

## Challenges for Implementing Industry 4.0 in Brazil

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### Abstract

*In this paper some perspectives on the New Industrial Revolution, known as Industry 4.0 will be presented. At a time of continuous advance and development of new technologies, the fourth industrial revolution emerged in Germany. Its objective was to consolidate the country as a leader in the technological area, increasingly strengthening its global competitiveness. Aiming at a new scenario, where the integration of the real world with the virtual is becoming even more frequent, the need to adapt the business strategies to the advanced level of process digitalization has arisen. This article seeks to address the challenges for Brazil to enter the fourth industrial revolution, based on data analysis that show the socioeconomic benefits of digital transformation. Industry 4.0 implementation will bring new challenges and benefits to the industrial sector. Productivity and flexibility rates are expected to be high, resulting in smart factories with more security in their processes and increasing their competitiveness in the market.*

**Keywords:** industry, technology, digitalization, fourth industrial revolution

### 1. INTRODUCTION

Over the years, the world has been going through several revolutions, resulting in great changes. Nowadays technological advances are observed as the main change where technology, when properly implemented, transcends for countless aspects of human life, bringing several benefits. According to Klaus Schwab (2016, p. 1) "we are at the beginning of a revolution that is fundamentally changing the way we live, work and relate to each other," this change is called Industry 4.0. The fourth industrial revolution originated in Germany during a government project to digitalize all factory production. For Rodrigues and Alcântara (2019) such a revolution will have a deeper and exponential impact, characterized by a set of technologies that allow the fusion of the physical, digital and biological world, that is, a great interaction of the real world with the virtual. The implementation of Industry 4.0 in Brazil is still a challenge that implies the gradual adoption of a set of technologies aiming at an intense digitalization of information and direct communication between systems, machines, products and people, being known as Internet of Things (IoT) (RODRIGUES AND ALCÂNTARA, 2019). What differentiates the fourth revolution from the previous ones, according to Cavalcante (2019), is that, despite having contributed with improvements in the processes along the global value chains, they have not shown such a capacity of interconnection between machines, products, suppliers and consumers (BUISÁN AND VALDÉS, 2017).

Section 2 of this paper presents the literature review, in which the challenges and benefits of Industry 4.0 will be addressed. Section 3 deals with economic development, discussing the Brazilian economy, the labour market and its challenges. Section 4 discusses issues related to technological development, focusing on technological capacity and artificial intelligence. Finally, section 5 analyzes future technological investments in the industrial sector and their socioeconomic impacts, followed by final considerations.

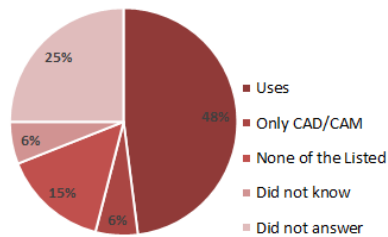
## **2. INDUSTRY 4.0: CHALLENGES AND BENEFITS**

The benefits of industrial evolution are remarkable throughout time, since the first changes, such as the invention of the steam machine. This provide the replacement of manual work by industrial work, which has enabled major improvements, making production allied to the use

of high technology. As time went by, innovations emerged, revolutionizing equipment, intensifying production chain and value processes, making communication between sectors more and more agile. As a result, the market becomes more demanding and competitive, constantly seeking new forms of production (ROCHA *et al*, 2019).

To contribute to the increase of digitalization in Brazil, it is necessary to promote a better digital infrastructure, investing and stimulating professional qualification and promoting the creation of specific financing lines (CNI, 2016). In figure 1, it is possible to verify that less than half of the industrial companies use at least one of the ten main digital technologies for better productivity, according to the CNI research (2016), only 58% of the total industries know the importance of the use of these technologies for the industrial competitiveness.

