Social Media Use and the Challenge of Complexity: Evidence from the Technology Sector

Article *in* Journal of Business Research · January 2020

DOI: 10.1016/j.jbusres.2019.12.026

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ACKNOWLEDGEMENTS:

This work was supported by the Spanish Ministry of Economy, Industry, and Competitiveness within the framework of two projects: ECO2017-88222-P and B-SEJ-042-UGR18. Moreover, it was supported also with funds provided by the University of Malaga and Granada.

This research is send to Journal of Business Research

Citated:

Available online 14 January 2020

Martín-Rojas, R., García-Morales, V. J., Garrido-Moreno, A., & Salmador-Sánchez, M. P. (2021). Social Media Use and the Challenge of Complexity: Evidence from the Technology Sector. *Journal of Business Research*.

https://doi.org/10.1016/j.jbusres.2019.12.026

Social Media Use and the Challenge of Complexity: Evidence from the Technology Sector

Abstract:

Social Media encourages networks in the complex and dynamic environment within which firms are immersed. The purpose of this study is to analyze the role and impact of Social Media on complexity variables and organizational performance. More specifically, we explore the presence of elements of "spontaneous order creation": heterogeneous agents with motives to connect with each other, and their impact on innovativeness and dissipative structures.

The research model was tested on a sample of 201 technology firms through Structural Equation Modelling (SEM).

Our research contributes to extant literature by exploring the impact of digitally enabled networks (Social Media) on complexity dynamics through analysis of their influence on firm performance. We aim to advance explanation of how increasing complexity changes behavioral dynamics in complex ecosystems, and how information and Social Media can be used to cope with the new managerial challenges posed by increasing digital complexity.

Keywords: Connections, Dissipative Structures, Heterogeneous Agents, Innovativeness, Social Media, Complexity Theory.

Social Media Use and the Challenge of Complexity: Evidence from the Technology Sector

1 INTRODUCTION

Impressive improvements in information systems, communication, and connectivity technologies are fundamentally reshaping traditional business strategies (Croteau & Bergeron, 2001; Galati & Galati, 2019; Henderson & Venkatraman, 1993; Tallon, 2008). This reshaping has led to the rise of digital business strategies in firms, defined as organizational strategies formulated and implemented by leveraging information systems and digital resources to create differential value. These strategies (1) imply the pervasiveness of information systems and digital resources in all of the various functional areas of the firm; (2) embrace information systems and technologies to recognize them as digital resources, in line with the resource-based view of strategy (i.e., Barney, 1991; Wernerfelt, 1995); and (3) explicitly link digital business strategy to creation of differential business value, viewing this strategy as driving competitive advantage and strategic differentiation in the firm (Bharadwaj, El Sawy, Pavlou, & Venkatraman, 2013; Kung, Cegielski, & King, 2015).

Various recent studies of the theory and practice of digital business strategy stress its importance (i.e., Drnevich & Croson, 2013; Kung et al., 2015; Jonsson, Mathiassen, & Holmström, 2018; Setia, Venkatesh, & Joglekar, 2013; Tsatsou, Elaluf-Calderwood, & Liebenau, 2010). Other authors write more broadly about Digital Business and Digital Business Ecosystems (i.e., Ransbotham, Fichman, Gopal, & Gupta, 2016; Senyo, Liu, & Effah, 2019).

Consistent with this generation of insights, complexity science is one potentially interesting theoretical lens for further study of digital business strategy (Benbya & McKelvey, 2006; Tanriverdi, Rai, & Venkatraman, 2010). Increasingly recognized as a significant theoretical framework in economics and organization science, this complexity science is emerging as a field in Information Systems (IS) research (Massa, Viscusi, & Tucci, 2018; Merali, 2006). Organizations are experiencing dramatic structural change and must respond to a globalized environment characterized by increasing connectivity, interdependence, and rapid technological change (Ferraro & Iovanella, 2017; Ritter, Wilkinson, & Johnston, 2004). In this context, firms must understand what strategies to adopt and what technologies can help them to address growing complexity (Jacucci, Hanseth, & Lyytinen , 2006). Digital strategy in increasingly complex co-evolving adaptive business ecosystems would benefit from studies exploring its causes, dynamics, and consequences from the perspective of complexity theory, which has been widely applied in organizational studies in the strategic domain (i.e., Gnyawali, Fan, & Penner, 2010; Jonsson et al., 2018; McKelvey, 2016; Ransbotham et al., 2016; Salmador & Bueno, 2005). New insights might emerge that reflect the outcomes of adaptive, emergent self-organized behaviors highlighted by complexity scientists (i.e., Ashby, 1968; Bak, 1996; Holland, 1996; Mandelbrot, 1982; McKelvey, Salmador, Morcillo, & Rodríguez-Antón, 2013).

Social Media tools have emerged as one of the main digital technologies and are transforming the way firms relate to the market, creating a new world of possibilities (Aral et al., 2013; Bharadwaj et al., 2013). Social Media encompasses a wide variety of Information and Communication Technologies with the common denominator of connecting users in ways that can bridge distance, time, and other traditional barriers. Social Media constitutes one of the most transformative impacts of information technology on business, both within and outside firm boundaries (Aral, Dellarocas, & Godes, 2013). Through Social Media and social networking, digital technologies are also changing the structure of social relationships in the space of both the consumer and the enterprise (Fernandez-Perez, García-Morales, & Bustinza-Sanchez, 2012; Jonsson et al., 2018; Ransbotham et al., 2016). Social Media is about information, knowledge, and networking. Since emergent behavior is a function of tiny initiating events (Holland, 1996), magnified by scale-free causes and networking (Caldarelli, 2007), the result is a much more complex and dynamic ecosystem for growth and innovation (Gnyawali et al., 2010). Firms need dynamic tools, such as Social Media, to support their management of the new types of innovation processes that emerge in the digital environment (Nylén & Holmström, 2015). The advent of platforms like LinkedIn, Facebook, and Skype offers firms a new way to connect and communicate with a wide range of stakeholders, gaining valuable knowledge to drive innovation processes and firm performance (Corral de Zubielqui, Fryges, & Jones, 2019; Mention, Barlatier, & Josserand, 2019; Singh, 2005). However, few studies examine how to implement these tools strategically (Felix, Rauschnabel, & Hinsch, 2017) or harness their full potential to foster innovation (Bhimani, Mention, & Barlatier, 2019). Despite the current complex and dynamic markets, there is a paucity of research on the specific impact of IT tools such as Social Media on business strategies and value creation (Chang, Park, & Chaiy, 2010; Melville, Kraemer, & Gurbaxani, 2004).

In the context of the digital environment (Ransbotham et al., 2016) and the dynamic and connective tools in strategy (Ferraro & Iovanella, 2015; Van de Ven, 1992), we are especially interested in studying complex ecosystems. Sectors with high-tech elements such as innovation networks or connectivities (Ferraro & Iovanella, 2017) are good examples of such ecosystems because they involve new managerial challenges in entrepreneurship (Martín-Rojas, García-Morales, & González-Álvarez, 2019; Slotte-Kock & Coviello, 2010). These elements also characterize shared values, beliefs, symbols, and ways of doing in the firm (Grinstein & Goldman, 2006). We also choose to focus on technology-intensive firms because they are potential drivers of economic development through transfer of knowledge from the academic environment to the production sector and because they are strategic for a country's economy (Fontes, 2001) in generating high levels of employment and wealth. Finally, this sector provides additional findings on technology transfer, business planning, network processes, practical learning, collaborative elements, open innovation and innovativeness, and integrated feedback in firms (Cinelli, Ferraro, & Iovanella, 2019; Ferraro & Iovanella, 2017; Garrido-Moreno, García-Morales, & Martín-Rojas, 2019; Lyytinen, Rose, & Yoo, 2010).

In response to the concerns and research needs mentioned, this study aims to explore the role of Social Media and its impact on complexity variables in technology firms' strategy process. Technology firms respond to strong forces driving R&D in innovativeness and entrepreneurship, characteristics that imply a corporate culture of technology (Martín-Rojas, García-Morales, & García-Sánchez, 2011). Specifically, we explored the presence of Kauffman's "spontaneous order creation" elements: (1) heterogeneous agents participating in strategy making; (2) connections among them; and (3) motives to connect, such as mating, improved fitness, performance, learning, reducing imposed tensions, innovate, etc. (Kauffman, 1993). These elements may impact self-organized criticality or innovativeness and dissipative structures—which are related to emergent innovation and self-renewal, respectively, as additional complexity ingredients for entrepreneurship and open innovation (Chesbrough, 2003; Corral de Zubielqui, Jones, & Statsenko, 2016; McKelvey et al., 2013; Nesij Huvaj & Johnson, 2019; Roundy, Bardshaw, & Brockman, 2018; To, Au, & Kan, 2018)—and organizational performance.

We define the heterogeneity of agents following previous research (Powell & Brantley, 1992; Scott, 1991) and analyze the diverse, heterogeneous agents with which each organization analyzed had contact. We consider the number of individuals, classified by categories, with whom the organization had been in contact over the past three years, at formal or informal levels, and that were related to the job. The categories were: a) internal sources, or sources within the enterprise or enterprise group; b) market sources, including suppliers of equipment, materials, components, or software; clients or customers; competitors or other enterprises in the industry; and consultants and commercial labs; c) education and research institutes, including universities or other higher education institutions; and government, public, or private research institutes; and d) other sources, such as conferences, trade fairs, exhibitions; scientific journals and trade/technical publications; and professional and industry associations.

We conceptualized the connections by evaluating the extent to which the firm used each of these categories to obtain a large quantity of information and/or support, and how often the organization had communicated or exchanged information with each category over the past three years, analyzing both amount and frequency of contact (Fried, Johnsen, Starrett, Calloway, & Morrissey, 1998; Peng & Luo, 2000). We included the motives to connect by asking the firm about heterogeneity and connections with the agents specifically related to the job and thus linked to the organization's performance or potential learning.

Following the definition of innovativeness developed by Knight (1997) and Zahra (1993), we evaluated the extent of change that may have taken place in the company over the past three years in the company's spending on new product/process development activities, number of new products/processes it added and introduced, emphasis on developing technologies and/or technological innovation, and top management emphasis on R&D, technological leadership, and innovations.

As in past studies (Martín-Rojas, Garcia-Morales, & Bolívar-Ramos, 2013; Zahra, 1993), dissipative structures indicate the extent to which the company had prioritized each of the following activities over the past three years: reorganizing units and divisions, coordinated activities among units to enhance company innovation, adopting flexible organizational structures, training employees in creativity techniques, and redefining the business concept and/or the industries in which the company competes.

We analyzed these relationships empirically in the technology sector, a particularly high-speed, global, knowledge-intensive, co-evolving industry (García-Morales, Martín-Rojas, & Lardón-López, 2018; Martín-Rojas et al., 2011), in Spain. The technology sector is strategic for the nation and includes activities that require a high level of knowledge and research efforts to create high levels of value and employment. Technology firms are central to economic development and act as potential vehicles for transferring knowledge from the academic environment to the production sector (Martín-Rojas et al., 2013). By analyzing how they influence firm performance, we obtain findings on the impact and effects of emergent digitally enabled platforms (especially Social Media) on complexity dynamics (Cinelli et al., 2019). We sought to contribute to the academic debate by explaining how increasing complexity changes behavioral dynamics in complex ecosystems, and how information and Social Media can be used to cope with the new managerial challenges posed by increasing digital complexity. These objectives focus on the technology sector, where knowledge-intensive technology to sense and scan new business opportunities (Singh, 2005) is required and user-driven innovations are seen as a major source of product creation (Martín-Rojas et al., 2011).

This paper is organized as follows. We begin by presenting the background and hypotheses, followed by the methodology. We then describe the main results and the insights derived from them. Finally, we tie these insights to the study's broader agenda and explain the main contributions and limitations of the study, as well as suggestions for future research.

2 Background and Hypotheses

The advent of Social Media has fundamentally changed the way we—as individuals and professionals—communicate, collaborate, consume, and create (Aral et al., 2013); and the way organizations relate to the market and to other relevant actors (employees, suppliers, competitors), creating a new world of opportunities and challenges for all aspects of the firm. With the emergence of the network economy and the network society (Merali, 2006), Social Media becomes a fundamental tool to adapt to the current complex environment, creating valuable connections. Social Media has emerged as a highly promising set of tools and approaches to connect and share information with third parties, enabling firms to establish networking competences (Corral de Zubielqui et al., 2016; Nicolescu et al., 2018). As a result, companies have in recent years begun implementing these solutions on a massive scale to transform their business models and managerial practices.

Embedded in the broad concept of Social Media are a number of new tools and approaches with the potential to support or enhance these strategic, organizational, and managerial modifications (Ngai et al., 2015). According to Kaplan and Haenlein (2010, p. 61), Social Media can be defined as "a group of internet-based applications that build on the ideological and technological foundations of Web 2.0, and that allow the creation and exchange of user generated content." This broad term has been applied to a variety of technologies, including wikis, blogs, microblogs, social networking sites, virtual worlds, and video-sharing sites (Corral de Zubielqui et al., 2019; Kietzmann, Hermkens, McCarthy, & Silvestre, 2011). The platforms are evolving rapidly, introducing new features and often blurring the distinctions among different types of Social Media technology (Kaplan & Haenlin, 2010). Among the best known of these tools are sites such as Facebook, LinkedIn, and Twitter, which now connect millions of users.

Social Media drives a new set of models for various kinds of businesses, challenging traditional business processes and operations (Hanna, Rohm, & Crittenden, 2011). Its transformative power extends beyond marketing and customer relationships (Aral et al., 2013). Social Media can serve as a tool to facilitate intra- and inter-organizational activities among peers, customers, business partners, and organizations, enabling collaborative learning and knowledge creation (Ngai et al., 2015). Companies today face a landscape characterized by network dominance, which is increasingly dynamic, complex, and uncertain (Merali & McKelvey, 2006; Singh, 2005). In this new environment, with increased levels of complexity caused by the pervasive role of information (Merali, 2006), Social Media has the potential to increase firm connectivity, enabling network emergence and synchronously connecting a wide number of heterogeneous agents free of cost. Using these tools can help companies to remain competitive in increasingly complex multi-actor and multi-stakeholder environments (Bhimani et al., 2019). As a new phenomenon emerging in the Information Systems (IS) arena, Social Media tools become an important weapon for dealing with the increasing complexity that companies face today.

In examining Social Media, recent literature focuses not only on features of this technology, but on their affordances, exploring what people do with the technology and the consequences of its use for organizations. The affordance perspective (Fulk & Yuan, 2013; Leonardi, Huysman, & Steinfield, 2013) claims that Social Media provides visibility and persistence of communicative actions, expanding the range of networks from which people can learn across and outside the firm. As organizations are increasingly aware of the need to be more ''social,'' the affordances of Social Media tools can act as a social lubricant, easing connection and communication to capture valuable knowledge (Leonardi et al., 2013). Compared to conventional technological systems, Social Media tools afford more extensive connections and thus help to create and sustain the social capital so critical to knowledge sharing in current complex environments (Fulk & Yuan, 2013). Through Social Media, companies can thus afford a high number of different active connections that act as bridges between individuals, supplementing existing relationships and serving as a valuable resource to improve collaboration beyond organizational boundaries (Bhimani et al., 2019; Gnyawali et al., 2010).

