Open Innovation and Industry 4.0: the new frontiers for value co-creation?

<Industry 4.0 and digital transformation>

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ABSTRACT

Purpose – Innovation and Information and Communications Technologies (ICTs) are new levers on which act for redesigning social and economic relations and structures. The technology shifts produce disruptive effects on business models, having revolutionary impacts on internal growth strategies for the future of manufacturing. Joining the vibrant debate about the role of Innovation and ICTs in ensuring companies' viable survival, the paper aims at investigating Open Innovation and Industry 4.0 using an interpretative framework rooted in Service and Systems research highlighting new opportunities to advance knowledge about value co-creation.
Methodology/approach – A brief literature review on Open Innovation and Industry 4.0 is conducted using the interpretative lens provided by the Service and Systems perspectives. A deductive approach is adopted for interpreting key processes of Open Innovation and Industry 4.0 as drivers for enhancing value co-creation.
Findings – The findings direct to identify Technology Readiness, Cognitive Alignment, Collaborative Orientation, and Shared Strong Beliefs as possible drivers that enhance the value co-creation potential created by Open Innovation and Industry 4.0. A framework of synthesis is outlined that can represent a useful reference for exploiting the value co-creation opportunities of Open Innovation and Industry 4.0.
Research implications/limitations – The paper contributes to the multi- and inter- disciplinary research stream aimed at overcoming the limitations of a still dominant reductionist view by adopting systems approaches. Analyzing Open Innovation and Industry 4.0 as potential paths for addressing future evolutions in value co-creation studies, the paper enriches previous managerial researches. Nevertheless, the work is currently a preliminary study mainly directed to share ideas and views within the multi-perspective context of the Naples Forum on Service.
Practical implications – Valorizing the opportunities for value co-creation linked to Open Innovation and Industry 4.0 practices, the paper provides decision makers with a road map for better understanding and managing critical drivers for effectively implementing value co-creation logics.
Originality/value – The paper enriches the ongoing debate about Open Innovation and Industry 4.0 providing new insights through the interpretative lens of the Service and Systems perspectives that highlight the great potential for value co-creation linked to these new technologies.

Keywords – Open Innovation; Industry 4.0; Value co-creation; Systems perspective; Service perspective.

Paper type – Conceptual

Introduction

As a result of the third industrial revolution (Rifkin, 2011) also known as the digital revolution (Dreyer *et al*., 2006), the attention in the management of Information and Communication Technologies (ICTs) has rapidly grown (Spanos et al., 2002; Del Giudice *et al*., 2016; Caputo & Walletzký, 2017).

Both scholars and practitioners have focused the attention on the key features of ICTs as drivers for firms' value (Southern & Tilley, 2000; Johannessen, & Olsen, 2010), on their impacts on social and economic configurations (Miller, 1987; Sweet, 2001; De Jong *et al*., 2014), and on the possible approaches for maximizing the advantages offered by the ICTs (Takahashi & Vandenbrink, 2004). All these contributions have enriched the managerial and organizational domains with powerful concepts usually developed through the building of multi- and trans-disciplinary research paths (Van Grembergen, 2004).

Among the recent outputs of the ongoing debate about the digital revolution, important advancements have been made in the domains of Artificial Intelligence (Elam & Konsynski, 1987; Brodie & Mylopoulos, 2012), Big Data (McAfee *et al*., 2012; Caputo *et al*., 2017), and Virtual reality (Nilan, 1992; Bell *et al*., 2001). These relevant advancements, however, seem to approach ICTs as 'tools' for increasing firms' performance and/or users' satisfaction (Barrett *et al*., 2015). Essentially, the prevalent approach is oriented to exploit new opportunities offered by the ICTs in consolidated domains (Misuraca & Viscusi, 2015). As a consequence, the more powerful potentialities of ICTs to catch and support the emerging social and economic dynamics and trends are not well understood (Ali *et al*., 2018).

With the aim to propose an enlargement (or better, an 'upgrade') of the view of the role of ICTs in a radically changing social and economic world, the paper adopts the interpretative lens provided by Systems thinking and Service logic for highlighting how ICTs are radically changing the actors' roles, perspectives, and behaviors in social and economic relationships and interaction. In this direction, the wide domains of Open Innovation (Chesbrough, 2006; Chesbrough *et al*., 2006; Del Giudice & Della Peruta, 2013; Santoro *et al*., 2018) and Industry 4.0 (Brettel *et al*., 2014; Lasi *et al*., 2014; Scuotto *et al*., 2017) are analyzed as examples of an emerging new logic in the relationships between socio-economic actors and technologies (Caputo *et al*., 2019).