**Figure 1 - Use of at least one of ten digital technologies**



Source: own preparation based on the report Sondagem Especial indústria 4.0 - CNI

\* CAD – computer-aided design

\* CAM – computer-aided manufacturing

## 2.1 Industry 4.0 in Brazil

The innovative concept of Industry 4.0 began in 2011 in Germany. It was first seen at an industrial technology event (Hannover Fair), presented as the new trend smart factories (TADEU E SANTOS, 2016). According to Lydon (2015), the main objective of this revolution is to improve manufacturing processes in several areas, including efficiency, responsiveness and the ability to meet customer needs in a timely manner. Yamada *et al.* (2018) point out that most of Brazil's industrial

sector is currently characterized by industries 2.0, making it behind schedule and with low global competitive power.

According to Ferreira (2017), in relation to Brazil, we can skip some stages and migrate directly to industry 4.0. However, there are risks. First, we need to train our workforce and enable it to meet the demands of this new industry. In addition, we need to create regulatory mechanisms for this industry to develop. Yamada *et al.* (2018) affirm that if the goal of implementing industry 4.0 in Brazil is achieved, it will be possible to compete with the major world powers, bringing numerous benefits to the country, especially in the economic sector. (*FEDERAÇÃO DAS INDÚSTRIAS DO ESTADO DO RIO DE JANEIRO*, 2016, p. 17-18).

## **2.2 Education revolution**

The fourth industrial revolution directly affects the education sector. The implementation of the 4.0 concept requires various changes in several sectors of the country. One of them, according to Candida (2019), is the change in education, having as main objective an education where the student develops the capacity to live together and adapt easily in active environments, dynamic with the breaking of time and space boundaries. For Brazil, this process of educational transformation is a great challenge, as the country is currently facing a scenario where educational investments are not in the foreground. Consequently, part of the productive young population is excluded due to lack of professional qualification. According to IBGE, the rate of evasion among young people aged 14 to 20 is alarming, which makes it difficult for a qualified workforce to implement the 4.0 concept in industries. The educational sector is being challenged by the fourth Industrial Revolution, where technology is of extreme necessity for the student's development, in order to provide him/her with a high capacity to seek information, create, suggest, adapt and qualify to enter the 4.0 labor market (CANDIDA, 2019).

## **3. ECONOMIC DEVELOPMENT**

The several industrial revolutions have provided great economic and social impacts, such as income growth, skilled labor and increased demand for products and services. However, despite the many benefits,

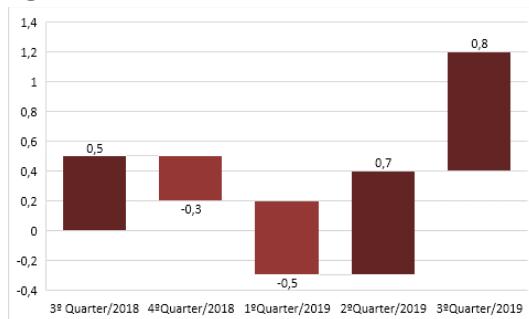
the advancement of this productive sector brings many challenges. The aim is to achieve positive economic results. Industry 4.0 is a strong combination of multiple technologies, having as main objective the transformation to a modern and digital world, changing the way companies act, how they generate their business, position themselves in the value chain and develop new products and services (COSTA, 2017).

### 3.1 Brazilian economy

The implementation of Industry 4.0 in Brazil will imply significant changes in business models and management, impacting the ways of working. According to the World Economic Forum (2016) many functions or specialties exercised today in industries did not exist ten years ago. This same study emphasizes that 65% of children who are in primary school will work in completely new jobs.

To make a consistent analysis of the economic impacts resulting from Industry 4.0, it is necessary to consider numerous factors, such as the extinction of occupations, which today is one of the greatest concerns of the population. However, it is necessary to consider the emergence of new jobs. The world is in a growing technological rhythm, with revolutionary changes in the social and economic system, according to data released by IBGE and CNI research. The Gross Domestic Product (GDP) of the industry increased after two consecutive quarters of decline, taking the industrial sector out of the picture of technical recession. As can be seen in figure 2, the expectation for 2020 is that the sector will be able to maintain constant growth after planning new investments.

