Industry 4.0 and Its Development in Colombian Industry

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Abstract. This article describes the prospective in the Colombian industry related to the "Internet of things" and the concept of industry 4.0, using an analysis of different platforms implementation throughout several fields of the Colombian industries.

Keywords: Industry 4.0 · Industrial internet of things · Internet of things platforms · Big data

1 Introduction

In the Global context, taken decisions are the ones that define differential aspects stablishing the path followed by a company or an enterprise [1], those decisions rely upon tools of acquisition, collection, organization and analysis of information of the scenery of study. Which is why, this article claims to show up the current state of the IoT existing platforms in the studied area with their definition, characteristics and differential factors of the applications in several countries and regions around the globe such as success cases, and how these platforms which are developed to enhance the growth of 4.0 industry concept [2], aims to help to make decisions that determinate the future of companies in the current society of information and knowledge [3].

For reading and research convenience, this article, is organized as follows: Sect. 1, is a general introduction of the research; Sect. 2 contains the definitions and current state of key concepts, Sect. 3 discusses the characteristics of each consulted IoT platforms, Sect. 4 describes the development of platforms worldwide, Sect. 5 portrays Colombian case according to the authors investigation. Finally, Sect. 6 presents conclusions disaggregate from the paper content.

2 Conceptualization

2.1 Industry 4.0

Industry 4.0 is the designation for the fourth industrial revolution, consistent with the current trend of data exchange and automation in the technology industry. It includes cyber-physical systems, internet of things (IoT) and cloud computing [4].

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Industry 4.0 describes industry future as the establishment of internet and technological information based on interactive platforms [5], integrating each time more factors of scientific production, resulting in a more automated and connected industry. In addition to custom manufacturing industry 4.0 also incorporates information and manufacturing technology, meaning that the revolution will be dominated by intelligent manufacturing, through intelligent factories [6].

Talking about the fourth industrial revolution, the following Table 1 shows the evolution of industrial revolutions throughout history:

Table 1. Development of industry revolutions.

First industrial revolution	Began in the middle of the eighteenth century thanks to the steam engine that achieved the mechanization of the factory
Second industrial revolution	Started in the mid-nineteenth century, with the power to implement mass production on a large scale
Third industrial revolution	Ocurred in the mid-twentieth century through electrical and information technology to get automated manufacturing
Fourth industrial revolution	Based on the later evolution of the industry, according with physical system of cybernetics to develop new manufacturing methods

As mentioned, industry 4.0 is based on cyber-physical systems [5], that connect virtual spaces with physical realities, integrating computing, communication and storage capacity, reaching goods results of stability, security and acceptable efficiency in real time (Fig. 1).

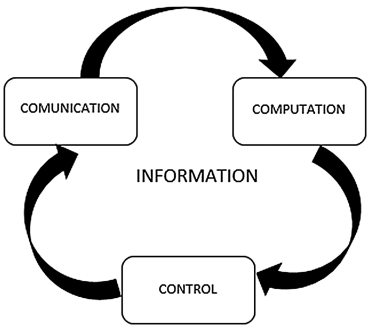

Fig. 1. Industry 4.0 structure. Adapted from [5]

Industry 4.0 structure works around three important concepts, computation, communication and control, to achieve interaction between the world and information in real time through feedback loops of engagement between computational and physical processes, with the purpose of increasing or expanding new functions, providing real time sensing, dynamic control and information feedback, among other characteristics.

A good comparison of the mechanism of the industry 4.0, could be a typical control system of an industrial process, in this case a variety of sensors and actuators are used

to trace the comportment of a property of the system in actual time and transmit it to data center through the wireless networks technologies to establish electronic files of manipulation. Some of the sensors and actuators are shown in the following Table 2:

Table 2. Sensors and actuators used in the industry.