In particular, our view of the role of Open Innovation and Industry 4.0 reflects a change in perspective from the technological and technical level to the changes introduced by these new technologies to the way interaction occurs thanks to these innovations. More specifically, we look at these new technologies as 'second order' changes, which are those that Watzlavick et al. consider changes "whose occurrence changes the system itself" differently from 'first order' changes that are changes "that occur within a given system which itself remains unchanged" (Watzlavick *et al*., 1974: 10). In other words, we see the revolutionary impact of the Open Innovation and Industry 4.0 new technologies in that they enable radically new ways of conceiving and implementing organizations and their functioning, which potentially impact on the *methods* and not only on the technical and the technological level of systems. In such a change, we envision new opportunities for value co-creation that would greatly benefit from the introduction of Open Innovation and Industry 4.0 technologies in the way service systems work e4specially in networked configurations up to ecosystems (Barile et al., 2016; Reynoso et al., 2018). In fact, impacting on the way interaction occur, these new relational environments promise to enhance the value co-creation potential of knowledge resources integration. On the other hand, the introduction of these new technologies, in that they imply radical changes, implies also new access requirements on the part of the actors interacting in the system. Accordingly, the study is aimed to investigate such requirements in order to identify new drivers for value co-creation.

Thus, the paper contribution to the ongoing debate about the role of ICTs in the emerging world aims to be threefold. First, the paper enriches previous contributions about ICTs management providing new insights in the light of systems and service perspectives. In this light, the role of ICTs

in systems' survival and its contribution to favoring the emergence of a value co-creation logic are discussed. Second, a set of key concepts such as Technology Readiness, Cognitive Alignment, Collaborative Orientation, and Shared Strong Beliefs are identified for supporting the understanding the enhanced opportunities of value co-creation in the digital world. Third, the paper envisions a radical change in approaching the ICTs role as a driver of value co-creation able to promote the emergence of a new interaction logic that promises to reshape the configurations of economy and society not simply impacting on the efficiency of consolidated socio-economic models but also creating new ones.

The paper is structured as follows. A brief outline of the theoretical background is presented for explaining the interpretative contributions provided by Systems and Service perspectives in understanding the impact of the ongoing digital revolution and for depicting the domains of Industry 4.0 and Open Innovation. After this, a concise interpretative framework is outlined for evaluating the role of Open Innovation and Industry 4.0 in supporting the emergence and development of value co-creation logics in the business domain. Finally, the main implications of the interpretative proposal, preliminary conclusions, and possible future directions for research are discussed.

Theoretical background

Re-reading Digital Revolution in the light of the Service and Systems perspectives

Digital revolution is commonly recognized as a widespread phenomenon that is radically changing social and economic dynamics (Dreyer et al., 2006; Helbing, 2015). Among the multiple research streams and disciplines that have payed attention to the several dimensions involved in the challenging domain of digital revolution, interesting contributions have been provided by computer science (Ensmenger, 2012), cognitive sciences (Bennett et al., 2008; Varela *et al*., 2017), and marketing studies (Kannan, 2017) among the others. All these domains have investigated digital revolution adopting a reductionist view interested in explaining specific dimensions such as technical contents (Van Tassel, 2006), security management (Van Tassel, 2006), and ethical issues (Reamer, 2013) for contributing to the definition of the articulated phenomenon of digital revolution.

Despite the interesting and relevant advancements in knowledge offered by all these contributions, a more holistic view for understanding, describing, and managing the ongoing Digital Revolution seems to be still missing (Mårtensson, 2000; El Sawy *et al*., 2010).

According to Demirkan *et al*. (2016), "digital revolution is rapidly transforming the fundamental nature of a wide range of public and private organizations and revitalizing their digital business models across industries" (p. 16). Accordingly, digital revolution can be considered as a disruptive change able to modify structure and dynamics of every organized entity.