**Figure 2 – GDP 2018/2019 - Industrial sector**



Source: own preparation based on data published by IBGE

### **3.2 The labour market**

The fourth Industrial Revolution is linked to the transformations in the labour market. Its changes as technological innovations occur, influencing the creation of new jobs and changes in existing functions. Therefore, the new market calls for professionals willing to adapt to such changes, which are occurring faster, innovating and reinventing themselves. According to Ramos *et al.* (2019), future forms of labor recruitment will go beyond the curriculum. Hiring new professionals in this highly technological market will consider compatibility, technical competence, and how people absorb the organization's culture. Still according to Ramos *et al.* (2019) the jobs with low risk of being replaced by automation will be those of social, creative and innovative nature. As these exceed the limit of machines and the development of new ideas.

### **3.3 Labour market challenges**

The adaptation of the current professions to the developments offered by Industry 4.0, in all sectors, represents today a challenge for the labour market. The high cost of skilled labor is a challenge to be met. It is important to point out that given the demand for new functions from Industry 4.0 there are relatively few professionals prepared to perform such tasks, which makes the workforce more expensive. The company and the professional work together so that the training of employees is advantageous for both. Both for the worker, who will remain employed, and for the company, by training its employees.

Another challenge is the adaptation of the organizational management and the internal communication of the companies in face of the changes occurred on their products and services. For example, a company with an operational production chain has supervisors, in person and in contact with its workers, who determine the working methods. For this company, when modernizing, its employees take on new functions and machines start to work in the production chain. With the exclusion of the old production line, including the employee - supervisor relationship, plant floor at strategic levels, internal communication and the entire organizational management of the company is affected.

A transition of this magnitude has pros and cons. However, when you put it on the balance, the results are positive. Therefore, it is necessary to fight the myth that the revolution that is happening today will result in mass unemployment. According to the World Economic Forum's "O Futuro dos Empregos" Report, a set of estimates indicates that 75 million jobs may be displaced by a change in the division of labor between humans and machines, while 133 million new jobs may emerge adapted to the new division of labor between humans, machines and algorithms. With technological advance, the tendency is that many positions become obsolete, especially those of an operational and repetitive nature. These will make room for strategic positions and vacancies that do not yet exist.

#### 4. TECHNOLOGICAL DEVELOPMENT

The great advance of technology in recent times, the digitalization of processes and the need for new technologies to solve everyday problems are notorious. However, this digital revolution is still in a somewhat distant reality for Brazil. Research published by CNI (2016) emphasizes that to achieve the much-desired technological advance, which Industry 4.0 provides, it is necessary a greater commitment from companies regarding digitalization, to know their gains in production. Unfortunately, there are some obstacles to this. The main challenge is the high cost involved in the digitization process but thinking about a future concept are many benefits (ROCHA *et al*, 2019).

According to a report presented by the Boston Consulting Group (BCG), there are ten technologies applied to Industry 4.0 (Table 1).

**Table 1 – Pillars of industry 4.0**

Technology	Description
Intelligent Robots	Able to interact with other machines and humans in a more flexible and collaborative way
Additive and Hybrid Manufacturing	Allows production through 3D printers
Virtual Simulation	Allows processes and products to be tested and tested during the design phase, reducing failure costs and design time

<b>Horizontal and Vertical Integration of Systems</b>	ERP, MES, SAP systems that integrate the entire production value chain through data analysis and decision making
<b>Internet of Things</b>	Allows connectivity between the various devices, making access and control more flexible throughout the production process
<b>Big Data &amp; Analytics</b>	Intelligent systems that identify process failures, improving the quality of production in real time, saving energy and improving the efficiency in the use of all productive resources
<b>Cloud Computing</b>	Access to the database and support from any location on the planet, allowing the integration of systems and plants in different locations, even if physically distant. Control and support can be carried out globally
<b>Cyber Security</b>	Increasingly secure and evolved communication systems ensuring accountability of the production process
<b>Augmented Reality</b>	Support that allows the user to act within cyber-physical systems (CPS) with assertive vision and mentoring
<b>Ethics</b>	Universal principles, actions that we believe in and do not change no matter where we are

