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Towards a new society: Solving the dilemma between Society 5.0 and Industry 5.0

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Abstract. Along with the technology development, new theoretical concepts are born continuously. Nowadays, given the challenges societies are facing (e.g., climate change, digitalization), an agreement on the meaning of concepts we want to build our societies on has never been more crucial. We have been living in Industry 4.0, and a new society is now approaching, grounded in two new conceptual perspectives: Society 5.0 and Industry 5.0. The level of common ground shared by these two new terms is not clear. On the one hand, they might be referred as synonyms, whereas on the other some differences are evident, as Society 5.0 seems to be related more to the human sphere, while Industry 5.0 seems to be more industrial-centered. A clarification is deemed mandatory. Therefore, the present article consists in a literature review, with the aim of clarifying which are the main commonalities and differences between Society 5.0 and Industry 5.0. 170 potentially relevant articles were found on Scopus, and 40 were analyzed by the authors, based on criteria such as language, relevance, and type of publication. For each article, the definition of Society 5.0 and Industry 5.0 was identified and analyzed. Finally, the definitions were compared and conclusions on the predominance of similarities over differences between the two concepts were drawn. With the present work, the authors took stock of the actual society, and give final indications on which studies are needed in the future.

Keywords: Society 5.0, Industry 5.0, Human, Technologies, Innovation

1 Introduction

With the constant improvement of technology, humanity has always had to adapt continuously to build a better society with cutting-edge industrial production processes. Humanity is now facing the Era of Industry 4.0 and the results of the adoption of the new technology provided by it will be shown no earlier than 2020-2025 [1].

In the last period, to be precisely in 2016, the concept of Society 5.0 was born. In 2016, the Japanese Government coined the concept of ‘Society 5.0’ as future society that Japan should aspire to. It follows the hunting society (Society 1.0), agricultural society (Society 2.0), industrial society (Society 3.0), and information society (Society 4.0). Society 5.0 is expected to achieve a high degree of convergence between cyberspace (virtual space) and physical space (real space). While Industry 4.0 is dealing with the future of industry, Society 5.0 focuses on a more Human-centered society [2].

The concept of Society 5.0 aims to create a smart society, in which the integration of cyberspace and the real world using state-of-the-art technologies helps different sectors, countries, and regions to cooperate with each other in such a way as to achieve the goals of sustainable development [3].

Society 5.0 is a new type of society where innovation in science and technology occupies a prominent place, with the aim of balancing social and societal issues that need to be solved, while ensuring economic development [4].

Together with Society 5.0, the term Industry 5.0 was coined. Industry 5.0 was first introduced on December 1st, 2015, in an article published by Michael Rada with the reference to the social network LinkedIn. Industry 5.0 is the efficient use of machines and people labor in a synergistic environment [5].

In the past industrial revolutions, Industry 1.0 introduced waterpower and steam power, Industry 2.0 introduced mass production system enabled through electrical power, Industry 3.0 created significant advancement through digital and electronic devices, and Industry 4.0 provided significant applications by using the cyber system, artificial intelligence (AI), Internet of Things (IoT), and other advanced technologies [6].

Industry 5.0 refers to the integration of physical and virtual space to solve not only production problems, but also the social ones. Indeed, all advanced information technologies, artificial intelligence, augmented reality and robots are used in everyday life, industry, healthcare, and other areas of human activity [1].

The term of Industry 4.0 was firstly introduced in 2011 by the German Government with the aim to achieve a high degree of technology improvement. At the same time, in America, the concept of Smart Manufacturing was born, which is described as the German Industry 4.0. The two terms, Industry 4.0 and Smart Manufacturing, have the same characteristics, but they were born in two different countries.

This literature review is poised to understand and clarify if the two new concepts, Society 5.0 and Industry 5.0, have the same characteristics in order to avoid managing the two terms differently in the future, similarly to what happened for Industry 4.0 and Smart Factory. In fact, the meanings of Society 5.0 and Industry 5.0 could be misled, with the former seeming more human-centered and the latter more industrial and centered on processes.