In such a direction, the study and understanding of digital revolution require to investigate its impact on the nature and dynamics of organized entities. On the point, useful indications can be provided by systems thinking and, specifically, by the Viable Systems Approach (*VSA*) as metalevel interpretative methodology interested in supporting understanding and explanation of both structure and dynamics of organized entities (Golinelli, 2010; Barile & Saviano, 2011; Barile & Polese, 2011; Polese *et al*., 2011; Barile *et al*., 2012, 2014; Saviano *et al*., 2017; Di Nauta *et al*., 2018).

As stated by the studies rooted in *VSA*, any organized entity interested in surviving over the time can be considered as a viable system and analyzed using the same interpretative frameworks (Barile *et al*., 2016; Calabrese *et al*., 2018). This basic assumption offers the opportunities for analyzing all the actors interested by digital revolution (firms, citizens, consumers, nations …) using the same interpretative lens (Barile & Saviano, 2011).

Adopting the interpretative lens provided by the *VSA*, the digital revolution can be considered as a homeostatic process through which socio-economic configurations are searching new balances as the results of radical changes produced by multiple events such as the globalization. Accordingly, digital

revolution can be considered the process through which social and economic relationships are restructured for ensuring a more efficient satisfaction of existing needs and/or the satisfaction of emerging needs thanks to the support provided by ICTs (Barile & Polese, 2010; Caputo & Walletzký, 2017). This latter point emphasizes the existence of a defined digital environment within new relationships produced by the digital revolution are possible only in the case in which involved actors can and want to use the ICTs. In this view, actors endowed by a low level of *Technology Readiness* as "people's propensity to embrace and use new technologies for accomplishing goals in home life and at work" (Parasurman, 2000: 308) are intrinsically excluded by the digital revolution dynamics and they can only suffer them (Mark & Semaan, 2008).

Following the discussion related to the dimensions of digital revolution that can be underpinned in the light of *VSA*, it is needed to recall that viable systems interact as a consequence of their ability and willingness to build conditions for reciprocal understanding (Barile and Saviano, 2013; Barile *et al*, 2014; Tronvoll *et al.*, 2018). Accordingly, the increasing number of connections that are possible as a consequence of the digital revolution cannot be considered as a source of value for involved actors because only a part of these connections became relationships and only a part of these relationships can contribute to value creation based interaction for involved actors. This possibility depends on the existing level of *Cognitive Alignment* in terms of compatibility and complementarity among involved actors' interests, beliefs, needs, and aims (Nooteboom, 2006a, 2006b; Corsaro & Snehota, 2011; Barile and Saviano, 2013).

Defined the state of art about conditions and dynamics able to influence the actors' possibility to be efficiently part of the relational network produced by the digital revolution, it could be useful to try to understand what are the reasons that motivate actors in developing an increasing number of relationships using the supports offered by ICTs (Caputo *et al*., 2016; Caputo, 2017; Heeks, 2010). About the point, for long time managerial and marketing studies have investigated social and economic configurations through which actors had the possibility for exchanging tangible resources useful for satisfying individual needs (Gitterman, 1983). With the emergence of the so-called digitalization, scholars and practitioners have started to reflect about the role of 'tangibility' in social and economic dynamics and they have underlined the possibility that economic and social interactions are not only direct to ensure physical exchange of goods (Lusch & Vargo, 2006; Barile et al., 2017).

Among the research streams that have postulated this hypothesis, the studies rooted in the Service Science (Spohrer *et al*., 2007; Maglio & Spohrer, 2008; Maglio *et al.*, 2009) and Service Dominant Logic (S-D logic) (Lusch *et al*., 2007; Vargo & Lusch, 2008; Lusch & Vargo, 2014a, 2014b) have clarified that the reason for social and economic interactions is the service "as the application of competences (knowledge and skills) for the benefit of another party" (Maglio *et al*., 2009). As a consequence of this radical change in perspective, S-D logic underlines that "value obtained in conjunction with market exchanges cannot be created unilaterally but always involves a unique combination of resources and an idiosyncratic determination of value" (Vargo & Lusch, 2008: 8).

