Sinergie
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Grand challenges: companies and universities working for a better society

Extended Abstracts

University of Pisa - Sant'Anna School of Advanced Studies, Pisa

September 7-8, 2020

Electronic Conference Proceedings of Sinergie - Sima Management Conference
Grand challenges: companies and universities working for a better society Pisa, 7-8 September 2020
University of Pisa - Sant'Anna School of Advanced Studies, Pisa

ISBN 97888943937-6-7

Gli Electronic Conference Proceeding sono pubblicati *online* sul portale di Sinergie Italian Journal of Management
http://www.sijm.it

Via Interrato dell'Acqua Morta, 26
37129 Verona - Italy

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Extended Abstracts

a cura di

Sandro Castaldo, Elisa Giuliani, Marco Frey e Marta Ugolini

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Al Lettore,

questo volume accoglie gli extended abstract del Convegno Sinergie-SIMA 2020, dal titolo *Grand challenges: Companies and Universities working for a better society*, Università di Pisa, Scuola Superiore Sant'Anna, Pisa, 7-8 settembre 2020.

Le società contemporanee si trovano di fronte a un bivio: da un lato i governi sono sotto pressione per raggiungere obiettivi ambiziosi di crescita economica, dall'altro tale crescita alimenta complesse sfide ambientali e sociali, parte degli obiettivi di sviluppo sostenibile, o Agenda 2030, delle Nazioni Unite. Ciò spinge verso un ripensamento del capitalismo così come tradizionalmente inteso.

Lo scopo del Convegno è di discutere del ruolo delle imprese e dell'università per affrontare queste sfide. Per quanto riguarda le imprese, un focus particolare è rivolto agli impatti positivi che esse possono esercitare sulla società e sull'ambiente attraverso varie iniziative: dagli investimenti responsabili al coinvolgimento degli stakeholder per affrontare rilevanti problematiche sociali. Altrettanto articolato è il contributo che le università possono offrire attraverso le proprie attività di ricerca, formazione e terza missione.

Gli Extended Abstract racconti in questo volume affrontano la tematica con una varietà di argomenti, punti di vista, prospettive.
Vengono altresì proposti studi e ricerche sul più ampio e generale capo del management, cui spetta un ruolo da protagonista anche al di fuori delle imprese.

Sandro Castaldo, Elisa Giuliani, Marco Frey e Marta Ugolini

Cari Lettori e Convegnisti,

il *call for paper* del Convegno Sinergie-SIMA 2020 Conference dal titolo *Grand challenges: companies and universities working for a better society* ha previsto la possibilità di presentare *extended abstract* oppure *full paper*. In totale sono pervenuti in redazione 113 *extended abstract* e 35 *full paper*.

Per gli *extended abstract*, la valutazione dei contributi ricevuti è stata operata dai Chair e dal coordinamento scientifico in base alla coerenza con il tema del Convegno e/o con gli studi di management secondo l'articolazione dei Gruppi Tematici SIMA. Sono state altresì valutate la chiarezza e la rilevanza (anche potenziale) dei contenuti proposti.

Per i *full paper*, la procedura di valutazione dei contributi è stata condotta secondo il meccanismo della *peer review* da parte di due referee anonimi, docenti universitari ed esperti dell'argomento, scelti all'interno dei soci SIMA e della comunità di Sinergie.

In particolare, nella valutazione dei contributi i referee hanno seguito i seguenti criteri:

- chiarezza degli obiettivi di ricerca,
- correttezza dell'impostazione metodologica,
- coerenza dei contenuti proposti con il tema/track del convegno e/o con gli studi di management,
- contributo di originalità/innovatività,
- rilevanza in relazione al tema/track del convegno e/o agli studi di management,
- chiarezza espositiva,
- significatività della base bibliografica.

L'esito del referaggio ha portato a situazioni di accettazione integrale, accettazione con suggerimenti e non accettazione. In caso di giudizio discordante la decisione è stata affidata ai Chair. Ogni lavoro è stato poi rinviato agli Autori completo delle schede di referaggio per la attuazione delle modifiche suggerite dai referee.

