ISSN 2007-9737

Artificial Intelligence for Industry 4.0 in Iberoamerica

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Abstract. Artificial intelligence applied to industry 4.0 will help the Iberoamerican industries to experiment and adopt a digital transformation. In this paper, we present a literature review of the work conducted by Iberoamerican countries regarding artificial intelligence for Industry 4.0. The works analyzed are aligned with the eight technological pillars that support industry 4.0, including robotics, Internet of things, big data, additive manufacturing and simulation, cloud computing, cybersecurity, virtual and augmented reality, and horizontal and vertical integration. As a result of our perusal, we propose many strategies that Iberoamerican countries could follow to successfully implement artificial intelligence to daily life.

Keywords. Artificial intelligence, industry 4.0, Iberoamerican countries, robotics, augmented and virtual reality, IoT, big data.

1 Introduction

Today, technology has advanced from both the hardware and software levels. The computer is one of the most significant technological advances. Charles Babbage and Konrad Zuse are considered the inventors of the computer [54].

Thanks to the computer, many tasks can be executed in an accurate and fast way. Moreover, the use of the computer has led to the growth of Artificial Intelligence (AI) and the technologies associated with industry 4.0.

In the research community, government, and business, AI and Industry 4.0 have been debated in many forums. Therefore, the implementation of technology based on Industry 4.0 has been growing more and more throughout the world. Iberoamerica[1] has not been the exception, showing advances in the industry, government, and academia.

The most advanced industries of the world are using AI techniques to control and optimize the production lines' processes.

[1] Term employed to define the set of territories where Spanish or Portuguese languages are spoken.

In addition, AI techniques are also being used to analyze a large amount of data that sensors and machinery produce daily. The use of these techniques in the production lines is known as industry 4.0.

In developed countries such as Germany, China, and Japan, the philosophies related to industry 4.0 have been successfully proved and adopted. However, in other regions such as Iberoamerican countries, adopting the philosophies associated with Industry 4.0 has a slight delay.

In this paper, we conduct a literature review to detect the newest works regarding the technological pillars to implement industry 4.0 in Iberoamerican countries. As a result, we detected papers from Spain, Portugal, Mexico, Colombia, Ecuador, Argentine, Chile, and Brazil.

The rest of the paper is organized as follows. Some facts related to AI are presented in Section 2. In Section 3, the analyzes of Iberoamerican works related to the technological pillars of industry4.0 are presented. Finally, the conclusions and future work are shown in Section 4.

2 Artificial Intelligence

AI can be defined as the ability of machines to carry out certain reasoning. It can also be defined as the science and engineering of machines that act intelligently. That is, when the machines decide appropriately in uncertain circumstances and learn to improve their behavior based on their experiences [61].

In its early years (the 50's), AI research aimed to reproduce human intelligence processes to provide solutions to problems formulated in controlled environments, such as proof of theorems and the solution of strategic games with previously defined rules [42]. In recent years, AI has expanded and diversified as a branch of science aimed at creating intelligent machines, with abilities to learn, adapt and act independently.

Today, AI is a discipline with a very high level of maturity. Therefore, its potential, applicability, and impact on our society cannot be questioned. Practically all of us in our homes, work offices, businesses, schools, and others, without realizing it, use some "smart" device that makes life easier, extends our capabilities, frees us from cumbersome activities, gives us security. In short, AI gives us a better quality of life.

The problems that AI addresses are related to the management of large volumes of data to derive useful information for the automatic generation of algorithms to solve complex problems associated with reasoning, perception, planning, learning, and the ability to manipulate objects.

Moeover, AI has been used in a wide number of fields such as robotics, language understanding, and translation, word learning, among others. The main and most prominent fields where a remarkable evolution of AI can be found are in Computer Science, Finance, Hospitals and Medicine, Heavy Industry, Customer Service, Transportation, and Games.

The following are specific examples of the application of AI in Iberoamerican countries [62]:

1. Transportation. Travel times in many cities have increased dramatically. GPS-based prediction systems, ride-sharing systems, and autopilot systems on airplanes help alleviate the problem somewhat. Future solutions: 1) autonomous cars, 2) optimized shared transportation, and 3) intelligent traffic light systems [49].

2. Email. Spam filters and smart mail classifiers are just two examples of the many smart engines that can be used for optimized email handling. Future Solutions: automated mail responders [38].