Accordingly, the network of relationships rooted in and made possible by the digital revolution can be considered as a source of value for involved actors only in the case in which they are characterized by a strong *Collaborative Orientation* as a deep willingness able to push actors towards sharing knowledge, competences, and capabilities in conceiving and developing solutions for satisfying common needs (Sorenson *et al*., 2008; Di Fatta *et al*., 2016; Del Giudice *et al*., 2017). This willingness and orientation for collaborations emerge as a consequence of compatibility (or ideally, complementarity) among actors' *Strong Beliefs* in terms of their views about the world and cognitive pillars and schemes on which their perceptions and expectations are built (Barile et al., 2014; Caputo *et al*., 2017; Del Giudice *et al*., 2017; Barile & Saviano, 2018).

Open Innovation and Industry 4.0

Among the multiple facets that the digital revolution has shown in the last few years, Open Innovation and Industry 4.0 can be considered challenging domains through which the multidimensionality of emerging digital world is largely expressed (Gawer & Cusumano, 2014; Scuotto *et al*., 2017).

According to Jazdi (2014), "Industry 4.0 is the emergence of digital factories that are to be characterized by the following features: Smart networking […], Mobility […], Flexibility […], Integration of customers […], [and] New innovative business models" (pp. 1-2). From a different perspective, Stock and Seliger (2016) state that "the paradigm of Industry 4.0 is essentially outlined by three dimensions: (1) horizontal integration across the entire value creation network, (2) end-to-end engineering across the entire product life cycle, as well as (3) vertical integration and networked manufacturing systems" (p. 537) while Kolberg and Zühlke (2015) outline that "Industry 4.0 is a network approach where components and machines are becoming smart and a part of a standardized network based on the well proven internet standards" (p. 1870). Pointing the attention on these definitions, it clearly emerges that Industry 4.0 requires a radical change in the ways in which social and economic relationships are approached because it proposes and pushes a shift from physical to digital world (Shamim *et al*., 2016).

Industry 4.0 is a disruptive change of consolidated approaches to social and economic configurations because it completely destroys known boundaries and logics in social and economic relationships opening up the possibility for building dynamic configurations in which each actor can interact with all the markets for accessing the resources needed (Lasi et al., 2014; Pisano *et al*., 2015; Lu, 2017).

The above-mentioned change in perspective has a pervasive nature because it is able to promote a paradigmatic shift in the approach to market. As a consequence of this shift, actors involved in market and social configurations cannot be analyzed more in the light of their 'position in the network' but they should be studied with reference to the total amount of resources and knowledge that they can exchange and their potential ability of building relationships (Mansell, 2002; Pisano *et al*., 2014a; Erol *et al*., 2016).

In a similar way, Open Innovation can be considered a change in perspective in which market and social structures are approached and managed for ensuring actors' satisfaction and survival over the time (Enkel *et al*., 2009; Martinez-Conesa *et al*., 2017). According to Chesbrough *et al*. (2006: VII), "Open Innovation is defined as: the use of purposive inflows and outflows of knowledge to accelerate internal innovation, and expand the markets for external use of innovation, respectively". More specifically, Chesbrough (2006: XXIV) states that "open innovation is a paradigm that assumes that firms can and should use external ideas as well as internal ideas, and internal and external paths to market, as firms look to advance their technology".

Thanks to the Open Innovation paradigm, organizations' boundaries completely disappear in the perspective of decision makers (Barile, 2009; Lakhani *et al*., 2013; Díaz-Díaz & de Saá Pérez, 2014; Natalicchio *et al*., 2017; Scuotto et al., 2017). The attention shifts from the structure as a set of resources useful for achieving *ex-ante* defined goals to the processes trough which actors can share resources building joint paths able to ensure both individual and collective satisfaction (Cautela et *al*., 2014; West *et al*., 2014). Embracing the interpretative framework provided by Open Innovation, it is possible to overcome consolidated view in which organizations' viable survival are related to their ability to build conditions for competitive advantages through transactional approaches and barriers (Pisano *et al*., 2014b; Pironti *et al*., 2015). Open Innovation promotes a new vision in which organizations' survival depends on the ability to understand social and economic dynamics selecting in the environment actors and knowledge that can be integrated in organizations' structures for building value co-creation processes that are not more limited by organizations' structural boundaries (Barile and Saviano, 2011; Bogers, 2011; Barile *et al.*, 2012).