Therefore, the authors provide an analysis of several characteristics of Society 5.0 and Industry 5.0. In particular, five categories were defined: "Definition" (i.e., how the two concepts are defined), "Focus" (i.e., why we need to change Society or Industry), "Enabler" (i.e., which technologies or factors have a direct impact on the development of the two perspectives), "Benefits" (i.e., which are the benefit of the two concepts), and "Barriers" (i.e., which limits hinder the technological progress).

The article is divided into four sections. First, the methodology through which the literature review was conducted will be illustrated. Secondly, the results pertaining differences and commonalities between Society 5.0 and Industry 5.0 along the abovementioned categories will be presented. Thirdly, the results will be interpreted, and some conclusions on the overlap between Society 5.0 and Industry 5.0 will be drawn. Finally, the authors will provide indications on future research directions.

2 Methodology

As anticipated in the introduction, the article consists in a literature review. Thus, the purpose of the present work is to critically evaluate important literature in a specific field meticulously (i.e., Society 5.0 and Industry 5.0). Indeed, this article is not just listing the contents found in the literature, but it focuses the attention on which methods the studies used. The methods through which this purpose was achieved will be illustrated for the sake of transparency and repeatability.

Firstly, two key research questions were strictly related to the definition of Society 5.0 and Industry 5.0 (i.e., “What is Society 5.0?” and “What is Industry 5.0?”). Furthermore, two additional key questions aimed at investigating the barriers/challenges for the development of both concepts (i.e., “Which are the barriers of Society 5.0?” and “Which are the barriers of Industry 5.0?”). In contrast, the authors added two more questions in order to point out which benefits could emerge with the realization of the two concepts (i.e., “Which are the benefits of Society 5.0?” and “Which are the benefits of Industry 5.0?”). Finally, the last two key research questions regarded the enabling technology/resources capable to create such concepts, (i.e., “Who and which enablers permits to reach Society 5.0?” and “Who and which enablers permits to reach Industry 5.0?”).

In order to obtain the articles and expand the literature, the research was conducted using Scopus as database. Future research will include other important search engines (e.g., Web of Science, IEEE Xplore, Taylor and Francis, Emeralds). The key words researched were “Society 5.0”, “Industry 5.0”, “Society 5.0” AND “Industry 5.0”, “Society 5.0” AND “Enabler”, “Industry 5.0” AND “Enabler”.

The total amount of articles found using these key words were 170. A significant percentage of the articles found were “Conference papers”. This is understandable, since these two concepts were born very recently. The authors tried to consider more journal articles, since they pass through a rigorous review analysis before being published in a journal and for this reason are more reliable. The total number of articles found were 39 (19 using “Society 5.0” key word and 20 using “Industry 5.0” key word). Amongst these 39 articles, only 34 were considered useful for this study. The others were excluded because of linguistic barriers (i.e., languages unknown to the authors) or because they were irrelevant to the purpose of the present study. No timeframe was specified in the criteria of the research and the first article found was published in 2018, with the majority of the other articles published in 2020 and 2021. Most of the articles were written by scholars and academics from Asian university, followed by American and European scholars and academics.

2.1 Analysis

The analysis conducted is poised to understand the main concepts regarding “Society 5.0” and “Industry 5.0” described in each article. The authors extrapolated the relevant information needed from all the articles considered. This was done in order to compare the main concepts of all the articles and, consequently, to find commonalities and differences.

The authors organized all the information in several main categories in order to critically evaluate them. The categories defined by the authors were the following:

- the *Definition* of Society/Industry 5.0 was extrapolated in order to understand the idea behind the concepts.
- *Main focus* of the two concepts (e.g., human, machines, technologies, social issues).
- *Enablers* concerned the factors which could permit to achieve the technological development.
- *Nationality focus*, regarded the possibility for the implementation of Society/Industry 5.0 to be cultural-specific (i.e., developed in a specific region or with some cultural constraints).
- *Benefits* included any advantage that each concept could bring to humankind and industrial development.
- *Differences* and *Commonalities* between Society/Industry 5.0 and Industry 4.0 were also defined.
- *Barriers and challenges* which could hinder the transition to Society 5.0 and Industry 5.0.
- *Maturity level* of the concept.

