Circular Economy and Industry 4.0: Contributions and challenges in the implementation of I4.0

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The purpose of this research is to understand the connection between the circular economy (CE) and Industry 4.0 (I4.0) in the context of supply chain management. The aim is to understand how I4.0 technologies enable CE and what difficulties companies might experience in the context of the CE. Methodologically, real case studies were searched for and subsequently analyzed. The results were used to develop a roadmap, as a guide to help companies move towards circularity.

Introduction

Over the past few years, organizations have started to focus on sustainable practices to solve environmental and social problems. In a linear economic system, raw materials are mined, products are produced, sold, consumed, and thrown away. This leads to a shortage of raw materials, and large amounts emissions and of waste. A CE keeps products and materials in circulation. This means that fewer virgin raw materials are used compared to linear economies. Furthermore, the value of the product is retained longer, and less waste is generated. The CE considers the entire product lifecycle, which includes the extraction of raw materials, the design, production and distribution of a product, its longest possible use phase and recycling. Nowadays, the question is whether the CE can be improved with the latest technologies. I4.0 is a comprehensive concept and a new trend in manufacturing and other related sectors. As there are many theoretical approaches of I4.0 technologies in connection to the CE, it is the goal of this research to find real world use case implementations. The research question is therefore: What potential contributions and challenges exist for the implementation of I4.0 technologies to achieve circularity in companies?

Methodology

The research question of the thesis was answered by a qualitative analysis to find out how companies (SMEs) can be supported on their way to CE with the help of I4.0 technologies. All analysis were developed on the basis of already existing theories and use cases, and in this way a deductive approach was applied. Therefore, the following activities were carried out: Databases searches, reports analysis, secondary analysis, content analysis, and summary statistics.

Result

Out of the 35 real-word use cases, each of the I4.0 technologies used was identified. Research results showed the frequency in which I4.0 technologies were used in the real-world case studies. It also demonstrated how the different I4.0 technologies can contribute towards the CE and what challenges companies face while implementing them. As for the challenges identified, it was evident that companies need trained workforces to implement the I4.0 technologies and they need to update their IT infrastructure, because the new technologies are constantly integrated with software, hardware, and networks. Based on the identified contributions and challenges, it was possible to create a 7-step roadmap, that will serve as a supporting tool for companies that want to move towards the CE.

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Roadmap for a circular supply chain management
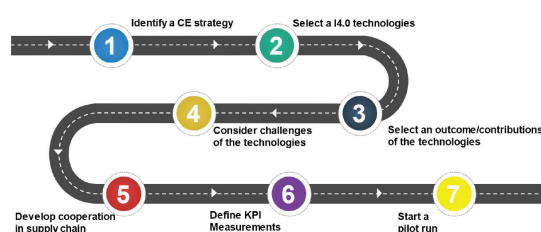
Proposed roadmap integrating I4.0 and CE