A seguito del processo di valutazione sono stati accettati 23 *full paper* e 111 *extended abstract*, pubblicati in due distinti volumi.

Tutti gli *extended abstract* di questo volume sono stati presentati e discussi durante il Convegno e pubblicati *online* sul portale della rivista Sinergie (***www.sijm.it***). Quest'anno sono anche disponibili on line i video con le presentazioni registrate dagli Autori.

Nel ringraziare tutti gli Autori per la collaborazione ci auguriamo che questo volume contribuisca a fornire un avanzamento di conoscenze sul ruolo che le imprese e l'università possono svolgere per conciliare la crescita economica e la necessità di affrontare le complesse sfide globali ambientali e sociali.

I Chair e il Coordinamento Scientifico

Marco Frey, Elisa Giuliani, Marta Ugolini, Sandro Castaldo,
Arabella Mocciaro Li Destri, Angelo Bonfanti

INDICE

Industry 4.0: challenge or opportunity for social sustainability in firms?

MICHELA PICCAROZZI* BARBARA AQUILANI•

Objectives. *The term Industry 4.0, which is currently widely used worldwide, refers to a series of technological innovations that in recent years have above all transformed industry and businesses.*

Lasi et al. (2014, p. 240) affirm that "Industry 4.0 collectively refers to a wide range of current concepts" such as for instance: Internet of Things, smart factory, cyber physical systems, new systems in distribution and procurement, new systems in the development of products and services, adaptation to human needs and also Corporate Social Responsibility.

This is a recent topic that is progressively developing in numerous fields of study, including the managerial one (Piccarozzi et al., 2018).

In this regard it is interesting to underline that a recent paper proposes a systematic literature review concerning Industry 4.0 in managerial studies and states that Industry 4.0 "[…] refers to the integration of Internet of Things technologies into industrial value creation enabling manufacturers to harness entirely digitized, connected, smart, and decentralized value chains" (Prause, et al., 2017, p. 423) able to "deliver greater flexibility and robustness to firm competitiveness and enable them to build flexible and adaptable business structures, [acquiring] the permanent ability for internal evolutionary developments in order to cope with a changing business environment" (Koether, 2006, p. 583), "as the result of a purposely formulated strategy implemented over time" (Piccarozzi et al., 2018, p. 16).

The above definition shows how the development of Industry 4.0 positively affects several important aspects and challenges in the life of firms, like global competitiveness (Mark et al., 2019), business model implementation (Gerlitz et al., 2016), supply chain (Glas and Kleemann, 2015), and also sustainability (Kagermann et al., 2013).

Indeed, sustainability, like innovation, is a key element for the management and strategies of modern businesses and a strong link exists between Industry 4.0 and sustainability (Kiel et al., 2017).

Some authors affirm that sustainability should be considered as one of the issues right at the core of Industry 4.0 strategy (Piccarozzi et al., 2018) while some others consider sustainability as one of the drivers of Industry 4.0 (Braccini and Margherita, 2018).

Even if it is true that some studies on the link between Industry 4.0 and sustainability have been developed following the triple bottom line approach including economic, environmental and social issues (Almada-Lobo, 2016; Frolov et al., 2017; Prause and Atari, 2017; de Sousa Jabbour, 2018), it is also true that Müller and Voigt (2018), for example, underline a lack of significant in-depth studies and development of literature just in this domain.

In particular, literature lacks in-depth contributions about the link between Industry 4.0 and social sustainability (Morrar et al., 2017), as also underlined more recently by Piccarozzi et al. (forthcoming) who consider this stream of literature in the start-up phase. Social sustainability can be defined as "a life-enhancing condition within communities, and a process within communities that can achieve that condition" (Mckenzie, 2004, p. 12) and, over the years, it has grown in importance just like the other pillars of sustainability (i.e., economic and environmental).

Indeed, to promote sustainable development, firms are asked to "overcome a purely economic vision, paying more and more attention to the environmental impact of their products and processes as well social issues and workers' wellbeing" (Siemieniuch et al., 2015, p. 20).

