).

In 2017, the manufacturing industry had to change its structure to face the crisis from 2015 and 2016, where it was reduced by approximately 2.5%. After this crisis, the Ecuadorian government established a dialogue with different sectors, obtaining an agreement trade with the European Union, which strengthened non-oil exports by 28.7% (Ecuador. Plan Ecuador 2030, 2019). Ecuador also managed to formulate a plan called Ecuador 2030 to support economic, social, and environmental development to strengthen the economic growth of the country (Ecuador. Plan Ecuador 2030, 2019). The lack of support in the manufacturing sector is reflected in Ecuador's low participation in the international market, low generation of patents, lack of market diversification, and a low level of innovation. In order to repower innovation skills, it is necessary to implement methodologies related to technological trends. An example is Design Thinking, which helps design new products and services to establish production processes (Banegas & Arroyo, 2020). This methodology is based on three fundamental pillars: user needs, economic feasibility, and technical feasibility. The implementation of these pillars gives way to significant innovation (Burmeister et al., 2016; Saavedra, 2018).

The arrival of industry 4.0 has represented a change for organizations. It has required expanding the general vision of productive areas and rethinking the initial vision of companies. The implementation of new technologies that constitute industry 4.0 must be applied in detail according to the business structure of the companies (Mora & Guerrero, 2020).

In their article on Industry 4.0 and its social and productive relations, López et al., (2018), elaborate on the change that companies belonging to the manufacturing sector have had to apply to their productive environment, taking a leap to a technological platform, which would fundamentally help the communication between productive sectors. It should be emphasized that the reality about the perception of industry 4.0 depends on each country (Büchi et al., 2020). In Ecuador, it is necessary to take action so that our country can drastically change the economy, work, the health system, the transportation system, among other sectors, in order to be able to compare ourselves with the rest of the world (Navarrete, 2017). In an interview with Jaime Macías, a researcher at ESPOL (Escuela Politécnica del Litoral), he explains that to achieve a true fourth industrial revolution, it is essential to establish a policy that supports economic, technological, and academic resources. Roberto Boloña, manager at Alimentsa, explains the importance of establishing a previous scenario, strengthening companies' confidence to enhance investments in new technologies. On the other hand, Xavier Abad, former Minister of Industries, agrees that it is necessary to work with the academy to achieve efficiency in the productive sector. Thus, it is essential to identify and develop areas of technological development and train entrepreneurs, which constitutes a considerable challenge for both entrepreneurs and academia.

In the 2030 business plan presented by the government in 2019, several scenarios are contemplated to boost industry 4.0 with new business models, as long as they comply with the SDG sustainable development goals. The

Ecuador 2030 plan is an initiative of the private sector, which focuses its work on a long-term vision based on the fundamentals of Industry 4.0, such as innovation, automation, and environmental protection, expecting a drastic change in the way of producing, transporting, and the global incursion of new products, this plan is evidenced on the page ecuador2030.org.

All industrial revolutions have meant extreme changes, and Industry 4.0 is no exception. Although this new revolution indeed poses new risks in the conventional form of economics, it also offers a variety of innovative improvement opportunities that will mark a before and after in the ways of the industry, and it is up to companies, government, and people to guarantee a positive use of trends coming from industry 4.0. Finally, industry 4.0 represents a challenge for most organizations that ensure sustainability and continuous improvement since implementing these new technologies requires a constant process for the evaluation of results, which must be defined by the companies (Zheng et al., 2018).

A real and worrying fact is that most companies do not know about Industry 4.0 and what it represents in the commercial sector, omitting critical factors for developing the manufacturing industry. This has caused this new revolution to be slow and uneven, very independent of the country of origin. Several experts have not established fundamental factors that would promote a radical change in companies since it varies according to technologies, tools, and methods born in this new revolution (Narula et al., 2020).

Connectivity is the most important factor for industry 4.0. An interconnected industry works by linking physical devices through a computer network. Intelligent manufacturing that starts from human-computer communication can create a highly flexible and customizable system to meet customer needs and efficiently manage all systems. From basic systems to complex systems, installing these new technologies within production must ensure that it does not present an environmental threat (Dalenogare et al., 2018). Continuous staff training is a responsibility that can support workers facing a new job or skill demands (Zhou et al., 2015).