Sensors	Actuators
Temperature - Temperature Light - Light/Dark Pressure - Pressure Moisture - Dampness/Dryness Water-Level - How full/empty a container is Movement - Movement nearby Proximity - How close/far is something Switch or button - If something is touching/ pressing it	Light bulb or LED - Creates light Heater - Increases temperature Cooling unit - Decreases temperature Motor - spins things around Pump - Pushes water/air through pipes Buzzer/Bell/Siren - Creates noise

2.2 Internet of Things

Taking an overall vision, IoT is the acronym that refers to each object that has its own virtual identity and the potential capacity to integrate and interact independently in a network with any other individual or either between machines [7]. According with Cisco concept, internet of things is simply the point in time, when more things or objects than people get connected to internet.

It is a priority for asset-intensive companies to use their equipment to the maximum and optimally to become more profitable. Increasing the performance depends on several factors as the operation, design, plans of maintenance and the operational context, the modeling of these factors will allow better control over the asset. However, this is only possible with the existence of accurate information that allows to characterize the equipment. The applications of IoT technology on industries created the concept of IIoT (Industrial Internet of Things), which has three phenomena that characterize it, as shown in Table 3:

Table 3. IIoT phenomena.

Miniaturization	It makes that components of serves become smaller, providing connection of anything, anywhere
Infrastructure	Mobile telephony infrastructure that has a great coverage
Proliferation	Of applications and services that use the data generated of IoT

2.3 Big Data

In short words, big data can be defined as the management of the variety, volume and speed of data transferred, often used by the industry as a tool to automatically track the performance of IT systems and their behavior, and to innovate in business strategies and improve overall operational efficiency [8]. Also, big data are massive amounts of data that accumulate over time, difficult to analyze and manage using common database

management tools [9]. In the same way Zdnet, interprets big data as tools, processes and procedures that allow an organization to create, manipulate and manage huge datasets and storage facilities, adding the concept of physical space to the Big Data dimension. The characteristics of the representative structure of Big Data will be shown below (Table 4):

Table 4. Four Vs for Big Data, representative characteristics.

Volume	Every day, companies record a significant increase in their data (terabytes, petabytes and exabytes), created by people and machines. Some companies generate terabytes of data every hour, every day of the year, which means, companies are flooded of data
Variety	It goes hand in hand with volume, because according to it and with technology development, there are many ways of representing data, it is the case of structured and unstructured data
Velocity	Of data creation, which measures the increase of software products developed (web pages, search files, social networks, forums, emails, among others)
Veracity	Level of confidence in data. One of the key challenges of Big Data is to ensure reliable data

3 Industry 4.0 Platforms

Nowadays, the success of a company that aims to implement industry 4.0 in its processes will depend of innovation capacity of companies [10], that goes hand in hand with interaction with other companies, through the development of platforms that make it easier for other companies to develop this philosophy. This paper will show the definitions, characteristics and advantages that each platform gives to the organization from its own development, taking into account that the platforms described here are in the first places in the ranking of worldwide demand.

3.1 Splunk

Definition: The Splunk platforms transforms machine generated data into valuable information, enabling companies to be more productive, profitable and secure [11].

Description: Splunk solutions can be describe through next cycle -Application distribution – Improved time of activity – Maintain SLA (Service Level Agreement) – Provides new information – Improve operations -Create performance information.

Relation with Big Data: Within the benefits offered by Splunk, big data plays an important role, because it allows to obtain and process the data generated by machines with one of the most complex and fastest areas of big data around the world, containing a record of all transactions, client behaviors, sensor readings, machine behaviors, security threats, fraudulent activities and so on, it is where Splunk helps discover the hidden value of all data generated by the machines, providing a unified method of organizing and extracting real time information from huge amounts of machine data

from practically any source: Websites, enterprise applications, social networking platforms, application servers, hypervisors, sensors, traditional databases, and warehouses open source data.

IoT and IIoT Relation: it provides real time information on sensors, devices and industrial systems such as SCADA by providing a flexible and versatile platform for machine data generated by all sources connected in current networks.

3.2 Anella Industrial 4.0

Definition: This platform was born in Cataluña and developed by technology centers and local industries with the aim of providing a secure, stable and accessible framework for the exchange of cloud-IT services as a global solution to the expansion of the IIoT. This is a digital transformation tool that through a marketplace facilitates digitization of processes and industrial companies will be able to access to a catalog of digital services for the industry. It gives efficient, secure and scalable access to standard software solutions.

