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Barriers and driving forces for the implementation of Industry 4.0 in organizations: a state of the art

Barreras y fuerzas impulsoras de la implementación de la Industria 4.0 en las organizaciones: un estado del arte

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Abstract

Industry 4.0 is a manufacturing concept that has gained strength in organizations because it delves into industrial automation, digitization, and new technology implementation to improve working conditions and productivity. This article aims to contribute to the current debate on industry 4.0 while providing an overview of barriers and facilitators. Based on documentary analysis of 49 articles written between 2014 and 2020, six categories related to barriers were identified: security, costs, human talent, organizational resistance, and use of technologies; and eight as driving forces of Industry 4.0 implementation: technological pre-existence, management commitment, efficiency, competitiveness, sustainability, competent employees, and government policies.

Keywords: industry 4.0, technologies, barriers, driving forces.

Resumen

La Industria 4.0 es un concepto de fabricación que viene tomando fuerza en las organizaciones, y que involucra: la automatización industrial, la digitalización y la integración de nuevas tecnologías para mejorar las condiciones de trabajo y aumentar la productividad. El presente artículo tiene como objetivo aportar en el debate sobre el estado del arte de la industria 4.0, agregando una visión general sobre los impulsores y barreras para su implementación. En este sentido, se siguió una metodología de análisis documental y de contenido de 49 artículos de investigación, publicados entre 2014 y 2020. Los resultados permitieron identificar seis categorías relacionadas con las barreras, a saber: seguridad, costos, talento humano, resistencia organizacional y uso de tecnologías. Igualmente, se identificaron ocho categorías como fuerzas impulsoras de la implementación de la industria 4.0, así: preexistencia tecnológica, compromiso gerencial, eficiencia, competitividad, sostenibilidad, empleados competentes y políticas de gobierno.

Palabras clave: industria 4.0, tecnologías, barreras, fuerzas impulsoras.

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1. Introduction

Industry 4.0 is a term widely used in academic literature to refer to the fourth industrial revolution. The concept was introduced in 2011 in Germany at the Hannover Fair, and has been known worldwide with some equivalent terms such as "manufacturing industry" in South Korea, the "Industrial Internet" in North America (Ghobakhloo & Fathi, 2019); "Smart industry" for the Netherlands, or "Digitization" for the Norwegian government (Mogos, Eleftheriadis, & Myklebust, 2019). Although there is no consensus on its definition, it is recognized as the technical integration of cyber-physical systems (CPS) in manufacturing and logistics, and the use of the Internet of Things (IoT), in industry. Utilizing these technologies is essential in the development of "smart manufacturing" processes, which include devices, machines, production modules, and products that can independently exchange information, trigger actions and control each other (Nolting et al., 2019; Pereira & Romero, 2017).

Although the term Industry 4.0 was coined to account for the widespread integration and adaptation of information technologies (IT) in manufacturing industries, (Ghobakhloo & Fathi, 2019) adds that this can be defined based on their technological trends; hence some authors define it as the equivalent of one, or several of the technologies that comprise it. Following this, the development of new technologies is a fundamental component for the optimization of processes in companies and in generating or strengthening their strategies, thus creating opportunities to satisfy the needs of customers, favor logistics processes, and supply chain management (Witkowski, 2017).

Likewise, organizations differ considerably in terms of what types and how many technologies they use and how advanced their level of implementation is (Dalenogare, Benitez, Ayala, & Frank, 2018). Therefore, it is critical to understand the difficulties companies face when implementing these technologies (Stentoft, Jensen, Philipsen, & Haug, 2019; Türkeş et al., 2019). In this sense, it is necessary to identify both barriers and facilitators companies face to adopt Industry 4.0 technologies and remain competitive in increasingly demanding markets. By analyzing the factors that affect their implementation, it will be possible to identify and develop strategies that will empower companies to implement these technologies in their organizational process, thus, allowing them to appropriate mechanisms that facilitate their implementation at a managerial level.

To this date, several articles published in this field, all of which study the key technologies developed, changes in business management models, and the impact on a company's principal processes. However, the academic discussion regarding Industry 4.0, the analysis of its content, and its detailed description, as well as the explanation of its possible future developments, merit more attention (Glas & Kleemann, 2016). In this sense, and knowing that the systematic study of the preceding literature on a specific topic constitutes an obligatory step in the knowledge construction process, the objective of this article is to contribute to the debate on the state Industry 4.0, adding an overview on both facilitators and barriers to its implementation in the business sector. The findings could help entrepreneurs better understand the implications and challenges faced when engaging in the fourth industrial revolution.

