SMART INDUSTRY – BETTER MANAGEMENT

Edited by Tanya Bondarouk
and Miguel R. Olivas-Luján

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INTRODUCTION

Tanya Bondarouk and Miguel R. Olivas-Luján

The age of Smart Industry has arrived! Definitions of Smart Industry are abundant (Habraken, this volume); however, most authors agree on the following characteristics. It involves future-proof industrial and product systems, which are smart and interconnected, and make use of Cyber Physical Systems, digitization, connectivity, and new manufacturing and product technologies (Kagermann, Helbig, Hellinger, & Wahlster, 2013). The history of and discourse around Smart Industry originated in Industry 4.0, the initiative that took off in Germany during the industrial trade fair Hannover Messe in 2011 (Pfeiffer, 2017). Following the trade fair 2011, the vision behind Industry 4.0 has spread to other countries under names such as 'Made in China 2025', 'Make in India', 'Advanced Manufacturing' (USA), Industrie 4.0 Österreich (Austria), Indústria 4.0 (Portugal), IPAR4.0 National Technology Initiative (Hungary), and Smart Industry (Netherlands), to name a few. Despite different labels, advocates of this initiative describe huge potentials for manufacturing industries. Among the promises, we can identify creating dynamic business and engineering processes, meeting individual customer requirements, facilitating optimized decision-making, and solving broader challenges like demographic change and resource efficiency (Habraken, 2020). In this volume, we have brought together high-quality articles that focus on innovative, evidence-based, cutting-edge research, case studies, new conceptualizations, and viewpoints on management in the age of Smart Industry.

Paraphrasing Huizinga et al. (2014), we emphasize the importance of a strategic vision of the future industry: a high degree of flexibility in production, in terms of product needs (specifications, quality, design), volume (what is needed), timing (when it is needed), resource efficiency and cost (what is required), being able to (fine-) tune to customer needs and make use of the entire supply chain for value creation. It is enabled by a network-centric approach, making use of the value of information, driven by Information Technologies and the latest available proven manufacturing techniques.

Another unique characteristic of this book is the combination of research conducted in divergent traditions of social sciences and engineering sciences. We need knowledge from all types of studies if we want to understand the complexity of recent developments in Smart Industry.

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Thus, Agata Leszkiewicz, Tina Hormann and Manfred Krafft discuss the impact of adoption of artificial intelligence (AI) on various stakeholders of a business-to-business organization. The cost-benefit approach allowed the authors to define the social value of AI as the combined value derived from AI adoption by a (B2B) organization with multiple stakeholders. The chapter explores further the social value of AI as the trade-off between (1) the benefits and improvements this technology brings for stakeholders and (2) the costs and concerns that arise from it. Specifically, we look at the impact of AI on (1) the internal stakeholders in the firm (e.g., executives, employees, etc.), (2) business customers, supply chain partners and competitors, and (3) society at large.

Klaas Stek takes us further in the discussion and his article claims that there is a serious gap between the intended learning outcomes in higher education and the needs of employees in Industry 4.0. His analysis shows that the history of the preceding industrial revolutions had the drawbacks of personality and character education; politicians have abused it to control societies in the nineteenth and twentieth centuries. The logic that soft skills are necessary to carry out hard skills calls for a shift towards a new type of citizenship that shapes the research question in the chapter: whether soft skills in education can lead to improved citizenship.

Sylwia Przytuła, Katarzyna Tracz-Krupa and Susane Rank continue the discussion about readiness for the impact of Smart Industry, but in the organizations, specifically – within and through the HRM function. Their chapter clarifies the state of opinion on expectations towards, and preparedness for, the impact of Industry 4.0 on human resources management and the implementation of various types of ambidexterity in these companies. By means of interviews with key HR informants from manufacturing companies operating in Germany and Poland, the authors have found that Industry 4.0 has a significant impact on HR practices. In international companies, various digital solutions in employee recruitment, development and performance have been implemented. There have also been mature examples of structural, contextual and sequential ambidexterity. Marie Molitor and Maarten Renkema investigate effective human-robot collaboration and present implications for Human Resource Management. Their research presents results of a vignette study that investigated factors affecting intention to collaborate with a robot.

Fabian Akkerman, Eduardo Lalla-Ruiz, Martijn Mes and Taco Spitters take us further on the Smart Industry road, to the field of a supply chain distribution and logistics strategy for which less-than-truckload shipments are consolidated into full-truckload shipments, also called cross-docking. The authors present results of the literature review on cross-docking literature, from 2015 up to 2020, that allows them to conclude about growing attention for Industry 4.0 concepts in cross-docking, especially for physical internet hubs (PI-hubs).