Description: Anella solution is represented by a cycle that aims to -Drive innovation -Facilitate infrastructure (in order to modify code) -Promote success stories and provide forums -Facilitate the adoption of new technologies -Participate of international forums and organizations.

3.3 Xompass Faas

Definition: This is an end-to-end solution that adds Edge Intelligence to thousands of assets in mining, water, power, oil, gas and power using cloud power.

Description: Platform oriented in three senses that facilitate to the company management of its operation from the advantages of the internet, big data, cloud computing and IIoT, allowing:

Rapid deployment, all assets can be connected in seconds, integrating them with existing control systems beyond the control layer, and is instantly available for implementation at every time.

Productivity improvement, the power of cloud and the new data management intelligence make it possible, to take better decisions in real time, which allow to operate assets efficiently, reducing product losses.

Downtime reduction, it is easier to avoid downtime with cloud-enabled predictive asset behavior models, by consolidating field data source, maintenance workforce is reduced, resulting in lower cost of preventive and corrective maintenance.

3.4 Microsoft Azure

Definition: Microsoft Azure is an open and flexible cloud platform to quickly build, deploy, and manage applications across a global network of Microsoft-managed

datacenters. It provides the foundation for business and consumer applications that deliver a consistent way for people to store and share information easily and securely in the cloud, and access it on any device from any location [12].

Description: Microsoft Azure works through three tools and developers which include the platforms functions:

IaaS: Services oriented to the user, in order to have full control of virtual infrastructure. It includes everything related to servers (virtual machines), where to choose operating system (Windows Server, Linux, Oracle, Open Logic, etc.), number of processing cores, RAM capacity or virtual disks.

PaaS: Platform which is already created by Azure and it is also managed by itself. PaaS escalates, develops and manages the customer needs through the apps.

SaaS: Services where infrastructure and platform remain hide under a cape of abstraction.

3.5 Watson IoT Platform

Definition: It allows making sense to data to optimize operations, manage assets, rethink products and services, and transform customer experience [13].

Description: See (Table 5).

Table 5. Watson IoT platform solutions.

Analyze	Natural Language Processing: Automatically binds spoken words with meaning and intention of user
	Automatic learning: Automates data processing and classifies data according to priorities
	Image and video analysis: Monitor unstructured video channel data and image snapshots to identify scenes and patterns in video data
	Text Analysis: Survey unstructured textual data
Connect	Easily connection of chip devices to smart devices to their applications and industry solutions
Manage	Management of information and integration of external data
	Manage risk and collect information from IoT environment using sophisticated dashboards and alerts
Insert	Enter data from other data sources and platforms, to increase data of devices and perform additional analysis
Develop	Develop a variety of cloud services as data track record

4 Industry 4.0 Pioneer Countries

4.1 Germany

Germany works around "Internet + Manufacturing" [14]. This country is a leader in the deployment initiatives on Industry 4.0 through new technologies, which make possible

digital transformation Germany, combines the participation of public administrations with the active role of companies, universities and research centers, to generate industry 4.0 ecosystems. An Example of this collaborative ecosystem is the project German National Academy of Science and Engineering (ACATECH) [5].

The Fraunhofer Institute of Industrial Engineering and automation in Germany predicts that in the country, industry 4.0 can improve productivity in a range of 20 to 30% points by 2025 [15]. In summary, the application for industry 4.0 represent an investment of 40 billion euros per year with a forecast of digital transformation of more than 80% of industries by 2021, with an efficiency increase of 18%, a cost reduction of 13% and a potential business growth of 425 billion euros in 2025 [16].

4.2 China

For the Asian country, the transitional program "Created in China" that evolves from the program "Made in China" as the complete transformation [5], establishes that manufacture future based on interactive platforms, internet and information technologies is going to be increasingly integrated to scientific and automated production factors, to networks creation and intellectuality added to standard of personalized manufacturing. In 2015, Chinese government promulgated "Made in China 2025" program, the Chinese version of Industry 4.0, which will be on the stage of history, in future development, directly related to the development of the industrial economy of China [5].