## Previous works

### *Industria 4.0 y economía circular: revisión de la literatura y recomendaciones para una industria sustentable en Ecuador*

The article reviews literature on the implementation of Industry 4.0 and the circular economy, highlighting that there are few studies on this topic. few countries have shown initiative in these matters. And regarding Ecuador, the country does not have experience in the implementation of technologies that are part of Industry 4.0, nor public policies that encourage the adoption of the circular economy (Alobuela & Morocho, 2021).

Alobuela, M. S. A., & Morocho, F. R. A. (2021). Industria 4.0 y economía circular: Revisión de la literatura y recomendaciones para una industria sustentable en Ecuador. *Ciencia Latina Revista Científica Multidisciplinar*, *5*(6), 14623–14638. https://doi.org/10.37811/cl_rcm.v5i6.1422

### *Manufactura ecuatoriana hacia la industria 4.0: estudio de caracterización del estado de madurez digital de las empresas de manufactura ecuatorianas*

The objective of the article is to know the state of maturity of manufacturing companies in Ecuador, through the study of 25 medium and large companies, which have different levels of maturity, ranging from pre-child to adult. Additionally, a roadmap and portfolio of tools is proposed for companies to begin their digitization (Valarezo Pumagualle, 2019).

Valarezo Pumagualle, M. A. (2019). *Manufactura ecuatoriana hacia la industria 4.0: Estudio de caracterización del estado de madurez digital de las empresas de manufactura ecuatorianas*. http://repositorio.usfq.edu.ec/handle/23000/10320

### *Análisis de la industria 4.0 como factor diferenciador del sector industrial del Ecuador*

The article proposes a methodology to determine the level of maturity of the implementation of Industry 4.0 in Ecuador. based on success factors of countries that have already carried out said implementation. Among the factors to take into account are strategy, technology, innovation capacity, innovation ecosystems and change management (Álvarez Vásquez, 2021).

Álvarez Vásquez, O. W. (2021). *Análisis de la industria 4.0 como factor diferenciador del sector industrial del Ecuador*. http://www.dspace.uce.edu.ec/handle/25000/24751

### *Análisis de Empleabilidad e Industria 4.0 en el Ecuador, como Estrategia para Mejorar los Programas Educativos*

The article analyzes the level of employability and automation, detailing the situation at the industrial level in which Ecuador finds itself, and compiles different educational programs focused on meeting the new needs of companies that are heading to industry 4.0 (Méndez-Mantuano et al., 2019).

Méndez-Mantuano, M. M. O., Caviedes, M. E. C. E., Ruiz, L. H. M. T., Villacres, I. M. A. G., Muñoz, I. S. B. C., & Vega, I. W. X. O. (2019). Análisis de Empleabilidad e Industria 4.0 en el Ecuador, como Estrategia para Mejorar los Programas Educativos. *European Scientific Journal, ESJ*, *15*(34), 44–44. https://doi.org/10.19044/esj.2019.v15n34p44

***Estudio de las tendencias 4.0 y su relación con el Diseño Industrial para el desarrollo del sector industrial manufacturero de la zona 9 del Ecuador***

The article addresses the situation of the manufacturing sector in the Metropolitan District of Quito (DMQ) and its relationship with industry 4.0. Highlighting the 4.0 trends that are related to industrial design. Likewise, it makes a classification of the tendencies with respect to the industrial sectors (Banegas Bravo, 2020)incentivando el cambio de procesos y mejoramiento de productos los cuales son cada vez más personalizables y producidos en masa, el presente trabajo trata sobre la situación del sector manufacturero en el Distrito Metropolitano de Quito (DMQ.