2. Methodology

2.1 The concept of industry 4.0 and its impact on productivity

The invention of the steam engine allowed the institution of mechanical production and impulsed the first industrial revolution that took over England in the mid-18th century. During the second half of the 19th century, the second industrial revolution arose in Europe and the United States, characterized by mass production, Taylor's division of labor, and the substitution of chemical and electrical energy for steam to

increase industrial productivity. The invention of the integrated circuit (the microchip) was the technological advance that triggered the third industrial revolution. These three industrial revolutions have one thing in common, their recognition after the technology that characterized them emerged. However, the fourth industrial revolution is the first to be identified before its implementation (Pereira & Romero, 2017).

The guiding principles of Industry 4.0 were published by Kagermann, Lukas and Wahlster (2011), and set the foundation for the manifesto published in 2013 by the German National Academy of Science and Engineering. Three dimensions compile the Industry 4.0 paradigm: the first refers to the horizontal integration throughout the value chain of a product life cycle and between the value chains of the life cycles of adjacent products, the second is related to end-to-end engineering throughout the product life cycle (from the acquisition of raw materials to the manufacturing system, the use of the product and the end of the product's useful life), and the third with vertical integration and networked manufacturing systems (Stock & Seliger, 2016).

According to Rejikumar, Arunprasad, Persis, and Sreeraj (2019), 6 principles are identified in the implementation of Industry 4.0 in organizations that have the following characteristics:

Interoperability. It refers to the ability of all segments to form teams, transmit and work together through the IoT.

Virtualization. Manufacturers following Industry 4.0 will use the "virtual twin" manufacturing of the brilliant industrial facility, which will improve current procedures.

Decentralization. Empowers plant experts to independently make the right choices without deviating from their path to a definitive hierarchical goal.

Real-time capacity. Industry 4.0 focuses on data collection and monitoring of various processes in real-time.

Service orientation. The Internet of administrations has become an indispensable segment of Industry 4.0.

Modularity. Effortless adaptability to changing conditions is crucial in Industry 4.0. Then, manufacturers must ensure minimum disruption in procedures when improving different elements.

Industry 4.0 also encompasses a set of future industry developments, yet, the technology is not considered complete. However, it does include customer-specific adaptation, reduced processing time, and new distribution channels. Therefore, this has impacted the nature of competition, the value chain, the business model, the organization of work, the work environment, the dynamic management of complex business processes, and corporate strategies in many industries (Agostini & Filippini, 2019). These transformations, as well as the underlying technologies, have allowed us to establish the potential that Industry 4.0 has to transform the business landscape through a dramatic productivity increase, such potential impact is the reason why industry 4.0 is truly an industrial revolution (Llinas Sala & Abad Puente, 2019). Due to the positive role, it has resulted in the sustainable business performance of companies, which in turn opens great opportunities for industries (Büchi, Cugno, & Castagnoli, 2020).

On the other hand, Industry 4.0 is a new manufacturing concept and involves industrial automation, digitization, integration of new production technologies to improve working conditions, productivity, and quality. It is not clear the opportunities and challenges perceived as antecedents of their implementation in manufacturing companies. Specifically, the current discussion lacks a differentiated analysis regarding the different sizes of companies, industrial sectors, or roles. However, in general terms, it has been identified that this industrial revolution will lead to possible profound changes, classified into six main areas: industry, products and services, business and market models, economy, work environment (socio-cultural factors), and skills development (Pereira & Romero, 2017).

Previous studies had confirmed the positive impact of technologies on company productivity at the level of processes, service quality, market share, flexibility, value chain management, customer satisfaction, improvement of innovation processes, among others (Bayo, Billón, & Lera, 2008; Zhang, van Donk, & van der Vaart, 2011; Garcia & Landeros, 2020; García, Lopez, & Epelde, 2020). In this sense, industry 4.0 represents an optimistic discourse with high expectations regarding performance improvement with its implementation, demonstrating that it can optimize internal operations and, also, has the potential to strengthen its market services (Müller & Däschle, 2018). Furthermore, this can confirm that their potential technological development will positively reflect the level of industrial performance and sustainable performance in SMEs (Dalenogare et al., 2018; Ghobakhloo, 2020; Haseeb, Hussain, Ślusarczyk, & Jermsittiparsert, 2019).