This article considers only five categories from those mentioned before: “Definition”, “Focus”, “Enablers”, “Benefits”, and “Barriers”. The other categories will be analyzed in future studies.

3 Results

This section is divided into six subsections describing the type of research design and all the categories abovementioned. The subsections are as follows: 3.1 “Type of studies”, 3.2 “Definition of Society 5.0”, 3.3 “Definition of Industry 5.0”, 3.4 “Focus”, 3.5 “Enablers”, 3.6 “Benefits”, and 3.7 “Barriers”.

3.1 Type of studies

Articles related to Society 5.0. The total number of articles found on Scopus using the key word “Society 5.0” were 19, but only 17 were useful to the study. Amongst these 17 articles, 13 were literature reviews and the remaining were experimental, analysis and survey research. The main topics of all the articles were related to understand the positive effects of technological development to optimize and improve the healthcare system [7, 8], to solve social issues [9], to improve the quality of education [4, 10], to create a sustainable environment [2, 11–14], and to understand how a high-tech environment can influence the working conditions [15]. All the articles considered were published in the time frame 2019-2021.

Articles related to Industry 5.0. The total number of articles found on Scopus using the key word “Industry 5.0” were 20, but only 17 were useful to this study. Amongst these 20 articles, 9 were literature reviews, 1 experimental study, 3 case studies and 4

survey research. The topics of the articles were related to the analysis of improvements that could be generated by Industry 5.0 to the healthcare system [6, 16], how the technology development could optimize the industrial sector [1, 17–25], in which way the marketing sector could benefit from the Industry 5.0 revolution [26], the level of education needed with the realization of the new concept [27], and the impact of the new perspective on the supply chain segment [28]. The articles were published in the time frame 2018-2021.

3.2 Definition of Society 5.0

In order to understand the commonalities amongst all the articles, the authors collected and analyzed the definitions of Society 5.0.

Table 1. This table contains all the definitions of Society 5.0.

Author(s), Year	Article	Definition
Sarfraz et al., 2020	Is covid-19 pushing us to the fifth industrial revolution (Society 5.0)?	Bridge Human / Machine
Liliasari et al., 2019	Innovative chemistry education: An alternative course models in the disruption era.	Integration between physical space and cyberspace
Cook et al., 2021	Insight into the millennial mind-set: Impact of 4IR and Society 5.0 on the real estate, construction and other industries.	Extension of networks, Increased digitisation and connectedness
Sołtysik-Piorunkiewicz and Zdonek, 2021	How Society 5.0 and Industry 4.0 Ideas Shape the Open Data Performance Expectancy.	Integration between physical space and cyberspace
Wolniak and Skotnicka-Zasadzien, 2021	Improvement of Services for People with Disabilities by Public Administration in Silesian Province Poland.	Integration between digital and real space
Fachrunnisa et al., 2020	Spiritual welfare creation for knowledge workers in society 5.0 a conceptual model.	Social resolution between virtual and actual world through harmony
Polat and Erkollar, 2021	Industry 4.0 VS society 5.0	Aims to use all advanced technologies on behalf of social life of society
Hysa et al., 2021	Social Media Usage by Different Generations as a Tool for Sustainable Tourism Marketing in Society 5.0 Idea.	Integration between physical space and cyberspace
Udin et al., 2021	Developing Interactive Mobile Mathematics Inquiry to Enhance Students' Mathe-	Sinergy between Human and Technol-

	atics Problem-solving Skill.	ogy
Carayannis et al., 2021	Known Unknowns in an Era of Technological and Viral Disruptions— Implications for Theory, Policy, and Practice.	Bridge Human / Machine and Integration between physical space and cyberspace and Human / Robot interaction
Nomura and Miyata, 2020	Digitization of the approach to food and nutrition respecting individual health values.	Data-driven Society
DeWit et al., 2020	An integrated approach to sustainable development, National Resilience, and COVID-19 responses: The case of Japan.	Integration between physical space and cyberspace
Gurjanov et al., 2020	The smart city technology in the super-intellectual Society 5.0.	Integration between physical space and cyberspace
Kojio, 2020	Sustainable Workplace in Kyoto – ‘Kyo-sei’ in Society 5.0.	Integration between physical space and cyberspace

