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Chapter

Industry 4.0: Current Status and Future Trends

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Abstract

This chapter focuses on the vision of one of the biggest changes that will mark our way to live: Industries 4.0. Our intention is to discuss its basics, the automation and improvements on the processes, the way to transform an small and medium enterprises (SMEs) into an Industry 4.0, some of the economic and educational aspects, return of the investment, etc. This topic is very extensive; nevertheless, our purpose is to give a current vision of the industry and also show the Industry 4.0's future trends. Furthermore, this chapter presents the process to migrate to Industry 4.0 until reaching to Society 5.0 and, in turn, includes a future version of Industry 5.0 that is expected to begin in 2020.

Keywords: Smart Factory, digital factory, pillars, economy, SME, migrate to Industry 4.0, Society 5.0

1. Introduction

The fourth industrial revolution happened as an evolution process in terms of technological advances, following the trend of the first industrial revolution; this first industrial revolution occurred in Britain, during the eighteenth century; it represents the social, economic, and technological changes that affected all Europe, and with the pass of time, were going to affect North America too [1].

The industrial revolution meant the end of the manual labors, as also finished with the use of animals for traction tasks; at the same time, new ways of work were developed, which reduced the working hours without affecting the amount of production. It is important to have in mind that this new instauration of order was not happening in a fast way and it required so many years to obtain a notorious process, which meant something more than a revolution. It was an evolutionary change that affected not only the industrial world but also the economics, population, the social structure, the culture, the relevance of some institutions, and, in a general way, the daily life. The industrial revolution transformed completely a nation full of farmers and craftsmen into the workforce nation, with some new revolutionary machines (steam machine and knitting machine, among other inventions). The first industrial revolution had a great impact in the textile industry [1]. This important change of order started around the 1750s and ended during the 1850s.

Some of the most important characteristics of the first industrial revolution were: the use of the motor force in the industry, the development of the manufacturing system, and the speed improvement in transport and communications, among others. The development of machines in each of the work fields in Europe during the middle ages meant a positive and an important improvement which helped to develop the first industrial revolution. One of the most important machines created during this time was the hydraulic mill, used to grind the wheat. This specific mill had the same system in the monasteries located along the majority of Europe lands, like Portugal, Scotland, Sweden, and the Czech Republic [2].

In England, at the end of the eleventh century, there was a huge hydraulic power that expanded almost 34 ropes and "there was 5624 mills and 3463 castles, which mean that more than the third part of all these castles had at least one mill, even two" [2, p. 184].

The middle age can be considered as one of the relevant moments in our history, where the fundamentals of the modern capitalist economy were settled.

Some of the biggest factors which boosted the economy and the first industrial revolution on the later days in Europe were the geographical discoveries in South America (during the colonization period), which provided new agricultural sources, not to mention the wealth increase; all of these background contributed to the capital accumulation [2]. Also, the monarchical state guaranteed the transport and was protecting all the goods. It was in charge to collect the taxes, and decided who could access to get money loans, which made easier to create great business. The renaissance and the religious reformation ended up promoting the search for the progress; in addition, the humanism which characterized these movements promoted the progress into the society. Finally, it is possible to say that the facts occurred during the middle age in England were the prelude for the industrial revolution [2].

The second industrial revolution occurred in the United States. The innovative technology was the electric energy. It happened during the 1850–1870s period, until the first world war in 1914 [3]. In this new industrial revolution, some of the most important and biggest changes in terms of technology and science appeared; also, the revolution expanded its developments throughout the world. The innovative technologies were based basically on the newest energy sources, such as fossil fuels, the use of new materials to improve machines (like iron), and new transport and communication systems (railroads and steamboats). All these developments generated changes related to work, education, scientific field, and mostly with the human consumption, which brought the mass production concept. So many countries joined into this process of industrialization, such as Germany, France, Japan, etc. Icons of this method such as Henry Ford, Orville y Wilbur Wright, and Nikola Tesla appeared in the book of our human history as great inventors who contributed to this second industrial revolution [3].

> *"The first industrial revolution increased the productivity for the Great Britain, while the second and the third industrial revolution created the global economy and the international division of work, which were responsible of the upper levels of life obtained around all Europe" [3, p. 56].*

The third industrial revolution focused on the development of digital technologies, a notorious improvement in the communication, the development of the Internet, the development of networks, and the new removable energies. These one appeared during the twentieth century, but it was not approved until June 2006, by the European Parliament. All computers, new equipment, communication systems, and, in a general idea, all the digital technologies are made up to improve and make themselves bigger and, even in some cases, have made substitutions for some jobs, relegating the human mind.