Recent literature stresses how Social Media tools facilitate information flows and knowledge sharing, and how firms are using these platforms for a wide range of organizational purposes (Bhimani et al., 2019; Corral de Zubielqui et al., 2019; Lam, Yeung, & Cheng, 2016): employee collaboration, inter-firm cooperation and supply chain management, idea generation and new product development, customer relationship management, and sales and marketing. In all of these activities, the use of Social Media as a new communication channel enhances firm interactivity and collaboration with key market-based actors such as customers, suppliers, and other relevant stakeholders (Corral de Zubielqui et al., 2019). We thus assume that the use of these platforms serves as a key enabler of firm connectivity and will have a significant impact, not only on the number of connections with key agents but also on the frequency of those connections.

As to number of connections, Social Media tools differ from more conventional media by enabling a larger and more diverse set of agents to connect and communicate multi-directionally, enabling more flexibility and freedom of participation (Ooms, Bell, & Kok, 2015). Density of linkages between network members is thus likely to be influenced by Social Media use. In this vein, Corral de Zubielqui et al. (2019) highlight that Social Media, as highly interactive platforms, provide firms with opportunities to involve different market-based actors, leading to more connections with them. As to frequency of connections with key agents, Social Media provides a firm with an open and accessible platform to become closer to its external customers or suppliers, who are often physically dispersed (Lam et al., 2016). Through these platforms, firms can share valuable information with customers and suppliers in a timely manner, enhancing responsiveness to increase frequency of connections with both. Ooms et al. (2015) stress that Social Media platforms enable a larger set of agents to connect across functional boundaries, enhancing strength of linkages and frequency of contact among them.

Prior empirical research seems to confirm these assumptions. Drawing on a sample of technology companies, Jussila, Kärkkäinen, and Aramo-Immonen (2014) observe that Social Media effectively opens many new opportunities for these firms, enhancing communication, interaction, learning, and frequency of collaboration. The authors argue that these tools enable firms to identify new business opportunities and new product ideas, deepen relationships with customers, and enhance collaboration with other parties. Along the same lines, Corral de Zubielqui et al. (2016) demonstrate empirically that Social Media applications not only facilitate customer-firm connections but enable important forms of interactivity throughout the supply chain. Therefore, we propose the following:

H1: Social Media use positively influences the number and frequency of connections with key agents.

The emergent connectivity generated by Social Media tools is unique, affording a wide range of opportunities for significant interaction with key agents (Treem & Leonardi, 2012). These tools help firms not only to increase their volume of connections but also to expand the scope of their potential networks, reaching more heterogeneous agents. Such structural diversity among group members—

including differences in roles, locations, or business affiliations—seems to be a valuable enabler of external knowledge sharing, as it involves more diverse information sources (Cummings, 2004). Social Media technologies, such as Social Networking sites, facilitate both bonding ties and bridging ties, spanning network size and scope (Bygstad, 2017). Using these tools among the different agents is thus one of the main sources of social capital in the current business landscape (Fulk & Yuan, 2013).

Social Capital Theory has been frequently used to explain Social Media affordances (Fulk & Yuan, 2013; Ngai, Tao, & Moon, 2015). This theory holds that social capital—the network of relationships possessed by an individual or a social network and the set of resources embedded within it—strongly influences the extent to which interpersonal knowledge sharing occurs (Gnyawali et al., 2010; Nahapiet and Goshal, 1998). One of the main dimensions of social capital is structural capital, the overall pattern of connections between actors, manifested in network ties or linkages between individuals. As Chiu, Hsu, and Wang (2006) note, the more social interactions undertaken by exchange partners, the greater the intensity, frequency, and breadth of information exchanged. Diversity also seems to be crucial; sparse networks unite knowledge from disparate sources, potentially enabling knowledge flows (McKelvey et al., 2013; Nahapiet & Goshal, 1998). Frequent use of Social Media applications can improve the acquisition of social capital (Leonardi et al., 2013), gaining firms access to wider networks composed of different actors.

The existence of heterogeneous agents is a key ingredient of todays' complex markets (McKelvey, 2016). The conditions for rapid knowledge sharing thus emerge as organizational capital, supporting intelligent work structures to combine global and local abilities. Social Media use can thus help firms to handle network diversity effectively. Since organizational networks are more complex than they were years ago, however, organizations increasingly struggle to organize and coordinate decentralized information (Dodds, Watts, & Sabel, 2003). Information is becoming extremely complex, and companies need the innovative capabilities of network agents to reap its benefits for the company (Corral de Zubielqui et al., 2016; McKelvey, 2016). Empirical evidence shows that Social Media can increase social network diversity, enabling companies to contact a wide range of different agents. Fulk and Yuan (2013), for example, argue that the use of social networking services affords higher levels of network diversity and access to social capital. Building relationships with others who are physically distributed across other parts of the organization or even outside its boundaries enables wider and more heterogeneous networks. Similarly, Han and McKelvey (2008) confirm that Social Media platforms enhance the ability to maintain a broader spectrum of relationships, enabling users to connect with large, heterogeneous groups of agents. Additionally, social networking technology helps users to create and maintain heterogeneous (bridging) ties. We thus hypothesize the following:

H2: Social Media use positively influences relations with heterogeneous agents.

This subsection explains why the heterogeneity of agents composing a network is essential to fostering connectivity among them. Here, it is important to note that homophily is generally considered as a significant driver of connectivity in a network context. In this context, the principle of homophily holds that contact occurs at a higher rate among similar people than among dissimilar people (McPherson, Smith-Lovin, & Cook, 2001). Because similarity brings connection, people in the same network community are more likely to be similar and think alike (Weng, Menczer, & Ahn, 2013). In an offline context, homophily has proven to be significant because people′s personal networks seem to be homogeneous with regard to many sociodemographic, behavioral, and personal characteristics (McPherson et al., 2001). This homogeneity not been proven, in an online context, however. In a systematic analysis of homophily in Social Media sites, Bisgin, Agarwal, and Xu (2010) do not confirm the assumption of homophily as essential to fostering connections in a specifically online context.

Our study focuses on the relevance of Social Media tools as key tools for facing complexity by enabling firms to establish relations with key market actors such as customers, suppliers, and business partners. As these agents are quite different in nature (have different characteristics, objectives, etc.), we assume that being in contact with all such heterogeneous agents will enhance firm connectivity, helping firms to be more open to the market. Among the main ingredients of today′s complex markets is heterogeneity of the agents that compose company networks, and connections and connectivities across those agents both inside and outside firm boundaries (McKelvey, 2016). Complex systems are non-linear systems composed of heterogeneous connected nodes that interact through diverse feedback loops (Merali 2006). As explained above, Social Media as an emerging IS platform can positively affect both the diversity of the agents that compose the company network and the number and frequency of connections in which the firm is involved. As to the existence of heterogeneous agents (network diversity), today′s companies are embedded in networks for knowledge sharing that may include not only customers or suppliers (Braun & Hadwich, 2016), but also competitors, universities, or research institutes (Corral de Zubielqui et al., 2016); and employees (Albino et al., 1998) or even emergency agencies (Simon, Goldberg, & Adini, 2015). Since all of these agents may have different goals, functions, and action patterns, they can be considered as heterogeneous (Ferguson & Soekijad, 2016; Wycisk, McKelvey, & Hülsmann, 2008).

A group of agents becomes a system when these agents interact. Interaction among heterogeneous actors is thus the second feature of complex networks (Ferrari & Granovetter, 2009). Networks consist of interconnected agents (nodes) that can communicate with each other; and the connectivity of each node is defined by the nature and number of its links (relationships) with other nodes (Merali, 2006). Since firms are embedded in an external ecosystem in which many stakeholders operate, the ways these agents connect and share information is essential for knowledge sharing and innovation (Corral de Zubielqui et al., 2016). In social systems, interactions could involve different forms of or connection for human communication. As long as agents remain motivated to exchange information and/or resources, a stable degree of interaction or connectivity is assured (Wycisk et al., 2008). The process of information exchange among heterogeneous agents thus leads to accumulation and transfer of information (Albino et al., 1998), which encourages connectivity.

Heterogeneity is one of the main drivers sustaining the motivation for interaction and connectivity between agents. Heterogeneous agents seek out other agents to copy or learn from them, to capture valuable knowledge and generate networks for learning (Han & McKelvey, 2008). In fact, heterogeneity is essential to fostering effective interaction; if all agents possess the same knowledge, they have no motivation to exchange information among themselves (Wycisk et al., 2008). In complex inter-organizational networks, both heterogeneity and interdependence among agents play a vital role, enabling the system to remain viable. Inherent heterogeneity provides the basis for renewing the system, as diversity underpins the social dynamics that feed development of complex social interaction (Antonacopoulou & Chiva, 2007). Since tension creates an imperative to act, heterogeneity, when couched within a context of interdependence, pressures agents to stay connected in the network, interacting frequently to share information and ideas (Uhl-Bien, Marion, & McKelvey, 2007).

According to biological theory, all that is needed to stimulate emergent structure in the form of connections are heterogeneous agents (DNA, cells). Interaction of heterogeneous agents encourages mutations that ensure survival of the system. This basic idea has been applied to organizations and learning (Han & McKelvey, 2008) to ground the assumption that diversity of agents in a network is a main driver of effective connectivity. Ferrari and Granovetter (2009) use complex network theory to analyze the complex innovative capability of Silicon Valley and to understand how heterogeneity of agents and multiplexity of ties support innovation, knowledge creation, and new business development. This case involved numerous heterogeneous agents (nodes) with multiple functions, and the dynamics of innovation depend strongly on completeness of the environment. Ferrari and Granovetter (2009) conclude that network′s structure (diversity of agents and degree of interdependence) influences its dynamics and connectivity. We thus posit that greater heterogeneity of agents within a network leads to higher level of connections for information sharing.

H3: The existence of heterogeneous agents within the network positively influences the number and frequency of connections with key agents.

In current complex markets, it is widely acknowledged that innovativeness results from the interaction of multiple different agents in the innovation system (Corral de Zubielqui et al., 2016). Assuming that innovation draws on many sources of ideas, firms can improve their odds of developing successful innovations by accessing a large number of knowledge sources at industry level (Leiponen and Helfat, 2010). The stronger the company′s connections, the greater its willingness to try innovative things. That is, organizations that connect and form networks with significant external and internal agents create opportunities to foster organizational learning processes (Husain, Dayan, & DiBenedetto, 2016) and increase emergent innovation within the firm (McKelvey, 2016).

To benefit from these external collaborations, firms need specific resources. Connections must be managed, requiring time and organizational effort. As the complexity of innovation processes increases, many firms′ knowledge base becomes insufficient to handle the challenges that emerge with openness (Spithoven et al., 2013). Some of the main obstacles in managing the innovation process following an open approach are financial and technological constraints, inadequate managerial competences, cultural resistance inside the firm, and lack of staff skills and knowledge (Bigliardi & Galati, 2016). These barriers have been found to be particularly significant for small companies (Lee, Kelley, Lee, & Lee, 2012; Spithoven, Vanhaverbeke, & Roijakkers, 2013; Teirlinck & Spithoven, 2013), but their effect has not been widely confirmed for medium-sized and large firms. Openness also seems particularly important in high-tech and knowledge intensive firms, which operate in particularly turbulent environments. Cruz-Gonzalez, López-Sáez, Navas-López, and Delgado-Verde (2015) demonstrate empirically how the external search for collaboration becomes crucial to fostering innovation and firm performance in very technologically dynamic environments, in which prior knowledge quickly becomes obsolete.

As mentioned above, our study focuses on the technology industry, which is characterized by high levels of dynamism and turbulence. Firms in this sector usually work closely, creating complex inter-organizational networks within the supply chain to provide innovative technologies and to implement newly developed technologies (Danneels, 2007; Han & McKelvey, 2008). In this high technology-intensive industry, a strong network of connections to promote core competences to innovate is essential (García-Morales, Bolívar-Ramos, & Martín-Rojas, 2014; Prahalad, 2012). A network of connections with different knowledge sources fosters and consolidates the learning innovation process (García-Morales, 2004; Tidd & Bessant, 2009), which in turn breeds innovativeness and competitiveness (Tsai, 2001).

Drawing on prior literature on innovation systems (Ahuja, 2000; Jugend et al., 2018; Zmud, 1983), we assume that lasting connections with diverse groups are a significant tie enabling knowledge sharing within the company and in turn improving acquisition of up-to-date complementary knowledge, encouraging innovativeness. Networks or connections influence innovation, determining organizations′ development (Gay & Dousset, 2005). Innovativeness is constantly stimulated by new knowledge a firm has accessed, knowledge both developed from the inside and acquired or adopted from outside knowledge sources (Meagher & Rogers, 2004). Organizational networks thus enhance the company's innovativeness, connecting traditional agents such as firms and institutions with new agents, such as communities, users, and technological platforms (Corral de Zubielqui et al., 2016).

Innovation acts as an intervening variable linking market, learning, and entrepreneurial orientations to business performance, as it enables introduction of new processes, products, or knowledge and business models in the organization as a result of the interactions among innovative agents (Dougherty & Dunne, 2011; To et al., 2018). Such connections with different agents strengthen the link between attitudes and subsequent innovative behavior (Gnyawali et al., 2010; Santiago & Benito, 2008; Wang, Pallister, & Foxall, 2006). Corral de Zubielqui et al. (2016) demonstrate empirically a significant relationship among complexity theory, networks, and innovativeness. More specifically, the authors find that heterogeneous agents (market-based networks [clients, suppliers, competitors], localized learning networks [universities, commercial laboratories/R&D enterprises, private not-for profit research institutes, and other institutional bodies and knowledge flows through networks) enabled firm innovativeness through dynamic network structures.

Furthermore, new innovative knowledge and innovative systems are acquired by these connections (Dodds et al., 2003; Nicolescu et al., 2018). Connections can generate a network of networks, linking companies, institutions, inventors, communities, and technologies (Cooke, 2012). Since these interactions give rise to communication structures within networks and shift the focus to network dynamics and innovative structures (McKelvey et al., 2013), social networks and connections are influential in determining organizations′ development and enabling innovativeness.

In sum, the evidence from prior research suggests that today′s environmental complexity requires dynamic network capital with different agents that enhance learning through global and local collaborative business processes, promoting the company′s innovativeness. We thus formulate the following hypothesis:

H4: The number and frequency of connections with key agents positively influences innovativeness in the firm.