In this way, digitalization is an appropriate trampoline for China. According with official Chinese estimations, Industry 4.0 can increase productivity of China by 25 to 30% and reduce production losses in approximately 60% [17]. Moreover, according with a study of the Chinese Academy of Engineering (CAE), the Chinese income per capita could keep catch up with countries such as United States, Germany and Japan, by the year 2045 thanks to the accurate and total implementation of the fourth industrial revolution.

5 Industry 4.0 in Colombia

5.1 Contextualization

Colombia, at Latin American level, has the fourth position in Open Data Index. Bogota ranks within the top three smartest cities in Latin America, along with Sao Paulo and Mexico City. However, this regional positioning doesn't guarantee an "industrial revolution" considering the magnitudes of industry. Colombia has just opened the Center for Excellence and Internet Acquisition of Things, its first public-private research and innovation center of IoT; in which five public universities, eight national companies, three multinational technology companies (Intel, Hewlett-Packard Enterprise and Microsoft), Colciencias and the TIC Ministry joined forces to create developments in this technological field.

The business sector agrees that successful organizations are those that manage their digital universe to analyze behaviors, based on real data and using the concepts of "cloud computing" in which they can quickly access to information to make decisions, which

follows the concept behind of Industry 4.0. While the state holds that technology is at hand, and that the way to use it has to be changed, it must pass from e-government to digital government. One major difficulty that Colombia has is that private companies do not use the technology properly, as they limit themselves in just having a web page, but without transforming their business model. Colombian companies use technology as a tool instead of a goal, wasting the technology is potential for innovation. This concludes that much remains to be done, recognizing the progress already made.

The challenge then is to understand that the development of the Colombian industry towards a higher level of intelligence and automatization is a task of everyone and that the way to achieve that is integrating government, companies and civil population in a perfectly related network. The government must also create suitable and optimum conditions to ensure sustainability of industry and support the entrepreneurship, characterized for its innovation and technology leverage to create value; all of which helps the government improves the life overall life quality of it is society by (allowing access to education for the entire population). Finally, the challenge for citizens and companies is to be ethical regarding the good acting and committing to generate shared value to society, realizing that ICT are not a luxury but a necessity to remain the market.

5.2 IoT Platforms Used in Colombia

In order to accomplish the objectives of the study, a survey was made for thirteen (13) companies, both private and public, with activity in the country with the purpose of having an overview of the real position of industries Colombia as was previously described. Most of the companies reviewed Industry 4.0 platforms, companies consulted covered areas of food production, manufacturing, mining, health, entertainment, services, sales, marketing, and collection and control of customs and taxes. Of the total of companies surveyed, it was found that only 23% of them do not use any platform to analyze company data, although those recognize the Industry 4.0 concept, while 47% of the companies affirmed to use two or more platforms simultaneously in different business areas (Fig. 2).

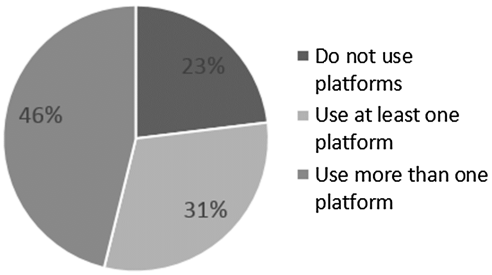

Fig. 2. Usage of IoT platforms in companies consulted.

The next step consisted in identifying the top platforms currently used platforms by the companies and to verify, their versatility and the field of application (large or small scale within the internal structure of business) (Fig. 3).

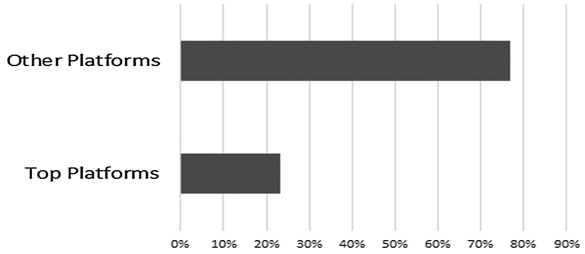

Fig. 3. Usage of IoT platforms reviewed and others.