2.2 Use of industry 4.0 technologies

Industry 4.0 technologies are the means to implement the principles of communication, flexibility, and real-time within an organization. According to Backhaus and Nadarajah (2019), there are a total of thirty technologies related to industry 4.0 identified. However, the scope of Industry 4.0 is delimited to the ten most frequently cited technologies in literature: cyber-physical systems (CPS), Big data and data analysis, advanced manufacturing solutions, simulation, horizontal and vertical system integration, IoT, cybersecurity, cloud-based services (CCS), additive manufacturing and augmented reality (AR) (Agostini & Filippini, 2019). Table 1 summarizes the concept of each of these technologies.

Table 1. Concept of main technologies related to industry 4.0.

Technology	Concept	Source
Cyber-Physical Systems (CPS)	CPS is the integration of computing, networking, and physical processing that interact with each other with physical inputs and outputs rather than in isolation.	(Trappey, Trappey, Govindarajan, Sun, & Chuang, 2016)
Big data	Big data is an analysis used to extract information from large amounts of collected data, which, after evaluation, enables decisions to be made with which to optimize production costs and quality.	(Backhaus & Nadarajah, 2019)
Collaborative or autonomous robots	This technology refers to sensor technologies integrated into robots and machines that are increasingly flexible, communicative, and cooperative. Its connectivity with products and the adequate collaboration of mechanisms with humans favor the reduction of the size of production batches at a reasonable cost.	(Moeuf, Pellerin, Lamouri, Tamayo-Giraldo, & Barbaray, 2018)
Simulation	Modeling tools allow analysis of product behavior, production line performance, and network coordination to use the collected data and optimize operations in real-time. Industry 4.0 allows simulation of the performance of all aspects of a production system.	(Moeuf et al., 2018)

Horizontal (IH) and vertical (IV) integration systems	IH systems refer to the integration through new global networks that create added value from various IT systems, processes, resources, and the information that flows inside and outside an organization. In the IV, the integration of these elements is through the departments and hierarchical levels of an organization; from product development to manufacturing, logistics, and sales.	(Pereira & Romero, 2017)
Internet of things (IoT)	IoT refers to the connection of all physical objects to the Internet, with the ability to capture information through radio frequency identification (RFID) and other detection technologies, which allow observing, identifying, and understanding the world regardless of people's limitations of time, attention, and precision.	(Atik & Ünlü, 2019)
Cyber-security	It is the process of protecting a more extensive number of communication channels without reducing the performance of the networks to guarantee the deployment of the strategies of Industry 4.0.	(Moeuf et al., 2018)
Cloud-based services (CCS)	Cloud computing is a service model that allows access to applications, data, and physical computing resources, which are available remotely through a network. Cloud Computing meets the need of Industry 4.0 for sharing information inside and outside the company.	(Bongomin, Gilibrays Ocen, Oyondi Nganyi, Musinguzi, & Omara, 2020)
Additive manufacturing	A term that refers to the 3D printing process which is a process that creates products by building successive layers of additive materials, thus avoiding the need for component assembly.	(Strange & Zucchella, 2017)
Augmented Reality (AR)	Computer graphics technique where virtual symbols are superimposed on a real image of the outer world and can sometimes be enhanced with computer-generated sounds and global positioning data.	(Yıldızbaşı & Ünlü, 2020)

2.3 Method

The methodology used in preparing the document follows the strategy known as content analysis (CA). In this strategy, the different stages are an accumulation of material, descriptive analysis of the inclusion and exclusion criteria, selection of categories, and evaluation of the material (Rejikumar et al., 2019).