Connectivities or networks in firms have changed the way companies organize themselves (Albino et al., 1998; Ketter, Peters, Collins, & Gupta, 2016; Leonardi et al., 2013; Maiga et al., 2015). A self-organizing system creates order through fluctuation while reacting selectively to information from the environment (Nonaka, 1998). Following prior studies on the topic (McKelvey, 2016; Merali, 2006), we conceptualize self-renewal as "dissipative structures" because these structures emerge to dissipate the tension created as a result of new and changing knowledge received from the environment. That is, firms reinvent themselves to adapt to these internal and external tensions.

If the essence of self-organization lies in creation of information, having a wide range of connections is a major driver of this process. Research shows that renovation at a firm is produced by tensions stemming from use of public sites, hierarchy problems when managers and employees become friends, and personal and work boundary issues (Piskorski, 2011). Collaboration and knowledge processes at work have transformed the way company workforces function. Renewal now comes by having employees feel more a part of a community and gain a better perspective on the organization. These employees then obtain feedback on ideas and assistance on solving problems (Ferguson & Soekijad, 2016; Leonardi et al., 2013), while increasing their social capabilities and learning in the company. Consequently, connectivities in companies improve their self-renewal by creating tighter structures within a firm and changing the processes of learning with and within these structures.

In the IS literature, Maiga et al. (2015) and Heidenreich (2005) highlight that networks with suppliers, distributors, and customers change the way the company is organized through coordination of policies, creation of regional networks and participation of regional actors, which enable impressive renewal of the company and make it much more efficient. The company′s adapts through the information exchange process between companies and institutions, such as governments (Shen, Wang, & Teng, 2017), where networks enable companies to be more responsive to public policy requirements and to technical and administrative procedures of public service organizations, dissipating tensions between supply and demand (Albino et al., 1998; Braun & Hadwich, 2016).

Collaborative external networks also enable emergence of dissipative structures, since cooperation among different agents enables development of collaborative enterprise strategies and mutual learning processes, leading to renewal of firm's capabilities (R&D, creation of new plants, and support of start-up companies) (Heidenreich, 2005; Singh, 2005).

In addition to external networks, internal networks deserve consideration in reinventing firms′ capabilities, as these networks involve sharing of pertinent knowledge and information among members of a supply chain (Prajogo & Olhager, 2012). Since such actions share design and manufacturing data among suppliers, focal manufacturers, and customers (Bardi, Raghunathan, & Bagchi, 1994; Kung et al., 2015), internal networks can change the firm′s organizational structure and decision-making process. When suppliers and customers are included in the decision-making process, they employ novel designs of products and processes to improve supply chain efficiency (Chen & Paulraj, 2004).

Networks thus create an abundance of information for organizational decision-making. Managers must continuously renew themselves by engaging in various strategies to increase accessibility, contextual cues, and intrinsic interest of the information provided (Leonardi et al., 2013) in order to produce a more open-minded culture in the firm and strategically renew the organization to benefit from such information and social relations. That is, organizations must self-renew by doing established things in new ways, by stopping doing unsuccessful things, and by doing new things (Sparrow & Ringland, 2010).

Once new knowledge has been integrated into the firm, employees can exploit the information gained through sharing by creating internal connections in the organization, enabling establishment of cooperative networks among the employees involved in a firm. Moreover, the information and know-how exchanged within the network involves novel specialist norms and procedures so that organizational structures can exploit new market and technical opportunities (Albino et al., 1998).

Finally, all evidence suggests that organizational networks promote self-renewal in companies, as they allow firms to acquire knowledge and connect with public institutions, citizens, or their own employees. Only after undertaking new, more flexible and open connections can the company engage in new promotion, planning, design, coordination, realization, increasing its capabilities. This ongoing model preserves know-how and increases effectiveness and efficiency of learning processes in firms with the appropriate structures (Ketter et al., 2016). A dissipative structure provides more advanced information technologies and deep integration of knowledge. In sum, IS literature shows that firms have changed structurally in the last few years as communication technologies increase connections with and within them (Leonardi et al., 2013). All in all, a new hypothesis may be proposed:

H5: The number and frequency of connections with key agents positively influence dissipative structures in the firm.

Today, firms either adapt to this accelerating complex environment or perish. Survival depends on firms′ adaptability in developing proactive innovations through new products, processes, technologies, or business models in hopes of gaining a competitive advantage (Oliveira-Teixeira & Werther, 2013).

A firm′s innovativeness thus involves the renewal and enlargement of its range of products and services and their associated markets; establishment of new methods of production, supply, and distribution; introduction of changes in structures, management, work organization, and workforce working conditions (Camisón-Zornoza & Monfort-Mir, 2012). Based on these changes, research in strategic management assumes that renovation of the company and its structure enhances the company′s innovative capacity or innovativeness.

The required renovation process involves a reengineering strategy that critically examines current business policies, practices, and procedures, rethinking them to then redesign the mission, critical products, structures, processes, and services (Prasad, 1999). This process is especially important in IS strategies, where internal changes may lead to broader shifts in products, markets, and society as a whole (Chan, 2000), provoking shifts in industrial engineering, systems analysis and design, socio-technical design, and total quality management (Davenport, 1993; Kovacic, 2001).

Strategic initiatives proactively pursued by decision makers in the organization lead to its adoption of innovations, which encourage its innovativeness. Adaptive organizations do not merely react to external environmental changes; they proactively undertake strategic actions that change the environment (Morel & Ramanujam, 1999; Nesij Huvaj & Johnson, 2019; Schneider & Somers, 2006; To et al., 2018). Insufficient integration of the different external and internal agents into the organizational characteristics within firm policies can hamper successful organizational renewal (Heidenreich, 2005; McKelvey, 2016). And if the company cannot self-renew, it will not become innovative, a useful capability in the current competitive environment. That is, the company′s innovativeness is promoted by its adaptation to the external environment and adoption of innovative products, internal processes, and structures, which galvanize it to achieve better organizational performance (Cheng & Chang, 2010; Subramanian & Nilakanta, 1996).

Nevertheless, an organization's external environment is uncontrollable. To be successful, an organization must adapt to changing environmental conditions by altering organizational characteristics such as its structure or processes (Lawrence & Lorsch, 1967; McKelvey, 2016; Morel & Ramanujam, 1999). Furthermore, an organization’s ability to innovate continuously in products and business systems is essential to its future success, as the effect of today's turbulent environment requires organizations to improve their competitive advantage and swiftly respond to changing technology and markets (Lyytinen et al., 2010). The emergent dissipative structures, which lead to flat structures (Oliveira-Teixeira & Werther, 2013), may combine customer or relational capital (knowledge linked to the firm's external relationships) and organizational capital (structures able to transform individual know-how into collective advantage for the firm as a whole). In so doing, they not only spread their competence to local customers, suppliers and collaboration partners but also acquire new innovative assets that improve innovativeness in the company, building and reinforcing its competitiveness in global markets (Husain et al., 2016; Porter & Van der Linde, 1995).

In Social Media, the foregoing discussion essentially implies that changes in a business model require organizations to change their services (Braun & Hadwich, 2016) and processes (Von Sheel, Maamar, & Von Rosing, 2015). An effective strategy supported by an organization is one that can rapidly alter business processes; listen to, identify, and manage risks early on; and generate sales opportunities. Innovativeness in Social Media is thus enhanced by adapting the organization to a new service and value to the customer.

Increase in innovativeness derived from organizational design change in a flexible manner is very likely to stem from sharing relevant information, including integrated information systems for joint problem solving and concurrent engineering (Maiga et al., 2015; Malerba, 2004; Nesij Huvaj & Johnson, 2019). The more renewal capability organizations have, the stronger the innovativeness they develop and consequently the higher the performance they achieve. Taking all of the previous literature into account, we can formulate the following hypothesis:

H6: Dissipative structures positively influence the firm's innovativeness.

Innovativeness can be defined as both the readiness to accept new ideas and the number of new ideas adopted and recognized. It is thus a cultural trait that affects innovative capacity (Hurley & Hult, 1998). If innovativeness is truly an enduring trait, innovative firms will remain highly innovative over time. Since innovativeness is associated with higher financial market valuation and business value, high levels of innovativeness should be associated with high levels of organizational performance (Subramanian & Nilakanta, 1996). Such encouragement includes productivity enhancement, profitability improvement, cost reduction, competitive advantage, inventory reduction, and other measures of performance (Melville et al., 2004).

This understanding of innovativeness is especially crucial for technology firms, which often achieve competitive advantages by delivering new products to the market (Zheng, Liu, & George, 2010). In the technology sector, innovativeness enables companies to create new products built using new technologies and continuously improve products by using the dominant technology (Lyytinen et al., 2010). Such systems thinking builds in virtuous loops, leading to higher innovativeness that encourages high business performance (Woodside, 2005), enabling firms to overcome competitors (Porter & Van der Linde, 1995). Fuller and Swanson (1992) demonstrate this progression in a study of

27 Information Systems Organizations, in which factors enhancing organizational innovations in the firms correlated with the organizations' success. Success occurs because a firm that is innovative has an innovation-oriented attitude, which can determine total sales volumes at the end of the month. It is also understood that innovativeness allows firms to achieve superior performance (Werlang & Rosetto, 2019).

Innovativeness leads to significant improvements in organizational efficiency and effectiveness. Although past studies have obtained conflicting results (Damanpour & Evan, 1992; Dos Santos, Peffers, & Mauer, 1993; Woodside, 2005), organizational performance efficiency is in fact enhanced by adopting more technical innovations and adopting them in a consistent manner (Subramanian & Nilakanta, 1996). Moreover, innovativeness has been significantly and directly associated with organizational efficiency and, in turn, encourages generation of positive financial returns and organizational effectiveness (deposit share). Specifically, complex organizations that adopt a larger number of innovations perform more efficiently than others (Dibrell, Craig, & Neubaum, 2014; Subramanian & Nilakanta, 1996) by promoting flexible planning systems that ensure the firm′s ability to alter its competitive posture by supporting customer needs, exposing new technologies, offering new products and methods of production, or shedding light on future market or technology trends. Such systems are especially important in technology firms, where technology transfer, network processes, and collaborative elements of integrated feedback are shared (Cinelli et al., 2019; Ferraro & Iovanella, 2017; Lyytinen et al., 2010).

Similar reasoning can be extended to the relationships between innovativeness and organizational performance. Organizational innovativeness facilitates the adoption of a large number of innovations, facilitates early adoptions and promotes consistency in the pattern of adoption of a large number of innovations that lead to greater organizational efficiency. Based on Information Systems thinking (Senge, 1990), customers strongly motivate innovativeness, which in turn is positively stimulated by networks with suppliers, distributors, and even employees (Heidenreich, 2005; Maiga et al., 2015). Furthermore, through intensification of inter- and intra-company networks, technology transfer programs and marketing initiatives to collaborate strengthen innovativeness for businesses, enabling taking up and starting new activities and attracting new firms (Heidenreich, 2005). Promotion of a learning community both inside and outside the firm is especially important to this goal, as the creation of new units, growing renovation of firms with digital strategies, proactive focus, and innovativeness of the organization are involved in the process of enabling higher performance.

In this vein, Woodside (2005) finds that nurturing customer orientation within the firm is a particularly useful strategy for innovativeness to increase performance. Innovativeness enables organizational performance by changing the way the company is organized, improving quality and reducing costs.

Multimedia technologies and connections between companies and institutions similarly enhance innovativeness in the firm through accumulation and transfer of technological, commercial, and cultural information among all companies and institutions involved in those activities. These connections create new opportunities for growth and dissemination of the firm by taking advantage of know-how, which stimulates effective competition to obtain competitive advantage over competitors (Albino et al., 1998). Sometimes termed collaborative innovation networks in the current literature, these connections involve members that act as hubs, constituting an attractive environment in which to create innovation (Cinelli et al., 2019) within organizations. They represent a valid organizational system able to sustain novel processes, achieve effects that generate innovative organizations (Cinelly et al., 2019), and simultaneously increase performance (Ferraro & Iovanella, 2017).

Innovative organizations have identifiable organizational characteristics that distinguish them from their non-innovative counterparts (Damanpour, 1987). Since innovation encourages aggressive and creative strategies to achieve higher levels of performance, it is considered as an integral dimension of organizational strategy (Miles & Snow, 1978). Functioning as a mechanism of differentiation between one firm and another, innovativeness has become an essential prerequisite for competitive advantage and a determinant of performance (Van de Vrande, De Jong, Vanhaverbeke, & De Rochemont, 2009). The adoption of innovativeness energizes the adapting organizations and increases their organizational performance, as high levels of innovativeness are expected to yield high levels of organizational effectiveness. In sum, innovative firms display a consistently high level of innovativeness over time, leading to higher revenues, which ultimately translate into higher organizational performance. Consequently, prior literature allows us to hypothesize:

H7: Innovativeness of the firm positively influences organizational performance.

3 RESEARCH METHODS

3.1 Data Collection

Prior to the primary data collection, several general managers, academics and consultants knowledgeable about complexity, information systems, and Social Media reviewed the measurement scales and the questionnaire for content, wording, and comprehensibility. Based on feedback from these interactions, we refined the questionnaire. We then pre-tested the refined version of the instrument with a random sample of fifteen general managers selected from database. After incorporating changes based on the responses to the pretest, we administered our instrument to firms in the technology sector in Spain. The sample was selected from the Sabi and Amadeus Databases.

We chose a relatively homogeneous geographical, political, legal, and cultural space in order to minimize the impact of the variables that cannot be controlled in the empirical research (Fernández-Pérez, Lloréns-Montes, & García-Morales, 2014). CEOs were our key informants, as they have information on all departments of the organization, and their actions and plans determine support for the Information Systems and Social Media to achieve organizational goals and improvements in performance (Baer & Frese, 2003; Westphal & Fredickson, 2001). Although some preliminary steps were taken to ensure that the CEOs were key informants, we added several questions to assess the informant's knowledge about the strategic research variables in the questionnaire. The mean score for each item indicated that the respondents were appropriate. We established a list of the organizations′ CEOs with the help of partial funding from the Spanish Ministry of Science and Research, and the Local Council for Economy, Innovation, and Science of Andalusia's Regional Government. A sample of 850 Spanish firms was selected randomly and several calls made and emails sent to each business from January to March 2017, increasing the response rate. The total number of completed valid questionnaires was 201 (23.64% response rate).

To increase the response rate, a report was offered summarizing the results of the study. We kept all individual responses completely confidential, providing information on an aggregate level to reduce possible desirability bias. We examined the data to assess potential problems of nonresponse bias and differences between early and late respondents. To test for nonresponse bias, we used Chi-square and t-tests to compare number of employees and annual sales for responding and non-responding firms. We found neither statistically significant differences nor evidence of any systematic difference between early and late respondents (Armstrong & Overton, 1977).

3.2 Measurement

With the exception of organizational performance and control variables, all constructs in the survey were measured by developing multi-item scales with seven-point Likert responses. A precise effort was made to adapt existing validated measures from prior studies for the latent constructs to make them more suitable to this study. Objective measurements were used for organizational performance. Appendix A displays the items used in this study.

