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Investigating the effects of Smart Production Systems on sustainability elements

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Abstract

The next generation of manufacturing systems will be self-organising. Networking of cyber-physical equipment and machinery are on the rise. In the field of sustainable manufacturing, an increasing level of computerisation is used to face the growing production requirements. Smart production systems will foster opportunities from its artificial intelligence to create value within the business and the community it operates. Smart production systems will integrate the virtual and physical worlds on these Internet of Things (IoT) platforms to ensure flexibility and resource efficiency. This research study investigated the dynamics of the next industrial revolution (Industrie 4.0) and used case studies on the market, suppliers and customers as benchmark to identify current trends. The technical, economic, social and environmental elements of possible smart innovations were evaluated in terms of resource efficiency. Prerequisites for tooling companies to use smart production systems were discovered. Future work was also discussed.

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1. Introduction

Networking of all kinds of equipment and machinery on the basis of cyber-physical systems are on the rise. In the field of manufacturing the increasing level of computerization is used to face the growing production requirements. Smart Production Systems are characterized by its flexibility, resource efficiency, ergonomic design and the ability to integrate customer and business partner into the value creation process.

For many decades in the twentieth century manufacturing was driven by the rising demand for standardized products. After the invention of the mechanical loom in 1784 the concept of the electrically driven conveyor belt which was first used in 1870 is seen as the second industrial revolution. Figure 1 shows an overview about the four industrial revolutions [1]. Henry Ford’s conveyor-belt assembly line which was used for car manufacturing at the Ford factory in Michigan in the early twentieth century is a popular example for the improvements of the second industrial revolution which brought the Ford Motor Company in a market leading position. With the mass production of relatively small numbers of products many companies had been successful for many decades. Volkswagen as one of the leading global car manufacturer had only three different types of cars in its portfolio until the beginning of the 1960’s.

![Fig. 1. Milestones in the history of manufacturing [1]](image)

In the last few decades the trend has been shifted from the classic mass production to individualized, customer-driven, high-tech products. Currently Volkswagen offers 33 different car models, each with hundreds of individual selectable options.

Complex processes on every hierarchy level, high numbers of product varieties and short product life cycles require a solid knowledge and permanent interactions with customers, suppliers and all kind of stakeholders. Under the perspective of globalization and rising competitive pressure an effective use of resources is indispensable.

To cover all requirements, the effective use of IT communication systems and the available data is essential to secure an enterprises market position. The connection and communication between software components and mechanical and electrical parts via wired or wireless data infrastructure like the internet are called cyber-physical systems or short CPS. Through the technology of CPS, it is possible to monitor and steer production systems in a very effective way to facilitate a cyber-physical production system or CPPS. The current technological literature speaks in regards to that form of intelligent or smart productions systems or the smart factory. A pioneering role takes the German government with a high-tech strategy project that speaks about the fourth industrial revolution and formed the term “Industrie 4.0” starting in 2011.
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