3. Banking and personal finance. Our banking transactions are carried out through AI-based engines: 1) mobile check deposit, 2) fraud prevention, and 3) credit granting. Future solutions: Intelligent advisory systems to recommend where and when to invest our money [21].

4. Social networks. Examples of systems are reported that 1) recognize the objects inside the images and make recommendations for similar objects, 2) identify the contextual meaning of emoji, being able to suggest response emoji automatically, and 3) follow

facial movements and add animated effects or digital masks. Future solutions: Intelligent Chatbots [40].

5. Online shopping. Many of the purchases that one makes today are through the internet. It includes search engines, recommenders, and fraud detectors. Future solutions: Fully customized purchasing systems [5].

6. Mobile telephony. Many of today's cell phones include voice-to-text converters and intelligent personal assistants capable of simple conversations (Siri and Cortana). Future solutions: Smart custom assistants that bridge the gap between humans and smart homes [17].

In terms of patents, the World Intellectual Property Organization (WIPO) estimates that in the last 5 years, there has been a ”boom” in AI, with more than 50% of all patents since 2013. From 2013 to 2017, growth has increased from 18,995 to 55,660 patents. IBM with 8290 and Microsoft 5930, respectively. Finally, machine learning has become the most widely used technique in patents, while computer vision is the most popular application.

3 Industry 4.0 in Iberoamerica

Currently, technology turns out to be essential since it is implicit in daily activities and is interacted with at all times. This has been possible due to rapid technological evolution, and thanks to this, new topics have emerged, such as industry 4.0.

Industry 4.0 consists on the digitization of the industrial processes by means of the interaction between artificial intelligence and the machines [3].

Until today, the concept of industry 4.0 has been applied in all industrial branches and has had a great impact, for which it has continued to develop and improve in all aspects, especially in industrial processes [43].

Industry 4.0 has been integrated into the industrial operation through different methodologies that allow the natural systems of the factories to converse with each other to form a more intelligent flow of information and that results in the improvement of the products, as well as of the processes [65].

By analyzing the literature one can find several opinions regarding the technologies needed to fully implement Industry 4.0. The technological pillars in which Iberoamerican industry is supported are shown in Figure 1.

For this study, we searched for journal papers related to the eight pillars shown in Figure 1. Only studies published by Iberoamerican authors between 2013 and 2021 were considered. The advanced search option from IEEE xplore, Science Direct, Willey, Springer link, ACM Digital Library, Google scholar was used to collect the papers. Examples of queries are: Internet of things (search term) and Mexico (author affiliations); Augmented reality (search term) and Spain (author affiliations).

In the following subsections a review of the works presented by Iberoamerican countries in industry 4.0 are presented.

3.1 Robotics

Today, nobody can talk about robots without intelligence. Just as computers were occupying practically every place on our planet, it is undoubted that very soon intelligent robots, either physical or as computer systems, will occupy our houses, offices, schools, hospitals, restaurants, among others. Robotics is the branch of computer science, mechanical, electrical, and electronic engineering that deals with the design, construction, operation, structural arrangement, manufacture, and application of robots [14].

Assistance robots are machines that interact with human beings to attend to some of their needs. For example, researchers from Spain, Colombia, and Brazil collaborated to create a robotic platform called CPWalker for gait rehabilitation in patients with Cerebral Palsy (CP). The platform allows patients to start experiencing autonomous locomotion through robot-based therapies. Significant improvements in the treatment outcomes were observed in patients that used the platform [11].

Cooperating intelligent robots (cobots) in factories help humans to perform complex tasks with less risk and with an efficiency and effectiveness

