Analyzing the Brazilian Scenario with regard to the Adoption the Industry 4.0 Standard

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Abstract— The concept of Industry 4.0 appeared for the first time in 2011 in Germany and it is used to designate the introduction of a set of emerging and disruptive technologies such as 3D printing, Internet of Things (IoT), advanced robotics and big data analytics to the manufacturing units, which gave rise to a new generation of factories, the "smart factories." The interest in the Industry 4.0 Standard (I4S) has grown significantly, and in several countries, large investments in technologies for Industry 4.0 have already been spent, mainly due to the benefits that adherence to industry 4.0 provides, for instance, faster detection and repair of production failures, improvement in quality and cost-cutting. The purpose of this paper is to present an overview of Brazil's situation about the adoption of enabling technologies of the I4S. In it are also pointed out cases of companies located in Brazil that have already invested in these technologies, Brazilian initiatives for industry 4.0 and some results of surveys on the adoption of these technologies worldwide.

Keywords— developing countries; industry 4.0 standard; emerging technologies

I. INTRODUCTION

Industry 4.0 Standard (I4S) has been a recurring theme in technology fairs, exhibitions, symposia and within universities, because of its importance for the future of industrial production and the world economy. The concept of I4S has been coined in Germany during the 2011 edition of the Hannover Messe Fair [1]. I4S can be understood as the "smart industry" way. The resultant introduction of digital technologies into machines, storage systems, and manufacturing facilities, which are linked to a worldwide network, forming Cyber-Physical Systems (CPS) [16, 17], and because of these characteristics they can exchange information among themselves, to exchange information with the entire value chain also linked to the network and to trigger actions in a totally autonomous way [2]. The name I4S is an allusion to the Fourth Industrial Revolution, which has begun at the turn of the 20th century for the 21st century and is based on the digital revolution, driven by the development of the Internet of Things (IoT) [19, 20, 21], 5G [19, 20], smart cities [18, 21], big data [21, 22, 23], advanced robotics, remote sensing [25, 26], all sorts of frameworks to speed up exams/automated computer-aided diagnoses in all knowledge areas [21, 22, 23, 24, 25], additive manufacturing, Artificial Intelligence (AI), cloud computing [19, 20, 21, 26, 27, 28, 29], and the use of new materials such as polyhexahydrotriazines (PHTs) and graphene. It differentiates itself from other revolutions and characterizes a new one by its evolution in exponential rhythm, amplitude, and systemic impacts, configuring itself as the fusion between physical, biological and digital domains [1].

II. INDUSTRY 4.0 ADOPTION BENEFITS

The I4S consolidation might bring the following benefits: stock reduction of 20-40%, improvement in labor productivity of 15-30%, reduction in machine stop of 30-50%, improvement in accuracy of decision of 80%, reduction of transportation and storage costs of 15-30%, improvement in processes yield of 2-5% and reduction in the administrative costs of the supply chain of 50-80% [3]. In Brazil, the I4S might cause an industrial cost-cutting of R$73 billion a year [4].

Accenture estimates that until 2030 only the implementation of technologies related to the IoT might impact the Brazilian GNP in approximately US$ 39 billion and generate gains of up to US$ 210 billion [5].

III. INDUSTRY 4.0 OVERVIEW: CURRENT SITUATION AND CHALLENGES

Results from the 2016 Digital Business Global Executive Survey showed that the I4S already has a significant role inside many organizations and some of them might become even more important for a large number of organizations within the next years [6]. This survey also identified the perception of the respondents about how close their organizations are of such an I4S organization when it comes to incorporating novel capabilities, engage talent across the organization, and drive new and value generating business models. This resulted in having only 13% of the respondents to choose a score equal or superior to 8 on a scale from 1 to 10, percentage that can be considered quite low [6].
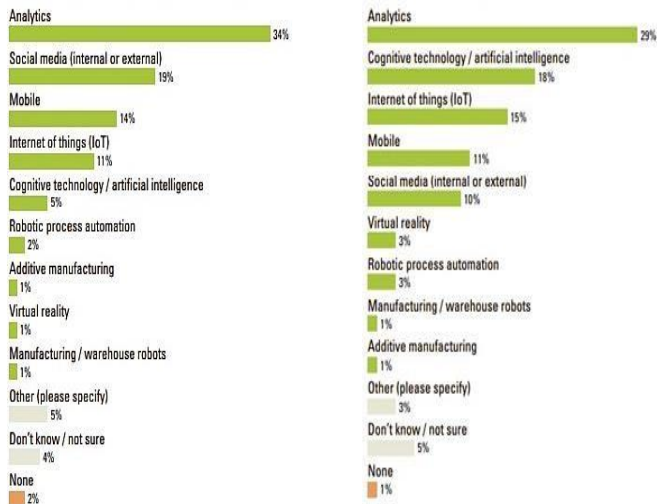
Fig. 1. Percentage of answers to the following questions: "To the best of your knowledge, which specific technology is the most important to your organization this year"? (on the left) and "To the best of your knowledge, which specific technology will be the most important to your organization in the next 3 to 5 years"? (on the right) [6].

