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Abstract

This project deals with a literary exploration of Industry 4.0 compared to Industry 5.0. In this sense, an investigation into the advancement of industrial technology as evidenced by the emergence of research on revolutionary disruptive technologies. Similar to the analysis of how humans in the Industrial Revolution 4.0 used technology to control the production of knowledge and intelligence, the Industrial Revolution 5.0 aims to produce this knowledge and intelligence using its own machines. The new stage in the industry suggests that collaborative robots (cobots) will become more common in the coming years, along with the release of intelligent software (bots), paving the way for a new concept of economic and industrial development. With the return of the human to the process and the production model, the human-technology relationship will take on new meaning. Finally, this article documents the review of literature published on the topics of Industry 4.0 and Industry 5.0. The articles were reviewed and researched in various data bases and high-level journals in order to gain a better understanding of both industries.

Keywords: Cobots; Industry 4.0; Industry 5.0; Artificial intelligence; Society 5.0.

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Resumen

El presente proyecto aborda una exploración literaria de Industria 4.0 comparado con Industria 5.0. De tal modo que el estudio realiza una exploración de la marcha del progreso industrial marcada por la aparición de tecnologías disruptivas que originan revoluciones con un importante impacto social y económico. De manera similar al análisis de cómo en la Industria 4.0 los humanos utilizan la tecnología para monopolizar la generación de conocimiento e inteligencia, la Industria 5.0 pretende generar este conocimiento e inteligencia a partir de las propias máquinas. La nueva etapa en la industria sugiere que los robots colaborativos (cobots) se harán más frecuentes en los próximos años, junto con el despliegue de software inteligente (bots), lo que allanará el camino para un nuevo concepto de desarrollo económico e industrial, con el retorno del hombre al proceso y al modelo productivo, la relación integradora entre el hombre y la tecnología adquiere un nuevo significado. Finalmente, este artículo documenta la revisión de la literatura que fueron publicados en el tema de la Industria 4.0 y la Industria 5.0, los artículos fueron revisados e investigados en diferentes bases de datos y en revistas de alto rango con el fin de obtener la mejor comprensión de ambas industrias.

Palabras clave: Cobots; Industria 4.0; Industria 5.0; Inteligencia artificial; Sociedad 5.0

Introduction

The topic of Industry 4.0 (Fourth Industrial Revolution) appeared less than ten years ago and needs to be associated with the digitalization of industrial production processes in its DNA.[1]. However, some visionaries have already begun to pay attention to the next industrial revolution, namely Industry 5.0. This technological revolution aims to promote the transformation of the industrial sector towards a smart space based on the Internet of Things and cognitive computing.[2].

It is highly possible that in 20 years people will work fewer hours per week, but in more specialized, qualified jobs closely linked to the knowledge-based economy. In addition to all this, together with collaborative robots (cobots), it will become increasingly popular in the coming years through the use of intelligent software (bots), which will pave the way for a new concept of economic and industrial development. Even the relationship between the integration of people and technology acquires a new meaning with the return of man to the field of production processes and models.[3].

One of the characteristics of today is that both society and its economy as a whole, industry and global production continue to be amazing, with all the achievements that the fourth industrial revolution brought with it, Industry 5.0, and the great revolution already has begun to settle [4]. However, many circumstances are still in the process of implementing Industry 4.0.[5]. The promise of Industry 5.0 is an opportunity to empower the individual and put them at the center of economic, production and control processes, and all of course because of how extraordinary the development of technologies supporting Industry 4.0 is, especially digital technologies, robotics and of course artificial intelligence [6] [7] [8] [9].

Development

Industry 4.0

The Fourth Industrial Revolution, also known as Industry 4.0 (I-4.0), proposes a change in the way businesses operate and, therefore, the environments in which they are forced to compete. In this way, the appearance of the I-4.0 is documented for the first time in Germany in 2011 as an alternative to expand a new concept of the German economic strategy based on the automation tactic.[10].