ISSN 2007-9737

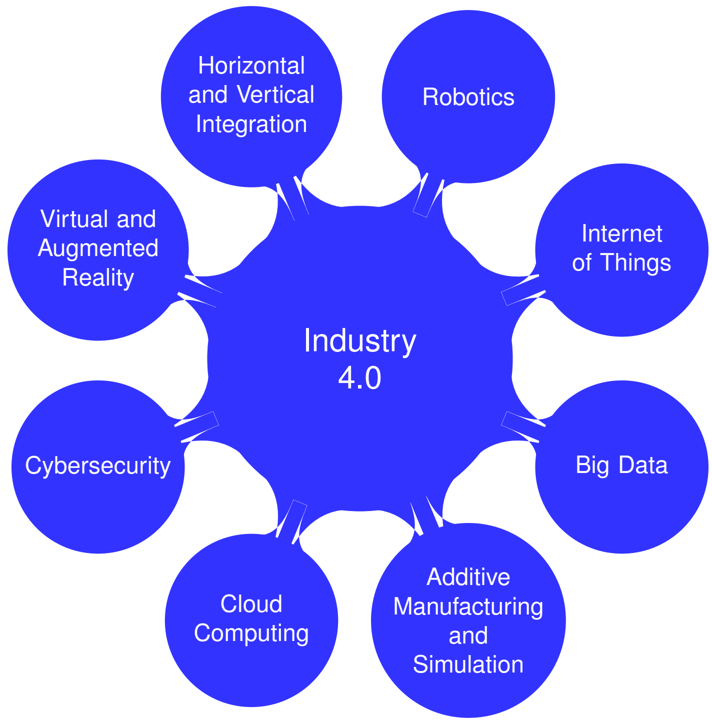

Fig. 1. The technologies to implement industry 4.0. in Iberoamerica

that could not be achieved with just groups of people. The work by Pliego and Arteaga [51] from Mexico addresses the problem of dexterous robotic grasping utilizing a telemanipulation system. The system was composed of a human operator, a single master, and two slave robot manipulators.

Humans can move and rotate objects from a remote location by moving the master end-effector. A set of experiments proved the excellent performance and capabilities of the proposal.

In terms of surveillance and security, groups of aerial, submarine, and terrestrial robots could monitor accesses, actions, and other activities that may occur in closed and open spaces. For example, in Mexico, the work by Parada et al. [47] presented the design and construction of a land-wheeled autonomous mini-robot (LWAMR) for indoor surveillance. The robot is capable of sending images and video in real-time by using a spy cam. The results revealed the effectiveness of the robot for indoor surveillance. The advantages of the proposal are low cost, versatility, modularity, robustness, and remote operation.

The most robotized countries for every 10,000 employees worldwide are Korea, Singapore, Japan, Germany, Sweden, Taiwan, Denmark, the US, Belgium, and Italy (Figure 2). Regarding Iberoamerican countries, Mexico ranks 33rd with 33 robots per 10,000 employees. Argentine ranks 36th with 16 robots per 10,000 employees, and Brazil, 28th with 11 robots per 10,000 employees.

3.2 Internet of Things (IoT)

Population growth implies greater use of digital services. According to DOMO [23], in the first four months of 2020, 59% of the world's population had access to the internet, and the number is increasing every day.

Internet is the backbone in the development of industry 4.0 because it practically manages the information in all aspects. Cloud computing, cyber security, simulation, and augmented reality are linked to the Internet, although to a lesser extent.

ISSN 2007-9737

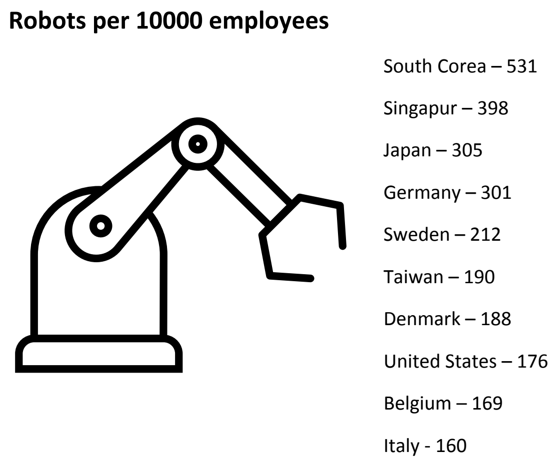

Fig. 2. Top ten of most robotized countries

The use of the Internet allows making every day a connection with other systems. For that reason, in many countries, the fourth industrial revolution is called the Internet of Things (IoT) [60].

In Mexico, the application of the Internet to agriculture is practically minimal. It does not have the dynamism that it is taking in other countries. Therefore, it is necessary to promote it to increase the productivity of small farmers. In work by Negrete [45] a review of the application of the IoT to Mexican agriculture was presented. The work analyzed the current agriculture situation and proposed practices to increase productivity and reduce Mexican rural poverty.

The work by the Mexicans Guzmán et al. [30] implemented an IoT based intelligent irrigation system. The system monitors soil moisture, luminosity, humidity, and temperature with sensors connected to a Raspberry Pi module. The data acquired from the sensors were stored in the cloud. The control system was implemented with fuzzy logic. The status of the system can be monitored with a mobile application. The results showed the correct behavior of the irrigation system.