From the analysis of all the definitions it seems evident that Society 5.0 is perceived as an environment in which there is the integration between the physical and cyber space. Furthermore, in each article there is a particular label with which Society 5.0 is defined. In the articles [7, 12, 14, 29, 30] this new concept is labelled as “Super-smart Society”, in the articles [2, 8, 9, 11, 14, 29, 31, 32] Society 5.0 is defined as “Human-centered Society”, in the article [33] the new concept is defined as the “Era of Digital Society”, and in the articles [4, 12, 34] Society 5.0 is described as based on knowledge and it is defined as “Society of Intelligence” or “Superintelligent/Superintellectual Society”.

It is evident from the literature that the main focus of Society 5.0 was the human. In particular, the aim of Society 5.0 is to solve various social and economic challenges through technology development [35].

3.3 Definition of Industry 5.0

In order to understand the commonalities amongst all the articles, the authors collected and analyzed the definitions of Industry 5.0.

The definitions of Industry 5.0 are similar to those related to Society 5.0. In most of the articles the characteristic of Industry 5.0 is the interaction between human and machines, as in the Society 5.0 with the integration of real (human) and cyber (machine) space. Unlike for Society 5.0, in the articles related to Industry 5.0, there were few labels which identified the Industry 5.0 concept. Only in 3 articles there was the presence of a specific label: in the article [6] Industry 5.0 is referring to a “Smart factory”; in the article [26] there is a conceptualization of Industry 5.0 as a “Society

founded on super smart people”; and in the article [27] Industry 5.0 is called “Super smart society”.

Table 2. This table contains all the definitions of Industry 5.0.

Author(s), Year	Article	Definition
Gopalakrishna Pillai et al., 2021	COVID-19 and hospitality 5.0: Redefining hospitality operations	Human cyber physical system
Carayannis et al., 2021	Known Unknowns in an Era of Technological and Viral Disruptions—Implications for Theory, Policy, and Practice	Renewed human centric industrial archetype
Carayannis et al., 2021	Smart Environments and Techno-centric and Human-Centric Innovations for Industry and Society 5.0: A Quintuple Helix Innovation System View Towards Smart, Sustainable, and Inclusive Solutions	Renewed human centered / human centric industrial paradigm
Javaid et al., 2020	Industry 5.0: Potential applications in COVID-19	Smart factories
Javaid and Haleem, 2020	Critical components of Industry 5.0 towards a successful adoption in the field of manufacturing	Cooperation between human beings and machines to meet customer requirements
Carayannis et al., 2020	Towards Fusion Energy in the Industry 5.0 and Society 5.0 Context: Call for a Global Commission for Urgent Action on Fusion Energy	Renewed human centered / human centric industrial paradigm
Dewi et al. 2020	Purchase Intention of Green Products Following an Environmentally Friendly Marketing Campaign: Results of a Survey of Instagram Followers of Innisfree-Indonesia	Society as containing super smart people
Özdemir and Hekim, 2018	Birth of Industry 5.0: Making Sense of Big Data with Artificial Intelligence, “The Internet of Things” and Next-Generation Technology Policy	Evolutionary, incremental advancement that builds on the concept and practices of Industry 4.0. Smart community, collaboration between people and smart technologies to take over on repetitive tasks integrating human creativity
Wasono Mihardjo et al., 2019	Boosting the Firm Transformation in Industry 5.0: Experience-Agility Innovation Model	

Nahavandi, 2019	Industry 5.0—A Human-Centric Solution	Robots are intertwined with the human brain
Jan et al., 2020	A Lightweight Mutual Authentication and Privacy-preservation Scheme for Intelligent Wearable Devices in Industrial-CPS	The digitalization, automation and data exchange of industrial processes
Martynov et al., 2019	Information Technology as the Basis for Transformation into a Digital Society and Industry 5.0	The efficient use of machines and people labor in a synergistic environment
Martynov et al., 2019	The Use of Artificial Intelligence in Modern Educational Technologies in the Transition to a Smart Society	Super smart Society
Pathak et al., 2019	Fifth revolution: Applied AI & human intelligence with cyber physical systems	Emphasize interaction between humans and machines

3.4 Focus

This section presents the key points on which both Society 5.0 and Industry 5.0 concepts are built, highlighting the common characteristics and the expressions frequently used.