Social Media: We reviewed existing literature as a basis for developing the three dimensions that guided construction of this scale (e.g., García-Morales et al., 2014; Martín-Rojas et al., 2013). Using previous scales, we drew up Likert-type seven-point scales (1 "totally disagree", 7 "totally agree") to measure Social Media (technological) knowledge capabilities (Real, Leal, & Roldan, 2006), Social Media skills (Byrd & Davidson, 2003; Ray, Muhanna, & Barnety, 2005), and Social Media support (Choudhury & Harrigan, 2014; Harrigan, Soutar, Choudhury, & Lowe, 2015; Jussila et al., 2014; Kärkkäinen, Kempa, & Puglisi, 2013; Nguyen, Yu, Melewar, & Chen, 2015; Suh, Shin, Ahuja, & Kim, 2011). We performed confirmatory factor analysis (CFA) and validated the six items on Social Media (technological) knowledge capabilities (χ^2_9=23.45, Normed Fit Index [NFI]=.99, Non-Normed Fit Index [NNFI]=.99, Goodness of Fit Index [GFI]=.99, Comparative Fit Index [CFI]=.99, Incremental Fit Index [IFI]=.99), three items on Social Media skills, and nine items on Social Media support (χ^2_{27}=69.89, NFI=.99, NNFI=.99, GFI=.99, CFI=.99, IFI=.99). The scales were one-dimensional and had high validity and reliability. We calculated the arithmetic mean of the items for each measurement and obtained a three-item scale to measure Social Media (a high score indicated a good level of Social Media knowledge, capabilities, skills, and support).

Connections: We used two items from Peng and Luo (2000) and Fried et al. (1998) to measure the number (1 "Not at all", 7 "To a great extent") and frequency (1 "Very often", 7 "Not very often") of connections with the different groups, sources of information, and knowledge. We asked each agent about these two issues and calculated the mean of the responses. Based on the Eurostat Community Innovation Survey, we selected the different potential agents to provide information and knowledge. We classified these agents into four information sources (Leiponen & Helfat, 2010; Veugelers & Cassiman, 1999), distinguishing among internal information sources (within your enterprise or enterprise group), market sources (suppliers of equipment, materials, components, or software; clients or customers; competitors or other enterprises in your industry; consultants and commercial labs), education and research institutes sources (universities or other higher education institutions; government, public or private research institutes), and other sources (conferences, trade fairs, exhibitions; scientific journals and trade/technical publications; professional and industry associations). Afterwards, we calculated the arithmetic mean of the items from each group to obtain a four-item scale. We also performed CFA to validate the scale (χ^2_2=24.90, NFI=.99, NNFI=.97, GFI=.99, CFI=.99, IFI=.99), which showed good validity and reliability.

Heterogeneous Agents: Following previous research (Powell & Brantley, 1992; Scott, 1991), we analyzed the heterogeneous and diverse agents with which the organization had contact, using a seven-point Likert scale (1 "Few", 7 "A lot"). After classifying the agents into four groups (internal information sources, market sources, education and research institute sources, and other sources), we calculated the arithmetic mean of the items from each group to obtain a four-item scale. CFA was performed to validate the scale (χ^2_2=22.81, NFI=.98, NNFI=.98, GFI=.99, CFI=.99, IFI=.99), which had good validity and reliability.

Innovativeness: We used Likert-type seven-point scales (1 "totally disagree", 7 "totally agree") of four items developed by Knight (1997) and Zahra (1993) to measure innovativeness. The items were adapted to the present study. We performed CFA to validate the scale (χ^2_2=15.36, NFI=.99, NNFI=.99, GFI=.99, CFI=.99, IFI=.99), which was one-dimensional and had good validity and reliability.

Dissipative Structures: Using past studies (Martín-Rojas et al., 2013; Zahra, 1993), we measured dissipative structures using a five-item scale adapted to this investigation. We validated the scale with CFA (χ^2_5=34.60, NFI=.99, NNFI=.99, GFI=.99, CFI=.99, IFI=.99). The scale was one-dimensional and had good validity and reliability.

Organizational Performance: Some researchers have used managers' subjective perceptions to measure beneficial outcomes for firms, while others prefer objective data such as return on assets, return on equity, or return on sales. As literature has established high correlation and concurrent validity between objective and subjective data on performance (Homburg, Krohmer, & Workman, 1999; Venkatraman & Ramanujam, 1986), it is possible to use subjective data if no objective data are available. Although the subjective data we obtained from the questionnaire correlated closely with the objective data, our study used a scale of three objective and precise quantitative measures for analyzing firm results. First, we used Return on Assets (ROA) computed as net income divided by total assets. An indicator of management efficiency, ROA is used to measure performance (Al-najjar, 2015; Athanasoglou, Brissimis, & Delis, 2008; Bharadwaj, 2000; Chen, 2010; Liu & Hung, 2006; Santhanam & Hartono, 2003). Second, Return on Equity (ROE), widely used to measure profitability of firms, is defined as net income divided by total equity (Al-najjar, 2015; Athanasoglou et al., 2008; Bharadwaj, 2000; Chen, 2010; Liu & Hung, 2006). Third, Return on Sales (ROS), the ratio of net income to sales, is another indicator of a firm's net profit margin (Bharadwaj, 2000; Santhanam & Hartono, 2003). The scale was one-dimensional and had good validity and reliability.

Control Variables: Several control variables (e.g., firm size and industrial sector) were used to account for other potential sources of influence on organizational performance in this study. Firm size was included as a control because it may be associated with firm performance (Camps & Luna-Arocas, 2009; Lin & Liu, 2016). The effect of size on organizational performance was found to be a strategic factor. Some authors find that firm size has a positive relationship to organizational performance. Others obtain a negative or insignificant influence (Garrido-Moreno, García-Morales, Lockett, & King, 2018; Khatab, Massood, Zaman, Saleem, & Saeed, 2011). Given this lack of consensus, many scholars include size as a firm-specific factor in their studies (Sritharan, 2015). Consistent with prior studies, we used the logarithm of the number of employees to operationalize firm size. We also used sector. Since competitors and the nature of competition vary in different markets and industries, organizational performance can be influenced by the sector in which the firm operates, necessitating analysis of sector influence (Gabrielsson, Seppälä, & Gabrielsson, 2016; Lloréns-Montes, Ruiz-Moreno, & García-Morales, 2005, Thornhill & White, 2007). A dummy coded variable was constructed to control for sector (manufacturing with high-technology, manufacturing with medium-high technology).

4 RESULTS

4.1 Measurement Model Analysis

The research model was tested through structural equation modeling (SEM). This statistical technique is used to test and estimate causal relations from a combination of statistical data and qualitative causal assumptions, enabling decomposition of the total direct effects into direct and indirect effects and testing for goodness of fit of the model as a whole. We used the statistical software LISREL 8.8. Following the two-step approach by Anderson and Gerbin (1988), we initially estimated a measurement model before examining the structural model relationships. This measurement model presents very good model fit (χ^2 (249 d.f.)=329.48 ($p>0.01$); NFI=0.98; NNFI=0.99; IFI=0.99; Parsimony Goodness of Fit Index [PGFI]=0.55; Estimated Non-centrality Parameter [NCP]=80.48; Relative Fit Index [RFI]=0.98; CFI=0.99; Root Mean Square Error of Approximation [RMSEA]=0.04). Testing the measurement model involved estimation of internal consistency, and convergent and discriminant validity of the measurement items included in our survey instrument. To assess the items′ measurement properties, we used Cronbach's alpha (Nunnally & Bernstein, 1994), average variance extracted (AVE), and composite reliability (Fornell & Larcker, 1981; Hair, Anderson, Tatham, & Black, 2009). Alpha coefficient values ranged from 0.90 to 0.96, well above the recommended 0.707 threshold (Nunnally & Bernstein, 1994). Composite reliabilities ranged from 0.91 to 0.97, above the recommended minimum of 0.70, and each AVE was above 0.50 (range from 0.73 to 0.90), indicating that the measurements are reliable and the latent constructs account for at least 50% of item variance. The significance of the factor loadings was also appropriate. Each loading (λ) was significantly related to its underlying factor (t-values>1.98). Collectively, the results shown in Table 1 (Cronbach's alpha, composite reliability, AVE, factor loadings, and t-values) suggest that the indicators account for a large portion of the variance in the corresponding latent constructs, providing support for convergent validity of the measures (Gefen, Straub, & Boudreau, 2000).

Insert Table 1 about here

To determine discriminant validity, we calculated the square root of the AVE for each construct and determined that these were greater than their correlations with any other construct (Fornell & Larcker, 1981). As can be inferred from the inter-construct correlation matrix in Appendix B (values on the diagonal represent the square root of the AVE of each construct), all constructs display sufficient discriminant validity. Tests also determined that no confidence interval in estimation of the correlation between each pair of factors contained the value 1, indicating that each construct differs from others, supporting discriminant validity (Anderson & Gerbin, 1988; Fornell & Larcker, 1981).

To further assess validity of our measurement instrument, a cross-loading table (see Appendix C) was constructed (Gefen et al., 2000). The table shows that each item loads much higher on its assigned construct than on the other constructs, supporting adequate convergent and discriminant validity. The items in this exploratory factor analysis should generally load above 0.30 on their corresponding conceptualized factors and have poorer cross-loadings on other factors (Costello & Osborne, 2005). All of our item loadings were higher than 0.58, and all item loadings exceeded cross-loadings.

Because our research design is based on a single respondent and mainly self-reported data, common methods bias is at least a potential concern. We used several procedures to determine whether common method bias threatened interpretation of the results. First, we incorporated several measures suggested by Podsakoff, Mackenzie, Lee, and Podsakoff (2003) into the study design to minimize this effect and reduce common-source bias: clearly communicating study goals and assuring respondents of the survey's anonymity, using previously well-tested and validated scales to reduce item ambiguity by randomizing order of presentation of the survey items across the subjects. Most issues examined in this research pertain to organizational actions rather than individual cognitions. Further, individuals responding to the survey questionnaire possessed both appropriate knowledge about constructs and specific organizational responsibility in the organization. These steps together minimize common method bias (Pandey, Wright, & Moynihan, 2008). Second, we tested for possibility of common method bias using Harman's one-factor test by conducting exploratory factor analysis (Konrad & Linnehan, 1995; Podsakoff & Organ, 1986). The rationale for the test was that, if common method bias poses a serious threat, a single latent factor would account for all manifest variables or one general factor would account for most of the covariance among the measurements. In this study, the one-factor model obtained using principal components analysis yielded several factors with eigenvalues greater than 1.0, which accounted for 79% of the total variance. A substantial amount of method variance does not appear to be present, since several factors, not just one single factor, were identified, and because the first factor did not account for the majority of the variance (Podsakoff & Organ, 1986). Third, other researchers have used CFA to test for common method bias. In this study, the fit was worse for the one-dimensional model than for the measurement model (RMSEA [Δ=.053], NFI [∇=.02], CFI [∇=.03], ECVI [Δ=2.24], AIC [Δ=447.34]). Worse fit for the one-factor model suggests that common method variance does not pose a serious threat. Fourth, another approach is to add a first-order factor with all measures as indicators to the researcher's theoretical model. We compared indicator loadings before and after adding the common latent factor and found no differences greater than 0.200, indicating that common method bias was not a major threat in our data set (Podsakoff et al., 2003). These tests confirm that the study's constructs do not suffer from common method bias.

4.2 Structural Model Analysis

Based on the theory and following the two-step approach (Anderson & Gerbin, 1988), we proposed a structural model (Figure 1). We used a recursive non-saturated model, taking Social Media (ξ_1) as the exogenous latent variable, connections (η_1) as the first-grade endogenous latent variable, and heterogeneous agents (η_2), innovativeness (η_3), dissipative structures (η_4), organizational performance (η_5), size (η_6), and sector (η_7) as the second-grade endogenous latent variables. Structural equation modeling (SEM) takes into account measurement errors, variables with multiple indicators, and multiple-group comparisons. Table 2 summarizes the descriptive statistics and correlations among the variables used in analysis of the model.

Insert Figure 1 and Table 2 about here

The covariance and asymptotic covariance matrix was used to conduct data analysis. We analyzed the structural paths proposed by the hypotheses; the estimated direct, indirect, and total effects; and the goodness of fit of the global model. Table 3 presents the statistical results of the structural model. All estimated standardized paths indicate significant relationship among the constructs (Figure 2) with good overall fit of the structural model (χ^2 (265 d.f.)=403.67 (p>0.01); NFI=0.97; NNFI=0.99;

IFI=0.99; PGFI=0.58; NCP=138.67; RFI=0.97; CFI=0.99; RMSEA=0.05). All relationships in the model tested were statistically significant, providing support for all of the study hypotheses.

Insert Figure 2 and Table 3 about here

Hypothesis 1, which predicted a positive relationship between Social Media and connections is strongly supported (γ_{11}=0.34 p<.01). Hypothesis 2, predicting a positive relationship between Social Media and heterogeneous agents (γ_{21}=0.68 p<.001), is also supported. Furthermore, the findings show an indirect effect of Social Media through heterogeneous agents on connections (0.40, p<.001, see Bollen 1989 for calculation rules). The total influence of Social Media on connections is thus 0.74 (p<.001), as predicted in Hypothesis 1. The results support Hypothesis 3, which indicated that heterogeneous agents are positively related to connections (β_{12}=0.59 p<.001). Comparing the magnitudes of these effects, we observe that the effect of Social Media on connections is larger than that of Social Media on heterogeneous agents. Globally, heterogeneous agents (R^2=0.47) and connections (R^2=0.74) are well explained by the model. The relationships between connections and innovativeness (β_{31}=0.34 p<.01) and connections and dissipative structures (β_{41}=0.70 p<.001) were supported, as predicted in Hypotheses 4 and 5. Furthermore, we find an indirect effect of connections on innovativeness through dissipative structures (0.28, p<.05). The total influence of connections on innovativeness is thus 0.62 (p<.001), as predicted in Hypothesis 4. The results support Hypothesis 6, that dissipative structures are positively related to innovativeness (β_{34}=0.40 p<.01). Comparing the magnitudes of these effects shows that the effect of connections on innovativeness is larger than that of dissipative structures on innovativeness. Innovativeness (R^2=0.46) and dissipative structures (R^2=0.48) are well explained by the model.