Therefore, in the current global and competitive context it is no longer sufficient to focus attention on traditional aspects of sustainability such as resources efficiency, cost and waste reduction or productivity (Rodrigues et al., 2016), but it is necessary to put the spotlight on social issues (i.e., working conditions and safety; Cherrafi et al., 2016).

This is even more important when dealing with firm innovation, in that maintaining the focus on social innovation can threaten the maintenance and development of conditions of social sustainability during innovation (Vallance et al., 2011); just think of the role workers can have in finding new ideas to innovate that are able to encompass all aspects of sustainability and especially social ones.

However, scholars have not yet reached consensus about the link between the last innovation drivers (i.e., digitalization, Industry 4.0, etc.) and social innovation. Indeed, Linkov et al. (2018, p. 1) for example affirm that "while

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Sinergie-SIMA 2020 Conference
Grand challenges: companies and universities working for a better society
7-8 September 2020 - University of Pisa-Sant'Anna School of Advanced Studies Pisa (Italy) - Online Conference

Electronic Conference Proceedings
ISBN 97888943937-6-7

DOI 10.7433/SRECP.EA.2020.01

the growth of a digital economy may increase productivity and benefit local and global economies, digitalization also raises potential sustainability challenges pertaining to social", while other authors state that Industry 4.0 can instead represent, with its innovations, an opportunity for the development of social sustainability (Rauch et al., 2019).

In this domain, the aim of this extended abstract is to map the state of the art of literature regarding Industry 4.0 and social sustainability in the domain of management studies seeking to identify some major gaps in literature. With this aim in mind, two research questions have been formulated:

- *RQ1: Which issues have authors analyzed jointly studying Industry 4.0 and social sustainability?*
- *RQ2: What kind of impact of Industry 4.0 on social sustainability do authors emphasize?*

Methodology. *This extended abstract is based on a systematic review of the literature, which is considered a rigorous methodology able to select all relevant papers pertaining to the subject matter as suggested by Transfiled et al. (2003).*

This systematic literature review was carried out from the 13th of February to the 5th of March 2020 and was organized into a series of consequential steps to collect and progressively skim the papers of interest for the topic analyzed, starting from the choice of databases.

Then, according to Newbert (2007), Merli (2018) and Sassanelli et al. (2019) the database Web of Science (WoS) and Scopus-Elsevier were chosen. Indeed, Abatecola et al. (2013) affirm that these databases represent those of greatest interest and usefulness for managerial studies.

Once the databases were chosen, the keywords for the search were selected, considering the following keywords crossed in sequence:

- *Research 1: "Industry 4.0" and "social sustainability";*
- *Research 2: "Digitalization" and "social sustainability".*

In addition to the specific word "Industry 4.0", the word "digitalization" has also been selected as it is commonly placed alongside the first as a related key word (Heng, 2014; Lasi et al., 2014; Ibbarra et al., 2018).

A total of 30 papers for Research 1 and 8 papers for Research 2 emerged at this stage.

Then, the identified papers were skimmed using ad hoc filters in the two databases to ensure focusing only on papers pertaining to business management.

The filters used were:

- *management, decision science, social science for Scopus;*
- *management for Web of Science.*

This phase returned 10 papers for the first research and 5 for the second.

Finally, the results that emerged from the databases regarding the two researches were compared in order to eliminate any duplicate papers.

In conclusion, 13 papers emerged: 9 from Research 1 and 4 from Research 2.

It is important to specify that, given the small number of papers returned by the research, no further selection of papers was made based on type of publication (i.e. only journals, proceedings or books).

All the papers were therefore selected without limiting the analysis to specific categories, in order to have the widest possible vision of the aspects analyzed.

Findings. *For clarity, results are divided into two sections.*

In the first section, the particulars of the papers were analyzed, extracting their main characteristics.

In the second section, papers were investigated in more detail to extrapolate the relevant research topics and main considerations in terms of the impact of Industry 4.0 on social sustainability.