Zambom et al. [66] from Brazil presented the state-of-the-art software platforms for Smart Cities. The study included 23 projects concerning the most used enabling technologies and functional and non-functional requirements. The studies were classified into four categories: cyber-physical systems, the Internet of things, big data, and cloud computing. Based on the study, it was derived a reference architecture to guide the development of next-generation software platforms for Smart Cities.

The work by Garrido et al. [27] from Spain proposes a solution for reverse supply chain management based on the cooperation of three different IoT communication standards. BLE and RFID were proposed for inventory management using smart containers, while a LoRaWAN context network was responsible for the environmental monitoring of industrial facilities.

The performance of the proposal was evaluated with four tests: data ingest, geographical spread, data size, and network latency.

3.3 Big Data

Due to the digital era, the demand for storage and processing capacity is constantly increasing. Therefore, digital solutions are becoming more complex as they integrate AI algorithms that make decisions and recommendations to users, including what to buy, what route to choose, and what to cook. Implementing solutions based on AI requires specialized infrastructure, and big data is an ally for its implementation.

Big data is a technique that involves multiple variants, techniques, concepts, strategies, and not only large volumes or blocks of data. According to de Costa et al. [20], big data is defined as ”5 V’s” where Volume is the storage capacity in bits, Velocity is the processing capacity in floating-point operations per second (FLOPS), Variety refers to the diversity of data types, Value is the importance and relevance of the data and Veracity is the seriousness and formality of the data source.

In a work by Torres et al. [64] from Cuba, the authors proposed a K-Nearest Neighbor (KNN) algorithm to identify anomalies in big data problems. Apache Spark was used to implement the solution. Several experiments were performed to analyze the behavior of the algorithm with different configurations. The execution times and the quality of the results were compared between the sequential variant and the big data variant.

ISSN 2007-9737

The better results were obtained with the big data variant.

Big data can be used to identify profiles in social networks, as was discussed by the Mexicans García et al. [26]. The research goal was to create an application to identify the best professional profiles in social networks such as LinkedIn, Twitter, and GitHub. The authors employed big data tools to create the Software Skills and Experience (SOFTSE) application. The application received input queries related to the abilities of software engineers and their knowledge about programming languages. The precision in the queries realized was almost 100%.

In the research of Albuquerque et al. [4] from Brazil, the behavior of COVID19 was analyzed with machine learning techniques based on clinical parameters. Data were obtained, cleaned, analyzed, and processed with the aim of training models that help in the identification of COVID cases. Two classification models were developed. The first classified the test results for patients with suspected COVID-19, and the second classified the hospitalization units of patients with COVID-19. Both models achieved an accuracy above 96%.

León and Pastor from Spain presented a big data approach for managing genomic data. Data obtained from genomics are heterogeneous, spread in hundreds of repositories, represented in multiple formats, and have different levels of quality. Therefore, the proposal can be adapted to the particularities of the domain. The results revealed that the proposal was helpful in improving the genetic diagnosis of epilepsy [35].

3.4 Additive Manufacturing and Simulation

Within the set of technologies involved in Industry 4.0, 3D printing and simulation play an essential role in developing products focused on manufacturing [3]. Simulation and additive manufacturing go hand in hand in many applications such as medicine, aerospace, education, among others.

The word simulation is defined as the imitation of a real-world process or system over time. Simulation models have been changing since the 1960s. Simulations have evolved from a technology used by mathematics and computer science experts to a standard tool for every engineer. At first, the simulations were used to solve a variety of design and engineering problems. Today, simulations have enabled the development, validation, and testing of solutions for individual systems and elements [44].

On the other hand, additive manufacturing, also called 3D printing, is a technique that uses cutting-edge technologies that make it easier for the designer and the manufacturer to create and produce components that are considered complex. Additive manufacturing builds 3D objects by adding layer-upon layers of material. The material can be plastic, or metal [2].

Arcos and Guemes [8] from Mexico presented a technological roadmap for additive manufacturing technology by the combination of three methodologies: technological surveillance, technological road mapping, and structural analysis. The authors concluded that additive manufacturing accelerates the development of complex and personalized products with fewer tools. Moreover, it favors the trends included in Industry 4.0 since it implements flexibility in production with the help of cloud computing.