Results also show that innovativeness is influenced indirectly both by heterogeneous agents (0.37, p<.001) through connections (0.59x0.34) and connections-dissipative structures (0.59x0.70x.0.40), and by Social Media (0.46, p<.001) through heterogeneous agents-connections (0.68x0.59x.0.34), heterogeneous agents-connections-innovativeness (0.68x0.59x.0.70x0.40), connections (0.34x0.34), and connections-dissipative structures (0.34x0.70x0.40). The variable dissipative structures is also influenced indirectly by heterogeneous agents (0.41, p<.001) through connections (0.59x0.70) and by Social Media (0.52, p<.001) through connections (0.34x0.70) and heterogeneous agents-connections (0.68x0.59x.0.70). Comparing the magnitudes of these effects, we observe that the effect of connections on dissipative structures is larger than that of Social Media or heterogeneous agents. Finally, results show that organizational performance is influenced significantly by innovativeness (β_{53}=.49, p<.05), supporting Hypothesis 7. Organizational performance is also significantly and indirectly influenced by connections (0.30, p<.05) through innovativeness (0.34x0.49) and dissipative structures-innovativeness (0.70x0.40x0.49). Comparing the magnitudes of these effects, we observe that the effect of innovativeness on organizational performance is larger than that of dissipative structures, connections, heterogeneous agents, or Social Media on organizational performance. Overall, organizational performance (R^2=0.24) is well explained by the model. R^2 values for all endogenous constructs exceed 10%, implying a satisfactory and substantive model (Falk & Miller, 1992). Size (β_{56}=-0.05 p>.10) and sector (β_{57}=0.04 p>.10) effects on organizational performance are not significant.

We compared the fit of the proposed model to that of alternative models to confirm that the hypothesized model is the best representation of the data (Bollen & Long, 1993). Comparison of the goodness of fit indices enables us to determine whether better alternative models exist (Hair et al., 2009). Table 4 presents the comparison of the models. For example, if we compare Model 1 (proposed structural model) to Model 2, we see that, although the fit indices are similar across the two models, the omission of the direct path does not significantly improve model fit (difference in χ^2=12.73, difference in d.f. = 1, p >0.1) and the second model has a worse RMSEA (Δ=0.002), ECVI (Δ=0.05), AIC (Δ=10.73), and NCP (Δ=11.77). The proposed model represents the most acceptable and parsimonious model. The same occurs with the other alternative models proposed.

Insert Table 4 about here.

5 DISCUSSION AND CONCLUSIONS

5.1 Key Findings and Insights

Drawing on complexity science, we developed a conceptual framework to explain how Social Media, as emergent IS phenomena, can help firms to create business value, leveraging networks effects and knowledge flows. Our results confirm that the use of Social Media as a cornerstone of their digital strategies can help firms properly to address the growing challenges posed by complexity.

The current dynamic environment with hyper-competitive conditions makes disruptive innovations indispensable to improve firms′ performance in society (Gnyawali et al., 2010; Lyytinen et al., 2010). This need is especially significant with the advent of Social Media, which has emerged as a highly promising set of tools and approaches to connect and share information with third parties, enabling firms to establish networking competences (Corral de Zubielqui et al., 2016). Social Media creates valuable connections that transform business models, changing the way different agents and organizations communicate with each other, in turn creating a vast array of new (internal and external) opportunities for firms (Aral et al., 2013).

We based our study on complexity science because the emergence of the network economy has caused a paradigm shift in IS, and complexity science provides the appropriate concepts and tools for examining and explaining this shift (Merali, 2006). Building on complexity theory, our study empirically explains the different stages through which Social Media use translates into organizational performance. Firstly, it describes how Social Media helps firms to increase their connections with relevant agents and to leverage knowledge gained from these heterogeneous agents. Second, network connections act as main drivers of the firm′s innovativeness and internal self-renewal, through dissipative structures. Finally, renewed dissipative structures promote increased innovative behaviors, positively impacting organizational performance. Our results represent a first attempt to explain how Social Media can be used to cope with increasing complexity, promoting changes in behavioral dynamics in complex ecosystems. By using digital networks strategically, firms can exploit knowledge flows to face new managerial challenges posed by increased complexity, especially in changing technological, entrepreneurial, and competitive environments (Roundy et al., 2018).

Focusing on Complex Systems, Van De Ven (2005) argues that entrepreneurial actions taken by individual firms are inadequate to explain the innovation and diffusion of complex systems because innovation is a collective achievement. Different actors and coordinating actions among them lead to successful innovation only after they mobilize the necessary resources and enable specific configurations of actor networks (Gnyawali et al., 2010; Yoo, Lyytinen, & Yang, 2005). Innovativeness must thus face ongoing relationships in the current dynamic environment, where the conditions for rapid knowledge sharing are created as innovative organizational capital, which supports intelligent working dissipative structures to combine global and local capabilities (Gnyawal et al., 2010; McKelvey, 2016; Nicolescu, Huth, Radanliev, & De Roure, 2018). Our results confirm how the current uncertain environment enhances innovativeness through new, redesigned structures (Albino, Schiuma, & Sivo, 1998; McKelvey, 2016; Lyytinen et al., 2010) and connections among diverse heterogeneous agents (Corral de Zubielqui et al., 2016; Ferguson & Soekijad, 2016) through Social Media (Fulk & Yuan, 2013; Treem & Leonardi, 2012) in complex environments. All of these interactions also lead to higher firm performance.

In sum, since rich forms of digital technologies have become an essential element of everyday life, it seems critical to examine how increased digitization affects the way organizations innovate (Jarvenpaa & Tanriverdi, 2003; Ransbotham et al., 2016). Our paper advances research in this line by analyzing how Social Media improves alliances and organizational networks in complex environments where firms especially demand connections with large numbers of different agents. The more heterogeneous the agents, the better knowledge flows achieved. Social Media thus also improves knowledge flows between heterogeneous agents and the firm. And Social Media and heterogeneous agents together lead to better and more flexible organizational connections. Our paper also sheds light on how degree of connectivity enhances innovativeness for the company to properly exploit new knowledge obtained and enable dissipative structures, as well as how these dissipative structures encourage innovativeness to obtain higher performance by exploiting alliance networks in today′s complex society.

5.2 Contributions to Research

Although complexity science has proven to be a valid theoretical lens to examine current challenges in the IS arena (Merali & McKelvey, 2006), research to date has not fully explored how specific tools such as Social Media interact with complexity concepts, enabling firms to create real business value.

Building on prior research, our study provides three main contributions to the IS and innovation literature.

First, by empirically investigating the global impact of Social Media use on organizational performance, it enhances our understanding of how these platforms create real value in current complex environments. Measuring the impact and value of Social Media on organizations warrants a great deal of additional attention (Aral et al., 2013), and our study helps to advance research on this topic. In the new digital economy, where inter-organizational collaboration and innovation are increasingly central to organizational effectiveness, more attention must be paid to social networks and the specific platforms supporting these interactions to better capture its organizational nature. Our conceptualization of Social Media provides richer understanding and appreciation of its strategic role in organizations and thus contributes to the IS literature by examining the value of Social Media use in the context of complexity theory, explaining how Social Media platforms can be used to foster valuable networks to cope with emerging challenges posed by current complex business ecosystems.

Second, our analysis helps to increase organizational and individual network awareness within and outside the organization. In an increasingly networked environment where open innovation flows are fundamental, our study empirically confirms prior research claiming that firms may achieve new knowledge through social networks and related knowledge flows (Tanriverdi, 2006) that support significant collaboration among heterogeneous agents. Such behavior has large-scale effects on enhanced innovative ability of network agents. The process of information exchange between individuals, companies, and institutions can be strongly supported—for instance, by multimedia technologies and computer networks, which enable similar transformations in the art of invention and innovation in firms′ processes and structural effects (Lyytinen, Yoo, & Boland Jr., 2016). These technologies enable accumulation and transfer of technological, commercial, and cultural information among all companies and institutions involved in the maintenance activities, creating new opportunities for growth and dissemination of this know-how (Albino et al., 1998; Meagher & Rogers, 2004). Research also notes that innovation emerges when a critical threshold of transactions and variety of agents is achieved, giving rise to sustained communication patterns within innovation networks (Corral de Zubielqui et al., 2016).

Third, our study contributes to complexity theory by empirically examining relevant complexity "ingredients" such as connections, heterogeneous agents, innovativeness, and dissipative structures. By combining these concepts with the use of relevant IS platforms like Social Media, our study is a first response to a recent research call to examine the effects of our modern digital world on complexity dynamics and concepts (McKelvey, 2016). Assuming that IT-enabled interconnections and interdependencies increase the complexity of business ecosystems (Ransbotham et al., 2016; Tanriverdi et al., 2010), our study shows the specific sequence firms must follow to exploit Social Media use to face a complex scenario. Our results support the view that firms must renew themselves to achieve global sustained innovation and outdo effective competition to obtain a competitive advantage over competitors. If firms do not exploit this innovation, up-to-date connectivity may overflow or congest their absorptive and learning processes, preventing new knowledge from flowing flexibly from one company to another (Luk et al., 2008). Such knowledge is tacit and can be difficult to transfer across longer distances and different people, enabling the company to obtain a sustainable competitive advantage (Cheng & Chang, 2010; Porter & Van der Linde, 1995). Innovativeness is also required when dissipative structures are present because connectivities can produce radical and discontinuous changes (Gay & Dousset, 2005). Exploitation of heterogeneous agent synergies thus leads to higher corporate performance (Tanriverdi, 2006).

5.3 Contributions to Practice

This study has also significant implications for practice, giving managers useful insights into how to materialize business benefits from Social Media use to manage complex networks. Internal and external networks require considerable IS infrastructure, software, and applications in the company, since new communication tools, network connection, standard data structure, unified coding standards, or electronic data interchange impact firm profitability (Kung et al., 2015; Maiga, Nilsson, & Ax, 2015) and improve performance. Following previous scholars (Heidenreich, 2005; Lyytienen et al., 2016; Maiga et al., 2015; Tanriverdi, 2006), we stress that developing networks with suppliers, distributors, customers (among others) can change the way the company is organized, improve quality, and reduce product cost. Such results are very likely to come from sharing relevant information, including integrated information systems for joint problem solving and concurrent engineering (Maiga et al., 2015).

Intensification of inter-company networks has also been shown to strengthen innovativeness for businesses, initiate activities and attract new firms (Heidenreich, 2005). These activities enable firms to innovate more broadly with new service models and associate new technologies and knowledge with infrastructures (Yoo et al., 2005). If we assume that creation of connectivities is only possible when technology transfer occurs with research centers, business incubators, and marketing initiatives to achieve collaboration between institutions, managers must foster such collaboration. Then, organizations should promote the use of IT-based platforms such as Social Media to establish valuable connections, at both intra- and inter-organizational level, fostering knowledge transfer among these networks.

Connectivity can also renew firms internally, since the emergent innovation in existing businesses facilitates start-up activities and attracts new firms by intensifying inter-company networks, clients, suppliers, competitors, new research facilities, academic institutions, non-profit research institutes, company incubators, and technology transfer institutions. These interactions may result in innovative projects, new ventures, and start-ups communities (Roundy et al., 2018) because innovative endeavors give rise to new industrial streams or technological paths that crystallize in the form of new institutions, providing input for existing businesses and creating positive feedback loops (Corral de Zubielqui et al., 2016). Such continuous transformation leads to exploitation of dissipative structures to transform firms and innovativeness (Arıkan, 2010). Managers must realize, however, that insufficient integration of networks within the company can hamper successful firm renewal.

Managers must be open to novel ways of organizing, perform cognitive changes, and share these changes with others in the network (Boland & Tenkasi, 1995), relying on digital technologies. These novel ways of doing include new enterprise platforms (enterprise resource planning and customer relationship management), new consumer products (smartphones and Amazon's Instant Video service), and existing products substantially enhanced by the addition of digital technology (e.g., digital infotainment systems). This robust digital technology enables creation of new innovation networks that deserve to be exploited, networks that may include Internet of things and global wireless networks, continued miniaturization, cloud computing CAD/CAM systems, product and project management platforms, customer feedback systems, and crowdsourcing platforms (Lyytienen et al., 2016; Bygstad, 2017; Nicolescu et al., 2018).

Additionally, this paper′s focus of empirical analysis on the technology sector yields significant implications for managers of high-tech companies, which operate in high-speed environments under extreme time pressure and conditions of rapid technological change and uncertainty (Han & McKelvey, 2008). As this sector is characterized by increased complexity, the framework developed is useful to explain the importance of using Social Media systems as a mechanism in facilitating effective knowledge transfer between different agents in this context. By enhancing connectivity, these tools can help technology firms to capture valuable ideas to develop successful innovations. In complex, uncertain, and heterogeneous environments such as the high-tech industry, knowledge is produced, transformed, and stabilized. Emergent innovation then exploits this knowledge through specific connections, which enable the emergence of dissipative structures, leading to continued expansion and reconfiguration of innovation networks.

5.4 Limitations and Future Research Directions

First, this study used Harman's one-factor test and various other tests to determine that common method variance was not a problem (Podsakoff & Organ, 1986; Konrad & Linnehan, 1995). It is incorrect to assume that using a single method produces systematic bias (Spector, 2006). We used measurements from diverse data sources (CEOs′ perceptions, objective data on organizational performance from the Sabi and Amadeus databases) to reduce the influence of response bias (Podsakoff et al., 2003). Drawing on prior research, we chose CEOs as key respondents because they had knowledge of the strategic variables analyzed (Shortell & Zajac, 1990). Future studies could, however, include data from employees or other stakeholders of the organization to provide a more complete view of the phenomenon studied.

Second, future research must develop longitudinal studies to explore how the dynamic nature of the variables in our analysis evolves over time and to identify possible reciprocal processes. Our research tried to reduce this limitation by paying special attention to theoretical arguments, integrating temporal considerations into measurement of the variables, and rationalizing the relationships analyzed

(Garrido-Moreno, Lockett, & García-Morales, 2014; Hair et al., 2009). The potential limitations mentioned derive from the nature of the sample used in this study, a sample limited to Spanish organizations in the technology sector. Future research should analyze a larger sample, preferably from other countries and sectors, to test whether the model relations are generalizable to other research contexts.

Finally, the model analyzes the relationship between Social Media and organizational performance through different entrepreneurial complexity-ingredients, such as heterogeneous agents, connections, innovativeness, and dissipative structures. Although an acceptable proportion of organizational performance (24%) is explained by these variables, future studies could consider other complexity-ingredients, such as emergent strategies (Mintzberg & Waters, 1985), learning (Senge, 1990), organizational culture (Frank & Fahrbach, 1999), or design (Galbraith, 1982), among others.

In identifying future lines of research, we find, despite the topic′s importance, a shortage of literature on digital complexity from a Social Media point of view. Social network models significantly under-theorize the role of digital infrastructures as critical connections (Bygstad, 2017) in which new technologies and innovativeness shape relationships among heterogeneous actors and firms. Future research should examine the tasks of effectively managing inter- and intra-organizational networks, as firms′ knowledge resources are important for organizational leaders (Jarvenpaa & Tanriverdi, 2003). Organizational design and IS literature may benefit from this knowledge resource, as firms are moving to transition from hierarchical structures to flat organizations that enable better knowledge flows among business units. Future studies can use the proposed framework as a guide or lens to examine how Social Media use enables connectivity and networking in different contexts, fostering innovativeness and dissipative structures, and creating value for the firm.