By analyzing the characteristics of the papers, one can highlight that 10 papers are published in international journals (The Journals of Cleaner Production and Sustainability have each published 3 papers for a total of 60% of the sample), while 3 papers are included in international conference proceedings.

The geographical origin analysis establishes that Italian researchers are the most active on this subject matter. Indeed, 31% of the papers (4 papers) are published by Italian authors, followed by Indian scholars with 15% of the sample (2 papers). The remaining papers are published in Europe (38% of the sample, 5 papers between Finland, Greece, Portugal, Spain and Sweden). The last two papers (15% of the sample) come from the USA and Indonesia. The concentration of studies in Europe is normal as the Industry 4.0 term was created and developed in Germany and then spread to the surrounding countries, before having a global impact.

Another interesting feature is related to the year of publication.

Research shows that papers have been published only in the last 3 years, while the Industry 4.0 term was created in 2011) followed by a crescendo.

In particular, 3 papers (23% of the sample) were published in 2017, 4 papers (31% of the sample) in 2018 and 6 papers (46% of the sample) in 2019.

Analyzing the methodological details of the publications, there is a balance between empirical (7 papers, 54% of the sample) and conceptual (6 papers, 46% of the sample) papers

In particular, conceptual papers used the literature review methodology, while the empirical ones are divided between qualitative (5 papers, 71% of the sample) and quantitative (2 papers, 29% of the sample) papers. Among the qualitative papers 3 studies present a single-case study while the remaining 2 used multiple case methodology.

Quantitative papers, in one case, apply structural equation modeling and in the other cluster analysis and were published respectively in 2019 and 2018.

The second section of results establishes the main topics emerged in the stream of literature under analysis (please see Table 1) and then the Industry 4.0 impact on social sustainability as explained by scholars.

Tab. 1: Classification of papers main topic

Theme	***n.***	***%***
Working conditions	*8*	*62%*
Supply chain	*3*	*23%*
Governance	*1*	*8%*
Knowledge	*1*	*8%*
Total	***13***	***100%***

Source: authors' elaboration

As is clear from Table 1, most papers (8 papers, 62% of the sample) focus the analysis on the impact that Industry 4.0 innovations can have on working conditions in the workplace (Bechtsis et al., 2017; Gregori et al., 2017; Nobre et al., 2017; Kumar et al., 2018; Papetti et al., 2018; Cagliano et al., 2019; Fox, 2019; Mark et al., 2019).

Another issue that emerges and seems to attract researchers' attention is linked to the analysis of the supply chain (3 papers, 23% of the sample) (Sendlhofer and Lernborg, 2018; Djunaedi, 2019; Perez et al., 2019).

The remaining two papers instead focus on firm governance (Linkov et al., 2018) and on the role of knowledge (Kashyap and Agrawal, 2019) in the application of Industry 4.0 in a context of social sustainability.

As "working conditions" was the topic most studied it appears necessary to deepen its analysis by dividing the results into sub-topics in order to better understand the specific characteristics of the "Working conditions" (please see Table 2).

Tab. 2: Classification of "Working conditions" issues

Sub categories	***n.***	***%***
Layout	*4*	*50%*
Disability	*1*	*13%*
Productivity	*1*	*13%*
Automation	*1*	*13%*
General	*1*	*13%*
Total	***8***	***100%***

Source: authors' elaboration

The results show that half the papers focus on the working conditions of personnel involved in production plants (Kumar et al., 2018; Cagliano et al., 2019; Fox, 2019; Gregori et al. 2019)

The other 3 papers (about 38% the sample) identify other significant issues like Disability (Mark et al., 2019), Productivity (Papetti et al., 2018) and Automation (Bechtsis et al., 2017), while one paper generally speaks about working conditions without further specification (Nobre et al., 2017).

For each paper, the type of impact highlighted by the application of Industry 4.0 innovations to social sustainability was analyzed (please see Table 3).

Tab. 3: Impact of Industry 4.0 on social sustainability

Impact	***n.***	***%***
Positive	*9*	*69%*
None	*4*	*31%*
Total	***13***	***100%***

Source: authors' elaboration

Most studies (9 papers, 69% of the sample) highlight a clear positive impact of Industry 4.0 on social sustainability, while the remaining papers (4 papers, 31%) do not express any consideration of this issue. However, in none of the papers was a negative impact of Industry 4.0 application on social sustainability highlighted.