Depicting the role of Open Innovation and Industry 4.0 in value co-creation

Value co-creation is a challenging concept that it is attracting the attention of an increasing numbes of researchers and practitioners as a consequence of its potentiality of completely changing the managerial and governmental models in the light of a more extensive view of social and economic dynamics (Prahalad & Ramaswamy, 2004; Payne *et al*., 2008; Nambisan & Baron, 2009; Grönroos, 2011).

According to Grönroos (2012), "value co-creation is defined as joint activities by parties involved in direct interactions, aiming at contributing to the value that emerges for one or both parties" (p. 1520). Following the path traced by this definition, value co-creation emerges as an illuminating concept in business and managerial scenario because it is able to provide a new light in approaches to and view of social and economic relationships (Ranjan & Read, 2016; Dominici *et al*., 2017). The challenging nature of value co-creation is well summarized by Saarijärvi *et al.* (2013) for which "the conventional view on exchange is being superseded by new forms and shapes of interaction. Understanding the logic of business environments and ecosystems featuring value co-creation is a near prerequisite to becoming and remaining competitive" (p. 6).

The key power of value co-creation as interpretative concepts is related to its ability of overcoming consolidated reductionist view of organizations as boundaries defined entities that survive combining internal resources and exchange them with external environment through transactional approaches (Galvagno & Dalli, 2014). Value co-creation enlarges the domain of business management underlining the need for extending the perspective from the organizations to the complex of actors, resources, and dynamics that influence and define business and social dynamics (Gummesson & Mele, 2010). With reference to the point, Edvardsson *et al*. (2011) underline that "value co-creation is shaped by social forces, is reproduced in social structures, and can be asymmetric for the actors involved" (p. 327).

The ambitious debate that is involving many researchers and practitioners about the role of value co-creation in redesigning managerial and government approaches and models is one of the most stimulating of the last decades (Romero & Molina, 2011). Managerial literature is full of contributions about the potentialities of value co-creation (Korkman *et al*., 2010) and the conditions that must be meet for ensuring the emergence of a value co-creation based logic (Barile and Saviano, 2014; Caputo *et al*., 2018) but few evidences are provided with reference to the ways in which value co-creation can be realized in the emerging dynamics of social and economic configurations (Polese *et al*., 2016).

As underlined in previous sections, the domains of Industry 4.0 and Open Innovation could be useful in the bridge of this gap in knowledge providing evidence about the ways in which value co-creation can be a practical path in the so-called digital world (Lee *et al*., 2012). More specifically, Industry 4.0 and Open Innovation could be considered as two sides of the same emerging phenomenon related to the radical change of social and economic structures and dynamics. On the one side, Industry 4.0 proposes a change in perspective about the environment within social and economic relationships are developed promoting multi-level interactions among actors endowed by an enough level of technology readiness and that are cognitive aligned. On the other side, Open Innovation traces practical paths through which organizations' boundaries can be exceeded, and it is possible to view social and economic actors as resource integrators (Gummesson & Mele, 2010) able to co-produce value as a consequence of their participation in collaborative paths affected by shared strong beliefs.