Following Londoño, Granados, and Villafañez (2014), we determined the benchmark terms. The databases used in the literature review were: Elsevier, Web of Science, Dialnet, Emerald, EBSCOhost, and Taylor and Francis, with articles published since that year, using search terms such as: Industry 4.0, manufacturing industry, industrial Internet, Smart industry, Digitization, Industry 4.0, and business or Industry 4.0 and SME. After reading the titles and abstracts of all identified results, 117 studies prevailed. Taking this into account, the following search equation arises:

ALL (industry 4.0) OR ALL (industry 4.0 AND barriers) OR ALL (industry 4.0 AND drivers) OR ALL (manufacturing industry) OR ALL (industrial Internet) OR ALL (Smart industry) OR ALL (Digitization) OR ALL (industry 4.0 AND business) OR ALL (industry 4.0 AND SME). PUBYEAR > 2014. Search Language = Auto.

During the second stage, a first review process took place to exclude documents that did not

meet the requirements defined by the research objective. Therefore, and under Hoyos (1999), a bibliographic review sheet was designed with the fundamental data that identifies the unit of analysis, as well as a synoptic sheet containing a synthesis of the document's research results: summaries, methodology, results, and conclusions. Following this process, we excluded the articles with a different scope from that determined for this investigation.

Subsequently, in stage 3, the categories of driving forces and barriers in the implementation of Industry 4.0 by the business sector were identified. Finally, stage 4 was an evaluation of the content of the documentary material based on these categories. In addition, the authors built a matrix of the key concepts and technologies identified. To conclude, there were a total of 49 articles identified which met the conditions outlined in the objective of this investigation.

3. Results and discussion

In general terms, it is possible to observe the marked tendency to increase publications around the topic of Industry 4.0, as identified by Rejikumar et al. (2019), who established that while in 2013 there were no publications in academic journals, in 2016 it was possible to identify ten. See figure 1.

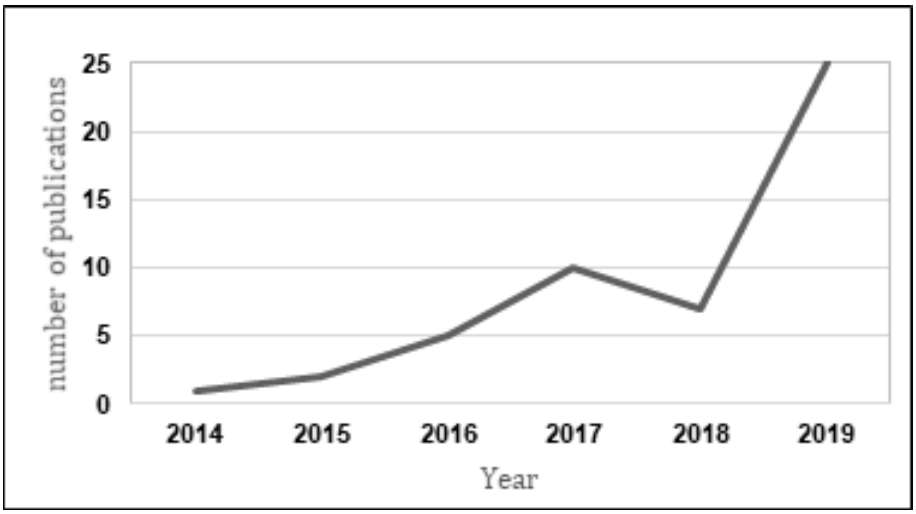

Figure 1. Trend of academic journals on implementation of Industry 4.0 publications.

It is evident that the year 2019, the most up-to-date that can be thoroughly assessed, was remarkably productive in terms of publications of interest for the intended objective. According to (Kang et al., 2016), the literature on technologies related to intelligent manufacturing increased dramatically in 2014. Hence, this document performed a systematic review of the academic articles published since that year, with 49 technical studies written by 157 authors selected. Regarding the methodology, 36% were empirical studies, 16% qualitative studies, 22% case studies, 11% of the articles are proposals for implementation routes, and 15% reviews. Regarding the publication's source, as mentioned by Rejikumar et al. (2019), a trend of high production by Germany and the US remains.

In the study, and to characterize the selected documents, the keywords were identified and noted. With the inclusion and exclusion criteria, there is a high presence of these terms: Industry 4.0, IoT, SMEs, Cyber-physical systems. These underpin the classification of the articles and allowed us to identify the trends found regarding the use of information technology in this field.