Industry 4.0 objectives

Manufacturers compete to meet changing market demands. This requires production lines to be adaptable, intelligent and flexible enough to meet updated requests. [eleven]. Business leaders and manufacturing managers have come to the conclusion that they must achieve integration of commercial and industrial production [12]. Such integration

requires considerable advancement in industrial processes and strategies. Furthermore, it can only be achieved by integrating various facets of a company, including suppliers, production lines, and customers. This multifaceted integration has been called the Internet of Things (IoT), which is the main asset of Industry 4.0.[13].

Why is Industry 4.0 a relevant topic?

It is essential to understand the suitability of the topic of the fourth industrial revolution called Industry 4.0 [14]. Industry 4.0 (I-4.0) proposes optimizing manufacturing activities and increasing income by transforming products [15]. Digital manufacturing refers to a manufacturing process that, supported by technologies such as virtual reality (VR), computer networks, rapid prototyping, and database [16]. In such a way that I-4.0 proposes to change the way of working, it also affects the way in which customers interact with things and the practices of interacting with a company. Additionally, there may be changes in the workforce that require new skills. Jointly, the concept of Cyber-Physical systems in an artificial intelligence environment associated with I-4.0 as an abstract concept can closely integrate the physical world with the virtual world [17].

The use of sensors and devices such as; Computer, analytics, and robotics, among others, can improve products in countless ways, from ideating prototypes and experiments to adding connectivity to previously unconnected products. These permutations in products lead to transformations in the supply chain and, therefore, in customers.

What are the effects of Industry 4.0?

In Industry 4.0, the term "smart" is becoming increasingly important, although a definition is difficult to find. However, a probable definition of this topic that corresponds to I-4.0, in accordance with the position of several authors, can be related to autonomous and independent devices that can communicate in real time and interact with other intelligent modules in a collaborative and automatic environment.

Industry 4.0 is a manufacturing paradigm that is highly focused on creating smart products and processes, through the use of smart machines and the transformation of conventional manufacturing systems into smart factories. In such a way, that today the topic of the smart factory is talked about as a crucial factor that is considered in the industrial revolution, this is the result of several advances that involved combination, digitalization and the use of flexible arrangements and intelligent media. At the same time, these industry resources create an intelligent environment throughout the entire value chain and allow flexible and adaptable processes. The smart manufacturing environment resides in a new composition of real-time link between all production resources (sensors, actuators, conveyors, machines, robots, etc.) that improves production efficiency and allows market demands to be met. in terms of quality and difficulty.

Smart goods and services are composed as an active part of the systems throughout the value chain, they monitor their own production management through data collection, they

can request the necessary resources and record production processes automatically. Also, smart products, like final products, need to know their parameters to be used and provide information about their status throughout their life cycle. Smart products can be called CPS since they are designed to create a link between the material and virtual world. In this sense, these products are specified by different typologies such as automation, data collection, communication and interaction with their environment, in order to define and collect data on their manufacturing process and providing information on other steps related to production and processing. maintenance. At the same time, smart products have a high degree of artificial intelligence, with the ability to autonomously distinguish and interact with their material environment over their life cycle.

Business models were greatly influenced by Industry 4.0, as the manufacturing paradigm implies a new form of communication throughout supply chains.

Customers are a key factor in any business model and Industry 4.0 provided them with a set of advantages, improving communication throughout the value chain and improving the customer experience.

But, industry 5.0 brings the emergence of new business models that better meet changing customer requirements, through real-time communication capabilities throughout the entire supply chain.

Industry 5.0

Industry 5.0 is considered the next industrial evolution, its objective is to harness the creativity of human experts in collaboration with efficient, intelligent and precise machines, to obtain resource-efficient and user-preferred manufacturing solutions compared to Industry 4.0 [18]. In this perspective, robots and people collaborate together. At the same time, it is considered that human beings will focus on tasks that demand creativity and thus robots will conceive the rest of the industry's operations. The main technological principles of Industry 5.0 are collaboration, coordination, communication, automation, data analysis processing and identification [19].