At this point and taking into account the percentage of companies that use any data analysis platform, 77% of the sample claimed to use collection and analysis of data platforms with solid implementations, but from these implementations only 30.7% correspond to any of the platforms named in this review. The remaining 69.3% of these companies, were asked which platform they used, aiming to cover a greater depth regarding the type of platform, its characterization and why these platforms were preferred in comparison to top platforms of this paper (Table 6).

Table 6. Platform used by companies.

Platform	Usage %	Platform	Usage %
Sharepoint	12,50%	NOW	6,25%
Watson IoT platform		Oracle	
Orange		Cognos	
Eclipse	6,25%	Logtrust	
Bizagi		JDA	
Azure		Survella	
Tableau		Weka	
SQL server		Datamelt	

Nevertheless, 86% of these platforms are non-license, buffering financial expenses of paying a license periodically, according with data processing type preferred by each company. From the survey results, there is a tendency of companies that understand Industry 4.0 platforms as a simple support for processes, rather than a tool of decision making at management levels (Fig. 4).

As mentioned, 30.7% of the 13 companies surveyed that reported the use of the top named platforms return the next results: from five (5) of those companies just three (3) of them use two of the platforms (Fig. 5).

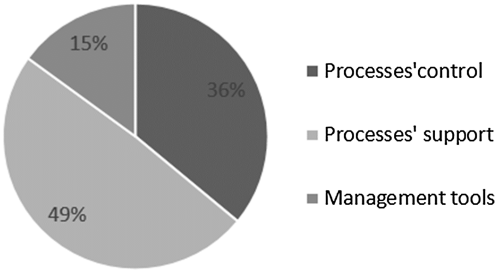

Fig. 4. Platforms usability.

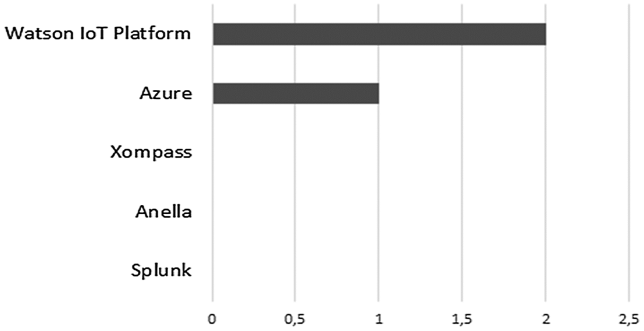

Fig. 5. Top platforms usage.

5.3 Implementation Barriers

Although it was previously said, Latin American levels stands out for the gradual reception of the most innovative business theories, not only in the case of platforms of Industry 4.0, but also of Big Data and business intelligence, among others [18]. Country evolution towards these tools of innovation and competitiveness is constrained by the high economic licenses costs of the best products (according with the ranking on global statistics by Capterra), and change resistance of which organizations are victims in adaptation processes [19].

6 Concluding Remarks

It is important to mention that companies that are leveraging their business model with this kind of tool are mainly B2B (Business to business) companies, those are too recent creation and are focused in generating value with services that improve the management indicators of large business companies. These companies are characterized because their founders are young people, who have mostly worked in large companies and have seen their specific needs, making the decision to solve those needs by building service.

Industrial revolutions throughout history have been characterized by the support, although late, of the government for its total implementation. The Colombian case of

Industry 4.0 requires a join effort of public sector headed by the government, businesses and the academy.

The commitment of the companies in investments related to Industry 4.0 platforms in the country should be understood as a requirement for the company is evolution and the increase of the value added to all the products and not only as a fashion industry or a mere global trend.

Open source tools are especially beneficial in Latin America because they are compatible with open data sources and have an attractive cost/benefit relation. On the other hand, licensed tools outstrip security platform correlation themes, technologies and algorithm capabilities to perform data analysis associated with security of technology platforms.

Finally, the dissemination, exhibition, consultation and research of technological tools that help to archive the fourth industrial revolution, development in general, are necessary to achieve the same development, this article is a sample and an attempt of it.

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