

Chapter 8

Industry 4.0 in the Context of the Triple Bottom Line of Sustainability: A Systematic Literature Review

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ABSTRACT

Industry 4.0 and sustainability are trending topics in the industry and scientific research. However, there is currently no comparable study, which summarizes the impacts of Industry 4.0 on all three dimensions of the Triple Bottom Line at the same time. This chapter aims to present a comprehensive overview of Industry 4.0 in the context of the Triple Bottom Line of sustainability. For this reason, a systematic literature review is conducted to find out the current state of literature about this topic. The chapter presents a systematic literature review on 64 peer-reviewed journal articles, which have been published between 2014 and 2019. An in-depth analysis of the content as well as an analysis of the empirical methodologies are conducted. To structure the existing knowledge, a framework is developed, and the findings are categorized into ecological and social aspects. On this basis the content is evaluated to discuss key findings and relating interdependencies.

INTRODUCTION

So far, Industry 4.0-related literature has mainly concerned technical aspects of the phenomenon (Kiel et al., 2017). Whereas further research disciplines, such as business management have begun to examine Industry 4.0 (Piccarozzi et al., 2018), ecological and social aspects of Industry 4.0 have been even less regarded. In particular, integrative investigations of economic, ecological, and social aspects remain rare (Birkel et al., 2019; Kiel et al., 2017). Several authors find that improving ecological and social aspects of industrial value creation whilst maintaining economic profitability is a challenging task. Several po-

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tentials and challenges of Industry 4.0 seem contradictory in each of the three dimensions of the Triple Bottom Line. For instance, working conditions shall be improved, whilst job losses are expected through Industry 4.0. Therefore, an interdisciplinary and integrative investigation of Industry 4.0 is necessary, not only balancing, but combining ecological and social potentials with market success (Müller et al., 2018a; Müller & Däschle, 2018; Stock et al., 2018). Further, several authors find that sustainability aspects of Industry 4.0 differ across countries and need to be incorporated in managerial practice and policy, for instance been the German initiative “Industry 4.0” and the “Internet Plus” initiative within the concept “Made in China 2025” (Müller and Voigt, 2018).

Still, sustainability in the context of Industry 4.0 has been addressed by some authors in recent time. According to Scopus, out of 137 articles that have “Industry 4.0” and “Sustainability” in abstract, title or keywords, 103 were published since 2018. This relates to articles in English language in journals or conference proceedings.

In order to provide a comprehensive overview of the current state of research regarding Industry 4.0 in the context of the Triple Bottom Line of sustainability, the article performs a systematic literature review. Thereupon, the article discusses and evaluates recent research findings, presenting managerial and theoretical implications, and promising avenues for future research.

Background

The term “Industry 4.0” is derived from the German “Industrie 4.0” initiative launched by the German government in 2011. It aims at ensuring future competitiveness of the German manufacturing industry (Kagermann et al., 2013; Lasi et al., 2014; Müller et al., 2017). In this context, Industry 4.0 indicates a predicted fourth industrial revolution. Industry 4.0 builds on several technological developments, including the Internet of Things and Cyber-Physical Systems, that shall enable real-time interconnection of products, production facilities, humans, and smart devices in a vertical and horizontal manner. Vertical interconnection means across several departments within an enterprise, horizontal interconnection expresses digital information sharing across several partners within a supply chain, including the customer. Further, the entire product lifecycle shall be encompassed, from production, to product usage, to recycling (Kagermann et al., 2013; Lasi et al., 2014; Liao et al., 2017; Müller et al., 2018b).

After 2011, when the German initiative “Industrie 4.0” was launched in the “High tech strategy” of the German federal government, several comparable programs and initiatives have been launched worldwide. For instance, the European Union initiated a program called “Factories of the Future”. It intends to ensure a digital and sustainable production in order to maintain global competitiveness. In the United States of America, The “Industrial Internet Consortium” represents a comparable initiative, whereas China launched the program “Internet Plus” within the program “Made in China 2025” (Liao et al., 2017; Müller & Voigt, 2018).

As the first industrial revolution (mechanization), the second industrial revolution (electrification), and the third industrial revolution, Industry 4.0 is expected to inflict changes in an economic, ecological, and social context (Birkel et al., 2019; Maynard, 2015; Kiel et al., 2017; Müller & Voigt, 2018).

Economic, ecological and social aspects subsume the Triple Bottom Line of sustainability (Elkington, 1987; Elkington, 1998; Norman et al., 2004). Since the World Commission on Environment and Development’s “Brundtland report” in 1987 (World Commission on Environment and Development, 1987), an increasing expectation of society to achieve ecological and social welfare whilst maintaining economic success can be observed. This is also and especially true for industrial value creation, which

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