Table I represents these revolutions on a timeline. Note the shortening of the time between revolutions. There were 100 years between the first three revolutions. To get to the fourth from the third has only taken about 40 years. It is possible that less than 40 years will be needed to crystallize the fifth revolution.

(1784)	(1870)	(1969)	(2011)	Future
Industry 1.0	Industry 2.0	Industry 3.0	Industry 4.0	Industry 5.0
• Mechanical production • Water and steam energy	• Division of labor • Production in more • Electric power	• electronics • IT Systems • Automation • Production	•bIoT • Robotics and artificial intelligence • big data • Cloud Computing	•Robotics and artificial intelligence • Sustainability • renewable resources • Bionics
First power loom	First assembly line	First programmable logic controller	Cyber physical systems	Human-Robot collaborative work bioeconomy

Table I. Stages from Industry 1.0 to Industry 5.0

Industry 4.0 is an initiative of the German Government. The theme of Industry 4.0 is "Smart Manufacturing for the Future". Its objective is simple and similar to previous revolutions: Increase productivity and achieve mass production using innovative technology. There are a number of trending technologies that help achieve Industry 4.0 [13]. The main ones are the Internet of Things, robotics and artificial intelligence (AI), big data and cloud computing. There are also other technologies that support Industry 4.0. 3D printing, virtual and augmented reality, smart factories, smart logistics and environmental intelligence are some of them. It must be taken into account that these technologies have not been developed specifically for Industry 4.0. The vision of Industry 4.0 brings these technologies together towards the goal of smart manufacturing. There is also criticism about Industry 4.0 as it is a top-down government initiative with a predefined notion [17].

Characteristics of Industry 5.0

- Motto: Man-machine collaborative work
- Reason: Smart world.
- Power supply: Renewable energies with a sustainable approach.
- Technologies involved: Sustainability in all elements involved in the design and manufacturing system
- Areas involved in development and innovation: Artificial intelligence, organizational exploration, systems improvement and innovation, business management, etc.

Industry 5.0 Values

Industry 5.0 presents some challenges:

- Cultural diversity in terms of human values and approval.
- The evaluation of the creation of environmental and societal value.
- The inclusion of the client throughout the value chain up to SMEs.
- Interdisciplinarity of research disciplines and complexity of the system
- Environmental policy with a flexible and results-oriented emphasis.
- High efficiency is required, while large investment is required

Social implications of work.

Humans are social creatures. They interact with their kind in various aspects of their lives, including work. Social events at work to increase the work performance of their workers are a common practice in many organizations. As the number of robots increases in the workplace, the number of humans is likely to decrease. This can limit interactions between humans. Even if the number of human employees remains the same, the introduction of robots into workplaces may have unprecedented effects on social interactions in the workplace. Some humans may prefer robots. Some will think that the social behavior displayed by robots is unrealistic, but the behavior is just computer programming that is, in fact, actually fake.

Employees will have different views on how to interact. with robots socially. The problem is complicated when there are robots in a managerial or higher position. Employees tend to show respect for their superiors or managers. Respect is a social behavior. Humans may be confused whether they should respect a robot manager or not. Since, in fact, respect will mean nothing to a robot.

Some of the issues will be new, confusing, and even frustrating for many.

The return of the human touch

The personal preference of whether or not to use a particular technology varies from one human being to another. There will be people who are eager to work with robots and who will strongly oppose the idea of working with robots. Organizations that want to benefit from human-robot collaboration in their workplaces should be aware of these preferences. If organizations consist primarily of employees with a negative attitude toward robots, then their transition to human-robot coworking environments will not be easy or possible.

However, personal preference for working with robots depends mainly on the media and not first-hand. experiences. There are many famous movies or TV shows that depict the fantasy of robots taking over the world or fighting against the human race. This negative environment has an effect on personal preference for working with robots.

An attempt is made to produce both the creativity and reflection of society and the execution capacity of machines. The purpose is to perfect, not replace, human intelligence with artificial intelligence, thus achieving new objectives and improving the quality of life of humanity [20].

