Smart Manufacturing Systems

Subjects: Industrial & Manufacturing Engineering
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**Definition**

Smart Manufacturing is considered as a new paradigm that make work smarter and more connected, bringing speed and flexibility through the introduction of digital innovation. Today, digital innovation is closely linked to the “sustainability” of companies. Digital innovation and sustainability are two inseparable principles which are based on the concept of circular economy. Digital innovation enables circular economy model promoting the use of solutions like digital platforms, smart devices, artificial intelligence that help to optimize resources. Thus, the purpose of the research is to present a systematic literature review on what enabling technologies can promote new circular business models.

**1. Introduction**

Today, the manufacturing industry is aiming to improve competitiveness through innovative technologies, the so-called enabling technologies with the aim of promoting new growth in the industrial sector. Competitiveness, innovation, and sustainability represent strategic levers for global economic development. In this regard, the attention of the industrial and academic community is to analyze how digital manufacturing systems will push companies toward “sustainability” and a “circular economy”.

**2. Smart Manufacturing Systems for a Sustainable Industry**

In fact, as recognized by several authors, innovation and sustainability are two crucial issues for the present and future generations of smart manufacturing systems. Indeed, the extraction of natural resources, excessive waste production, and global warming are problems known to all. In this regard, emerging searches have shown how a circular model to reuse waste has a positive influence on improving the entire supply chain to manufacture products, while others have focused on the impacts of digital technologies in the domain of manufacturing, optimization processes, and scheduling problems to solve the problem of industrial pollution and a waste of resources. It is a vitally important issue worldwide. As a matter of fact, according to the study published by the United Nations Inter Governmental Panel on Climate Change, only 12 years remain to limit the devastating effects linked to climate change, rethinking production, and consumption patterns on a global scale to take into account the concept of finite limit of resources. Exploiting the digital technologies underlying the Fourth Industrial Revolution to promote the introduction of a circular economy can be a first step toward the development of responsible production and consumption. In fact, the adoption of digital technologies such as artificial intelligence (AI), additive manufacturing (AM), and cyber-physical systems could promote circular economy models, helping to generate value by increasing energy efficiency, extending the useful life of products, component materials, and recovering the value at the end of the cycle. In this scenario, the European Innovation Council Accelerator (EIC) supports innovations that promote the implementation of the European Green Deal. In particular, the EIC supports over 1100 “green” companies for a total of over € 550 million. This represents almost 25% of all companies supported by the EIC. Most of the “green” companies, which produce green technologies and products, are young: almost half of them were founded between 2012 and 2017. Green innovators attracted around € 730 million in private investment after receiving the grant, which means that every € 1 invested in green companies by the EIC mobilized € 1.72 in private investment. Most of the private investments were made in the energy, power, and business software sectors. Furthermore, all the member states of the United Nations signed the 2030 agenda in 2015, though introducing concrete actions on a global scale seems difficult to achieve. Although there are all these initiatives, there remains a common disagreement. In fact, during the last Conference of Parties in Madrid (COP25), an agreement was not reached on the markets of CO2. Despite a timid appeal for more ambitious efforts and a call for the urgent need to increase cuts in climate-changing gas emissions, all decisions have been postponed to the next meeting (COP26 in Glasgow). However, where national (and above all supranational) policies do not seem to be able to produce the desired results, companies can begin to take a first step toward sustainable production (and consumption) models,
implementing circular economy models, and using digital technologies as a starting point [17]. A new paradigm, a change of mindset, is needed [18]. Developing new efficiency models around the digital world represents an opportunity for growth from a social and economic point of view [19][20][21], a topic that is still underexplored. Thus, the purpose of this research was to analyze how the development of digital technologies could promote circular economy models. In this regard, a systematic literature review (SLR) approach was proposed. The use of a SLR represents a very useful scientific tool for summarizing the state-of-the-art of a specific topic. It uses systematic methods to collect secondary data and provides useful ideas for the scientific community [22]. In the present research, SLR was used as through a “protocol”, it is possible to define a specific objective of investigation, to describe literature review sources, and select primary studies. Definitely, a protocol for a systematic review describes the rationale for the review, the objectives, and the methods that will be used to locate, select, and critically appraise studies, and to collect and analyze data from the included studies [23]. Although, SLR does not represent a scientific innovation, it is valuable since in a single document, it provides a complete, exhaustive summary of previous works produced on a specific topic [24]. The main output of our research is the first categorization of recent literature to analyze the state-of-the-art.

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**Keywords**

Smart Manufacturing System; Applied Industrial Technologies; Circular Economy; Sustainable Manufacturing; Industrial Policy; Systematic Literature Review

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