Society 5.0. From the analysis it is evident that Society 5.0 is poised to create new values and solve social problems through advanced technologies [36], indeed 8 out of 17 articles focused on the benefit to solve social issues by transforming the actual Society into the new Society 5.0. Other important key points frequently used in the articles were “Economic development”, “Sustainable development”, and “Increase efficiency”.

Industry 5.0. In the articles related to Industry 5.0, the most important key points for the technology development were: first of all, “Company sustainability”, because, in contrast to Industry 4.0 which focused on production, Industry 5.0 provides a perfect solution to save the environment with the use of advanced digital technologies [18, 32]. Another relevant point was that the integration of new technologies with humans can change the production focus, shifting from a “mass production” process to a “mass personalization” process with the consequent benefit on “value co-creation” by means of customer involvement [25]. Other terms on which most of the articles focused were “Increase efficiency”, “Increase safety” and “Reduce waste” within the company boundaries. Furthermore, there were few articles regarding “Social value”.

3.5 Enablers

Society 5.0. In order to transform the actual society into Society 5.0, there is the need to improve and develop new technologies. Indeed, in most of the articles it was emphasized that “Artificial Intelligence”, “Internet of Things”, and “Robots”, with the support of “Big Data”, could facilitate the transition towards the new society. Society 5.0 is the society where advanced IT technologies (Internet of Things, Artificial Intelligence, Robots) are aggressively used in peoples’ life, industry, health care, and other provinces of activity not for the progress, but for the advantage and convenience of each person [37].

Industry 5.0. The enablers of Industry 5.0 were similar to those of Society 5.0. The frequent expressions were “Big Data”, “IoT”, “Artificial Intelligence”, and “Robots”. Other expressions used in few articles were “Automation” and “Blockchain”. IoT in industry 5.0 (as, indeed, in Industry 4.0) should not be the technology for the sake of technology, but it should be aimed at improving the quality of human life [38].

3.6 Benefits

Society 5.0. It was evident that the benefits were human-centered. Indeed, most of the articles highlighted the positive impact of the future transition on humanity. The goal of Society 5.0 is to create a society centered on the human being, where both economic development and the resolution of challenges of social issues are achieved and people can enjoy a high quality of life, life to the full, fully active and comfortable [37]. Another important benefit is to make life easier for the increasing elderly population [30].

Industry 5.0 In most of the articles it was highlighted that the transition towards Industry 5.0 could have a positive impact on the involvement of Human’s creativity. The rise of the fifth revolution tends to a new human machine symbiosis, which distributes work in humans and machines. This partnership between human and machines allows human to concentrate on more creative work enhancing creativity and critical thinking skills, and machines should be left for mundane tasks [18, 25].

3.7 Barriers

Society 5.0. What was found in the articles it was not particularly helpful for the study, since only few of them described which barriers could prevent the realization of Society 5.0. From the limited information extrapolated from the articles, it was evident that the lack of funding, adequate managerial measures (e.g., healthcare sector) and skilled technological support were potential limitation for the successful application of technological tools of Society 5.0 [7]. Other obstacles to establish and harmonically develop the Society 5.0 were the low level of civilian activity, which prevented the progressive ideas new economic model implementation in all places,

and business absence of desire to support financially the technologies of clear social application [34].

Industry 5.0. For Industry 4.0 the barriers were related to “Ethical issues”, “Skilled Worker”, “Cost”, and the delay of Industry 4.0 concepts development. Autonomously controlling production lines require a great deal of artificial intelligence applied in the software agents operating in the factory. This created concerns about how autonomous systems can incorporate ethical principles, and that ethical behavior in autonomous systems must be subject to verification and validation [23]. Fifth revolution demands high skilled people and robots working together to create personalized products, services and experiences [25].

