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## Smart products development approaches for Industry 4.0

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### Abstract

In the last few years, the global economy and market requirements have been changing rapidly. The increasing demand for high complexity and the last technological developments potentiated by industrial transformation have led to the development of more complex and smarter products with new capabilities. However, producing smart products means deep changes in product development processes that have experienced several advancements in the last years in terms of theory, methods and approaches. In this research, a literature review is made to provide knowledge about smart products development (SPD) approaches. Disruptive changes addressed by Industry 4.0 had impact in the whole product lifecycle, with the emergence of advanced digital tools for product development and prototyping that comprise advanced computing platforms, such as virtual and augmented reality. Allowing the combination of digital and physical prototyping, these technologies are rewriting the rules of product development processes, bringing new opportunities and challenges for SPD.

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*Keywords:* Smart products; Industry 4.0; New product development; Augmented reality; Cyber-physical systems

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### 1. Introduction

In the last few years, an increased attention has been turned towards Industry 4.0. This term, which arose firstly in November 2011 when the German government presented the high-tech strategy for 2020, is frequently used to describe the emerging fourth industrial revolution [1]. Industry 4.0 comprises several technological developments that consist in the combination of optimized industrial manufacturing systems and advanced digital technologies. Cyber-physical systems (CPS), considered one of the basis of Industry 4.0, are one of the most significant advances in these disruptive

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developments. CPS are characterized by the interaction between digital and physical workflows. The potential application fields of CPS have no boundaries and the expected emergence of them may be responsible for changing a lot of aspects in our life [2].

Due to these disruptive technological advancements, the industrial landscape has been changing over the last years. Beyond the emphasis on traditional manufacturing transformation, smart factories and intelligent machines, Industry 4.0 concept embraces a set of technological developments that influence both products and processes, allowing the creation of smart products through the integration between digital and physical world [3]. Similar to the industrial landscape, also the market requirements are changing rapidly, demanding for smarter products that are characterized by increased functionalities and more complexity, based on interaction of several technologies [4].

Therefore, a crucial role in this manufacturing transformation is played by smart products development (SPD). Smart products are able to storage a large amount of data, self-process and communicate with industrial systems. They are capable to collect information and interact with their environment without human intervention during their whole lifecycle [3]. As a result, the companies that are moving towards Industry 4.0 are facing the challenge to design and introduce innovative smart products that are able to meet the enterprises and the market requirements. The companies have to adopt SPD approaches, in order to ensure the innovation in their products and processes. The introduction of advanced technologies such as Augmented Reality and Virtual Reality for prototyping and product development represents a huge potential in SPD, allowing the creation of highly flexible products at an affordable cost [5].

This paper intends to provide empirical knowledge about SPD approaches that meet Industry 4.0 drivers and new market requirements. In fact, Industry 4.0 concept can be very useful to define these approaches, through the introduction of new trends and technological tools that result in innovative processes and new ways of integrating information, such as the use of virtual and augmented prototyping to bring product design and visualization together.

This paper is structured in six sections. Firstly, section 1 provides a brief introduction about Industry 4.0, smart products and SPD, while the research methodology is explained in section 2. A comprehensive definition about Industry 4.0 concept is provided in section 3 and the concept of smart product is analyzed and its main potentials in Industry 4.0 framework are identified in section 4. The section 5 presents the concept and approaches of SPD and, finally, section 6 presents the main conclusions about SPD approaches in this new industrial paradigm.

## **2. Research methodology**

The purpose of this paper was the comprehensive understanding about SPD and which approaches are suitable to the new emerging industrial paradigm called Industry 4.0. Although this concept is currently one of the most frequently discussed and researched topics among academics and organizations, it is still not consensual regarding its vision and implications and drivers. This paper aims to provide empirical knowledge about how SPD practices are able to meet Industry 4.0 drivers and new market requirements.

In order to understand the impact of SPD and their relation to the manufacturing field, the applications, problems, and techniques related to SPD and manufacturing, a comprehensive literature review was carried out and these topics have been studied by analyzing author provided keywords (Smart products, Industry 4.0, New product development, Augmented reality, Cyber-physical systems), using text mining. this research was carried out using the main scientific databases, journal articles, conference papers, books and other relevant documentation. The objectives of this investigation were twofold: (1) to identify potentially impactful articles that are related to SPD and (2) to find out how SPD has evolved regarding to problems, applications and techniques.

## **3. Smart products in Industry 4.0**

The fourth industrial revolution comprises a set of advancements that involve both products and processes. Smart products are one of the key aspects of this new industrial paradigm, representing several potentials for organizations and markets. This section provides comprehensive knowledge about Industry 4.0 concept and its implications. Furthermore, the emergence and capabilities of smart products are analyzed, as well as, its main potentials in Industry 4.0 framework.

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