Banegas Bravo, J. D. (2020). *Estudio de las tendencias 4.0 y su relación con el Diseño Industrial para el desarrollo del sector industrial manufacturero de la zona 9 del Ecuador*. http://www.dspace.uce.edu.ec/handle/25000/22203

***Desarrollo Endógeno: una perspectiva conceptual comercial del modelo de gestión en Tungurahua-Ecuador en la Industria 4.0***

The article studies the different paths for the improvement of companies dedicated to the primary sector in the province of Tungurahua. Among the ways to promote the development of the province is the implementation of industry 4.0 so that companies can build quality products in less time (Acosta Orellana & Ortiz Paredes, 2021)

Acosta Orellana, J. V., & Ortiz Paredes, J. F. (2021). *Desarrollo Endógeno: Una perspectiva conceptual comercial del modelo de gestión en Tungurahua-Ecuador en la Industria 4.0*. https://repositorio.uta.edu.ec:8443/jspui/handle/123456789/32181

***Economía circular y la industria 4.0 como estrategia del Comercio Internacional en el Ecuador***

The article describes aspects for obtaining an environmental social responsibility in Zone 8 of Ecuador, this topic being an enabler of industry 4.0. Political objectives and supporting norms of arguments of professionals and academics of the Ecuadorian industry are detailed, along with a sample of 195 people. Showing interest in the implementation of circular economy and industry 4.0 in zone 8 (Bravo Alay & Martillo Fernández, 2019).

Bravo Alay, K. V., & Martillo Fernández, K. E. (2019). *Economía circular y la industria 4.0 como estrategia del Comercio Internacional en el Ecuador*. http://repositorio.ug.edu.ec/handle/redug/45780

***Industria 4.0: el reto en la ruta hacia las organizaciones digitales***

The objective of the article is to detail the challenges that the implementation of industry 4.0 poses to companies. Through a literature review, aspects such as industrial revolutions, characteristics of industry 4.0 and its influence on organizations are encountered (Mora-Sánchez & Guerrero-Marín, 2020).

Mora-Sánchez, D., & Guerrero-Marín, L. (2020). Industria 4.0: El reto en la ruta hacia las organizaciones digitales. *Estudios de la Gestión: revista internacional de administración*, *8*, 186–209. https://doi.org/10.32719/25506641.2020.8.7

***El desafío de la cuarta revolución industrial como objetivo de competitividad de las industrias ensambladoras de vehículos en el Ecuador con visión al 2025***

The article carries out a qualitative exploratory study on the automotive industry of Ecuador, which is going through a severe crisis due to the lack of competitiveness in the face of economies of scale. Analyzes the implementation of industry 4.0 as a way of competitiveness in a period of five years. concluding that the industry is not strategically prepared for new technological challenges (Aguirre Araujo, 2020).

Aguirre Araujo, J. C. (2020). *El desafío de la cuarta revolución industrial como objetivo de competitividad de las industrias ensambladoras de vehículos en el Ecuador con visión al 2025.* https://repositorio.uide.edu.ec/handle/37000/4371

***El impacto de la cuarta revolución industrial en las relaciones sociales y productivas de la industria del plástico IMPLASTIC S. A. en Guayaquil-Ecuador: retos y perspectivas***

The article analyzes different aspects of industry 4.0 with which to determine social and productive impacts globally, and then ground these parameters in the Ecuadorian context and in the plastics industry INPLASTIC S.A. (López Franco et al., 2018).

López Franco, M. L., Lovato Torres, S. G., Abad Peña, G., López Franco, M. L., Lovato Torres, S. G., & Abad Peña, G. (2018). El impacto de la cuarta revolución industrial en las relaciones sociales y productivas de la industria del plástico IMPLASTIC S. A. en Guayaquil-Ecuador: Retos y perspectivas. ***Revista Universidad y Sociedad***, ***10***(5), 153–160.

## Methodology

The Competitive Industrial Performance Index (CIP) results from eight quantitative indicators related to industrial performance. The data is collected by UNIDO databases. This index positions countries according to their industrial development. The CIP consists of four pillars to measure industrial competitiveness, which are (Freire & Oleas, 2010):

- Industrial capacity: The Manufacturing Value Added (MVA) per capita is used to measure the country's industrialization.
- Manufacturing export capacity: The export of the manufacturing sector per capita.
- Intensity of industrialization: it is measured in relation to two indicators; the percentage that the manufacturing sector has in relation to GDP and the ratio of medium and high technology activities in the MVA.
- Export quality: The ratio of total exports in relation to the manufacturing of high and medium technology products.