The third industrial revolution has done the transition between the analogical and the digital concept; it has invented the integrated circuits that have helped to reduce production costs. The use of the communication technologies and informatics has been indispensable, making possible the assisted use of the computer, the use of optical fiber, telecommunications, studies on the genetics field, and the development of lasers [4].

The fourth and last industrial revolution brought advice and forecast into the system. This new age of revolution is based on the creation of an integrative and collaborative environment, with the intention to add cyber physical systems and to consider the customer as part of the production process. On this fourth industrial revolution, the analysis and the test of the product are done before it goes to the market, not after, which bring up the opportunity to predict what is going to happen before it happens, improving the management of the investment that is made around the production. The main input that came up with the fourth industrial revolution was the setup of the Intel industries, where it is not just about data compilation, but keeping in mind the importance of the interaction between all these information, being allowed to connect it with different information sources and being able to create a controlled system with a high speed and flexible kind of production [4].

2. The Industry 4.0 pillars

2.1 Theoretical framework

The fourth industrial revolution is the last advancement of humanity; it has been promoted from technological advances that the population have in their hands nowadays. It is mainly based on the digitalization or automation of the factories through the use of the Internet of Things (IoT); also, it is paired up with cyber-physical systems. These systems (or pillars) will be the autonomous kind of-systems, with the capacity to make their own decisions, applying machine learning [5]; it will also collect data in real time, which will be analyzed and saved into the cloud. Industry 4.0 will allow to exploit pillars such as the Internet of Things (IoT), Big Data and data analytics, augmented reality (a virtual representation of the real world), cybersecurity, collaborative robots, additive manufacturing, cloud computing, artificial intelligence, and finally, 5G networks. In addition, Rojko [6] says, Industry 4.0 could be capable to decrease the production costs by 10–30%, logistic costs by 10–30%, and quality management cost by 10–20%." "The Intel industry products have implemented sensors (IoT) connected to the network, capturing and storing information constantly into the cloud (or a server), with the purpose of being processed later; this means the information is closely related to the pillars of Big Data and data analytics. Also, the IoT is related to the cybersecurity pillar because of the interaction between the devices connected to the Internet, communicating between it selves constantly, making them highly vulnerable to a computer attack.

1. Collaborative robots, which are going to work with humans in the industry, making a significant amount of processes in an efficient way, are more sophisticated than their predecessors; these robots will allow to obtain a considerable decrease of costs related to the building of fences or safety cells that, in

the previous days, kept the robots isolated from the humans. Rounded-look alike limb from the sensitive robots has been investigated too, with the intention of avoiding dangerous blows that could hurt the operators; these robots will use high-quality strength sensors to guarantee more safeties to work with them. This new system makes possible for the robot to have the ability to stand up with a determinate strength, allowing him to avoid obstacles [6, p. 82].

2. Augmented reality tries to incorporate, or to make a mix-up with virtual elements, using some of the digital content as the standard tool to our tangible reality, in real time. The main idea is to add some digital information to regular and common objects that are observed; it ends up being extremely useful to understand in a deeper way these objects. This process is achieved using a digital system related to a camera, a GPS system, a 3D scale, and an algorithm which is in charge of making the bond with reality. These tools have the capacity to increase the human performance, providing the required information to make a specific task. Also, the collected information by the algorithm and the camera has to be situated on the right place, keeping in mind the respective object that is being observed. Augmented reality can reduce lots of bugs in an immediately way, reducing time that is usually used to repair it [6].

3. As far as cost reduction is concerned, the simulation pillar is the most indicated and outstanding. Simulation modeling is the method that makes use of real models or imagined system models, which allows to make some experiments to validate designs, processes, or systems [5].

Simulation modeling allows to know about the complex systems through the development of complex and versatile products, which allows testing new concepts and systems, resource policies, and new operations before their actual implementation, allowing information and knowledge to be collected without interfering with the operating system [5, p. 9].