5.5 Conclusions

The present study contributes to research and practice through the theoretical development and empirical testing of a research model that links Social Media use to organizational performance. Drawing on complexity theory, we analyze empirically a sample of 201 technological companies in Spain to examine the relationships between Social Media, connections, heterogeneous agents, innovativeness, dissipative structures, and organizational performance. The overall results support all hypotheses developed in the study, suggesting that digital technologies like Social Media are a valuable tool for facing increased complexity in current changing markets. Social Media platforms support interactions and connectivity with a wide range of heterogeneous agents, enabling firms to capture important knowledge from them. This knowledge can be leveraged not only to foster external innovativeness by developing new products and services, but also to self-renew internally as a result of this new knowledge, through the emergence of dissipative structures. Globally, the results suggest that Social Media use and the resulting connectivity with different agents are important learning mechanisms that enable knowledge sharing and innovation in a digital ecosystem. The proposed research model should help firms achieve higher performance, innovativeness, and success in our changing world. Our study is a first attempt to connect IS research, recent findings about social network theories, and key elements of complexity science to provide a solid explanation of how Social Media can be used to face the emergent challenges posed by increased digital complexity.

6. References

Ahuja, G. (2000). Collaboration networks, structural holes, and innovation: A longitudinal study. *Adm. Sci. Q., 45*(3), 425-452.

Albino, V., Schiuma, G., & Sivo, G. (1998). Firm networks for building maintenance and urban renovation: The technological and organisational evolution. *Eur. J. of Purch. & Supply Manag.,* 4, 21-29.

Al-najjar, B. (2015). Does ownership matter in publicly listed tourism firms? Evidence from Jordan. *Tour. Manag.,* 49, 87-96.

Anderson, J. C., & Gerbing, D. W. (1988). Structural equation modeling in practice: A review and recommended two-step approach. *Psychol. Bull., 103*(3), 411–423.

Antonacopoulou, E., & Chiva, R. (2007). The social complexity of organizational learning: The dynamics of learning and organizing. *Manag. Learn., 38*(3), 277-295.

Aral, S., Dellarocas, C., & Godes, D. (2013). Introduction to the Special Issue—Social media and business transformation: A framework for research. *Inf. Syst. Res., 24*(1), 3-13.

Arıkan, A. T. (2010). Regional entrepreneurial transformation: A complex systems perspective. *J. of Small Bus. Manag., 48*, 152-173.

Armstrong, J. S., & Overton, T. S. (1977). Estimating nonresponse bias in mail surveys. *J. of Mark. Res.,* 14, 396-402.

Ashby, W. R. (1968). Principles of self-organizing systems. In W. Buckley (Ed.), *Modern systems research for the behavioral scientist* (pp. 255-278). Chicago: Aldine.

Athanasoglou, P. P., Brissimis, S. N., Delis M. D. (2008). Bank-specific, industry-specific and macroeconomic determinants of bank profitability. *J. of Int. Financial Mark., Inst. and Money, 18*(2), 121-136.

Baer, M., & Frese, M. (2003). Innovation is not enough: Climate for initiative and psychological safety, process innovations, and firm performance. *J. of Organ. Behav.*, 24, 45-68.

Bak, P. (1996) *How nature works: The science of self-organized criticality*, New York: Copernicus.

Bardi, E. J., Raghunathan, T. S., & Bagchi, P. K. (1994). Logistics information systems: The strategic role of top management. *J. of Bus. Logist., 15*(1), 71-85.

Barney, J. (1991). Firm resources and sustained competitive advantage. *J. of Manag.,* 17, 99-120.

Benbya, H., & McKelvey B. (2006). Using coevolutionary and complexity theories to improve IS alignment: A multi-level approach. *J. of Inf. Technol.,* 21, 284-298.

Bharadwaj, A. S. (2000). A resource-based perspective on information technology capability and firm performance: An empirical investigation. *MIS Q., 24*(1), 169-196.

Bharadwaj, A., El Sawy, O. A., Pavlou, P. A., & Venkatraman, V. (2013). Digital business strategy: Toward a next generation of insights. *MIS Q., 37*(2), 471-482.

Bhimani, H., Mention, A. L., & Barlatier, P. J. (2019). Social media and innovation: A systematic literature review and future research directions. *Technol. Forecast. and Soc. Change,* 144, 251-269.

Bigliardi, B., & Galati, F. (2016). Which factors hinder the adoption of open innovation in SMEs?. *Technol. Anal. & Strat. Manag., 28*(8), 869-885.

Bisgin, H., Agarwal, N., & Xu, X. (2010). Investigating homophily in online social networks. *Proceedings of the 2010 IEEE/WIC/ACM International Conference on Web Intelligence and Intelligent Agent Technology*, 533-536.

Boland, R. J., & Tenkasi, R. V. (1995). Perspective making and perspective taking in communities of knowing. *Organ. Sci.,* 6, 350-372.

Bollen, K. A. (1989). *Structural Equations with Latent Variables*. Michigan (USA): Wiley-Interscience Publication.

Bollen, K. A., & Long, J. S. (1993). *Testing structural equation models*, Newbury Park, CA: Sage.

Braun, C., & Hadwich, K. (2016). Complexity of internal services: Scale development and validation. *J. of Bus. Res.*, 69, 3508-3522. http://dx.doi.org/10.1016/j.jbusres.2016.01.035.

Bygstad, B. (2017). Generative innovation: A comparison of lightweight and heavyweight IT. *J. of Inf. Technol., 32*(2), 180-193.

Byrd, T. A., & Davidson, N. W. (2003). Examining possible antecedents of IT impact on the supply chain and its effect on firm performance. *Inf. & Manag.,* 41, 243-255.

Caldarelli, G. (2007). *Scale-free networks: Complex webs in nature and technology*. Oxford, UK: Oxford University Press.

Camisón-Zornoza, C., & Monfort-Mir, V. M. (2012). Measuring innovation in tourism from the Schumpeterian and the dynamic-capabilities perspectives. *Tour. Manag.,* 33, 776-789.

Camps, J., & Luna-Arocas, R. (2009). High involvement work practices and firm performance. *International J. of Hum. Resour. Manag., 20*(5), 1056-1077.

Chan, S. L. (2000). Information technology in business processes. *Bus. Process Manag. J.,* 6(3), 224-237.

Chang, W., Park, J. E., & Chaiy, S. (2010). How does CRM technology transform into organizational performance? A mediating role of marketing capability. *J. of Bus. R., 63*(8), 849-855.

Chen, M. H. (2010). The economy, tourism growth and corporate performance in the Taiwanese hotel Industry. *Tour. Manag.,* 31, 665-675.

Chen, I. J., & Paulraj, A. (2004). Understanding supply chain management: Critical research and theoretical framework. *Int. J. of Prod. Res., 42*(1), 131-163.

Cheng, S. L., & Chang, H. C. (2010). Cognitive complexity implications for research on sustainable Competitive advantage. *J. of Bus. R.*, 63, 67-70.

Chesbrough, H. W. (2003). *Open innovation: The new imperative for creating and profiting from technology*. Boston: Harvard Business School Press.

Chiu, C. M., Hsu, M. H., & Wang, E. T. G. (2006). Understanding knowledge sharing in virtual communities: An integration of social capital and social cognitive theories. *Decis. Support Syst., 42*(3), 1872-1888.

Choudhury, M. M., & Harrigan, P. (2014). CRM to social CRM: The integration of new technologies into customer relationship management. *J. of Strateg. Mark., 22*(2), 149-176.

Cinelli, M., Ferraro, G., & Iovanella, A. (2019). Network processes for collaborative innovation. *Int. J. of Entrepreneurship and Small Bus., 36*(4), 430-452.

Cooke, P. (2012). *Complex adaptive innovation systems: Relatedness and transversality in the evolving region*. London: Routledge.

Corral de Zubielqui, G., Jones, J., & Statsenko, L. (2016). Managing innovation networks for knowledge mobility and appropriability: A complexity perspective. *Entrepreneurship Res. J., 6*(1), 75-109.

Corral de Zubielqui, G. C., Fryges, H., & Jones, J. (2019). Social media, open innovation & HRM: Implications for performance. *Technol. Forecast. and Soc. Change,* 144, 334-347.

Costello, A., & Osborne, J. (2005). Best practices in exploratory factor analysis: Four recommendations for getting the most from your analysis. *Pract. Assess. Res. & Eval., 10*(7), 1-9.

Croteau, A. M., & Bergeron, F. (2001). An information technology trilogy: Business strategy, technological deployment and organizational performance. *J. of Strateg. Inf. Syst., 10*(2), 77-99.

Cruz-González, J., López-Sáez, P., Navas-López, J. E., & Delgado-Verde, M. (2015). Open search strategies and firm performance: The different moderating role of technological environmental dynamism. *Technovation,* 35, 32-45.

Cummings, J. N. (2004). Work groups, structural diversity, and knowledge sharing in a global organization. *Manag. Sci.,* 50(3), 352-364.

Damanpour, F. (1987). The adoption of technological, administrative, and ancillary innovations: The impact of organizational factors. *J. of Manag.,* 13, 675-688.

Damanpour, F., & Evan, W. M. (1992). The adoption of innovations over time: Structural determinants and consequences in library organizations. *J. of Libr. and Inf. Sci. Res., 14*(4), 465-482.

Danneels, E. (2007). The Process of Technological Competence Leveraging. *Strateg. Manag. J.,* 28, 517-533.

Davenport, T. H. (1993). *Process innovation: Reengineering work through information technology*. Boston, MA: Harvard Business School Press.

Dibrell, C., Craig, J. B., & Neubaum, D. O. (2014) Linking the formal strategic planning process, planning flexibility, and innovativeness to firm performance. *J. of Bus. Res.,* 67, 2000-2007.

Dodds, P., Watts, D., & Sabel, C. (2003). Information Exchange and the Robustness of Organizational Networks. *Proceedings of the National Academy of Sciences 100*(21), 12516-12521.

Dos Santos, B. L., Peffers, K. G., & Mauer, D. C. (1993). The impact of information technology investment announcements on the market value of the firm. *Inf. Syst. Res., 4*(1), 1-23.

Dougherty, D., & Dunne, D. D. (2011). Organizing ecologies of complex innovation. *Organ. Sci.,* 22, 1214-1223.

Drnevich, P. L., & Croson, D. C. (2013). Information technology and business-level strategy: Toward an integrated theoretical perspective. *MIS Q., 37*(2), 483-509.

Falk, R. F., & Miller, N. B. (1992). *A primer for soft modeling*. Akron, Ohio: The University of Akron Press.

Felix, R., Rauschnabel, P. A., & Hinsch, C. (2017). Elements of strategic social media marketing: A holistic framework. *J. of Bus. R.,* 70, 118-126

Ferguson, J. E., & Soekijad, M. (2016). Multiple interests or unified voice? Online communities as intermediary spaces for development. *J. of Inf. Technol., 31*(4), 358-381.

Fernandez-Perez, V., Garcia-Morales, V., & Bustinza-Sanchez, O. (2012). The effects of CEOs' social networks on organizational performance through knowledge and strategic flexibility. *Pers. Rev., 41*(6), 777-812.

Fernández-Pérez, V., Llorens-Montes, F. J., & García-Morales, V. J. (2014) Towards strategic flexibility: Social networks, climate and uncertainty. *Ind. Manag. & Data Syst., 114*(6), 858-871.

Ferrari, M., & Granovetter, M. (2009). The role of venture capital firms in Silicon Valley's complex innovation network. *Econ. and Soc., 38*(2), 326-259.

Ferraro, G., & Iovanella, A. (2015). Organizing collaboration in inter-organizational innovation networks, from orchestration to choreography. *Int. J. of Eng. Bus. Manag.,* 7, 24-37.

Ferraro, G., & Iovanella, A. (2017). Technology transfer in innovation networks: An empirical study of the Enterprise Europe Network. *Int. J. of Eng. Bus. Manag.,* 9, 1-14.

Fontes, M. (2001). Biotechnology entrepreneurs and technology transfer in an intermediate economy. *Technol. Forecast. and Soc. Change,* 66, 59-74.

Frank, K. A., & Fahrbach, K. (1999). Organization culture as a complex system: Balance and information in models of influence and selection. *Organ. Sci., 10*(3), 253-277.

Fried, B. J., Johnsen, M. C., Starrett, B. E., Calloway, M. O., & Morrissey, J. P. (1998). An empirical assessment of rural community support networks for individuals with severe mental disorders. *Community Ment. Health J., 34*(1), 39-56.

Fornell, C., & Larcker, D. F. (1981). Structural equation models with unobservable variables and measurement error: Algebra and statistics. *J. of Mark. Res., 18*(3), 382-388.

Fulk, J., & Yuan, Y. C. (2013). Location, motivation, and social capitalization via enterprise social networking. *Journal of Computer-Mediated Communication, 19*(1), 20-37.

Fuller, M. K., & Swanson, E. B. (1992). Information centers as organizational innovation: Exploring the correlates of implementation success. *J. of Manag. Inf. Syst., 9*(1), 47-67.

Gabrielsson, M., Seppälä, T., & Gabrielsson, P. (2016). Realizing a hybrid competitive strategy and achieving superior financial performance while internationalizing in the high-technology market. *Ind. Mark. Manag.,* 54, 141-153.

Galati, F., & Galati, R. (2019). Cross-country analysis of perception and emphasis of hotel attributes. *Tour. Manag.,* 74, 24-42.

Galbraith, J. R. (1982). *Designing complex organizations*. Reading, MA: Addison-Wesley.

García-Morales, V. J. (2004). *Aprendizaje organizacional: Delimitación y determinantes estratégicos*. Granada, Spain: Universidad de Granada.

García-Morales, V. J., Bolívar-Ramos, M. T., & Martín-Rojas, R. (2014). Technological variables and absorptive capacity's influence on performance through corporate entrepreneurship. *J. of Bus. Res., 67*(7), 1468-1477.

García-Morales, V. J., Martín-Rojas, R., & Lardón-López, M. E. (2018**.** Influence of social media technologies on organizational performance through knowledge and innovation. *Baltic J. of Manag., 13*(3), 345-367.

Garrido-Moreno, A., Garcia-Morales, V. J., Lockett, N., & King, S. (2018). The missing link: Creating value with social media use in hotels. *Int. J. of Hosp. Manag.,* 75, 94-104.

Garrido-Moreno, A., García-Morales, V. J., & Martín-Rojas, R. (2019). Fomentando la innovación abierta a través del uso de herramientas social media. *Rev. de la Asoc. Esp. de Contab. y Adm. de Empresas, 127*(September), 36-39.

Garrido-Moreno, A., Lockett, N. J., & García-Morales, V. (2014). Paving the way for CRM success: The mediating role of knowledge management and organizational commitment. *Inf. & Manag., 51*(8), 1031-1042.

Gay, B., & Dousset, B. (2005). Innovation and network structural dynamics: Study of the alliance network of a major sector of the biotechnology industry. *Res. Policy,* 34, 1457-1475.

Gefen, D., Straub, D. W., & Boudreau, M. C. (2000). Structural equation modeling and regression: Guidelines for research practice. *Commun. of the Assoc. for Inf. Syst., 4*(7), 1-70.

Gnyawali, D. R., Fan, W., & Penner, J. (2010). Competitive actions and dynamics in the digital age: An empirical investigation of social networking firms. *Inf. Syst. Res., 21*(3), 594-613.