The work by Aguilar et al. [1] from Mexico presented the implementation of a genetic algorithm to reduce the printing time and improve the dimensional precision during a fused filament fabrication. In addition, a comparison of the proposal versus the traditional printing method was presented. The results showed that GA helps reduce the lead time by 11.2% with a greater surface texture than traditional printing.

Brazilians Camargo et al. [19] presented the use of electrofused mullite for additive manufacturing by digital light processing (DLP). First, the authors developed photosensitive mullite suspensions, and then their rheological behavior, stability, and thermal decomposition were investigated. Mullite parts were printed from suspensions with different ceramic loadings, debound, and sintered at different temperatures. The results showed that mullite parts could be successfully printed by DLP using slurries based on electrofused powder.

Laguna et al. [34]from Spain presented a review on additive manufacturing and materials for catalytic applications. The research presented a background of the history of additive manufacturing and the classification of the different printing techniques. The intensification of processes was identified as the key to understanding the union of additive manufacturing and catalysis. Finally, a series of perspectives was proposed in which the most probable courses of new advances in this field of research were identified.

3.5 Cloud Computing

In the literature, several definitions explain the meaning of cloud computing. According to De la Prieta [53], cloud computing is a model with convenient, on-demand network access to configurable computing resources such as networks, servers, storage, applications, and services supplied by a provider. Batista et al. defined cloud computing as the availability of computing services on demand, including applications for storage and processing power over the internet and pay-as-you-go [10]. According to the Brazilians, Souza et al. [63] cloud computing could be classified into Software as a service (SaaS), Platform as a service (PaaS), and Infrastructure as a service (IaaS).

Sánchez et al. [59] from Mexico presented an architectural model to create on-demand, edge-fog-cloud processing structures to handle big health data continuously. The model served to execute services for fulfilling non-functional requirements. Modular blocks were implemented as microservices and nanoservices. The blocks were recursively interconnected to create processing structures as infrastructure-agnostic services. A prototype was built to show the feasibility of the model. The case study consisted of processing health data for supporting critical decision-making procedures in remote patient monitoring.

The Brazilians Batista et al. [10] presented a systematic literature review to enumerate the existing solutions and open issues in the security of a Service Level Agreement (SLA) in cloud computing. Also, a classification of the papers and a discussion about the management of security SLAs in clouds was presented. As a result, the aspects that must be considered during the SLA negotiation and operationalization were detected. Moreover, it was detected that is necessary to develop a robust and autonomic solution to SLA for cloud security, managing all life cycle.

Guerrero et al. [29] from Spain proposed a context-aware software architecture to support the availability of the services deployed in mobile and dynamic network environments. The proposal was based on a service replication scheme and a self-configuration approach for the activation/hibernation of the replicas of the service depending on relevant context information from the mobile system. Moreover, an election algorithm has been designed and implemented.

The proposal can be applied in many domains such as emergencies, education, and tourism. The Colombians Rosero et al. [56] identified the elements considered by different authors to define a cloud-based architecture and ensure the appropriately supervised learning functionality under a microgrids cluster environment. The authors executed microgrid simulations and tested real-time simulation platforms. Moreover, connections to a virtual server for microgrid control were tested. As a result of the research, a scalable and autonomous cloud-based architecture that allows power generation forecast, energy consumption prediction, and real-time energy management was proposed.

3.6 Cybersecurity

Cybersecurity is a complicated challenge for companies aligned to industry 4.0. Moreover, the systems connected to the Internet are protected from cyber threats using cybersecurity [36].

According to Parraguez [48] the cost of cybercrime incidents can reach US$6 trillion by the end of 2021. Moreover, four out of five countries in the Americas region do not have cybersecurity strategies or the laws to judge the cybercrimes.

Today, it is essential to protect companies from cyberhacking of users, networks, industrial data, machines, and equipment [16].

From Latin American countries, Chile is one with the highest digital penetration. Therefore, the work by Flores et al. [24] established the main issues that must be addressed to avoid vulnerabilities. The list includes i) the lack of procedural activities to analyze the security regularly; ii) there are no established security procedures; iii) technical ignorance, and iv) lack of financing

According to work by Gallegos [25], the three main areas in which cybersecurity is applied in Mexico include cryptography, infrastructure security, and security for the IoT.

Colombia is a country that has suffered cyberattacks. However, more than 43% of the companies do not have strategies to confront the cyberattacks [46]. As a consequence, Colombia created in 2011 a public policy called Conpes to define the guidelines for the domain of cyberspace and safeguarding its security and defense [15].