System modeling allows to decrease costs as well as reducing the time-lapse of developing and increasing the quality of the product. The imitation of the entire environment of a manufacturing factory allows to make an analysis to know on what point of manufacturing some problems could appear which could delay the production of the product [7].

An Intelligent Factory is not only about the digitalization of the processes but also related to the efficient use of energy, optimization of the processes, and the reduction of the impacts on the environment. At the moment, the best way to achieve this in an immediately way is using simulation. Simulation processes are carried out with advanced software tools, which have great economic impacts on manufacturing factories. The visualization of these processes favors the economy of the factories, since it allows to anticipate situations that could generate losses, to detect the weak points, and to improve phases of the production before putting them into operation [5].

4. Additive manufacturing is an enabling technology, capable to help with the new products, new business models, and supply chains. A set of technologies that allows "3D printing" of physical objects builds up the term additive manufacturing. Unique products can be manufactured without the conventional surpluses, making it a great advantage [5]. A better definition could be "additive manufacturing creates complex parts from the scratch, constantly adding one layer at a time, based on a 3D CAD model" [8].

With the 3D printing and the additive manufacturing, the operator could be able to have customized designs for clients with previously unimaginable figures (incredible geometric designs), compared with the ones that have been made up with its predecessor technology. 3D printing personalizes the design of the part that is needed for the final assembly.

The main idea for each customer is: they can make an order at their liking, and Industry 4.0 is going to take care of the whole relevant process to get the final and personalized result. Also, the additive manufacturing would reduce the consumption of resources and costs: "greater customization without the need of additional tools or manufacturing costs, maximizing the use of the material, fostering a 'zero waste' motto [9].

5. The pillar system for integration can be of two types: vertical and horizontal.

Horizontal integration is related to the inter-company integrality and is the basis of a close and high-level collaboration between several companies, using information systems to enrich the product life cycle by creating an interconnected ecosystem within the same value creation network [5]. Vertical integration is a network manufacturing system, is related to the intra-business integrality, and is the basis for the exchange of information and collaboration between different levels of the hierarchy of the company, such as business planning, production programing, or management [5].

6. Cybersecurity is responsible for providing protection to the stored information, either on a device, or on the network. The system is capable to protect the information from threats like computer strikes, or even from physical kind of threats. It is necessary to know that any system in the world is 100% secure and there always be a risk that must be assumed. In addition to local security (cybersecurity), it is important to talk about physical security (biometrics, safes, steel doors) which is an extremely important method that helps the user to preserve the information in a data center, just to make an example. Cybersecurity has its focus on three key points: data confidentiality, data integrity, and availability of data or CID [10].

Computer threats can be a virus, Trojan, and malware, among others, and they can proceed from an USB device and also from a strange mail with false advertising content. On the other hand, physical threats could be associated to the use of superpower force to break into the place where information is stored, or if the user ´s information to enter into the storage system is robbed. In the same way, there are encrypted, boot, filed, or the overwrite viruses, among others. The most important thing on Industry 4.0 is to provide good and safety practices to factories, which can be reviewed on the ISO 27001. The industries presented on this document have a vital importance because with the interconnection of devices due to the IoT incorporation, industrial plants become more vulnerable [10]. The increase in connected devices means more possibilities of cyberattacks [5]. "The IoT must be built on the basis of secure communications at each point of the manufacturing processes and it has to guarantee the interoperability of security between facilities as basic elements of the supply value chain" [5, p. 14].

The high connectivity required by Industry 4.0 has introduced more open and easily accessible systems to the world, which have increased the possibility of new cyberattacks. Nowadays, it is common to see in the industrial control system that connectivity is based on TCP/IP and Ethernet, or even in the use of standardized wireless systems. "For a variety of industrial attacks, software-defined networks

(SDN) and virtualization of network functions (NFV) can facilitate automatic response for incidents" [5, p. 14].

SDN and NFV make possible an automatic response to the incisions, for a faster detection of system failures, and, for a temporal time-lapse, replace these affected systems with virtual implementations. SDN and NFV are technologies to improve these following aspects: (1) network visibility, (2) network capacities (allows network traffic flows with better management), and (3) deployment and control of network functions using software, instead of specific hardware dle-boxes [5].

7. The IoT pillar is mainly about connecting "things" or objects to the network. The idea of bringing sensors and actuators to the industry would allow capturing data on real time related to the manufacturing process of a product, as well as the behavior of the industrial environment the will be analyzed later by the Big Data pillar. Since it is a large volume of information, it will be stored in the cloud with the help of the cloud computing system [6].