These first insights help answer the two main research questions behind this study.

RQ1: Which issues have authors analyzed when jointly studying Industry 4.0 and social sustainability?

From the analysis of the literature it is clear that, when we talk about the impact of Industry 4.0 on social sustainability, the attention is mainly focused on the "human dimension of social sustainability" (Zink, 2014, p. 35).

For instance, Cagliano et al. (2019) are certain that technology becomes an indispensable tool for the organization of work and working spaces and therefore is able to create a better environment for workers.

Gregori et al. (2017), on the other hand, highlight that smart architecture within the concept of Internet of Things factory, could positively influence social sustainability in a production site through a series of steps and tools that can monitor working conditions in factories. The authors propose a model to create factory layout using digital tools (i.e. system space virtualization or simulation on virtual maps) and periodically monitoring the well-being of workers through data acquired by sensors and direct interviews.

Bechtsis et al. (2019) focusing on some specific characteristics of the workplace, such as nuisance of noise level, vibrations and harshness in general, argue that innovation and robotics, in particular, allow the minimization of these factors which normally disturb workers, thus creating a more comfortable environment.

In addition, the application of Industry 4.0 to firms can trigger a virtuous circle in that achieving social sustainability can also lead to productivity gains.

Indeed, Papetti et al. (2018) state that innovative tools, such as the application of Internet of Things, can optimize human work and implement the quality of working conditions, contributing in this way to increasing the efficiency of the entire production system.

Even more interesting, is the paper by Mark et al. (2019) who decline social sustainability in terms of inclusion of the disabled worker.

The authors affirm that technologies are fundamental to allow the inclusion of disabled workers even in the highly technical areas of factories.

Moreover, the same authors highlighted that certain conditions are necessary for the effective achievement of social sustainability. Indeed, there are some threats that must be overcome to take advantage of Industry 4.0 implementations, like for example, the high costs for firms and the related lack of incentives by Institutions when speaking about assistance systems for people with disabilities (Mark et al. 2019).

RQ2: What kind of impact of Industry 4.0 on social sustainability do authors emphasize?

Results clearly reveal that innovations introduced by Industry 4.0 have a positive impact on social sustainability, at least at a literature review level. Contrary to what has already been mentioned in the introduction, from a study of Vallance et al. (2011), it seems that Industry 4.0 innovations are linked to sustainable development, thus they are able not to compromise the rights and environment of workers and the social condition in general.

In this sense, Mark et al. (2019, p. 1) state that "despite many fears that Industry 4.0 will lead to machines gradually replacing employees, Industry 4.0 aims much more at a human-centered production in which humans will continue to play an important role in the future".

However, it should be underlined that in none of the papers analyzed is there a precise measurement of this positive impact.

Even if it is true that some papers highlight this positive impact through the analysis of case studies (5 papers, 71% of the sample), there is no mention of specific measurement methodologies and/or parameters used and/or applied to evaluate the positive fallout of Industry 4.0 on social sustainability; this represents an important gap in literature to be considered in future studies.

Indeed, using technology pertaining to Industry 4.0, the role of human capital does not seem to suffer negative impacts.

On the contrary, these technological innovations can contribute to raising the position of the worker (Bechtsis et al., 2017; Gregori et al., 2017; Nobre et al., 2017; Kumar et al., 2018; Papetti et al., 2018; Cagliano et al., 2019; Fox, 2019; Mark et al., 2019) towards a favorable climate and respect for his particular skills.

Therefore, impacts seem to be mainly positive even if some problems must still be overcome, in some cases, taking full advantage of these positive fallouts triggered by Industry 4.0 on social sustainability (i.e. Mark et al. 2019).

Furthermore, the issue of governance should not be underestimated.