Ednilson Bernardes and Hervé Legenvre explored the nature and functioning of the inter-organizational governance mechanism underpinning an increasing number of Smart Industry initiatives. They also considered the nature and position of the technology within the broader set of technologies and the selected governance mechanisms and their relation to value capture.

The article by Devrim Murat Yazan, Guido van Capelleveen and Luca Fraccascia provides a conceptual framework about the current status and future development of smart decision-support tools for facilitating the circular transition of Smart Industry, focussing on the implementation of the industrial symbiosis practice. Based on the principles of a circular economy, the utility of such practices to close resource loops is analysed from a functional and operational perspective. For each phase of the life cycle – e.g., opportunity identification for symbiotic business, assessment of the symbiotic business and

sustainable operations of the business – the role played by decision-support tools is described and embedding smartness in these tools is discussed.

Finally, the article written by Christian Versloot, Maria Iacob and Klaas Sikkel brings us to the companies that specialize in providing an analysis of the underground. Geophysical techniques such as Ground Penetrating Radar (GPR) are harnessed for this purpose. The authors present their work to amplify the analysing GPR data by means of Machine Learning (ML). In this work, harnessing the Action Design Research (ADR) design science methodology, an Intelligence Amplification (IA) system is designed for decision-making with respect to utility material type. It is driven by three novel classes of Convolutional Neural Networks (CNNs) trained for this purpose, which yield accuracies of 81.5% with outliers of 86%. The tool is grounded in the available literature on IA, ML and GPR and is embedded into a generic analysis process.

It is not difficult to notice that all nine chapters differ in terms of the research discourse and vocabulary, research methods in case of empirical studies, and application cases (types of industry). We have learnt a great deal from these chapters and engaging in the double-blind, peer-review process for all submitted manuscripts. To our knowledge, this is one of the first volumes that have combined manuscripts that describe one increasingly influential industry phenomenon in contemporary management – Smart Industry. We are convinced that this is the way to progress in science and practice: through integration of social and engineering research, to understand, cross-pollinate, and improve the discourse through approaches that are less familiar. The challenges brought about by the COVID-19 pandemic, particularly in the area of supply chain management, magnify the importance of such multi-disciplinary approaches into the future.

We are very thankful to all the authors, who joined us in this journey to explore the complexity of Smart Industry. Now, it is our readers' turn to contribute to this ongoing conversation!

REFERENCES

Habraken, M. (2020). *Becoming smarter: A study into industry 4.0 and its job design effects*. PhD thesis, University of Twente, Enschede.

Huizinga, G., Walison, P., Bouws, T., Kramer, F., Van der Beek, H., Tops, P, … Grosfeld, T. (2014). Smart industry: Dutch industry fit for the future. Retrieved from http://www.kennisbanksocialeinnovatie.nl/nl/kennis/kennisbank/smar t-industry–dutch-industry-fit-for-the-future/1287?q=. Accessed on April 2, 2020.

Kagermann, H., Helbig, J., Hellinger, A., & Wahlster, W. (2013). *Recommendations for implementing the strategic initiative Industrie 4.0: Securing the future of German manufacturing industry; final report of the Industrie 4.0 working group*. Forschungsunion.

Pfeiffer, S. (2017). The vision of "Industrie 4.0" in the making – A case of future told, tamed, and traded. *NanoEthics*, *11*(1), 107–121.

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REFLECTIONS OF UNDERSTANDING SMART INDUSTRY

Milou Habraken

ABSTRACT

This chapter reflects on the understanding of the phenomenon known as Smart Industry, Industry 4.0, fourth industrial revolution, and many other labels. It does so by reflecting on the issue of terminology, as well as the existing diversity regarding the description of the phenomenon. The issue of meaning is addressed by assessing the results from Culot, Nassimbeni, Orzes, and Sartor (2020) and Habraken and Bondarouk (2019) which are, subsequently, used to develop a workable description. Findings from the two assessed studies raise the question of whether a workable construction of the phenomenon is to be understood as the key technologies or the distinctive developments? A question without a definitive answer, but I will present my view by taking inspiration from the manner in which the prior industrial revolutions are commonly understood. This leads to a, still multifaceted though, more focused understanding of the phenomenon. The insights, formulated proposition and developed model stemming from the reflection of terminology and meaning of the phenomenon helps move the current technology-related phenomenon forward. They assist with the establishment of well-documented papers. A critical aspect if we aim to understand how management will look like in the era of this phenomenon.