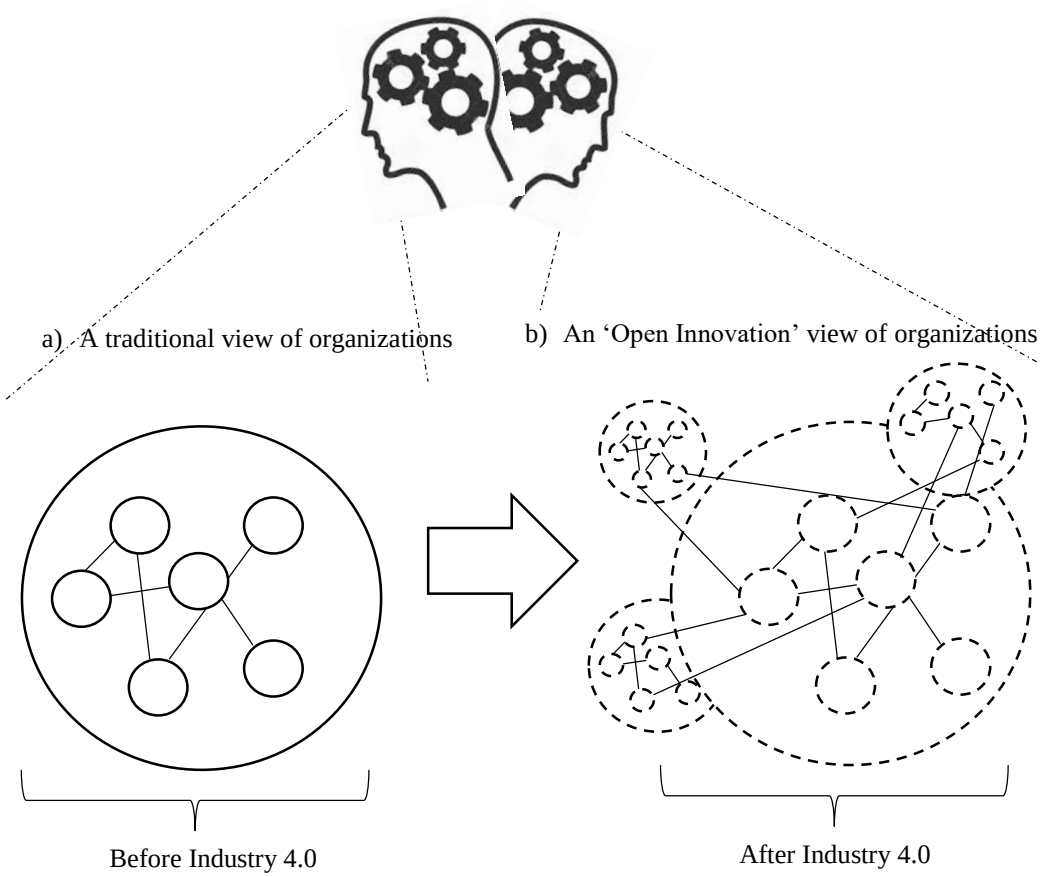
In other terms, while Industry 4.0 defines the context conditions for promoting multi-level collaborations required for value co-creation, Open Innovation traces the path through which social and economic actors can be considered resource integrators in the process towards value co-creation. In this perspective, a shift in organizations representation can be envisioned as illustrated in the following Figure 1.

As shown in Figure 1, Open Innovation and Industry 4.0 in the domain of value co-creation could be considered as the set of conditions required for structural and dynamics reconfigurations of

organizations. While Open Innovation implies the organizations' boundaries vanishing in the decision makers' view, Industry 4.0 implies the redesign of organizations' relational processes. Both these phenomena can be then considered as potential new frontiers for the application of value co-creation logic in business and managerial domains.

The main implication of these changes is the re-definition of the actors' context towards and *eco-systems* configurations.

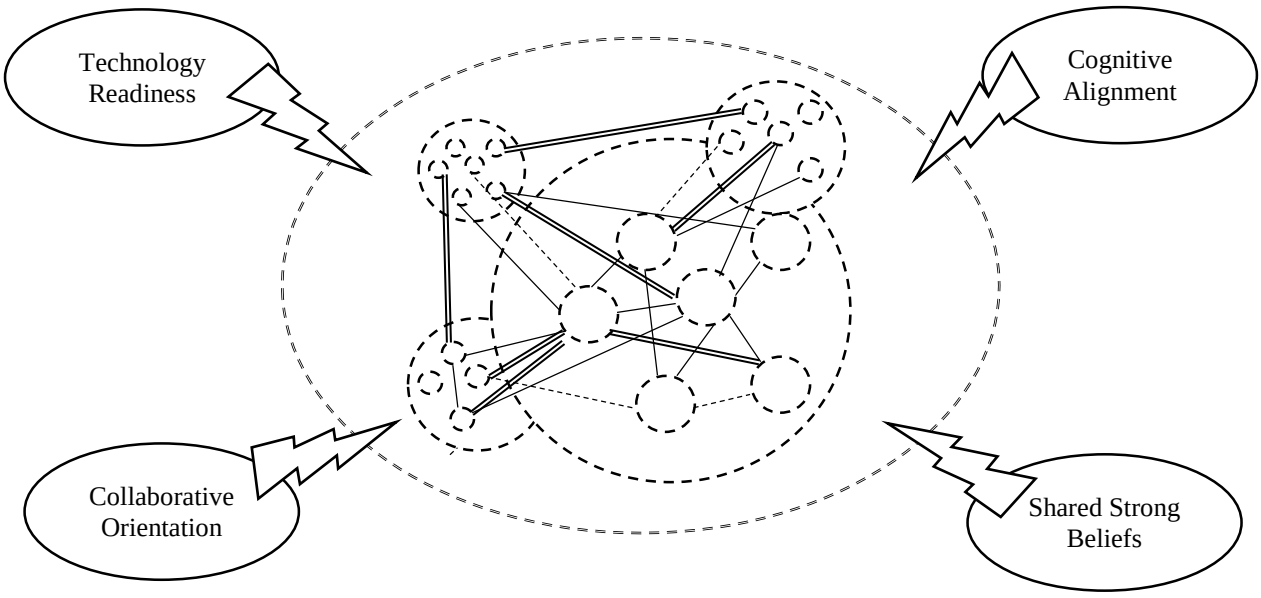
Figure 1. An Open Innovation and Industry 4.0 view of organizations