Grinstein, A., & Goldman, A. (2006). Characterizing the technology firm: An exploratory study. *Res. Policy,* 35, 121-143.

Hair, J. F., Anderson R., Tatham, R. L., & Black W. C. (2009). *Multivariate data analysis* (7th ed.), Upper Saddle River, NJ: Pearson-Prentice Hall.

Han, M., & McKelvey, B. (2008). Toward a social capital theory of technology-based new ventures as complex adaptive systems. *Int. J. of Account. & Inf. Manag.,* 16, 36-61.

Hanna, R., Rohm, A., & Crittenden, V. L. (2011). We're all connected: The power of the social media ecosystem. *Bus. Horizons, 54*(3), 265-273.

Harrigan P., Soutar, G., Choudhury M. M., & Lowe M. (2015). Modelling CRM in a social media age. *Australasian Mark. J.,* 23, 27-37.

Heidenreich, M. (2005). The renewal of regional capabilities experimental regionalism in Germany. *Res. Policy,* 34, 739-757.

Henderson, J. C., & Venkatraman, H. (1993). Strategic alignment: Leveraging information technology for transforming organizations. *IBM Syst. J., 38*(2-3), 472-484.

Holland, J. (1996). *Hidden order: How adaptation builds complexity*. Addison Wesley: Helix Books.

Homburg, C., Krohmer, H., & Workman, J. P. (1999). Strategic consensus and performance: The role of strategy type and market-related dynamism. *Strateg. Manag. J.,* 20, 339-357.

Hurley, R. F., & Hult, G. T. (1998) Innovation, market orientation, and organizational learning: An integration and empirical examination. *J. of Mark.,* 62, 42-54.

Husain, Z., Dayan, M., & DiBenedetto, C. A. (2016). The impact of networking on competitiveness via organizational learning, employee innovativeness, and innovation process: A mediation model. *J. of Eng. and Technol. Manag.,* 40, 15-28.

Jacucci, E., Hanseth, O., & Lyytinen, K. (2006). Introduction: Taking complexity seriously in IS research. *Inf.Technol. & People*, *19*(1), 5-11.

Jarvenpaa, S. L., & Tanriverdi, H. (2003). Leading virtual knowledge networks. *Organ. Dyn., 31*(4), 403-412.

Jonsson, D., Mathiassen, L., & Holmström, J. (2018). Representation and mediation in digitalized work: Evidence from maintenance of mining machinery. *J. of Inf. Technol.*, *In Press*.

Jugend, D., Jabbour, C. J. C., Scaliza, J. A. A., Rocha, R. S., Junior, J. A. G., Latan, H., & Salgado, M. H. (2018). Relationships among open innovation, innovative performance, government support and firm size: Comparing Brazilian firms embracing different revels of Radicalism in innovation. *Technovation,* 74, 54-65.

Jussila, J. J., Kärkkäinen, H., & Aramo-Immonen, H. (2014). Social media utilization in business-to-business relationships of technology industry firms. *Comput. in Hum. Behav.,* 30, 606-613.

Kaplan, A. M., & Haenlein, M. (2010). Users of the world, unite! The challenges and opportunities of social media. *Bus. Horizons, 53*(1), 59-68.

Kärkkäsinen, J., Kempa, D., & Puglisi, S. J. (2013). Linear time lempel-ziv factorization: Simple, fast, small. In: J. Fischer, & P. Sanders (Eds.) *Combinatorial Pattern Matching. CPM 2013. Lecture Notes in Computer Science*, (vol. 7922, pp. 189-200). Berlin, Heidelberg: Springer.

Kauffman, S. A. (1993). *The origins of order: self-organization and selection in evolution*. New York: Oxford University Press.

Ketter, W., Peters, M., Collins, J., & Gupta, A. (2016). A multiagent competitive gaming platform to address societal challenges. *MIS Q., 40*(2), 447-460.

Khatab, H., Masood, M., Zaman, K., Saleem, S., & Saeed, B. (2011). Corporate governance and firm performance: A case study of Karachi stock market. *Int. J. of Trade, Econ. and Finance, 2*(1), 39-43.

Kietzman, J. H., Hermkens, K., McCarthy, I. P., & Silvestre, B. S. (2011). Social media? Get serious! Understanding the functional building blocks of social media. *Bus. Horizons, 54*(3), 241-251.

Knight, G. A. (1997). Cross-cultural reliability and validity of a scale to measure firm entrepreneurial orientation. *J. of Bus. Ventur.,* 12, 213-225.

Konrad, A. M., & Linnehan, F. (1995). Formalized HRM structures: Coordinating equal employment opportunity or concealing organizational practice?. *Acad. of Manag. J., 38*(3), 787-820.

Kovacic, A. (2001). Business renovation projects in Slovenia. *Bus. Process Manag. J., 7*(5), 409-419.

Kung, L. A., Cegielski, C. G., & King, H. J. (2015). An integrated environmental perspective on software as a service adoption in manufacturing and retail firms. *J. of Inf. Technol., 30*(4), 353-363.

Lam, H. K., Yeung, A. C., & Cheng, T. E. (November 2016). The impact of firms' social media initiatives on operational efficiency and innovativeness. *J. of Oper. Manag.,* 47-48, 28-43.

Lawrence, P. R., & Lorsch, J. W. (1967). Differentiation and integration in complex organizations*. Adm. Sci. Q., 12*(1), 1-47.

Lee, H., Kelley, D., Lee, J., & Lee, S. (2012). SME survival: The impact of internationalization, technology resources, and alliances. *J. of Small Bus. Manag., 50*(1), 1-19.

Leiponen, A., & Helfat, C. (2010). Research notes and commentaries: Innovation objectives, knowledge sources, and the benefits of breadth. *Strateg. Manag. J.,* 31, 224-236.

Leonardi, P. M., Huysman, M., & Steinfield, C. (2013). Enterprise social media: Definition, history, and prospects for the study of social technologies in organizations. *J. of Comput. Mediat. Commun., 19*(1), 1-19.

Lin, Y. T., & Liu, N. C. (2016). High performance work systems and organizational service performance: The roles of different organizational climates. *Int. J. of Hosp. Manag.,* 55, 118-128.

Liu, Y. C., & Hung J. H. (2006). Services and the long-term profitability in Taiwan's banks. *Glob. Finance J.. 17*(2), 177-191.

Lloréns-Montes, F. J., Ruiz-Moreno, A. R., & García-Morales, V. G. (2005). Influence of support leadership and teamwork cohesion on organizational learning, innovation and performance: An empirical examination. *Technovation, 25*(10), 1159-1172.

Luk, C. L., Yau, O. H. M., Sin, L. Y. M., Tse, A. C. B., Chow, R. P. M., & Lee, J. S. Y. (2008). The effects of social capital and organizational innovativeness in different institutional contexts. *J. of Int. Bus. Stud.,* 39, 589-612.

Lyytinen, K., Rose, G., & Yoo, Y. (2010). Learning routines and disruptive technological change. *Inf. Technol. & People,* 23(2), 165-192.

Lyytinen, K., Yoo, Y., & Boland Jr., R. J. (2016). Digital product innovation within four classes of innovation networks. *Inf. Syst. J.,* 26, 47-75

Maiga, A. S., Nilsson, A., & Ax, C. (2015). Relationships between internal and external information systems integration, cost and quality performance, and firm profitability. *Int. J. of Prod. Econ.,* 169, 422-434.

Malerba, F. (2004). *Sectoral systems of innovation*. Cambridge: Cambridge University Press.

Mandelbrot, B. (1982). *The fractal geometry of nature.* San Francisco: Freeman.

Martín-Rojas, R., García-Morales, V. J., & Bolívar-Ramos, M. T. (2013). Influence of technological support, skills, competencies, and learning corporate entrepreneurship in European technology firms. *Technovation,* 33, 417-430.

Martín-Rojas, R., García-Morales, V. J., & García-Sánchez, E. (2011). The influence on corporate entrepreneurship of technological variables. *Ind. Manag. & Data Syst., 111*(7), 984-1005.

Martín-Rojas, R., García-Morales, V. J., & González-Álvarez. N. (2019). Technological antecedents of entrepreneurship and its consequences for organizational performance. *Technol. Forecast. and Soc. Change, 147*, 22-35.

Massa, L., Viscusi, G., & Tucci, C. (2018). Business models and complexity. *J. of Bus. Model*., *6*(1), 59-71.

McKelvey, B. (2016). Complexity ingredients required for entrepreneurial success. *Entrepreneurship Res. J., 6*(1), 53-73.

McKelvey B., Salmador, M. P., Morcillo, P., & Rodríguez-Antón, J. M. (2013). Towards an Econophysics view of intellectual capital dynamics: From self-organized criticality to the stochastic frontier, *Knowl. Manag. Res. & Pract., 11*(2), 142-161.

McPherson, J. M., Smith-Lovin, L., & Cook, J. M. (2001). Birds of a feather: Homophily in social networks. *Annual Rev. of Sociol.,* 27, 415-444.

Meagher, K., & Rogers, M. (2004). Network Density and R&D Spillovers. *J. of Econ. Behav. & Organ.,* 53, 237-260.

Melville, N., Kraemer, K., & Gurbaxani, V. (2004). Review: Information technology and organizational performance: An integrative model of IT business value. *MIS Q., 28*(2), 283-322.

Mention, A. L., Barlatier, P. J., & Josserand, E. (2019). Using social media to leverage and develop dynamic capabilities for innovation. *Technol. Forecast. and Soc. Change,* 144, 242-250.

Merali, Y. (2006). Complexity and information systems: The emergent domain. *J. of Inf. Technol., 21*(4), 216-228.

Merali, Y., & McKelvey, B. (2006). Using complexity science to effect a paradigm shift in information systems for the 21st century. *J. of Inf. Technol., 21*(4), 211-215.

Miles, R. E., & Snow, C. C. (1978). *Organizational strategy, structure, and process.* New York: McGraw Hill.

Mintzberg, H., & Waters, H. A. (1985). Of strategies, deliberate and emergent. *Strateg. Manag. J., 6*(3), 257-272.

Morel, B., & Ramanujam, R. (1999). Through the looking glass of complexity: The dynamics of organizations as adaptive and evolving systems. *Organ. Sci., 10*(3), 278-293.

Nahapiet, J., & Ghoshal, S. (1998). Social capital, intellectual capital, and the organizational advantage. *Acad. of Manag. Rev., 23*(2), 242-266.

Nesij Huvaj, M., & Johnson, W. C. (2019). Organizational complexity and innovation portfolio decisions: Evidence from a quasi-natural experiment. *J. of Bus. Res.*, 98, 153-165.

Ngai, E. W., Tao, S. S., & Moon, K. K. (2015). Social media research: Theories, constructs, and conceptual frameworks. *Int. J. of Inf. Manag., 35*(1), 33-44.

Nguyen, B., Yu, X., Melewar, T. C., & Chen, J. (2015). Brand innovation and social media: Knowledge acquisition from social media, market orientation, and the moderating role of social media strategic capability. *Ind. Mark. Manag.,* 51, 11-25.

Nicolescu, R., Huth, M., Radanliev, P., & De Roure, D. (2018). Mapping the values of IoT. *J. of Inf. Technol.,* 33, 345-360.

Nonaka, I. (1988). Creating organizational order out of chaos: Self-renewal in Japanese firms. *Calif. Manag. Rev., 30*(3), 57-73.

Nunnally, J., & Bernstein, I. (1994). *Psychometric theory*. New York: McGraw Hill.

Nylén, D., & Holmström, J. (2015). Digital innovation strategy: A framework for diagnosing and improving digital product and service innovation. *Bus. Horizons, 58*(1), 57-67.

Oliveira-Teixeira, E. D., & Werther, W. B., Jr. (2013). Resilience: Continuous renewal of competitive advantages. *Bus. Horizons,* 56, 333-342.

Ooms, W., Bell, J., & Kok, R. A. (2015). Use of social media in inbound open innovation: Building capabilities for absorptive capacity. *Creativity and Innov. Manag., 24*(1), 136-150.

Pandey, S. K., Wright, B. E., & Moynihan, D. P. (2008). Public service motivation and interpersonal citizenship behaviour in public organizations: Testing a preliminary model. *Int. Public Manag. J., 11*(1), 89-108.

Peng, M. W., & Luo, Y. (2000). Managerial ties and firm performance in a transition economy: The nature of a micro-macro link. *Acad. of Manag. J., 43*(3), 486-501.

Piskorski, M. J. (2011). Social strategies that work. *Harvard Bus. Rev., 89*(11), 116-122.

Podsakoff, P. M., Mackenzie, S. B., Lee, J. Y., & Podsakoff, N. P. (2003). Common method biases in behavioural research: A critical review of the literature and recommended remedies. *J. of Appl. Psychol., 88*(5), 879-903.

Podsakoff, P. M., & Organ, D. W. (1986). Self-reports in organization research: Problems and prospects, *J. of Manag., 12*(4), 531-544.

Porter, M. E., & Van der Linde, C. (1995). Towards a new conception of the environment-competitiveness relationship. *J. of Econ. Perspect., 9*(4), 97-118.

Powell, W., & Brantley, P. (1992). Competitive cooperation in biotechnology learning through networks? In N. Nitin, & R. Eccles (Eds.) *Networks and organization* (pp. 366-394). Boston: Harvard Business School Press.

Prahalad, C. K. (2012). Bottom of pyramid as a source of breakthrough innovations. *J. of Prod. Innov. & Manag., 29*(1), 6-12.

Prajogo, D., & Olhager, J. (2012). Supply chain integration and performance: The effects of long-term relationships, information technology and sharing, and logistics integration. *Int. J. of Prod. Econ., 135*(1), 514-522.

Prasad, B. (1999). Hybrid re-engineering strategies for process improvement. *Bus. Process Manag. J., 5*(2), 178-197.

Ransbotham, S., Fichman, R. G., Gopal, R., & Gupta, A. (2016). Special Section Introduction—Ubiquitous IT and digital vulnerabilities. *Inf. Syst. Res.*, *27*(4), 834-847.

Ray, G., Muhanna, W. A., & Barnety, J. B. (2005). Information technology and the performance of the customer service process: A resource-based analysis. *MIS Q., 29*(4), 625-652.

Real, J. C., Leal, A., & Roldan, J. L. (2006). Information technology as a determinant of organizational learning and technological distinctive competencies. *Ind. Mark. Manag.,* 35, 505-521.

Ritter, T., Wilkinson, I. F., & Johnston, W. J. (2004) Managing in complex business networks. *Ind. Mark. Manag., 33*(3), 175-183.

Roundy, P. T., Bardshaw, M., & Brockman, B. K. (2018). The emergence of entrepreneurial ecosystems: A complex adaptive systems approach. *J. of Bus. Res.,* 86, 1-10. https:// doi.org/10.1016/j.jbusres.2018.01.032.