With the data obtained from the previous statements, the calculation can be established as follows:

$$l_{p,r} = \frac{x_{p,r} - Min_{p,r}}{(Max_{p,r}) - (Min_{p,r})} \qquad (1)$$

$l_{p,r}$ Normalized index for each country

$x_{p,r}$ Current value of the indicator

Max y $Min$: are the maximum and minimum values of the sample.

The value obtained is multiplied by a standard indicator, 100. And thus, an average of the indicators belonging to the IRIC is obtained (Banegas & Arroyo, 2020).

After carrying out several investigations by (Ashton & Klavans, 1997; Rodríguez, 1999; Vargas & Castellanos, 2005) have come up with a general methodology for trend analysis. This methodology has four phases necessary to carry out the investigation. Figure 1 represents the phases for the study of trends.

### Phase 1: Planning and Identification of Needs

To start with trend research, it is essential to direct the research process. For this, the first phase of trend analysis is related to the pre-process, which allows selecting data, research places, and questions.

### Phase 2: Information Identification, Search, and Training

Once the first phase has been carried out, the search, initial review, information classification, and information processing parameters are established.

### Phase 3: Information Classification, Purification, and Analysis

After a first purification of the information, it is necessary to structure it through indicators, such as activity indicators, indicators related to companies, institutions or public research bodies, and second instance indicators related to joint data analysis or relationships between the subject matter to be addressed.

### Phase 4: Communication and Decision-Making Process

This phase is a complementary process for the study, in which the conclusion of the information acquired from the trend analysis is established and evaluated in a general way for the stage of socialization or dissemination of results.

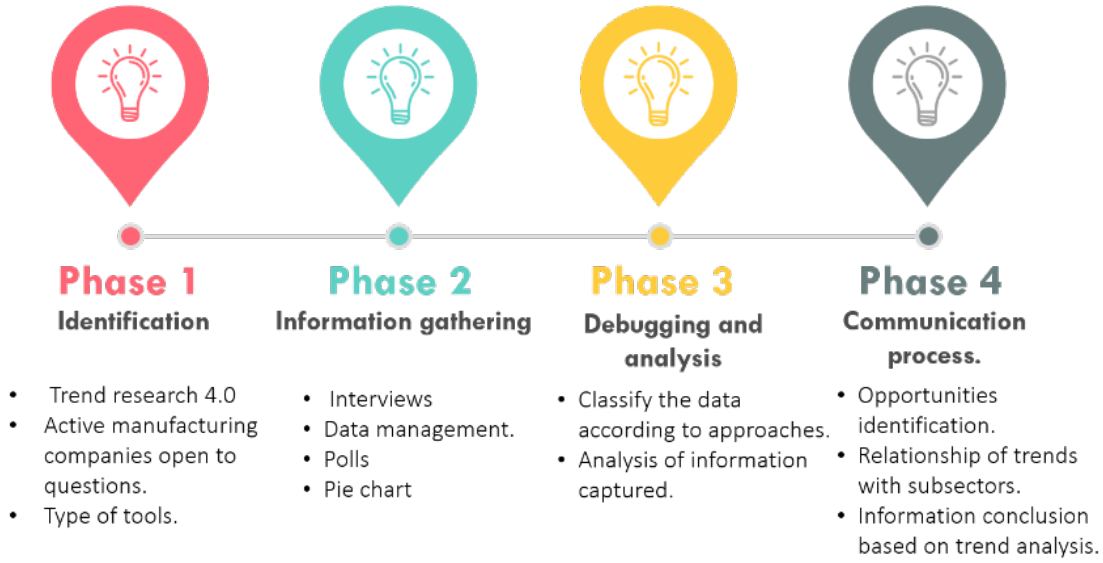



Figure 1. General Methodology for Trend Analysis

Source: (Banegas & Arroyo, 2020)

## Development

### Competitiveness of the Ecuadorian manufacturing sector

The manufacturing sector is one of the bases that sustain the world economy, and it encourages change in the traditional way the economy develops (Naudé & Szirmai, 2012). Countries with scarce resources depend for the most part on manufacturing since it is the source of employment for people with less academic reach. Latin America has been characterized by giving employment opportunities to people with low qualifications. In other words, an operator does not need high educational studies. However, with the implementation of technology, the manufacturing sector tends to have a greater risk in the change of labor because of technological implements.