Keywords: Smart Industry/Industry 4.0; terminology; meaning; model; fourth industrial revolution; smart manufacturing

What started out as a German initiative to strengthen the competitiveness of the German manufacturing sector resulted in a global phenomenon which has received an increasing amount of attention over the past years; a development that has been documented both in words and numbers. But contradictory to its popularity, the understanding of the phenomenon is surrounded by ambiguity. For not only did the interest in the phenomenon

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grow, so did the number of labels and meanings related to the phenomenon. Given the impracticality behind this combination (i.e. popularity and ambiguity), the confusion and lack of conceptualization of the phenomenon has received attention by scholars. With a recent study being the systematic literature review by Culot et al. (2020), the authors assessed definitions for the phenomenon, that is Industry 4.0 and similar concepts, in academic as well as non-academic articles. In light of the findings from this systematic literature review, the proposition written in the dissertation by Habraken (2020, p. 136) and the importance of establishing a more stable foundation from which to work with regarding the current phenomenon, this chapter reflects on the understanding of the phenomenon from both a terminology and meaning perspective. By reflecting on noticeable issues that are at play, steps can be constructed that will help move the phenomenon forward. In other words, this chapter does not offer specifics when it comes to the question of management in the era of the current phenomenon. The combination of novelty and diversity surrounding the phenomenon makes how management will look like in this era a topic that requires time and, importantly, well-documented efforts. In contrast, this chapter offers insights that will assist with the creation of answers to the question of management in the era of the current phenomenon. It does so by reflecting on the notion of the label the fourth industrial revolution and the existing yet unnecessary diversity in labels which creates an integration challenge, both of which address terminology, and the multifacets of the phenomenon as well as the topic of workability which are both grouped under the understanding of meaning. But first the understanding of terminology is addressed.

UNDERSTANDING OF TERMINOLOGY

Made in China 2025, Make in India, Advanced Manufacturing, Smart Manufacturing, Factories of the Future, Industrial Internet, Industrie 4.0 (translations like Industry, Indústria & Pramonė 4.0), or… Smart Industry. They are all examples of, likely many more, labels that currently exist to highlight a phenomenon that is also often referred to with the term the fourth industrial revolution. Before turning to the apparent diversity, I first want to focus attention on the notion of the fourth industrial revolution.

Fourth Industrial Revolution

To start, let it be clear that the phenomenon in question can bring about fundamental changes (i.e. be disruptive). From this point of view, the terminology of a fourth industrial revolution is definitely appropriate. However, it is relevant to consider that a revolution is also tied to the concept of speed, as visible in understandings of the word 'revolution' – 'are *fast*, disruptive and destructive' (Blanchet, Rinn, Von Thaden, & De Thieulloy, 2014, p. 7) – and the word 'industrial revolution', 'a *rapid* major change in an economy…' ('Industrial Revolution', n.d.). When one takes this lens into account, the fit appears to become less suitable. The prior sentence includes the word 'appears' for, as Madsen (2019) points out, there is 'relatively little evidence on I4.0 adoption rates in different parts of the world' (p. 14). In addition, what is considered fast in this context is open to different interpretations. Consequently, a definite outcome regarding the speed of this phenomenon cannot be made. Nonetheless, available data do not hint at the phenomenon being a fast development.

For example, in 2016, two years after the introduction of Smart Industry in the Netherlands, only 15% of the respondents in a Dutch survey among entrepreneurs

indicated to have heard of the term Smart Industry (Smetsers & Borst, 2017).[1] Within the same survey conducted in 2020, still 72% of the respondents stated to never have heard of the term or, having heard of it but not knowing what it is (Vegter, Witvliet, & Reinhartz, 2020). Though it is possible that companies have Smart Industry elements in place while being unfamiliar with the terminology, this is expected to be an exception rather than the rule; especially with the phenomenon being promoted at national and regional level as well as by platforms such as the Dutch Chamber of Commerce (KvK). The fact that respondents only represent small and medium sized enterprises (SME's), that is companies up to 50 employees, in addition cannot be used as a justification for the results since firms up to 50 employees account for 99% of all Dutch businesses in 2019, according to Statistics Netherlands (CBS) (2021). They make up the bulk of the economy and must therefore be considered when it comes to the speed of the revolution. The mention of barriers for adopting Smart Industry, like lack of time and investment budget, in the 2016 and 2020 survey further signals that the phenomenon does not have the speed associated with a revolution. The presence of barriers even transcends the Netherlands as can be understood from publications like Moktadir, Ali, Kusi-Sarpong, and Shaikh (2018) or Orzes, Rauch, Bednar, and Poklemba (2018). Lastly, results predate COVID-19, excluding it as an explaining factor.

To conclude, the phenomenon does not appear to be fast or rapid. Neither should that be a goal in and of itself. Technology needs to serve a purpose, and not be introduced because it is available. However, from a terminology perspective, the applicability of the label fourth industrial revolution can be questioned when adding speed to the equation. From solely a disruption standpoint, the term is understandable. As its predecessors, the term fourth industrial revolution indicates the presence of a major change. Whether we need a separate term to stress this fact, especially with the number four embedded in labels such as Industry 4.0, is another discussion.