As individually distinguishable by the real world, "things" can be anything like an object or a person. Nowadays, IoT is widely used, for example, for transportation, healthcare, or public services. Thing-to-thing, thing-to-human, and human-to-human form a network within IoT, connected to the Internet [5].

This network allows the exchange of information between devices; it is an interaction which goes beyond physically, and it is focused on the virtual and in the digital concept of things. The object carries sensors so that the user can interact both physically and digitally (virtual), improving the user experience. "For different purposes, the digitized information can be used to adjust production patterns with the use of the physical world and using sensor data" [5].

8. The cloud computing pillar refers to the possibility of offering certain services over the Internet or the network, to a customer. "Assante and others characterized cloud computing for small and medium enterprises (SMEs) as a common fund of resources with rapid elasticity and measured service, self-service on demand and wide access to the network" [5, p. 3].

The implementation of the cloud computing pillar has advantages related to the reduction of direct and indirect costs, eliminating IT infrastructure in the organization and optimizing resources in a dynamic way, which users usually consume, or related to the portability of any type of devices, connected to the Internet which can be accessed from anywhere in the world [5].

Each service has its own characteristics that differentiate it between others: for software as a service (SaaS), the idea focuses on having a software in the cloud, with an option to offer its services from the same server to all the customers, being able to interact with any kind of software, program, or license created by the company, which from now on is going to be called the supplier. The great advantage of this system lies in the ease of managing, maintaining, and updating it. In the case of the infrastructure as a service (IaaS), what the provider offers is the infrastructure, its facilities, its servers, and its bandwidth, so customers can develop high-performance jobs, which need a lot of equipment hardware, high-speed Internet, or large data storage that a normal person would hardly have. The user pays for its use, avoiding the spending of administration and maintenance of servers or large data storage [11].

PaaS service "platform as a service" offers a combination of the previous two services, hardware tools and the basis of its software, to make a new application.

Customers do not need to install any software at home; the provider offers the basis of the software, adding the infrastructure to run it. With the PaaS, users have the possibility to create applications without worrying about building the infrastructure, or even the server's maintenance. In addition to this, it is important to keep in mind that users or customers can make their service package as scalable as they wish, either by adding more resources, decreasing resources, or migrating to the next level of service, while the latter refers to capacity and ease of being able to advance from one level of IaaS to the next as PaaS [11].

9. Big Data refers to a large amount of data structured as unstructured and semi-structured data that is difficult to manage, analyze, and process, given the complexity of the management of these kind of data, the speed with which these databases grow, and the multiple sources which are producing it [12]. The important thing is not the huge amount of data, but what organizations can do with these data. When these data are analyzed by a company, business, or an organization, it allows these companies to make big decisions to subserve its economy. All the data generated by the new technologies are used for its analysis, such as weblogs, radio frequency identification (RFID), sensors built into devices, machinery, vehicles, Internet searches, social networks such as Facebook, laptops, smartphones and other mobile phones, GPS devices and call center records. Finally, Big Data must be combined with a relational (structured) database, so the management could increase its effectivity [5].

What makes Big Data so important is the user is allowed to generate an opinion or a point of reference to information which the company did not know they could have, the possibility to obtain external information about the company that they did not have before, such as comments (or "likes") in social networks, results of marketing campaigns among others that can make us understand if the products or services are being received by the public. All these well-organized data has its importance to the company to find problems and solve them before they can occur or find trends that they can use to favor the economy of the company [12].

The quality of the data is the big problem facing Big Data, due to what is known as the Four dimensions (4Vs): volume, speed, variety, and Value; other experts mention more dimensions to take into account.

According to the Big Data definitions investigated, unlike traditional data processing, the first suggestion to characterize Big Data was related in terms of volume, variety, and speed, also called the Three Vs. In order to continuously process large amounts of heterogeneous unstructured data collected in formats, such as video, audio, and text, among others, in addition, other dimensions have been attempted for better characterization, such as: veracity, vision, volatility, verification, validation, variability, and value [5, p. 7].