According to data formulated by (Instituto Nacional de Estadísticas y Censos) INEC in Ecuador, the sector with the most significant influence on the Gross Domestic Product (GDP) is manufacturing, representing 11.57% of the total generated in 2015 for 2016. The manufacturing sector had a share of $28 million of GDP (BCE, 2016). The manufacturing industry represents around 20% of sales at the corporate level, being one of the generators of employment due to the implementation of labor and sales (Mogro et al., 2020).

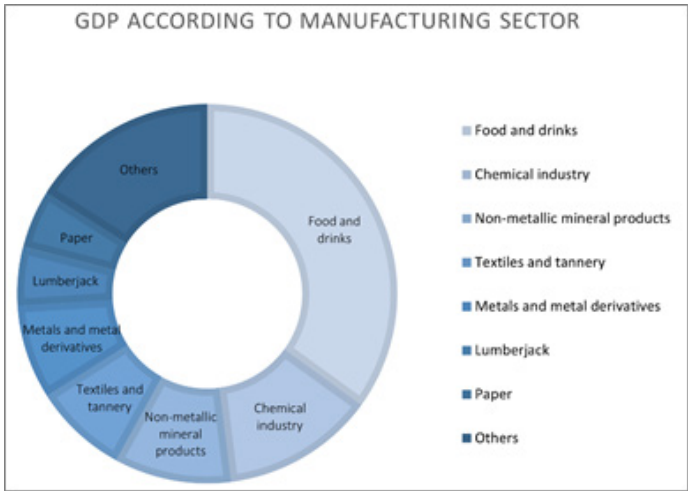


Figure 2 distinguishes the manufacturing sectors and their importance within the country's GDP. The food sector is the main responsible for the total GDP generated by the manufacturing industry, which is approximately $28 million.

In zone 9 of Ecuador, there is a strong presence of manufacturing companies adapting to a new productive balance. This has encouraged the implementation of technology for the innovation and development of this sector. Despite the pandemic witnessed in 2020, the manufacturing sector grew by 0.1%, which evidenced a positive outcome in metal, food, and paper manufacturing (BCE, 2020). Figure 3 shows a historical GVA corresponding to zone 9 of Ecuador expressed in dollars. The sector that has the most significant relevance in the GVA is the manufacture of textile products, followed by the production of food products. These sectors are not attached to the innovation of its products but a redesign of its presentation.

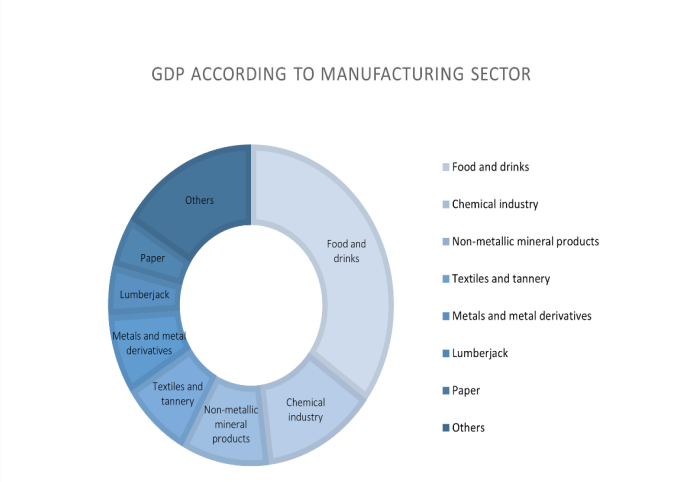
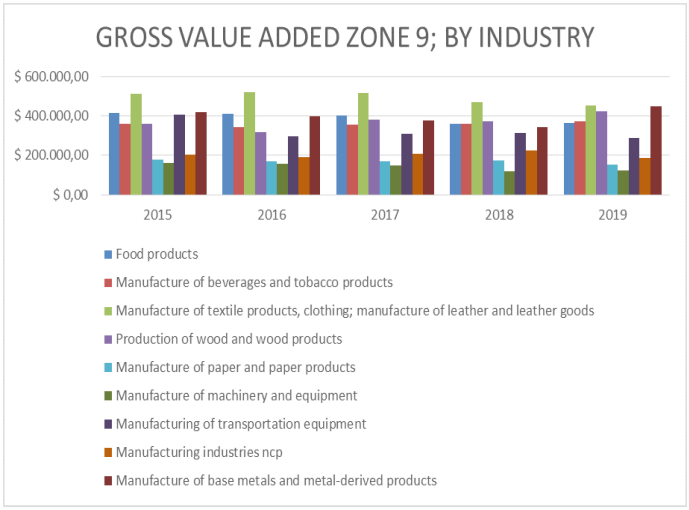