Diversity of Labels

Having addressed the essential distinction in the interpretation of the word revolution, I turn to the existing diversity in labels used to denote the phenomenon. For some labels the overlap with the initial, German terminology Industrie 4.0 is relatively clear and interchangeability can therefore be easily assumed. Other labels are more unique and, as a result, give the impression that the label represents something different; in other words, not related to the Industrie 4.0 phenomenon. But based on the following evidence, the distinction signalled by the use of unique labels can be considered a pretence:

> You should not bring a German term like Industrie 4.0 to the Netherlands. We don't really like German labels, it must always sound a bit English, and if you give it an original name it seems as if you invented something new. As if you invented it yourself. Then of course it is very smart to call it Smart Industry. (A quote from a Dutch Smart Industry expert; from the study discussed in Habraken & Bondarouk, 2019)

> Implementing advanced manufacturing technology services/Industry 4.0… (Sentence on the website of the National Institute of Standards and Technology, that is part of the US Department of Commerce[2])

> In response to the recent global reindustrialization tide and Germany's high-tech strategy Industry 4.0, the State Council of China announced the Made-in-China 2025 Plan in May 2015 and Both Industry 4.0 and Made-in-China 2025 focus on the new round of industrial revolution and employ manufacturing digitization, CPS, IoT, and intelligent manufacturing. (Li, 2018, pp. 67–68)

> The analysis [a systematic literature review of academic studies providing a definition of Industry 4.0 and similar concepts] underlined how very few differences among definitions can actually be explained by the label used to describe the phenomenon. (Culot et al., 2020, p. 9)

The diversity with which we are faced with today thus stems from: 1. translations of the original German label into ones native language and a more international applicable, or English, label; 2. a countries desire to create their own label or brand to denote, the countries specific approach regarding, the phenomenon that arose in Germany, and; 3. creations by companies, General Electric for instance promotes the term Industrial Internet (Evans & Annunziata, 2012). These origins are also what make the movement towards the use of a single label complicated. Countries and companies cannot simply change a promotional label which they have heavily invested in. And as long as countries and companies use their labels, so will, in all probability, the academics and consultants embedded within those countries/companies. As Habraken (2020) pointed out, the use of a single label among scholars will therefore only be established if this topic is discussed. An achievement which, given the broadness of the phenomenon (i.e. scholars from a wide range of disciplines are involved), is a challenge in and of itself. As a result, a question that arises is whether the obtainment of one label is of enough importance that it justifies tackling this huge challenge? Or, can we work with the current unnecessary diversity while at the same time reduce expected issues as much as possible, such as a lesser awareness of scholars conducting research in this domain leading to reinventions of the wheel.

Though I am in favour of the establishment of a single label, it might be better to work with the situation that has emerged. Not just because of the complexity of the challenge, but also since striving for full awareness of all domain-specific knowledge is in general – thus probably also with a single label – a difficult task to achieve given today's knowledge generation and dissemination age. It, however, does not imply that we should abandon all attempts to improve awareness and integration. To assist this, existing developments like the presence of duplicate key words (i.e. the inclusion of several of the aforementioned labels as distinct key words) could be embraced and used to our advantage. For example, we could agree on counting a certain set of words as a single key word (e.g. to see inclusions like Industry 4.0, Smart Industry and Advanced Manufacturing as one entry). This would allow the retaining of multiple interchangeable labels while facilitating knowledge transfer across diverse labels, without interfering with the limitations, often placed on the available amount of key words.

UNDERSTANDING OF MEANING

As with the number of labels, diversity is also apparent regarding the description of the phenomenon in question. But the presence of various descriptions cannot be attributed solely to the existence of a multitude of labels. First, there are multiple definitions in existence, offered by both scholars and practitioners, with respect to one label. Take for instance the prevalent label Industry 4.0. In the paper by Culot et al. (2020), it is mentioned that 42 definitions of Industry 4.0 were found in the included academic sources and six definitions in the non-academic sources assessed. Bringing the number of descriptions for the label Industry 4.0 already to 48 based only on papers included in the systematic literature review by Culot et al. (2020). Second, Habraken (2020) showed that the label Smart Industry in the Netherlands has been described differently over time, by one source. Observations that in part are due to new insights, that is, descriptions changed with new knowledge. But another reason lies in the different facets, each containing various elements, that encompass the phenomenon. It, in other words, facilitates the emergence of variations. This presence of multiple facets also explains why the phenomenon is often coined as being 'broad' and 'overarching'.