10. AI (or Artificial Intelligence) is nowadays considered separately from collaborative robots. AI is starting to being taken into account as another important pillar for Industry 4.0. AI is the use of computer programs to perform complex tasks. These programs are installed on robots of any type (whether they are sensitive or collaborative) to perform tasks or jobs, giving the possibility to robots to adapt into situations in a faster an efficient way. AI helps robots learn autonomously, act logically, and communicate with each other. The use of collaborating robots, at the same time AI I'd being used, conforms a fundamental tool for the optimal and efficient operation of production processes in the Smart Industry or Smart Factory [13].

Simulation and AI methods provided an improved solution for the robot arm's movement path, which saves 5% of time, which means a significant improvement in productivity [13].

Thanks to the sensors installed in the production systems, AI allows to capture the energy consumption of the individual machines, analyze the maintenance cycles, and optimize them in the next step. It can also indicate when the operating data is defective. As the amount of data increases, the system optimizes its efficiency and allows more accurate predictions [13].

11. "The 5G network comprises a software-defined architecture, which allows dynamic programming to provide separate layers for different applications. This will allow new and diverse cases of business use" [14, p. 150]. It is important to talk about 5G technologies or networks since this will be mainly the IoT advance engine, which will allow more mobility and will support the incredible growth of the number of devices connected to the network that had already been mentioned before. This network is 10–100 times faster, and also has better capacity to support real-time applications than 4G LTE. With speeds of 10 Gb/s, latency of less than 1 mS, supporting several billion applications and billions of 5G machines, will provide an always active user experience [14].

Some of the various applications that 5G will allow will be: "high levels of network reliability: electrical networks, industrial control, traffic, cyber health and smart city management, high volume of information—remote video surveillance, etc. and battery-powered sensor networks low cost/low energy" [14, p. 150].

Nowadays, combinations between fixed and wireless networks are needed for large IoT projects, but with 5G, it will be different since it will have a reliability of 99.999%, latency of 1 mS, low energy consumption that will remedy the deficiencies of the technologies of existing communication and flexibility due to standardization to handle the large number of IoT devices. With an exponential growth of the following technologies that will drive Industry 4.0—additive manufacturing or 3D printing, sensor technologies, nanotechnology, artificial intelligence, robotics and drones—there is no doubt that 5G will be of great help but it will be important to add that new technologies will appear and Industry 4.0 needs a communication network technology that satisfies the industry over time, heterogeneity, security, and protection of industries [14].

5G will allow manufacturers to automate end-to-end operations and configure or eliminate virtually new product lines or entire factories. With billions of sensors, machine-controlled robots, and autonomous logistics, all of them capable of communicating and operating remotely in real time through 5G, manufacturers can achieve huge productivity gains. 5G will be the platform that will allow growth and transformation in many industries, contributing directly to social and economic development [14].

5G technologies can play a key role in the integration of new technologies; the aforementioned technologies and the pillars of Industry 4.0 can offer a platform to interconnect machines, robots, processes, self-guided vehicles, and goods, among others. 5G can be seen as an additional pillar that will be responsible for interconnecting and communicating other pillars quickly, flexibly, and safely, providing the support for the massive growth of IoT in an intelligent industry. In an upcoming future, 5G will be indispensable in any manufacturing company that intends to migrate to intelligent industry [14].

As for the pillars that will be used to design and create the architecture, it is planned to make the first visit to the manufacturing company and based on what can be analyzed of the company, the pillars will also be selected.

3. Transforming a small and medium enterprises (SMEs) into Industry 4.0

According to the European Commission, an SME is a company that employs less than 250 employees and has an annual balance sheet that does not exceed 43 million euros. SMEs, as a general idea, have deficiencies in many aspects (limited financial resources, lack of organizational culture, investment, and research and development in technology, among others). If they are compared to multinationals, in addition to most existing, I-4.0 maturity models are more focused on large companies than on SMEs.

The level of development in which SMEs are located (the majority is considered at a level 0) to address migration to I-4.0 is not taken into account. By conducting a survey of SMEs, it is possible to find out to what level of development the company is in and which should initially be improved to get into the transformation into Industry 4.0. The main aspect to keep in mind will be that a maturity model of Intelligent Industry/Industry 4.0 focused on SMEs is needed that takes into account the level of development 0, in which most of them are located; it is also convenient that the company has included a self-assessment tool to know the state in which it is and the progress toward Industry 4.0; it should be taken into account that the change from level 0 to 1 will require more time, effort, and resources of the entire company [8].