Source: own preparation based on the Boston Consulting Group (BCG) report

Despite the existence of major challenges for the implementation of the 4.0 industry in Brazil, the Brazilian industrial sector is expected to move towards advanced manufacturing, becoming more competitive worldwide.

#### 4.1 Technological capacity

Studies conducted by the *Confederação Nacional da Indústria (CNI)* indicates that Brazil is considerably behind in the use of technologies in industries. These showed that among the 24 industrial sectors, 14 are still in a late process of adopting new technologies. According to IBGE this group is responsible for about 40% of all industrial production in the country, that is, only half of what is produced by Brazilian industry results from an automated digital reality. Table 2 presents the global innovation index for the top 10 countries in the years 2018 and 2019. This index is published annually by Cornell University, INSEAD and WIPO - considering data on R&D investment, productivity increase, education levels and export of highly technological products. In total 129 countries participate in this rank.

**Table 2 – Global index of innovation**

Country	2018 Classification	Country	2019 Classification
Switzerland	1°	Switzerland	1°



Netherlands	2°	Sweden	2°
Sweden	3°	United States	3°
United Kingdom	4°	Netherlands	4°
Singapore	5°	United Kingdom	5°
United States	6°	Finland	6°
Finland	7°	Denmark	7°
Denmark	8°	Singapore	8°
Germany	9°	Germany	9°
Ireland	10°	Israel	10°
Brazil	64°	Brazil	66°

Source: Own preparation based on Cornell University report, INSEAD, WIPO

In one year, Brazil fell two places in the rank, thus being further away from the top 10 most innovative countries in the world. The need for a great and important future work to become a more innovative and promising country is notorious, being such performance compatible with the 9th economy in the world. Today we live in an environment of growing international competition, where innovation is extremely important. An innovative industrial concept is a great differential and will have an increasing weight for the development of a country.

#### 4.2 Artificial intelligence

The interest in Industry 4.0 tends to grow in the coming years as it provides an increase in productivity and cost reduction through manufacturing platforms' transformation. However, for the fourth industrial revolution to fulfill its role, synergy with the Internet of Things (IoT), which is responsible for making the cyber-physical system work, is needed.

Industrial innovation is the way to a more productive and developed country, according to the Brazilian Agency for Industrial Development. For this, it is necessary to transform the productive mindset of existing factories into more intelligent, flexible, agile and connected factories. In this process, it is important not only the commitment to cloud storage, but also to data security. This can be done by implementing technologies such as big data and blockchain to identify defects in the manufacturing process, ensure quality in product design to the customer and prevent fraud.

According to Coelho (2017, p. 15), Industry 4.0 goes beyond the digitization of the process, going through a more complex form of innovation based on the combination of multiple technologies. Coelho highlights in his study that the changes will be on both sides:

"The client looks for experiences, everything is considered at the time of purchase, from the packaging, the brand, the customer service, after sales services, what others says about the product, what the product says about itself, how the experiences are shared by other consumers, what is said on social networks, what information is available so that a conscientious choice can be made based on facts and not just intuition". (Coelho, 2017, p. 16) <sup>1</sup>

To meet this new trend, it is necessary that besides the agility and flexibility on the part of the company, the products and services are enhanced through the implementation of tools that make up Artificial Intelligence (Big Data, Blockchain, IoT, Cloud Computing), to improve the performance of those who offer goods and services, deliver results and optimize shopping experiences among customers and business partners.