In the research conducted by Catota et al. [13], an analysis of the factors that are impeding the development of cybersecurity in Ecuador was presented. The factors detected were the lack of academic instruction and security specialists, the almost null interactions between academy and industry, the insufficient understanding of cybersecurity demand, and the government intervention. Moreover, a study of IoT cybersecurity in smart cities was presented by the Ecuadorians Andrade et al. [6]. The study defines and validates an assessment model of cybersecurity maturity of IoT solutions to develop smart city applications.

Martins and Oliveira [39], from Brazil, established that with the digital transformation, power electronics becomes a concern for cybersecurity. The events succeeded in different Brazilian companies have alerted the government to invest money in programs to overcome cybersecurity attacks.

Undoubtedly, from Iberoamerica countries, Spain is the one with the most advances regarding cybersecurity. Spain adopted in 2013 what was called the specific national cybersecurity strategy. The strategy is oriented to three main categories i) computer network defense; ii) computer network attack; and iii) computer network exploitation [9].

Gonzalez and Fuentes from Spain [28] observed that it is clear that cybersecurity needs are becoming essential. It is projected that by 2022, millions of cybersecurity jobs will be generated. The companies will need to hire qualified people with the skills to avoid cyber attacks. Therefore, the Iberoamerican countries must define a strategy to include cybersecurity courses in the students' curricula. The courses must be prepared to be offered online and to include both theoretical and practical activities.

3.7 Virtual and Augmented Reality

Virtual Reality (VR) and Augmented Reality (AR) are a central part of industry 4.0 because they allow users to interact and manipulate virtual objects to perform a process.

VR and AR are two different concepts; however, they are frequently confused. The former refers to a computer-generated environment in which scenes and objects are entirely virtual [55]. The latter refers to the improvement of the real world by superimposing virtual objects into the real scene that is observed on a screen [41].

VR completely immerse a user inside a synthetic environment. In contrast, AR allows the user to see the real world enhanced with computer-generated information. Both technologies have advantages and drawbacks; however, many applications in different fields can be observed in the literature. After the perusal, we have detected that most applications are focused on education and training.

Scott et al. [58] from Argentine, presented a literature review regarding 3D virtual learning environments. The authors conclude that today's education must consider individual learner needs and preferences. Therefore, the recommendation is to design personalized learning approaches where the environment easily adapts to the learners.

In Mexico, López et al. [37] presented a comparative study of 2D and 3D virtual reality applications for healthcare education. The results demonstrated that gamification helped students to improve their learning.

A work from Brazil presented the results of an evaluation of instruments for physical therapy using virtual reality in stroke patients. Physiotherapeutic rehabilitation is essential to improve functional mobility, muscular strength, balance, and quality of life of stroke patients. However, conventional techniques are monotonous. VR offers an alternative method to promote improvement in muscle strength and balance. The results demonstrated that the most used instruments are: the Berg Balance Scale, the Fugl–Meyer Assessment, and the Stroke Impact Scale [7].

A mixed work from Mexico and Spain presented an alternative and affordable virtual reality tool for training live-line maintenance. The random forest classifier was used to discriminate between the trained and untrained students. In addition, by using the visual tool, several error patterns in trace data associated with misconceptions and confusion were identified [57].

On the other hand, the work by the Brazilians de Souza et al. [22] presented a literature review about the applicability and usefulness of AR on industrial processes. As a result, it was observed that most works in the industry are focused on providing instructions for assembly processes. The AR instructions are also used for maintenance and training. The industries that have most benefited from AR reality are engineering, construction, automotive, electronics, and automation.

A study to understand how AR contributes to education was performed in Colombia by Hincapie et al. [32]. As a result of the study, the main educational research trends detected were engineering education, followed by simulation, tracking, gamification, and human-computer interaction. Moreover, it was observed that social sciences were less addressed than basic sciences.

An AR application for helping students to learn the computation of simple interest was presented by the Mexicans Hernández et al. [31]. One hundred three undergraduates participated in a study where the variables related to motivation, technology acceptance, prototype quality, and students achievement were assessed. The findings revealed the positive effect of the AR tool on students' achievement and motivation. Moreover, students expressed their interest in using the prototype because of its quality.

In Spain, Picallo et al. [50] presented an AR application to help hearing impairment people that assist to a show in an auditorium or a theatre. Using HoloLens smart glasses, the AR application provides users with 3D multimedia content such as subtitles and additional information about the show. Moreover, the application includes a call button to ask the auditorium staff for assistance. The interference with the wireless channel was solved using a deterministic 3D ray launching algorithm.