Small and medium enterprises from now on must take into account this new industrial revolution that brings with it a technological revolution to improve the competitiveness of the company, as is the case of SEI Laser that since the beginning of the 1990s has been evolving technologically and receives Industry 4.0 less disruptively. The data collection of the actors present in the production chain helped SEI Laser to improve labor productivity that increased up to 40% and improved the technical capacity of the laser process, among others. Industry 4.0 will help to find solutions to improve any of the three main elements of the business model such as capturing value, offering value, and creating value [15].

The migration of an SME company to Industry 4.0 depends a lot of states in which the company is located (its cultural organization, its information systems, organizational structure, and resources), which is possible to be known through a survey of the SMEs that helps to collect information to know the status of the company and finally focus on Industry 4.0 [16].

3.1 Automation and improving of process

Nowadays, the changing market requires production processes with flexibility, adaptability, and agility in real time for any companies. Thus, the manufacturing automation or Smart Factory is the response to this issue. Automation or digitalization brings benefits, e.g., with virtualization process, the physical world can be linked virtually (virtual and simulation models). Another benefit is real-time capability; with sensors (IoT), it is possible to analyze data continuously to react to any changes in the environment in real time. The Internet of Things (IoT) allows connection of machines, people, and systems in enterprise, improving production process [17].

When a company invests in "Industry 4.0," it will change technological aspects, product development processes, marketing, logistics, manufacturing, after-sales services, and security [18]. Higher quality, flexible production, advanced planning and controlling with relevant, real-time data, rapid reaction to changes in demand, stock level, errors by to mention other advantages and improvements in the enterprise [17].

3.2 How to migrate?

It is possible to say that migrating to Industry 4.0 is quite complex and it is not just about implementing new technologies and making large investments in equipment, machinery, software, hardware, robots, and education [15]. It is a vision and a disruptive change in the way companies have been working so far. There is already reports from experienced companies that are living in the process of transformation toward Industry 4.0 gradually, since it is not advisable to change the whole structure completely because it can generate major disorders in the production process. There are recommendations for migration and a transitional process between the current productive model and where the company wants to go, which is a digitalized and intelligent industry [16].

One of the models was proposed by Jhon Paul Kotter. This chapter is going to summarize in eight steps of the proposed methodology: create the sense of urgency to migrate; form a coalition; create a vision—visual communication; eliminate obstacles; integrate others by giving them faculties; generate short-term results; deepen changes; and create institutional changes. On the other hand, it is important to mention that there are a number of requirements related to tell if an specific industry is an intelligent one, digitalized or Industry 4.0 [19].

Among the requirements, it is possible to mention: an interconnected production model between the components of the production chain and each of its processes, the digitalization of documents improving efficiency and optimizing resources, an automated production model, digitized and integrated from the management to the production chain, return to school all the staff that work in the company to be a proactive member in each of the departments that make up the company, a new management model optimizing machine-machine relationships machine, man-man, a change in cultural aspects traditionally managed in self-management, management, business culture, an increase in production, personalization of the product or service thinking of the end customer [15, 16].

The productive model, which was thought related to the personalized need of the final customer, a complete transformation of the business model, both at the level of supply and demand, new service platforms which optimize the value proposition, optimize the management of data and information, adapt or create new standards in the different elements that are part of Industry 4.0, redefine the concepts of quality, ensure the prestige of the company, increase cyber security of data and information, modify or adapt the laws of different countries to the new production model, the adaptation of international relations at the commercial level, measure the environmental impact generated by the new business model, to include concepts such as happiness, joy, well-being in the people linked to the production process.

3.3 Investment return

Investment return is a key element in business world. For this reason, when migrating or digitizing a company, it must be done in a personalized way and according to the model of each business. During this process, technologic aspects should not be the only thing to focus between the transformations to a new production model. It is very important to deepen in the benefits and efforts involved in migrating to a digitalized industry. In order to do it, a key process is to meticulously calculate the investment return in each aspect that is migrated; it can be technological, training management, process improvement, automation, etc. [20].

These calculations must be performed in each area to know exactly the benefits that could be obtained when performing the migration, and with that information, the company executives will have better tools to decide on how to perform the migration to Industry 4.0 or how it should be adjusted to obtain a better investment return. It must be estimated over time, either in the short, medium, and long term, and it is recommended to perform it in different phases, in order to maintain a continuous feedback throughout process; for SMEs, it is approximately 12 years, while for large companies, it is approximately 7 years.