**Chart 1 - Artificial Intelligence (AI) tools and how they can cooperate in the process of the fourth industrial revolution**

Tool	Definition	How it can contribute to industry 4.0	Examples
<b>Blockchain</b>	System composed of a chain of blocks that functions as a database for business transactions. Fraud-proof.	Economy; privacy; transparency; less risk; speed; productivity; efficiency; quality and result.	Data Protection between Customers and Suppliers; Fraud protection with validation of information that cannot be altered.
<b>Big data</b>	Large volume of unstructured data that is processed and transformed into useful information. Analysis and use in a timely manner.	Volume; Velocity; Variety; Truthfulness; Value; Decision power; Strategic marketing.	GOOGLE can capture consumers' wishes and offer products and services based on their searches; Insights from data that allow marketing to speak exactly what the consumer wants to hear.
	Remote access to programs, files and services over the	Storage; database; flexibility; geographic	On a factory floor, for example, reports or

<sup>1</sup> Original Quote: “ O cliente procura experiências, tudo é considerado na altura da compra, desde a embalagem, a marca, o serviço de atendimento, serviços pós venda, o que os outros dizem sobre o produto, o que o produto diz sobre si mesmo, como são partilhadas as experiências por outros consumidores, o que se diz nas redes sociais, que informação está disponível para que se possa fazer uma escolha conscienciosa baseada em factos e não apenas intuições.” (Coelho, 2017, p. 16)

<b>Cloud Computing</b>	Internet. No worries about physical location and no need to install programs.	freedom; reliability; productivity; speed.	project instructions can be sent to the cloud through bluetooth and be accessed by employees.
<b>Internet of Things (IoT)</b>	Smart sensors and software that connect physical objects to each other and to the user via the Internet. Allows a coordinated action to be executed.	Intelligent Recognition; Communication; Information Exchange; Decision Making; Management; Data Invocation.	Cars with on-board computer and GPS; Smart homes; Smart watches; Portable health care.

Source: own preparation based on the book, *Introdução a Big Data e Internet das Coisas* (Introduction to Big Data and Internet of things)

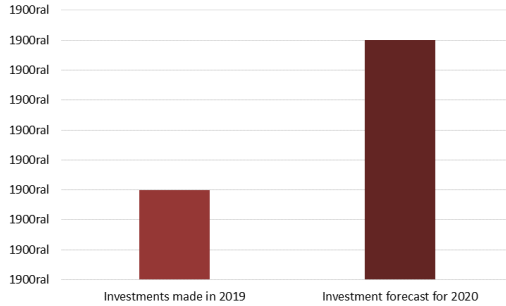
Currently, the challenge for implementing the technology, which will leverage the fourth industrial revolution, is to invest in innovative resources (Big data, blockchain, IoT, Cloud Computing). As well as qualified professionals to plan, execute and manage technological innovations. It will be a robust process of data capture and governance. Because, in addition to digital and modern resources, they must create or access the necessary infrastructure.

## 5. ANALYSIS

For an exploratory analysis, industrial investment data were collected through surveys conducted by CNI in 2019. The major economic powers have as their main characteristic their strategies and technologies. Such resources, when applied in a broad and direct manner in industrial activities, provide numerous benefits such as increased operating efficiency and cost reduction, shortening product launch times in the market (ROBSON BRAGA DE ANDRADE (CNI), 2018).

The research conducted by CNI, *Investimento em Indústria 4.0- Investment in Industry 4.0* (2018), shows the need for new technological investments to make possible the industrial advance, providing Brazil with this new reality. In figure 3 it can be noted that in the year 2019, approximately 74% of Brazilian industries made some type of investment. This number increases about 10% to 2020, that is, 84% of the companies intend to invest in technology, seeking higher productivity, cost reduction and improvements in the manufacturing process.