Recent research of the Projeto Indústria 2027: Riscos e Oportunidades para o Brasil Diante de Inovações Disruptivas showed that less than 2% of the organizations located in Brazil adopt technologies which characterize the I4S. According to the same research, the percentage of adoption will reach 22% in 2027 [7].

Based on the results from the research made by the Projeto Indústria 2027, there is a great expectation of acceleration of the diffusion of technologies of the I4S. Furthermore, there is a high probability that they will become dominant in the sectors of activity of the companies and the potential impact of these new technologies on the different attributes of competitiveness is already recognized. However, it is remarkable that the effort effectively made by the companies aiming at the adoption of these technologies is still limited, as can be seen in the graph below [7].
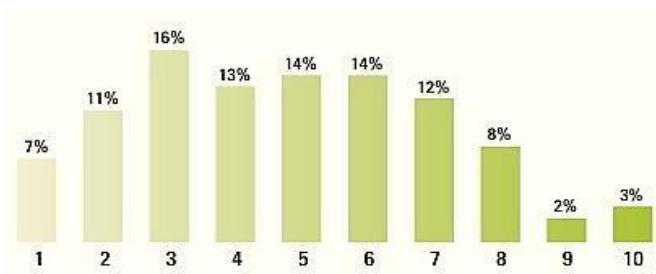

Fig. 2. Percentage of answers to the question "Imagine an ideal organization utilizing digital technologies and capabilities to improve processes, engage talent across the organization, and drive new and value-generating business models. On a scale from 1 to 10, how close is your organization to that ideal"? [6].
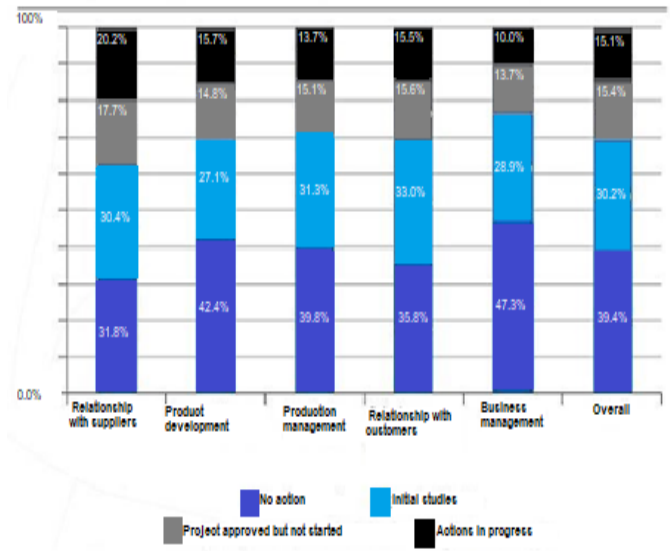

Fig. 3. Actions indicated by the respondents to incorporate the technologies of Digital Generation 4.0 (today), in% of the number of respondents [7].

When considering only large-sized companies (250 or more employees), the use of digital technologies is much higher. According to recent research of the Confederação Nacional da Indústria (CNI), 73% of the large-sized enterprises used digital technologies in early 2018. In 2016, the percentage of adopting was 63% [8].

Among large-sized enterprises which use digital technologies, most of them (90%) use at least a technology focused on the production process and/or business management. Furthermore, the investment in digital technologies in Brazil is very focused in companies that already employ these technologies. Almost all the companies which intend to invest in digital technologies (96%) already use at least one of the thirteen technologies mentioned in the survey [8].

The low robotic density is one of the technological problems that hinder the I4S implementation in Brazil. The estimate is that there are only 10 robots for every 10,000 workers in the industries, number below the global average, which is 74. On average, 1,500 robots per year are installed in the country [9].

A research made by Confederação Nacional da Indústria (CNI) in 2016 named "Desafios para a Indústria 4.0 no Brasil" point out the following priority dimensions for the I4S development in Brazil:

- Applications in the production chain and suppliers development;

- Ways to induce the adoption of new technologies;

- Technological development;

- Expansion and improvement of the broadband infrastructure;

- Regulatory issues;

- Development of human resources; and

- International articulation [10].

As can be observed, the technological question directly or indirectly takes part in more than one of these dimensions.