In the transformation process, there are some recommended steps: analysis of the company current state, well-defined objectives for transformation, a work plan to achieve the objectives, calculation of investment return in every phase and area where the transformation will occur, and a detailed report to the company executives.

3.4 Taxes

In general, finance, industry, and economy ministries are making great efforts for the digitalization of many companies of different industries. To track this process, they have different platforms that allow them to identify the advance of each company and the challenges they face when transforming to Industry 4.0. One of the relevant aspects in the new industrial revolution will be the resource management by the different ministries. At this moment, each country handles them with different platforms and tools, and the efficiency level is different for every case [21].

Perhaps the resources management problem, received by the state through taxpayers, depends a lot on cultural, social, and political characteristics and control systems. The finance ministries are not exempt to adapt all their instruments and working system for a fully digitalized resource and administration management. The objective is to improve efficiency and control of tax collection; more intelligent platforms and management process are needed that can share information with different industries in real time and at every step of the production; it allows to constantly coordinate the financial management between suppliers and clients, and the information provided can be evaluated in a faster and more efficient way [21].

For this, the tax agency, as well as the industries, will have to digitize in order to have a better management of public resources, minimizing the possibilities of criminal acts and evasion, resulting from bad economic management and bad real time information management, it will lead to an increase in public collection and allow to improve the citizens quality of life.

3.5 Standardization

The standardization in the productive chain and the business model requires interfaces that allow all levels of the productive sector to handle a common language, for each element to be fundamental for the proper management of the business model; and not to be independent entities performing their function individually under a common objective. The idea is that everything is integrated and to achieve it, a new productive culture is required.

On the other hand, the traditional standards known as the ISO and IEC will have to evolve toward new standards according to the digitized and intelligent industry. In other words, technological facilitators will be needed to make possible an Industry 4.0. These technological facilitators must be present in every existing pillars and other fundamental technological entities, such as 5G mobile telephony and new management software (CRM, ERP, PLM, etc.); the integration between management, logistic production, and others software will be fundamental for the transition to Industry 4.0 and the decision-making of the company's management.

3.6 Economy

At the beginning of the fourth industrial revolution, all economic, financial, social, cultural, and environmental models will receive a great impact; they must adapt to this new revolution. One of the biggest challenges is the negative impact in the environment of the traditional production model; it affects human life but there is not enough awareness to start facing it. Perhaps people think that it affected others and not themselves.

The large volumes of plastics produced go to the ocean, food produced that end up thrown into the trash, computers, telephones, cars in the stock of companies due to overproduction exceeding the demand, excessive electricity consumption, excessive use of gas vehicles, poor policies to mitigate and control environmental pollution, excessive CO_2 emissions including computer equipment and computer romos [22].

For all these reasons, Industry 4.0 is an opportunity to modify all these superficially considered aspects of the traditional economic model. There must be awareness that the natural resources are limited and it cannot be allowed to continue destroying them as is being done so far. The new economic model must consider that the natural resources must be protected and the environmental impact must be minimized. It should be tried to unify two concepts: create wealth and wellness but simultaneously cause minimal environmental impact.

Similarly, one of the big bets for Industry 4.0 is the productivity increase generating greater wealth, but a consequence of that wealth must be greater equity in the resources distribution as a result of good management of the fiscal and tax control by the ministry. A serious mistake would be to focus on the overproduction and natural resources exploitation, and neglect the impact it has on nature. Some economists call it a circular economy, biophysical economics, and ecological economics. This economy is based on three principles: preserve natural capital by controlling natural and renewable resources, optimize the resources used more times, promote a more efficient system that eliminates external and internal aspects in the productive chain and particularly that has minimum environmental impact, design no waste products, elastic and flexible diversity, renewable energy increase, consider everything as a system, re-evaluate the costs and prices management [23].

3.7 Legal challenges in Industry 4.0

It is a well-known fact for people working in science and engineering that this field has evolved faster than the legal environment or the countries' constitutions; it is important to stand out that most of the countries' constitutions are from past centuries, and what jurists do is adapt the technological and scientific advances to the current law. This has been done throughout the history and that is why it is noticeable that science and the legal framework in general are asynchronous and outdated, causing difficulties in implementation and scientific development in real time. In addition, non-tech experts take the final decision on scientific issues and technological advances. For this reason, adaptation of the legal framework is necessary and should be constantly evolving in parallel with the sciences and technological advances.

