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A review of the meanings and the implications of the Industry 4.0 concept

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Abstract

The global industrial landscape has changed deeply in the last few years due to successive technological developments and innovations in manufacturing processes. The Industry 4.0 concept has emerged and the academic literature has paid an increased attention to this topic, which remains non-consensual or ill defined. In this research, a literature review is made to understand this concept in its technological dimension, and to comprehend its impacts. This new industrial paradigm brings together the digital and physical worlds through the Cyber-Physical Systems enhanced by Internet of Things and it is expected that this novel has consequences on industry, markets and economy, improving production processes and increasing productivity, affecting the whole product lifecycle, creating new business models, changing the work environment and restructuring the labor market. Therefore, this paper focuses on Industry 4.0 concept and contributes for its clarification and further understanding about the importance and implications of this complex technological system.

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1. Introduction

In the last years, with the growing advancements in manufacturing processes and technology, many new global concepts have emerged. The term “Industry 4.0” has become an increasingly important topic in the last few years.

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This concept appeared firstly in an article published in November 2011 by the German government that resulted from an initiative regarding high-tech strategy for 2020 [1].

The global industrial landscape has changed deeply in the last years and is a result of successive technological developments and innovations. Industry 4.0 can be tentatively compared with three industrial revolutions that occurred in the last centuries and that represent the main disruptive changes in manufacturing that have resulted from several technological advances [2].

The First Industrial Revolution took hold in England in the middle of the 18th century and was potentiated by the invention of the steam engine. During the second half of 19th century, the Second Industrial Revolution came up in Europe and USA. This revolution was characterized by mass production and the replacement of steam by chemical and electrical energy. In order to meet the growing demand, several technologies in industry and mechanization have been developed, such as the assembly line with automatic operations, allowing the increasing of productivity. The invention of the Integrated Circuit (microchip) was the technological advancement that has triggered the Third Industrial Revolution. The use of electronics and Information Technology in order to achieve further automation in production is the key feature of this revolution that emerged in the last years of 20th century in many industrialized countries around the world [3], [4].

The increasing productivity is the core of every industrial revolution. The first three industrial revolutions had a strong impact in industrial processes, allowing productivity and efficiency increase through the use of disruptive technological developments, such as steam engine, electricity or digital technology [5]. Industry 4.0, which may eventually represent a fourth industrial revolution, is a complex technological system that has been widely discussed and researched, having a great influence in the industrial sector, since it introduces relevant advancements that are related with smart and future factories. This emerging Industry 4.0 concept is an umbrella term for a new industrial paradigm that embraces a set of future industrial developments regarding Cyber-Physical Systems (CPS), Internet of Things (IoT), Internet of Services (IoS), Robotics, Big Data, Cloud Manufacturing and Augmented Reality. The adoption of these technologies is central to the development of more intelligent manufacturing processes, which includes devices, machines, production modules and products that are able to independently exchange information, trigger actions and control each other, enabling an intelligent manufacturing environment [6].

This new approach will bring together the digital and physical worlds through the CPS technology, embracing a set of future industrial developments that will allow the improvement of productivity and efficiency among the companies that are adopting this new manufacturing paradigm [1]. Industry 4.0 holds a huge potential and it will provide a set of economic and social opportunities through the paradigm shift regarding to work organization, business models and production technology [7].

The influence of Industry 4.0 is being researched by academics and companies in recent years, which has resulted in an increasing number of publications about this topic. However, this concept that intends to highlight the new industrial environment and the involved technological advancements is not always consensual, as well as its potential consequences in industry and manufacturing, which are not yet clearly defined. The purpose of this paper was the comprehensive understanding about the Industry 4.0 concept, as well as a research about its importance, regarding the impacts, challenges and opportunities for the organizations that adopt this novel approach.

This paper is structured in seven sections. After this introduction about the Industry 4.0 phenomenon, section 2 explains the research methodology and section 3 provides a comprehensive definition about this concept, presenting several points of view about Industry 4.0 visions and concepts. The key Industry 4.0 technology enablers are described in section 4, while the section 5 provides an analysis about the impacts and influence of this new industrial paradigm. Lastly, section 6 draws the main conclusions and findings about Industry 4.0 concept and implications.

2. Research Methodology

In order to understand the importance of Industry 4.0 as a complex technological system, and in order to attempt a consolidation of this nonconsensual concept, a comprehensive literature review was carried out using the main scientific literature databases, journal articles, conference papers, books and other documentation, as the source of the utilized secondary data. Furthermore, the literature review was conducted considering the following electronic databases: ISI Web of Knowledge, Elsevier (Science Direct), Scopus, Emerald Insight and Springer, over the 2000-2017 timeframe period. The objectives of this investigation consisted in: (1) the identification of the main articles and

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