Furthermore, there were six categories related to the implementation barriers of Industry 4.0 identified, which contrasts with the eight driving forces identified in the literature review, see Figure 2. Although several documents in the scientific literature compile important bibliographic compendiums, this field of research observes an exponential growth in published articles. Therefore, the current state-of-the-art of Industry 4.0 needs to be replicated since it is highly feasible that the environment dynamics and the conditions that characterize it rapidly change.

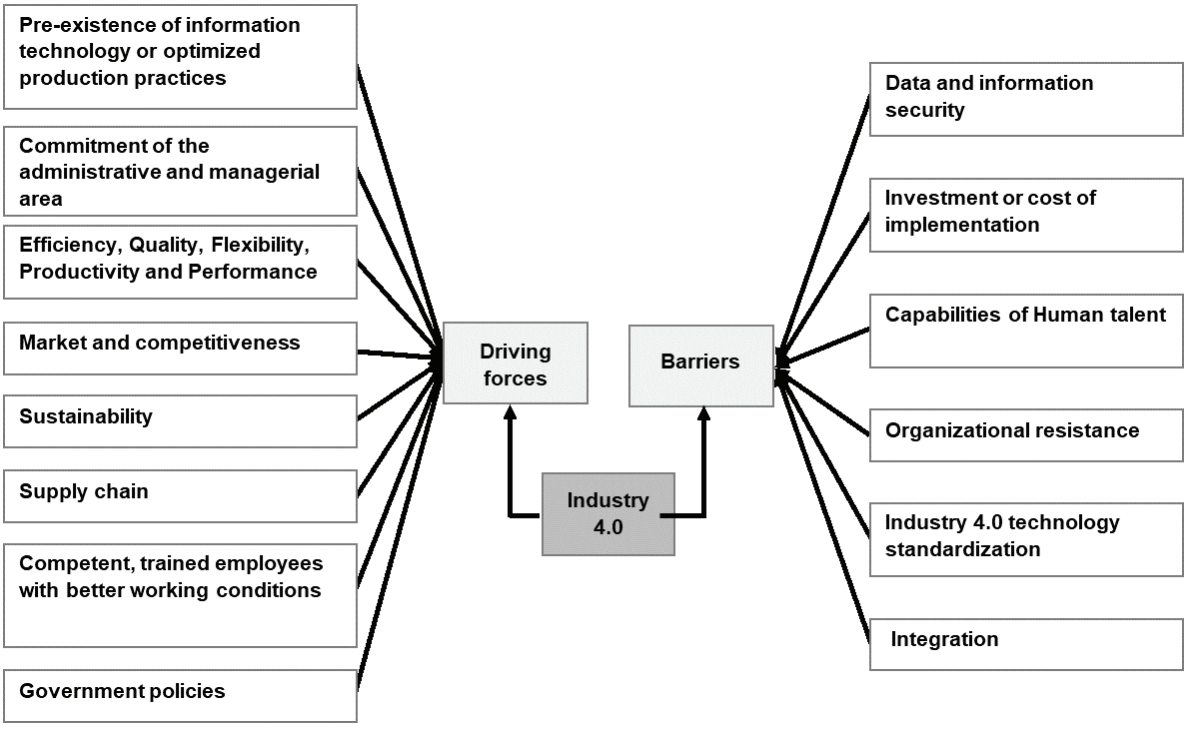

Figure 2. Driving forces and barriers in the implementation of Industry 4.0.

3.1 Driving forces in the implementation of Industry 4.0

As previously mentioned, Industry 4.0 shows the potential to transform the business landscape through a significant increase in productivity. And although there are currently disagreements between companies in the implementation of Industry 4.0, the performance gap can worsen, and the risks for laggards potentially insurmountable (Liboni, Cezarino, Jabbour, Oliveira & Stefanelli, 2019; Llinas-Sala & Abad Puente, 2019). Consequently, it is necessary to recognize the facilitators of Industry 4.0 implementation, which are related to technological pre-existence, management commitment, productive efficiency, market and competitiveness, sustainability, competent employees, and government policies.

Pre-existence of information technology or optimized production practices

The capabilities implemented in manufacturing companies related to IT infrastructure, play a fundamental role in the digitization and implementation of Industry 4.0. Small and medium-sized enterprises (SMEs) in developing countries aim to implement technology to remain competitive in the Industry 4.0 era. Such as systems for intelligent enterprise resource

planning (ERP), Computer-Aided Design and Manufacturing (CAD / CAM), and industrial automation programs (Ghobakhloo & Fathi, 2019; Glas & Kleemann, 2016).