4 Discussion

Society has always adapted to the exponential technology development. In the last few years, new definitions of society and industry emerged, such as Society 5.0 and Industry 5.0.

This study consisted in a literature review, and it is poised to find commonalities and differences between the two definitions. Industry 5.0 was firstly introduced in 2015 by Michael Rada [5], whereas Society 5.0 in 2016 by the Japanese Government [2]. The current work researched articles only on Scopus, and the articles found were published no prior to 2018. This consists in a limit, and future research will include other search engines.

From the literature is evident that Society 5.0 and Industry 5.0 are defined as the integration between real space (composed by humans) and cyber space (composed by machine). Indeed, both highlight the importance of human-machine interaction. Furthermore, both Society 5.0 and Industry 5.0 refer to a “Smart Society”, meaning that the two concepts are human-centered. Both are built on the same technologies, “IoT”, “Artificial Intelligence”, “Robots”, “Big data”, and the focus is to increase sustainability, to increase efficiency and to involve more the human in the production process, to, on the one hand, foster human’s creativity and on the other, to shift from a mass production to a mass personalization which could cover all customer satisfaction gaps with a consequent improvement of people’s lives.

Part of the current debate refers to the potential overlap between Industry 5.0 and Industry 4.0. In this regard, the authors propose that, although the concepts are indeed interlaced, they can be differentiated. As represented in Fig. 1, Industry 4.0 is the typical factory that is more machine-oriented and does not give an important role to the human worker (i.e., smaller industry icon in Fig. 1). Industry 5.0 includes Industry 4.0, with the difference that it is more human-focused because there is the need to reintegrate the human’s creativity throughout the whole industrial process (i.e., bigger industry in Fig. 1). Both the concepts are embedded in Society 5.0, which can be defined as an environment in which everything is connected, characterized by a human-centered perspective (i.e., circle in Fig. 1).

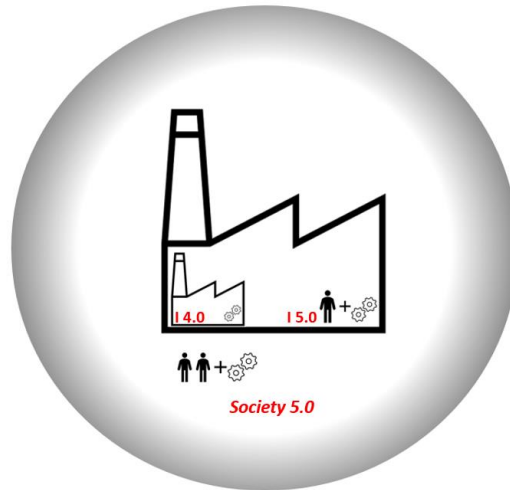


Fig. 1. Visual representation of the concepts of Industry 4.0, Industry 5.0 and Society 5.0. The smallest one is the representation of Industry 4.0 with the focus on the gear (machine). Industry 4.0 is embedded in the Industry 5.0 concept which shifts the attention towards the Human involvement (importance of creativity). The last one is the representation of Society 5.0 which embeds all the perspectives into society.

5 Future research

Society 5.0 and Industry 5.0 are newborn concepts; therefore, it is necessary to run more studies in order to improve our knowledge. What is particularly necessary is to design studies on the pros and cons of the two concepts, in order to make more visible and evident that the two terminologies are referring to the same concept, and in particular Society 5.0 is more human-centric embedding the Industry 5.0 perspective as well. Furthermore, what should be investigated is the cost to make all these efforts, because in all the articles found there was not any information about implementation cost which is the first constraint an innovative solution has to deal with. What is impeding the actual society to shift towards Society 5.0 / Industry 5.0 is the fact that Industry 4.0 will be able to show its results and achievements no earlier than 2020-2025 [1, 32]. Since the actual society is in the time interval 2020-2025, and the main achievements of Industry 4.0 are occurring now, there is the urgency to find a new perspective [39].

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