Figure 2. Composition of Manufacturing GDP by Activities

Source: (Banco Central del Ecuador [BCE], 2016).




On the other hand, in less representation is the manufacture of machinery. This is due to the level of innovation that this sector requires to compete with international brands already positioned in the country.

Figure 3. Gross Value Added Zone 9 by Industry

Source: (BCE, 2020)

At the beginning of 2018, The World Bank (2017) detailed advice towards the manufacturing industry to cope with technological change. It included: Competitiveness: which related to the adoption of modern business models to reduce the cost of labor; Training: which relates to the creation of new opportunities based on the experience, training, and education of employees; and Connectivity: which is essential to maintain a connection not only in the technological sense but also in the communication between people and machinery. The synergy of these same tools will drive technological development for this industrial sector.

Figure 4 shows the relevance of the fundamental pillars for the transformation of manufacturing, being the sophistication of the market and the innovation of processes the most relevant points in manufacturing. In 2018, Ecuador was located in the 97th position out of 126 countries. This results from a deterioration in the fundamental pillars considered to increase the level of innovation. Among the least developed pillars are business sophistication, market growth, and human capital. This result has a low index in knowledge and technology (Amaya, 2019). In Ecuador, the low levels of academic research and minimal training in new technologies are reflected in the low generation of patents. In other words, the result that Ecuador has had in GII (Global Innovation Index) 2019 has shown that investment in innovation is urgent as well as a change in the research structure of academia and government, especially

when the manufacturing sector requires both private and public economic growth (Banegas & Arroyo, 2020).

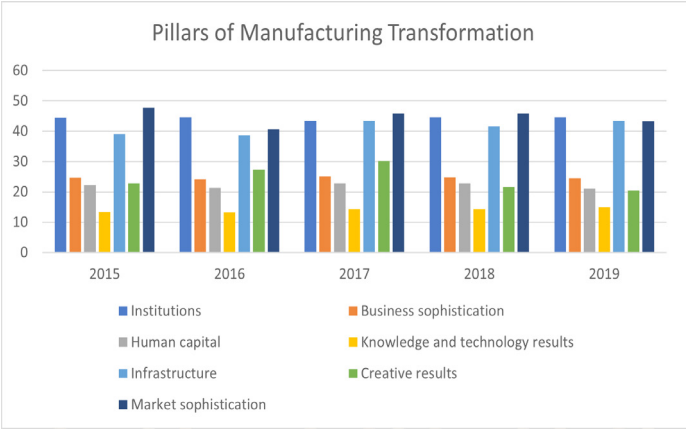



Figure 4. Pillars of Manufacturing Transformation

Source: (Banegas & Arroyo, 2020)

During phase 1, the manufacturing sector was classified according to productive sectors. An investigation of a total of 100 companies within zone 9 of Ecuador was carried out. The interviews addressed questions such as, ¿What type of technology is most important in your sector? ¿Are you developing new technologies in the manufacturing industry? What 4.0 trends is the company currently using? ¿Does your company have innovation areas for new products, among others? Comparisons were made between the data published by public entities and those presented by private companies. Among the relevant data are ICG, innovation in the manufacturing sector, and patents.