Research by Deloitte with 1,603 global executives in the second half of 2017 identified some factors that influence the companies' investments in advanced technologies [11]. The two most pointed factors were" if new technology can be foundational for new business models" and "ability to integrate new technology with what we already have in-house," both with 36%. The same research also identified the most common challenges the organizations face as they seek to adopt new technologies and their applications. The four most pointed challenges were the followings: lack of internal alignment about which strategies to follow (43%), lack of collaboration with external partners (38%), short-termism (37%) and lack adequate technologies (36%) [11].

In Brazil, the Confederação Nacional da Indústria (CNI) identified factors that affect the decision to invest in digital technologies in companies which intend and companies which do not intend to make this type of investment in 2018.

The expectation of resumption of demand and technical factors positively affected the decision to invest, while financial resources and regulation or bureaucracy were considered limiting factors [5].

Fig. 5. Factors that affect investment decisions. Comparison between companies that intend (A) and do not intend (B) to invest in digital technologies. Percentage of responses (%) of companies planning to invest in 2018 [8, 10, 11].
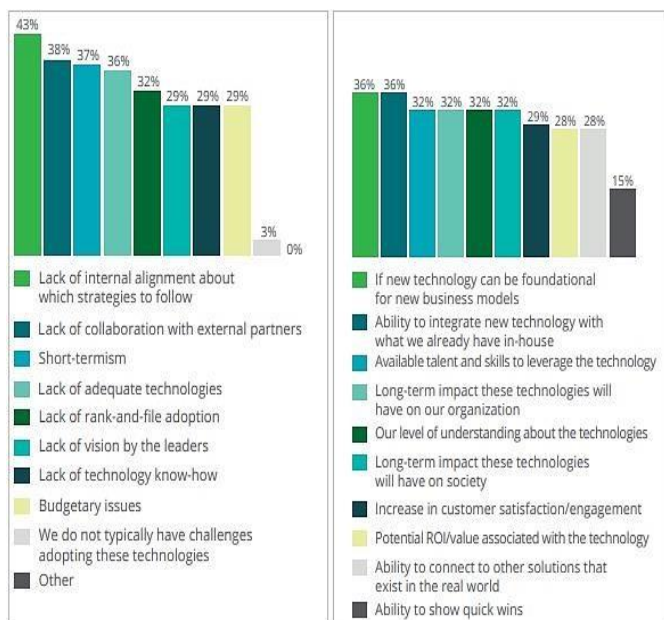

Fig. 4. Answers to the following questions: "What are the most common challenges your organization faces as it seeks to adopt new technologies and their applications"? (on the left) and "What influences your investment in advanced technologies"? (on the right) [8, 10].

IV. I4S CASE STUDIES AND BRAZILIAN GOVERNMENT INITIATIVES

Mainly since 2017, the cases of investments in technologies of the I4S have increased significantly in Brazil, and some government initiatives have been launched [5], e.g.,

- Internet of Things National Plan (Plano Nacional de Internet das Coisas);

- Science, Technology and Innovation Plan for Advanced Manufacturing in Brazil: Production of the Future (ProFuturo - Produção do Futuro);

- Brazil More Productive (Brasil Mais Produtivo); and

- Industry 4.0 Working Group (Grupo de Trabalho Indústria 4.0).

There are lots of cases of investment in I4S technologies in companies located in Brazil. Some case examples are:

- The Volkswagen Group initiative called Fábrica Digital consists of a set of software tools that simulate virtually new production processes and new infrastructure projects before they are implemented physically, to improve the jobs ergonomics. Considering only six major projects of the Group, in the last five years, the initiative has already avoided expenses that exceed R$ 6 million. The communication between men, machines, and parts, through the internet of things, and the use of 3D printers is already a reality in all four factories of Volkswagen in Brazil [12].

- Renault has introduced 3D printers in the manufacture, the remote operation and monitoring of equipment by mobile phones, the use of virtual reality glasses by its employees to protect and advise them on equipment use, and other innovations [13].

- Embraer has begun the 3D virtual factory floor training. On the production line, workers use computers and tablets with augmented reality technology and can consult videos as a way to aid in the correct execution of operations in case of doubts [14].

- Siemens has a remarkable involvement with the I4S development, ranking as one of the leaders in this area. Siemens provides a range of software for companies migrating to the I4S, such as Mind Sphere, an open internet operating system for the IoT that enables the connection of machines and physical infrastructures to the digital world. Powerful Product Lifecycle Management (PLM) software, which enables the development and optimization of new products virtually, and Totally Integrated Automation (TIA) Portal, an engineering platform with several features for I4S that assists in performing automation tasks [15].

CONCLUSION

As noted, I4S seems to be the future of industrial production. In Brazil, especially since 2017, government initiatives to intensify the adoption of I4S technologies have begun to be discussed and launched. In addition, many companies located in Brazil, especially large ones, have already made use of at least some of these technologies. With all the advances, however, Brazil still demonstrates that it is only at the beginning of a long process until the total implantation of the "smart factories," as several types of research point out.

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