However, viable job creation can only become a reality if nations allocate the necessary funds to teach coding and robotics in schools and provide more opportunities for vocational education.

Comparison between Industry 4.0 and Industry 5.0 Vision

	Industry 4.0	*Industry 5.0 vision 1*	*Industry 5.0 vision 2*
Motto	*Smart manufacturing*	*Collaboration between humans and robots*	*Bioeconomy*
Motivation	*Mass production*	*Smart society*	*Sustainability*
Power source	• *Electric power* • *Fossil energy sources* • *Renewable energy sources*	• *Electric power* • *Renewable energy sources*	• *Electric power* • *Renewable energy sources*
Technologies involved	• *Internet of Things (IoT)* • *Cloud Computing* • *Big data (Big data)* • *Robotics and intelligence* • *Artificial (AI)*	• *Collaboration between humans and robots* • *renewable resources*	• *sustainable agriculture* • *Bionics* • *Production* • *renewable resources*
Research areas involved	• *Organizational research* • *Process improvement and innovation* • *Business management*	• *Smart environments* • *Organizational research processes* • *Improvement and innovation* • *Business management*	

Taken from [8]

Digital technologies provide a new paradigm in manufacturing and eliminate repetitive jobs. Applies human intelligence to understand the requirements of a human operator. Data in manufacturing can be analyzed using machine learning and artificial intelligence (AI) [21]. Technological advances and revolutions happen faster and faster, so a company needs clear visions for company developments, as well as a clear mindset for transformation [22].

Ethical issues

Being honest, hardworking, and helpful are among the ethical behaviors expected of human employees. Robots that are selfless, have no ambition, do not know laziness and cannot lie, will undoubtedly have an effect on the way they perceive the current ethical values of work. Humans may not be able to compete with robots to achieve a good ethical standard in this regard. It is difficult to predict how work ethics will evolve in a human-robot co-working environment.

Additionally, there is likely an ethical standard that defines interactions between humans and robots. In one study, it has been reported that humans can feel sorry even for events such as a robot behaving badly towards another.

Working 'hand in hand'

Humans know robots as a concept from books and movies. However, human-robot

coworking will be new for almost all office employees. While interacting with robots is expected to be easy, the actual experience may be different from the expectation. We may have to learn how to behave with the robot to get what we really want. Non-verbal communication is an important part of human interaction. Robots may or may not understand these communications.

Humans will need time to learn and get used to working with robots. In addition, there will be robots with different capabilities. Some will be advanced and some will not. It will be difficult and confusing to distinguish robots with different capabilities. Robot manufacturers will need to find a way to develop them, and be able to report their capabilities without confusion, because they will need to learn to work with their different types.

Negative views of Human-Robot work

What humans fear most from robots, both personally and socially, is the loss of jobs. As robots begin to take over humans' jobs, there is likely to be a negative attitude toward robots. Some will argue that the use of robots will increase unemployment. The counterargument to this view is that new jobs will be created.

History shows that this counterargument has validity. While robots take over mundane jobs, humans will focus on jobs that require creativity, artistry, research and development. So, there is no need to fear the world of the unknown, because it could be a real success.

Conclusiones

Typically, an industrial revolution is driven by transformative technological advances, which have led to fundamental changes in the way industry functions. These changes have economic and social consequences. Some are intentional and desirable; others unintentional and undesirable. Like other predecessors, Industry 4.0 is driven by technology.

However, Industry 5.0 is value-driven. The former needs the latter to remember essential social needs, value and responsibility as ultimate goals; the latter requires the former for technological pushes and solutions.

However, a warning is that a proliferation of buzzwords, such as industries 4.0+, industries 4.5 and even industries 6.0 and industries 7.0 in the not-too-distant future, may befall us. These buzzwords may invite paper writing or grant writing; They are not conducive to making any business decisions and facing technology challenges. To this end, dry heads and wise minds are required.

And of course, regardless of whether Industry 5.0 will focus on humans and robots working together or not, it will still be a big change for organizations. Attitudes toward robots will likely evolve as humans experiment with robots.

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