In addition to the prior existence of IT tools, literature has given attention to the benefit of implementing Industry 4.0, which comes with the pre-existence of production practices such as lean management. In this case, there's confirmation that incorporating Industry 4.0 in lean manufacturing industries can improve their processes with no need to maintain determined efforts (Ghobakhloo & Fathi, 2019; Glas & Kleemann, 2016; Sanders, Elangeswaran & Wulfsberg, 2016).

Commitment of the administrative and managerial area

Kohnová, Papula, and Salajová (2019), estimate that companies that want to implement Industry 4.0 will be able to make radical changes and innovations if they ensure the support of all areas in their organization. In fact, (Agostini & Filippini, 2019), suggest that the transformation towards Industry 4.0 must be at an organizational and managerial level before dealing with technology. Managers must apprehend an organizational transmutation adapting the company to flexible hierarchical structures and an honest strategic vision (Hamzeh, Zhong, & Xu, 2018; Kiel, Müller, Arnold, & Voigt, 2017).

Efficiency, quality, flexibility, productivity and performance

Ralston and Blackhurst (2020), argue that intelligent systems could improve supply chain resilience, flexibility, and performance, allowing organizations to be better prepared to deal with and recover from unexpected events and respond to highly dynamic factors in the business environment. In this regard, several investigations establish that among the benefits obtained from the digitization of the factory are greater flexibility in manufacturing, massive customization of products, better quality, better business relationships, waste reduction, costs reduction, and productivity improvement concerning process control, digital communication with suppliers and inventory reduction (Ancarani, Di Mauro, & Mascali, 2019; Cardoso, Júnior, Bertosse, Bassi, & Ponciano, 2017; Mogos et al., 2019; Müller, Buliga, & Voigt, 2018; Paritala, Manchikatla, & Yarlagadda, 2017; Zhong, Xu, Klotz & Newman, 2017).

Market and competitiveness

According to research by Strange and Zucchella (2017), Industry 4.0 offers a strategic and commercial model of long-range opportunities to maintain and expand the company's competitive position. The author indicates that strategic opportunities are the main antecedents of the Industry 4.0 implementation for large companies, while operational opportunities are drivers for SMEs. The latter is in line with Prause (2019), who states that the adoption of advanced or intelligent manufacturing for SMEs is driven by market and external factors, not by internal factors within the organization.

Sustainability

Considering that Industry 4.0 seeks to connect resources, services, products, and human beings in real-time through digitization, significant impacts on sustainability in terms of economic, ecological, and social aspects of the Triple Line of the Sustainable Value Creation Fund is expected (TBL). This creation of value must make it possible to face the challenge of satisfying the growing world demand for capital and consumer goods while guaranteeing a sustainable evolution of human existence in its social, environmental, and economic dimensions. In this same direction and concerning the 2030 Agenda for Sustainable Development of the United Nations Organization, and objective No. 12, the aim is to guarantee responsible production and consumption for which Industry 4.0 and its key technologies, which contribute to the reduction of environmental impacts caused by industrial manufacturing (Ancarani et al., 2019; Asiimwe & De Kock, 2019; Müller & Däschle, 2018).

Supply chain

The supply chain in Industry 4.0 consists of: i) integration of information technology (IT) systems used in the manufacturing and commercial planning processes within a company and between different companies; ii) integration of several computer systems in the different hierarchies; and, iii) integration in the engineering process of the digital and real-world throughout the value chain. To that end, the fourth industrial revolution has severely affected supply chain interactions due to the exponential growth of sensitive data and the spread of digitized processes, which is why the supply chain is considered a significant driver towards Industry 4.0 (Ghobakhloo & Fathi, 2019; Stock & Seliger, 2016).

Competent, trained employees with better working conditions

Paradoxically, Backhaus and Nadarajah (2019), point out that Industry 4.0 is the industrial revolution that uses most digital technologies, human resource management can be even more relevant. Research by Stock & Seliger (2016), pointed to competent employees as one of the most fundamental success factors in setting up digitization. This resembles the research by Stock & Seliger (2016), which showed through a case study that after the implementation of Industry 4.0 in which employees were involved, the exchange of information with them was improved to the point where they used their own smart devices for it. All this unveils the importance of balancing technical, organizational, and sociocultural skills (Molero, Batista & Puentes, 2019; Maisiri, Darwish, & van Dyk, 2019).