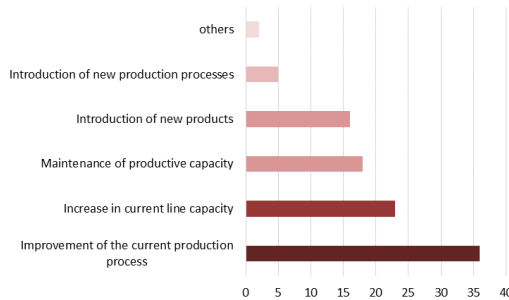
**Figure 3 – Investments 2019/2020**



Source: own preparation based on the report *Investimento em Indústria 4.0- Investment in Industry* – CNI

In figure 4, the focus of business investment for 2020 can be noted. It is evident that 36% of the companies intend to invest in the improvement of their productive processes and 23% seek to increase the capacity of the current line. With the innovation of the industries, increases in competitiveness and in the added value of goods are expected.

**Figure 4 - Investment forecast 2020**

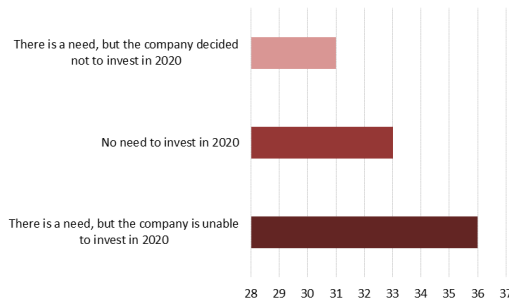


Source: own preparation based on the report *Investimento em Indústria 4.0- Investment in Industry* – CNI

Even with an increase in the percentage of companies that intend to invest in some way in 2020, some will not do so, which is harmful for a sector that aims to launch itself into Industry 4.0. In figure 5 it is noted that about 15% of companies do not intend to make any type of innovative investment in 2020, which impacts them negatively. The

other 36% responded that there is a need for investment, but that they will not do so. The alarming point is that 33% of companies claim that no new investment is needed. According to CNI surveys, innovation benefits the production chain and the country, demonstrating impacting results for the companies involved and for the country's economy.

**Figure 5 – Main reasons for companies not investing in 2020**



Source: own preparation based on the report *Investimento em Indústria 4.0- Investment in Industry* – CNI

According to the article, the president of SAP Brazil, Cristina Palmaka, says that only the businesses that propose a digital transformation will survive the economy of the future. The world is at the pace of innovation and the rise of machines. Research conducted with data from the International Federation of Robotics reveals that industrial automation is constantly growing, with expressive numbers in some countries. In 2015 the average of industrial robots was 66 robots for every 10,000 employees. After a year of disclosure of this data this index increased to 74. Table 3 presents a ranking with the countries that have more robots.

**Table 3 – Number of robots every 10 thousand employees**

Country	2018 Classification	Country
1	South Korea	631
2	Singapore	488
3	Germany	309
4	Japan	303
5	Sweden	223
39	Brazil	10

Source: Own preparation based on data published by Forbes magazine

## 6. CONCLUSION

The evolution of the industry will provide a completely innovative industrial model, making the production process wide and optimizing time. The research concludes that the fourth Industrial Revolution has as its premise the improvement in production, communication and flexibility, making increasing use of new technologies. The data shows the need for Brazil to promote a better digital infrastructure, emphasizing that the first step is to adapt to the new market, thus increasing the competitive potential.

The analysis of the data shows a 10% increase in the companies' technological investment intention for 2020, compared to the previous year, with the improvement of the productive process as the main objective. If this forecast comes true, it will bring numerous economic benefits, such as an increase in GDP. Given the reality in Brazil, where approximately half of the companies are still considered industry 2.0, such change should be gradual.

It can be concluded that two of the major challenges for the consolidation of the 4.0 industry in Brazil are: the lack of investments in technology and qualification/computer education. These barriers can be broken down and as a consequence, productivity would increase and time and resources would be used efficiently. Another fact is that the mentality within the companies needs to go through a transformation process so that the employees can face the fourth industrial revolution without fearing the process. Brazil, even if discreetly, is already moving to adapt to such innovations.

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