Source. *Authors' elaboration*

The proposed shift from the traditional view of organizations to an 'Open Innovation' view of organizations offers the possibility for depicting the conditions needed for developing an effective path for value co-creation. Thanks to adoption of an open innovation based framework, it is possible to highlight the relevant role of interconnection among the actors involved in the same ecosystem overcoming the reductionist view imposed by organizations' boundaries. Moreover, Industry 4.0 offers the opportunity for enhancing above mentioned interconnection trough the definition of platforms within the role of each actor, its participation and the potential value generation can be estimated as a consequence of few key conditions defined by Technology Readiness, Cognitive Alignment, Collaborative Orientation, and Shared Strong Beliefs. Accordingly, an ecosystem view can be represented in the light of Open Innovation and Industry 4.0 in which value, role, and power of interconnections can be defined as summarized in the following Figure 2.

Figure 2. Towards a value co-creation ecosystem view based on Open Innovation and Industry 4.0



Legenda: Kind of interconnection

---------- Potential ——— Effective ═══ Value co-creative

Source. *Authors' elaboration*

Conclusions, implications and future directions for research

The increasing variety and variability of all social and economic phenomena is one of the most debated challenge for managerial researchers and practitioners. Consolidated managerial approaches and tools based on organizations' boundaries and defendable competitive advantages are showing an increasing incapability in explaining emerging social and economic dynamics and in supporting organizations definition of paths for survival.

In such a scenario, value co-creation is a fresh concept able to recall managerial attention on the need for a radical change in perspective in organizations view and government (Gummesson & Mele, 2010). Unfortunately, its diffusion is still strongly related to the conceptual level and few contributions have been provided with reference to the ways in which it can became a practical path in emerging social and economic scenario (Hilton *et al*., 2012).

With the aim to enrich the ongoing debate about dimensions and conditions for value co-creation in the digital world, the paper adopts the interpretative lens provided by service and systems thinking for extending consolidated view of the so-called digital revolution and for identifying key concepts able to summarize conditions under which value co-creation can be considered an integrative part of emerging digital world. In such a direction, the concepts of technology readiness, cognitive alignment, collaborative orientation, and shared strong beliefs are briefly introduced, and their conceptual background are integrated in the light of service and systems thinking for underling possible links between Open Innovation, Industry 4.0 and value co-creation.

Reflections herein are summarized in an explicative conceptual representation direct to emphasize the role of Open Innovation and Industry 4.0 in contributing to the radical shift in organizations view and management required for ensuring the emergence of value co-creation logic. Specifically, the

role of Open Innovation for enlarging the perspective of decision makers from organizations' boundaries to organizations' environment is underlined and the contributions of Industry 4.0 in redefining organizations' relationship in the light of a more intensive and multi-level collaboration is shortly presented.

The paper can be considered as a piece of the multi-dimensional debate rooted in value co-creation aimed to provide insights on a renewed context for value co-creation contributing to both theoretical reflections and empirical development in the managerial domain providing a new light to the application of value co-creation logic in the digital world. Proposed advancements in knowledge should be still considered in their embryonic phase because more elements should be added to the defined representative model for representing the role technology readiness, cognitive alignment, collaborative orientation, and shared strong beliefs in affecting conditions for value co-creation. In such a direction, next steps for the research will focus the attention on the implications of these domains for value co-creation and on the measurement of their possible influences on the emergence of value co-creation managerial approaches and views.

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