Regarding technical skills, companies are automating monotonous tasks while also changing employee responsibilities, which means that human talent must be trained and specialized to take advantage of the system (Ralston & Blackhurst, 2020). Regarding organizational skills, technologies based on Industry 4.0 can significantly contribute to organizational development learning capacities both individually and collectively (Tortorella, Vergara, Garza-Reyes, & Sawhney, 2020). And, in terms of socio-cultural skills, these refer to emotional or intangible elements that are generally underestimated but are still relevant to improve operation, productivity, and business performance (Tortorella et al., 2020).

Government policies

The term industry 4.0 was first mentioned in 2011, and the concept did not expand until 2013 when the German government launched the initiative to bring manufacturing to the fourth industrial revolution - the digital one. Since then, Industry 4.0 has inspired a series of government policies and actions in multiple countries of the world to support companies (especially medium-sized and small, of great economic power and employment in most markets) both through funds and through training programs and institutional actions aimed at nurturing the relationship between the company and external actors (Agostini & Filippini, 2019; Pisar & Bilkova, 2019).

3.2 Implementation barriers

There are many challenges associated with the fourth industrial revolution, such as financial capacity, data security issues, maintaining the integrity of the production process, information technology (IT) development, and knowledge competencies, among others (Ghobakhloo, 2018). However, identifying these challenges will eventually enable decisions that will ultimately facilitate the appropriation and implementation of Industry 4.0 in organizations.

Data and information security

Implementing Industry 4.0 technologies suggests risks associated with increased data usage, as well as the connection to millions of sensors and communication devices. Every data exchange has weaknesses and, since each is a potential entry for malicious hackers, there is an imminent risk of being a victim of cybercrime, unauthorized access, and industrial espionage.

In such a way that the same interoperability that creates operational efficiency and effectiveness, also exposes more units of a company to cyber risks (Kiel et al., 2017; Paritala et al., 2017). New technological solutions always carry security vulnerabilities, which most of the time reveal unexpected risks. In fact, with the increasing reliance on technology for competitive advantage, security issues have been one of the most critical and challenging requirements for a successful business, as cybersecurity threats are practical risks in the industry.

Investment or cost of implementation

According to empirical investigations by Basl (2017), and Cardoso et al. (2017), the most significant barrier to the adoption of integrated digital technologies is the cost of implementation. Unfortunately, many companies are unaware of the benefits obtained from investing in these resources (Nagy et al., 2018). Also, and particularly concerning small and medium-sized companies, the research by Ghobakhloo and Fathi (2019), found that given their limited financial capacity, most SMEs can only digitize certain areas of their operations. In this sense, companies need to recognize that using these technologies makes the flow of information between the production line, business management, and supply chain management more transparent and organized, thus reflecting on their economic performance by reducing labor costs (Fatorachian & Kazemi, 2020).

These are developed principally in industrialized economies, with ample financing instruments available for these companies and developed financial markets, where it's less difficult to obtain financing for these types of companies. However, in developing countries, investment for SMEs, both traditional and technological, comes mainly from the banking sector, and such financing is generally scarce in these countries.

Capabilities of human talent

At the human resources level, the challenges posed by Industry 4.0 require innovation and continuous learning since the technology is not intelligent per se, thus depending on the capacities of people to be configured and accurately implemented. Therefore, promoting employees' professional development is very important for the early stages of transition to digitization. Nonetheless, it is a fact that in most countries, the workforce in manufacturing companies is turning gray because of demographic development. Hence, valuing the employment of older workers is the only way for a nation to maintain its competitive advantage in international markets and continue to build prosperity in the future (Agostini & Filippini, 2019; Bauer, Hämmerle, Schlund, & Vocke, 2015).

Technological advancement is faster than the preparation of people. Meaning that, before acquiring technology, it is necessary to make a cultural transformation focused on preparing and retaining human talent. In this sense, the disciplines related to technology will lead the advancement of the countries, so it is necessary to promote an education based on technological skills and knowledge to meet the needs demanded by both society and the current and future labor market.