Indeed, Linkov et al. (2018) affirm that governance, both at the governmental and individual firm level, must support the integration of innovations to achieve social benefits. In fact, authors introduce the concept of "adaptive governance" permitting intervention on the potential threats that digitization could present to sustainability, making it possible to achieve the desired objectives.

Research limits. *It is necessary to point out some limitations of the research.*

Firstly, the number of databases used are a limitation of this study. Moreover, the limited number of keywords may have restricted the study presented in this short paper. Although the methodology of the systematic review of the literature is a replicable and standardizable model, at the same time some proposed assumptions are affected by the subjective analysis of the researcher.

Practical implications. *This extended abstract has theoretical and managerial implications.*

From a theoretical point of view, the paper helps to provide an initial overall view of the link between Industry 4.0 and social sustainability studied so far by scholars in an international context.

Indeed, as the review of the literature has underlined, this link has only been studied in very recent times and thus deserves more attention. In particular, some gaps in literature have emerged. Firstly, it is clear that there is no comprehensive view of how Industry 4.0 affects firm social sustainability. Indeed, the papers analyzed focus on single

aspects of this issue (i.e. situation of workers, supply chain, etc.) without proposing and/or suggesting for example how or to what extent Industry 4.0 can positively impact on social sustainability aspects while also enhancing the overall impact, thanks to existing or future relationships of social sustainability. In this same domain, further research should study possible virtuous links between firms, investors as well as universities and research centers in supporting firm transitions to digitalization having only or also a positive impact in the social sphere. In this respect, it is worth remembering that Industry 4.0 will reshape all firm environments and challenges and, in this way, will involve the entire society in developing future paths different from those of the past, like what happened with past industrial revolutions (Aquilani et al., 2019).This change in society will in turn, bring new challenges and changes in firms above all from a social point of view, because people operating in firms will ask for different working conditions, tools, etc. Literature should also focus attention on these important and unexplored issues to paint the full picture of the link between Industry 4.0 and social sustainability and vice versa, remembering that this change also involves, for example, the higher education system and research developed by institutions (i.e. Universities, research centers, etc.).

Indeed, none of the papers studied considers enhancements in social sustainability which need specific tools and/or innovations to be realized thanks to Industry 4.0; the effect and/or affect of social sustainability on Industry 4.0 development has to date been completely unexplored.

For both the above-mentioned research gaps, effects of Industry 4.0 on social sustainability and vice versa, more studies are needed above all in the empirical domain; only 2 quantitative studies have been retrieved considering only a few aspects of social sustainability.

On the other hand, costs and investments represent a critical element for the introduction of innovations linked to social sustainability, notwithstanding the fact that they are not widely investigated in literature.

From a managerial point of view, this paper can be of interest for managers and entrepreneurs to understand potential impact and benefits when applying Industry 4.0 innovations, also from a social sustainability point of view, even if difficulties and/or application problems (i.e. costs, governance aspects) must also be carefully taken into account.

Future research steps should consider the inclusion of other databases and/or search engines and other keywords related to the subject in order to widen the research at a desk level and refine the literature review presented in this extended abstract. Then, a framework regarding positive fallouts of Industry 4.0 on social sustainability could be created and tested, first thanks to multiple case studies and then seeking to create some measures or standards to evaluate the real achievement and improvement of social sustainability through Industry 4.0 implementation. After this stage it would be possible to complete a first picture on this subject matter also considering investments towards a respectful implementation of Industry 4.0 considering social innovation issues not only in terms of costs and/or investments, but also in terms of activities, worker involvement actions, etc. On completion of this research, managers would have a useful framework to choose activities that best suit their needs, given the specific nature of their firm and awareness of the necessary costs and/or investment, thus also paying sufficient attention to their budget.

Originality of the study. *The study proposes an initial overall analysis of the main aspects of Industry 4.0 and social sustainability and, thus far, represents the first systematic review of the literature on the topic.*

This research provides some initial considerations on the impact of Industry 4.0 on social sustainability from a managerial perspective, highlighting the positive effects but also the potential difficulties and/or problems for the achievement of their sustainable development objectives.

Key words: *Industry 4.0, social sustainability, systematic literature review, impact, sustainable development.*

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