After analyzing data, it has been possible to determine that the technological level of the manufacturing sector depends a lot on the capacity for innovation, investment, and knowledge that companies have. The shortcoming of these characteristics is due to the fact that in Ecuador, the manufacturing sector is dedicated to primary production, and there is no evidence of industrialization as such. The products obtained by the manufacturing industry are products with low added value, being a clear example of the current situation in terms of innovation. Figure 5 shows which activity is most supported to incentivize innovation within the manufacturing sector. The acquisition of machinery is the most important activity. This responds to the change of equipment, modernization, and improvements in the productive area. The little participation of industrial design in innovation is due to the fact that there is no solid support for designers, and the activities of designers are affected by the lack of knowledge on the part of companies in the scope of the creation of new products and their improvement. This is an excellent help that industrial designers could give.

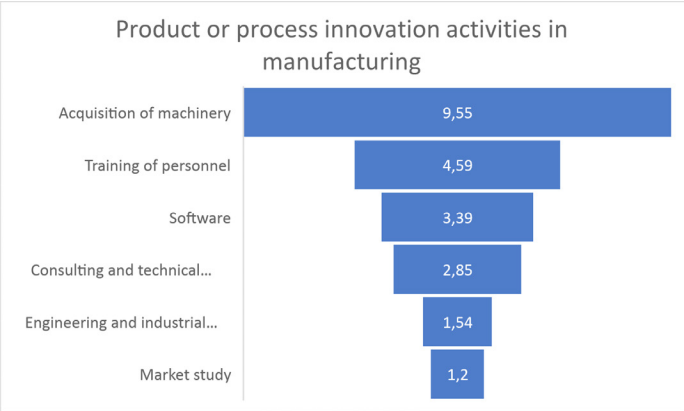



Figure 5. Product or process innovation activities

Source: (Instituto Nacional de Estadísticas y Censos [INEC] & Secretaría de Educación Superior, Ciencia, Tecnología e Innovación [SENESCYT], 2015)

Figure 6 classifies the types of innovation used in a general way: product innovation, process innovation, organizational innovation, and marketing innovation. In the manufacturing sector, the kind of innovation that is mainly applied is innovation in processes with a 9.9% incursion, continuously improved by using software and technological tools that drive a change in this area of the industry.

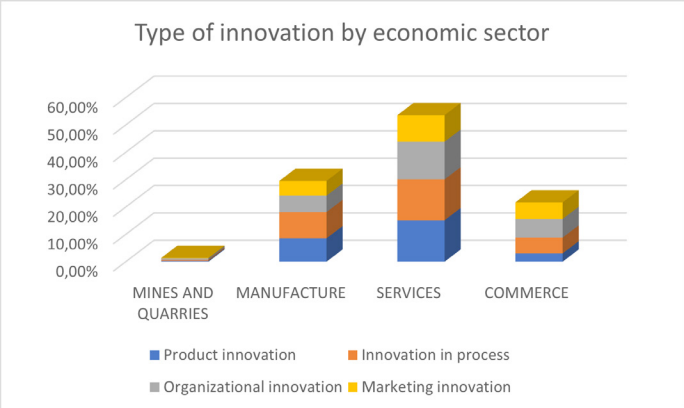



Figure 6. Type of innovation by economic sector

Source: (INEC & SENESCYT, 2105)

The research allowed to identify that 60% of the companies in the manufacturing sector use updated software for the making of their products. 15% of these companies train their employees every five years to update their knowledge. This sector's investment is the highest compared to other productive sectors in Ecuador, with 0.08% of total GDP. Of this investment, most of it goes to acquiring machinery and equipment with 9.55% of the total invested, leaving an investment in training staff of 4.59%. The investment provided for engineering and industrial design

is well below these values with 1.54%, which confirms that the realization of final products does not have an added value to compete internationally.

In the interviews carried out, 92% of those interviewed assure that they do have the ability to create new products. This, however, does not mean that all companies create or improve their products regularly, since this infers in various details such as investment, market study, the study of new requirements, and their applicability.

For several companies, it is not essential to have an R&D&I area. However, 62% of them, which know what industry 4.0 means and the importance of using the tools of this new revolution for the growth of the manufacturing sector, try to have a space for the development of innovation and research.