Organizational resistance

Organizational resistance at both the employee and management levels can significantly hamper the introduction of Industry 4.0 technologies. For example, in research such as Nagy et al. (2018), some employees were found to have damaged the sensors and interface devices or refused to follow the instructions (Horváth & Szabó, 2019). Likewise, in the case study carried out by Ghobakhloo and Fathi (2019), despite showing that when taking employees into account for the digitization process, the vast majority were willing to participate in the process and showed a high level of participation. Another finding was that, despite the efforts of the investigation team and management, there were employees who had to be fired by the company when terminally resisting change.

Industry 4.0 technology standardization

Although companies are partially digitized, they cannot be acknowledged as intelligent factories if they do not use high-end digital technology across all product lines. Hence, transformation and standardization can be particularly challenging for SMEs because of their low degree of process standardization, their less automated production equipment, and their resource limitations (Müller, Kiel, & Voigt, 2018; Nagy et al., 2018).

Integration

According to research by Moeuf et al. (2018), the most frequent challenge in the implementation of Industry 4.0 is technology integration. Companies face the task of implementing intracompany and intercompany connections based on their IT infrastructure. Usually, intra-business connection requires transformation and modification of production facilities, as well as electrical and digital components harmonization. On the other hand, IoT technologies and interface standardization are fundamental to guarantee interaction between companies.

Although some companies aim to establish an automated system facilitated by IT interconnection, they must also struggle with uncertainty and complexity. For example, in research by Müller, Buliga, et al. (2018), one of the respondents stated that they had lived the experience of an interconnected machine that malfunctioned and dragged an interruption in all production. Hence, companies must ensure that the existing and newly added IT infrastructure are harmonized and integrated so that all the components of the intelligent factory are interconnected and interoperable (Ghobakhloo, 2018).

Although the application of artificial intelligence is still a challenge, it is necessary to integrate it with other technologies (BigData, IoT, neural networks, etc.) to facilitate the automation of processes. The most positive thing is that artificial intelligence is applicable in a wide variety of processes, enabling tasks to be performed with fewer resources and time.

4. Conclusions

As a result of the literature review, we have fulfilled the research objectives in expanding knowledge regarding Industry 4.0 impact on organizations, and contributed to identifying the main barriers and facilitators that companies face in implementing it within their processes.

The study initially identified the main definitions given for Industry 4.0 from its main actors, trying to clarify its concept. It also explained that this new paradigm has enormous potential for organizations and, in addition to the industry transformation, it will impact many other fields such as products and services, new business models and market development, economy, environments, and work. The document also identified the key technologies used in Industry 4.0 development to establish the conceptual framework and, also, to identify enabling technologies for digitization in businesses. Although the importance of industry 4.0 is expanding these technologies implementation, organization, and digitization, especially SMEs, must contribute to obtaining the expected benefits of the technological transition.

The study reviewed a significant body of recent research and identified six categories regarding barriers that companies face. These are related to data security, implementation costs, human talent capabilities, organizational resistance, and lack of technology standardization. These categories represent an essential factor that determines that one must work from within organizations and make decisions that allow progress in each of them and government policies that facilitate their mitigation.

The study identified eight driver forces of the Industry 4.0 implementation: technological pre-existence in organizations, management commitment, efficiency, competitiveness, sustainability, competent employees, and government policies. These forces provide companies with leverage to increase the Industry 4.0 implementation and obtain the best benefits from this industrial transformation.

In this sense, and to achieve better efficiency and competitiveness of the processes, companies that want to get involved in Industry 4.0 must know the main factors for their implementation. This type of study expects that both government, academic, and business entities can identify the strengths and weaknesses of the organizations and design strategies designed to facilitate the digitization process.

Finally, concerning the document review, we can affirm that the literature is in a transition process. Apart from identifying the most relevant technologies and their importance in this transformation process, new studies will present perspectives such as human resource needs and methodologies of implementation. It is evident due to the technological advancements and the increase in automated systems that the complexity of the skills required by organizations' human resources will also rise. Furthermore, this highlights that a strong partnership between industry, technical and academic institutions support the importance of a country's adoption of industry 4.0. so that essential requirements are appropriately and efficiently incorporated into educational structures and existing study programs; understanding that the role of human resource management will be enormous.

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