3.8 Horizontal and Vertical Integration

The processes carried out in the industry are complex and diverse. It is important to keep track of processes in addition to managing the machines. Therefore a strategic configuration for the adaptation of the machines to the processes is necessary to reduce times.

This implies that the information must be useful, and the data generated allow day-to-day traceability.

Companies have adopted horizontal and vertical integration strategies to consolidate their position among competitors. Vetical integration occurs when a company takes over activities that has traditionally delegated to third parties. Horizonatl integration occurs when a company acquires, merges or creates another or other companies that carry out the same activity [33].

The work by the Mexicans Pérez et al. [52] proposed and validated a methodological tool for evaluating the technological and operational criteria within companies. Considering the vertical and horizontal systems the tool placed the companies in the right level for a transfer to the new industrial revolution. The methodology was divided in two phases. The firs consisted in the creation of an intrument to collect the information. The second refers to the validity and reliability tests regarding to the instrument. The reliability of the instrument was determined by means of the Cronbach alpha.

Bárcenas and Begoña from Spain [12] analized the privatisation of public firms when firms were vertically integrated with their suppliers. A mixed duopoly with a vertically integrated public firm was considered. the results revealed that a private firm vertically integrates with its supplier only if goods are weak substitutes. Also the results showed that there is less vertical integration in the mixed duopoly than in the private duopoly. The final finding was that the public firm was privatised when goods were close substitutes and the bargaining power of the private firm was low enough.

The work by the Brazilians de Braganca et al. [18] used a vertically integrated framework to examine a decision by a generator or gentailer to undertake a costly project to increase its retail market share. The results demostrated that vertical integration can serve as a hedge in an electricity market. Moreover, the results demosntrated that firms will be more willing to invest in growing their retail presence in markets that are concentrated, heavily vertically integrated, or have well developed derivative markets.

3.9 Discussion

The search for articles related to the pillars that support industry 4.0 in Iberoamerica was not easy. Spain, Mexico and Brazil lead the production of papers. However, there are countries such as Bolivia, Paraguay, Honduras and Peru that do not have production on the subject studied.

Robotics, Iot, Big Data and Augmented reality are the fields with most papers. While in Horizontal and Vertical Integration field only few articles have been published. As result of the perusal, we have observed that AI and realted technologies has become a multidisciplinary field with a vast potential to generate benefits for the society. However, in Iberoamerica there are few undergraduate and graduate programs specialized in AI and the technological pillars of industry 4.0.

Therefore, it is necessary to put into operation more undergraduate and graduate programs, networks, and consortia that promote the assimilation and use of the technology. Moreover, it is important to create groups to define niches of opportunity, to organize related events, to attract funds, and to propose adequate solutions to those in society who demand it.

Also, it is imperative to articulate interdisciplinary research groups that bring together researchers, academic technicians, and students capable of developing foundations and methodologies oriented to the modeling of phenomena and the resolution of social problems.

Finally, to solve the complex problems of the sectors of society, it is necessary to move from carrying out isolated investigations conducted by researchers with access to limited infrastructure with regional relevance but the little national impact to groups with high performances and critical masses, of regional relevance and national impact. It is impertaive that researchers have access to world-class infrastructure and networks.

4 Conclusion and Future Work

In this paper, we have presented an analysis of the research works conducted by Iberoamerican countries regarding AI and the technological pillars of industry 4.0. We have analyzed investigations related to many fields such as industry, education, medicine, transportation, agriculture, supply chain, among others.

As result of our study, we have proposed strategies that Iberoamerican countries could follow to successfully integrate AI and the technological pillars of industry 4.0.

In the future it will be desirable to extend this study for searching published in conference proceedings.

Acknowledgments

The authors would to express their sincere appreciation to the Universidad Autónoma de Ciudad Juárez, the Instituto Politécnico Nacional, the Universidad del Valle de Atemajac and the Benemérita Universidad Autónoma de Puebla for the support provided to carry out this work. This research was supported by grants Secretaría de Investigación y Posgrado-IPN 20210788, CONACYT-Fronteras de la Ciencia FON.INST./39/2016 65, and CONACYT FORDECYT-PRONACES CF-CD24-20200211185113358-6005.

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Article received on 07/01/2021; accepted on 28/02/2021.
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