On the other hand, a digitalized environment brings new challenges to customers; whether they are natural persons or companies, the way of work and relationships will be re-evaluated; they must adapt to the new needs and also protection, security, etc. of the information are important. In the same way, it will be necessary to work on values and ethics since the most important element in the fourth industrial revolution will be the information management, the regulation to achieve it, and the adaptation of all the legal systems to a fully digitalized world.

3.8 Future trends: Industry 5.0 or Society 5.0

Industry 5.0 makes a great change of perspective; the core of Society 5.0 focuses on people as fundamental axis of the production sector. Both production and marketing fields agree that beyond the focus of Industry 5.0 is the Society 5.0. In Society 5.0, the products or services offered will be customized to the customer needs. The intention is to reach a fusion between technological development and human beings, with the main objective of people and machines complimenting their activities, and not people being replaced by machines. The use of cobots and robots is a fundamental change for collaboration of repetitive, danger, and unsafe tasks. Furthermore, the humans work will be intellectual production, which means it will be necessary to be qualified to be proactive in this society model [24].

This new approach of man-machine interaction is expected to increase production and offer greater satisfaction to both the worker and the final customer, with customized products. Again, is important to emphasize that Industry 5.0 goes beyond just a production process, and looks for a Society 5.0, thought and made for people and cobots integrated.

One of the great contradictions with previous generations is the model focused on people. The automation of processes, the introduction of cobots and the evolution of technology allow people to develop new skills in the production process.

In this disruptive approach, in order to achieve an intelligent society education need to change from its traditional form, new tools, software and hardware are needed and must be integrated with cobots, and high technological training of people for Society 5.0. A huge difference between Industry 4.0 and Society 5.0 is Industry 4.0 has robotics and other technological pillars as the center of the industrial revolution, while in Society 5.0 technology, complements or collaborates with human's work. It is important to stand out that technological advances achieved in Industry 4.0, increase the efficiency and productivity of Society 5.0 by adding the focus on the productive process to creativity and craftsmanship of humans. A different vision is expected, another relevant aspect in this new society is the environment as a priority and the circular economy [24].

Also, it is important to mention that the personalization of products and services is done according to the real market requirement, in order to avoid oversupply and unsalable inventories, which happens in Industry 4.0; the main idea is to produce what the population really requires, leading to a minimum over costs and waste due to overproduction. This also reduces the CO_2 emissions and the environmental impact.

The vision is a society where intelligent industries, autonomous cars, intelligent cities, etc. are integrated, besides the actions against climate change is: minimize all negative issues in business world and management systems. A more supportive society, with greater cooperation between people, communities and countries, greater trust among people, minimum corruption in public management, a more equitable resources distribution can be an ideal thought; regarding to markets, the basis of the production process would be greater trust and credibility between clients and companies [25].

The Society 5.0 is expected to be more inclusive and environmentally friendly; and also to have a better individuality management and a simultaneous integration with the environment and the society. The general expectation is a more sustainable world where environmental, social, and economic impact issues are related and integrated.

3.9 Circular economy

The circular economy has begun to be implemented in Industry 4.0 and will be the fundamental element for the development in Society 5.0. In this economy, wasting, destroying, or throwing away are re-evaluated concepts and are changed for reuse and recycle; nothing will be wasted and everything not used is considered as a resource for the productive process; so repairing, adapting, and updating will be part of the daily life, not only for a few but for all the people in Society 5.0. Innovating, recycling, and preserving will be daily concepts for the people participating in this society.

4. Conclusions

This document shows a vision of the present and future of Industry 4.0. This chapter includes an introduction to the history of industrial revolutions, the pillars of Industry 4.0 such as systematic review, 5G networks, and artificial intelligence which are incorporated as other pillars because some experts consider them important in the Smart Factory. An economic approach and a return on investment approach are examined to see the benefits provided by the Smart Factory. In addition, this document provides an essential tool in the process of migration to Industry 4.0, the survey. Finally, it covers what Society 5.0 is and a future vision of Industry 5.0 that is expected to begin in 2020.

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