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Manufacturing in the fourth industrial revolution: A positive prospect in Sustainable Manufacturing

Núbia Carvalho^{a*}, Omar Chaim^a, Edson Cazarini^a, Mateus Gerolamo^a

^aUniversity of São Paulo, Av. Trabalhador Sancarlense – 400, São Carlos 13566-590, Brazil

Abstract

Industrialization throughout history has been one of the main contributors to pollution, disregard for environmental issues, resulting in an unsustainable production model. A change from this context, the imminent new industry model called the Fourth Industrial Revolution or Industry 4.0, aims for a manufacturing system that is both viable and sustainable. This paper seeks to describe the main forms of collaboration of Industry 4.0 in relation to sustainability. Scientific works point out the advantages provided by the new industry model such as improved product life cycles, manufacturing works in an integrated way with the use of cyber-physical systems allied to the principles of this industry, such as decentralization, virtualization, interoperability, among others which lead to more adaptability to natural resources availability and environmental costs. Smaller batches can lead to a more accurate response to the demand curves and consequently lessen the waste for production.

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1. Introduction

The process of industrialization went through three phases that were described as industrial revolutions. Each one presented its specificities, and along with them, its characteristics of how to preserve the environment and avoid the accumulation of waste. With the attainment of revolutions this environmental preservation has become more complex, large-scale production, the demand for primary raw materials and the generation of waste have increased significantly.

* Corresponding author. Tel.: +55 16 98155-6907.

E-mail address: nubia.carvalho@usp.br

The intensification of global industrialization along with the accelerated population increase, the development of new products, high levels of production and excessive consumption contributed to economic development, but resulted in environmental degradation of ecosystems. Within this context, the development of corporate environmentalism, as a strategic part of the business, is one of the most significant changes occurring in the markets at the beginning of the 21st century [1].

Since the First Industrial Revolution, subsequent revolutions have brought radical changes in manufacturing, from steam engines to automated electrical and digital production. Manufacturing processes have become more complicated, automatic and sustainable, meaning that people can operate machines simply, efficiently, and persistently [2]. Today, modern manufacturing plays a key role, especially in European countries. About 17% of GDP is represented by industry, which also creates some 32 million jobs with several complementary occupations in the European Union [3].

Aiming at the imminent industrial revolution it is observed that it covers technological concepts and solutions to generate a combination of economy of scale and economy of scope. This fourth industrial revolution or Industry 4.0 is characterized by a high level of complexity and use of a full network integration of products and production processes. [4] Using the definition formulated by the World Commission on Environment and Development [5], sustainability consists of: "meeting the needs of the present without compromising the ability of future generations to meet their own needs", so industries must pay attention special not only to the development of products and their life cycles, but also to the processes that involve their elaboration.

Based on this explanatory context, this paper aims to present the main characteristics of the imminent industry 4.0 that have already been perceived and described in scientific works, and in what ways these characteristics cooperate for the environmental preservation resulting in the permanence of an industry model that includes sustainable methods, processes, techniques and strategies.

2. Fourth Industrial Revolution

2.1. First aspects of Industry 4.0

By the mid-eighteenth century, the initial movement in terms of industry began in England. Following the US and European countries such as Germany began a shift from agricultural society to industrial society [6].

The phenomenon of Industry 4.0 was mentioned in the German language for the first time in 2011 in Germany, during the "Hannover Fair" event as a proposal for the development of a new concept of German economic policy based on high technology strategies, symbolizing the beginning of Fourth Industrial Revolution [7, 8].

Passive machines and robots have replaced the workforce, which means that they are controlled by a human being without consciousness. Already in 2012, the number of industrial robots was about 273 per 1000 workers in Germany [9].

The imminent Industry 4.0 implies a complete communication network that will exist between various companies, factories, suppliers, logistics, resources, customers, etc. Each organizational area optimizes its configuration in real time depending on the demands and status of the associated sections in the network. In addition, costs and pollution, raw materials and CO₂ emissions, for example, will be reduced. In other words, the future business network is influenced by each cooperating section, which can achieve a self-organized status and transmit the responses in real time, in the financial sphere generates the maximum profit for all the cooperatives involved with the limited resources of sharing [10].

2.2. General understandings of the Industry 4.0 structure

Industry 4.0, has been perceived as a collective term for technologies and concepts of value chain organization. Within modular intelligent manufacturing factories 4.0, Cyber-Physical Systems (CPS) monitor physical processes, create a virtual copy of the physical world, and make decentralized decisions. Internet of Things (IoT) and CPS communicate and cooperate with each other and with humans in real time. Through Internet of Services (IoS), both internal services and interorganizational services are offered and used by participants in the value chain [11, 12, 13].

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