Another example of the level of research is the search for patents. In the manufacturing sector, the main reason for searching for patents is to monitor competitors, followed by a search for information on the current market. At a very low level of 2.82%, it is applied for the development of a new project or problem solving, detailed in figure 7.

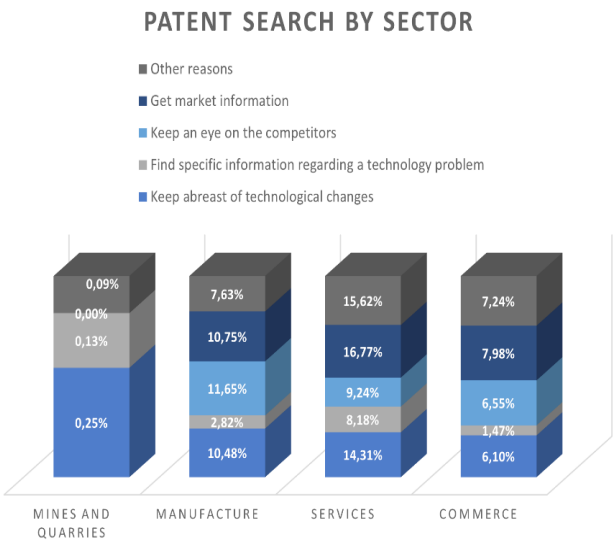



Figure 7. Patent search by sector

Source: (INEC & SENESCYT, 2015)

Once the research is completed and the relevant characteristics are analyzed, it is possible to improve the quality of the manufacturing sector through innovation, as long as it is supported by continuous training in new technologies. This training depends on a restructuring in the academy oriented towards the research and training of new technologies, as well as on the investment by private companies for the acquisition of new avant-garde knowledge in production and government support for the growth of companies and academia.

The innovation of the manufacturing sector depends on different variables that revolve around the economy. This directly influences the level of technification of each manufacturing sector. In the food sector, which is one of the largest in the market, only 37% of these companies dedicate space to investigate new products. This includes the creation of new food products as well as the redesign of packaging or ways of reaching the market. It is one of the sectors with the most significant tendency toward research and innovation activities. As for the automotive, metalworking sector, there is a strong influence on process improvement, supporting continuous improvement. Thanks to this constant improvement, it is easier for these sectors to innovate in their processes. 90% of this sector has the ability to acquire new technologies. The manufacturing industry's technology acquisition capacity helps it be one of the largest investors in technology compared to other economic sectors. With 9.55% acquisition of machinery, 1.54% in the implementation of engineering techniques and industrial design, the wood sector is one of the largest exporters in the manufacturing industry, with an export of around 26%. However, it has a very low as it does not represent notable international competitiveness. The chemical sector has departments dedicated to innovation, with around 78% due to a shift in the business that requires constant research to improve or create new products. After the investigation, it was noted that for a company to want to participate in the innovation of its processes and products, they require the academy's support. This implies the quality of a higher educational level and the training that employers can give to update knowledge according to the area. This is one pillar of many that require a foray into Industry 4.0.

## CONCLUSIONS

In recent decades, many developed countries have proposed innovation policies, added to investment in R&D for the growth of productivity and exports of the manufacturing sector. The results show the positive relationship between investment in innovation and productivity growth in the manufacturing industry in developing countries.

In Ecuador, companies do not carry out innovation activities due to economic limitations, fiscal problems, limited development in science and technology, lack of credit promotion programs, limitations to technological capacity, and lack of innovation development centers. Ecuador has a low investment in spending on research and development (R&D) in the business sector. Government efforts

in recent years have focused on fostering an innovative culture.

The manufacturing sector is one of the economies with the highest economic growth projection. As long as there is an improvement in production techniques since manufacturing production is becoming obsolete, it is necessary to implement cutting-edge technology, widen knowledge to new generations, innovate from the way of conceiving the product to the way in which the customer is reached. A change in perspective will help Ecuador to be internationally compared with other manufacturing benchmarks.

Industry 4.0 has challenged productive players in all areas. The technological challenges include improving the different production systems and developing technological infrastructure, avoiding the concentration of new technologies in a handful of companies. For this reason, a new form of governance must be included in all activities carried out in the manufacturing sector.

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