Salmador, M. P., & Bueno, E. (2005). Strategy-making as a complex, double-loop process of knowledge creation: Four cases of reestablished banks reinventing the industry by means of the Internet. In G. Szulanski, J. Porac, & Y. Doz, (Eds.) *Strategy process: Advances in strategic management* (pp. 267-318). United Kingdom: Emerald Group Publishing Limited.

Santhanam, R., & Hartono, E. (2003). Issues in linking information technology capability to firm performance. *MIS Q., 27*(1), 125-153.

Santiago, A., & Benito, R. M. (2008). Connectivity degrees in the threshold preferential attachment model. *Physica A,* 387, 2365-2376.

Schneider, M., & Somers, M. (2006). Organizations as complex adaptive systems: Implications of complexity theory for leadership research. *The Leadersh. Q.,* 17, 351-365.

Scott, J. (1991). *Social network analysis*. London: Sage.

Senge, P. (1990). *The fifth discipline*. New York: Doubleday Currency.

Senyo, P. K., Liu, K., & Effah, J. (2019). Digital business ecosystem: Literature review and a framework for future research. *Int. J. of Inf., Manag.,* 47, 52-64.

Setia, P., Venkatesh, V., & Joglekar, S. (2013). Leveraging digital technologies: How information quality leads to localized capabilities and customer service performance. *MIS Q., 37*(2), 565-590.

Shen, L., Wang, Y., & Teng, W. (2017). The moderating effect of interdependence on contracts in achieving equity versus efficiency in interfirm relationships. *J. of Bus. Res.,* 78, 277-284.

Shortell, S. M., & Zajac, E. J. (1990). Perceptual and archival measures of Miles and Snow’s strategic types: A comprehensive assessment of reliability and validity. *Acad. of Manag. J., 33*(4), 817-832.

Simon, T., Goldberg A., & Adini, B. (2015). Socializing in emergencies: A review of the use of social media in emergency situations. *Int. J. of Inf. Manag., 35*(5), 609-619.

Singh, J. (2005). Collaborative networks as determinants of knowledge diffusion patterns. *Manag. Sci., 51*(5), 756-770.

Slotte-Kock, S., & Coviello, N. (2010). Entrepreneurship research on network processes: A review and ways forward. *Entrepreneurship Theory and Pract., 34*(1), 31-57.

Sparrow, O., & Ringland, G. (2010). A system for continuous organizational renewal. *Strateg. & Leadersh., 38*(4), 34-41.

Spector, P. E. (2006). Method variance in organizational research: Truth or urban legend?, *Organ. Res. Methods, 9*(2), 221-232.

Spithoven, A., Vanhaverbeke, W., & Roijakkers, N. (2013). Open innovation practices in SMEs and large enterprises. *Small Bus. Econ., 41*(3), 537-562.

Sritharan, V. (2015). Does firm size influence on firm's profitability? Evidence from listed firms of Sri Lankan hotels and travels sector. *Res. J. of Finance and Account., 6*(6), 201-207.

Subramanian, A., & Nilakanta, S. (1996). Organizational innovativeness: Exploring the relationship between organizational determinants of innovation, types of innovations, and measures of organizational performance. O*mega, Int. J. of Manag. Sci., 24*(6), 631-647.

Suh, A., Shin, K. S., Ahuja, M., & Kim, M. S. (2011). The influence of virtuality on social networks within and across work groups: A multilevel approach. *J. of Manag. Inf. Syst., 28*(1), 351-386.

Tallon, P. P. (2008). Inside the adaptive enterprise: An information technology capabilities perspective on business process agility. *Inf. Technol. and Manag., 9*(1), 21-36.

Tanriverdi, H. (2006). Performance effects of information technology synergies in multibusiness firms. *MIS Q., 30*(1), 57-77.

Tanriverdi, H., Rai, A., & Venkatraman, N. (2010). Reframing the dominant quests of information systems strategy research for complex adaptive business systems. *Inf. Syst. Res., 21*(4), 822-834.

Teirlinck, P., & Spithoven A. (2013). Research collaboration and R&D outsourcing: Different R&D personnel requirements in SMEs. *Technovation, 33*(4), 142-153.

Thornhill, S., & White, R. E. (2007). Strategic purity: A multi-industry evaluation of pure vs. hybrid business strategies. *Strateg. Manag. J., 28*(5), 553-561.

Tidd, J., & Bessant, J. (2009). *Managing innovation: Integrating technological market and organizational change*. (4th ed.). Oxford, U.K.: John Wiley & Sons Ltd.

To, C. K. M., Au, J. S. C., & Kan, C. W. (2018). Uncovering business model innovation contexts: A comparative analysis by fsQCA methods. *J. of Bus. Res.*, *In Press*. https://doi.org/10.1016/j.jbusres.2018.12.042.

Treem, J. W., & Leonardi, P. M. (2012). Social media use in organizations: Exploring the affordances of visibility, editability, persistence and association. *Commun. Yearb.,* 36, 143-189.

Tsai, W. (2001). Knowledge transfer in intraorganizational networks: Effects of network position and absorptive capacity on business unit innovation and performance. *Acad. of Manag. J., 44*(5), 996-1004.

Tsatsou, P., Elaluf-Calderwood, S., & Liebenau, J. (2009). Towards a taxonomy for regulatory issues in a digital business ecosystem in the EU. *J. of Inf. Technol., 25*(3), 288-307.

Uhl-Bien, M., Marion, R., & McKelvey, B. (2007). Complexity leadership theory: Shifting leadership from the Industrial Age to the Knowledge Era. *Leadersh. Q.,* 18, 298-318.

Van de Ven, A. H. (1992). Suggestions for studying strategy process: A research note. *Strateg. Manag. J., 13*(S1), 169-188.

Van De Ven, A. H. (2005) Running in packs to develop knowledge-intensive technologies. *MIS Q., 29*(2), 368-378.

Van de Vrande, V., De Jong, J. P. J., Vanhaverbeke, W., & De Rochemont, M. (2009). Open innovation in SMEs: Trends, motives and management challenges. *Technovation, 2*(6), 423-437. http://dx.doi.org/10.1016/j.technovation.2008.10.001.

Venkatraman, N., & Ramanujam, V. (1986). Measurement of business performance in strategy research: A comparison of approaches. *Acad. of Manag. Rev., 11*(4), 801-814.

Veugelers, R., & Cassiman, B. (1999). Make and buy in innovation strategies: Evidence from Belgian manufacturing firms. *Res. Policy,* 28, 63-80.

Von Sheel, H., Maamar, Z., & Von Rosing, M. (2015). Social media and business process management. In M. von Rosing, H. von Scheel, & A. W. Scheer (Eds.). *The complete business process handbook* (pp. 377-394). The Netherlands: Elsevier, Inc.

Wang, H. C., Pallister, J. G., & Foxall, G. R. (2006). Innovativeness and involvement as determinants of website loyalty: II. Determinants of consumer Loyalty in B2C e-Commerce. *Technovation,* 26, 1366-1373.

Weng, L., Menczer, F., & Ahn, Y. Y. (2013). Virality prediction and community structure in social networks. *Sci. Rep.,* 3, 2522.

Werlang, N. B., & Rossetto, C. R. (2019). The effects of organizational learning and innovativeness on organizational performance in the service provision sector. *Gestão & Produção, 26*(3), e3641: 1-18.

Wernerfelt, B. (1995). The resource-based view of the firm: Ten years after. *Strateg. Manag. J., 16*(3), 171-174.

Westphal, J. D., & Fredickson, J. W. (2001). Who directs strategic change? Director experience, the selection of new CEOs and change in corporate strategy. *Strateg. Manag. J., 22*(12), 1113-1137.

Woodside, A. G. (2005). Firm orientations, innovativeness, and business performance: Advancing a system dynamics view following a comment on Hult, Hurley, and Knight's 2004 study. *Ind. Mark. Manag.,* 34, 275-279.

Wycisk, C., McKelvey, B., & Hülsmann, M. (2008). Smart parts supply networks as complex adaptive systems: Analysis and implications. *Int. J. of Phys. Distrib. & Logist. Manag., 38*(2), 108-125.

Yoo, Y., Lyytinen, K., & Yang, H. (2005). The role of standards in innovation and diffusion of broadband mobile services: The case of South Korea. *J. of Strateg. Inf. Syst.,* 14, 323-353.

Zahra, S. A. (1993). Environment, corporate entrepreneurship, and financial performance: A taxonomic approach. *J. of Bus. Ventur., 8*(4), 319-340.

Zheng, Y., Liu, J., & George, G. (2010). The dynamic impact of innovative capability and inter-firm network on firm valuation: A longitudinal study of biotechnology start-ups. *J. of Bus. Ventur.*, 25, 593-609.

Zmud, R. W. (1983). The effectiveness of external information channels in facilitating innovation within software development groups. *MIS Q., 7*(2), 43-58.

Figure 1.

Proposed Structural Model

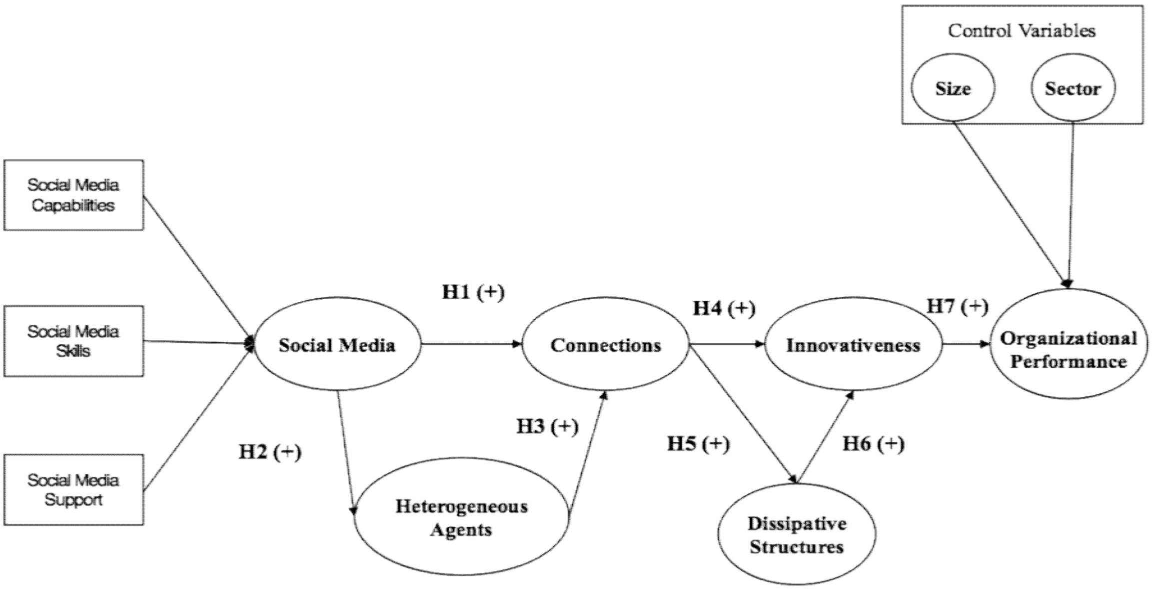

Figure 2.

Proposed Structural Model

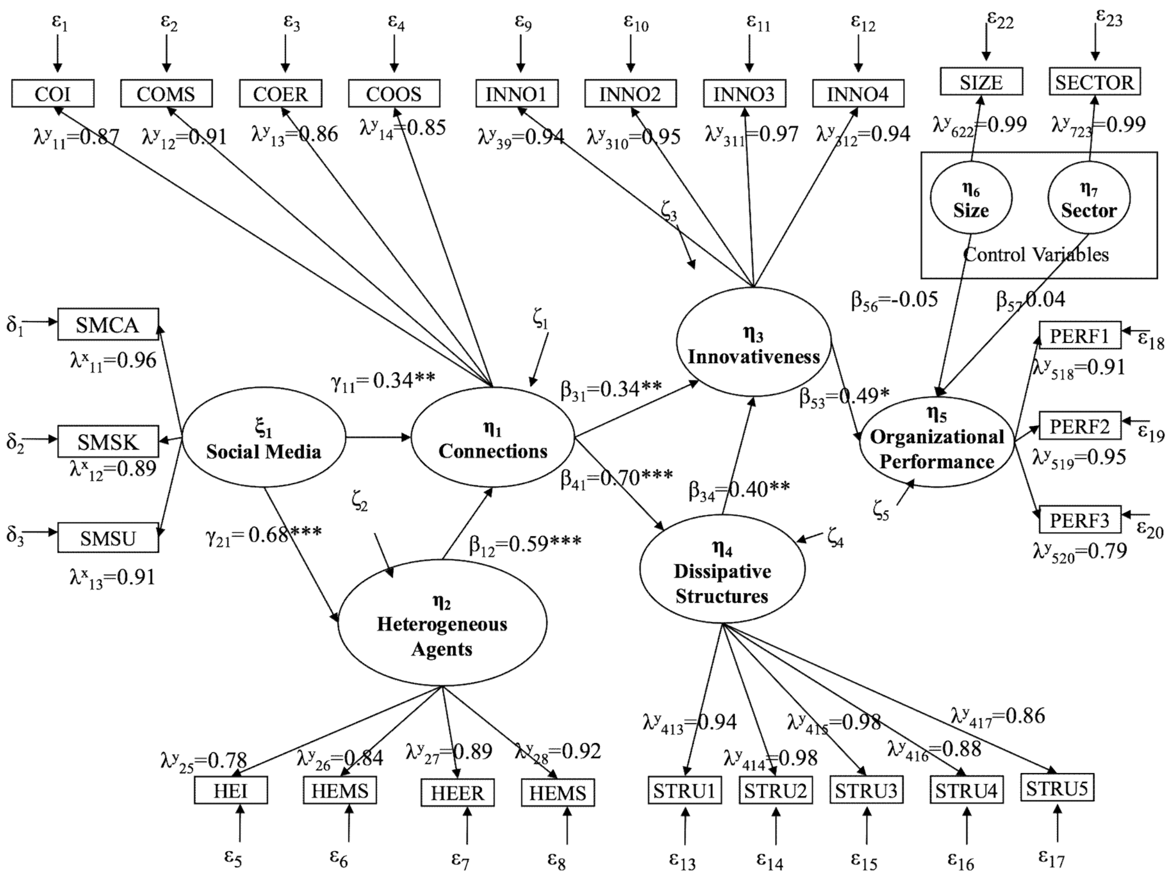

Table 1.

Measurement Model Results

Constructs	Items	Loading (t)	R^2	α	Composite Reliability	Average Variance Extracted
Social Media	SMCA	0.96***(25.50)	0.91	0.932	0.945	0.853
	SMCK	0.89***(18.68)	0.79			
	SMSU	0.91***(18.86)	0.82			
Connections	COI	0.87***(9.53)	0.76	0.922	0.930	0.770
	COMS	0.91***(15.08)	0.82			
	COER	0.87***(18.83)	0.76			
	COOS	0.86***(18.89)	0.74			
Heterogeneous Agents	HEI	0.78***(8.56)	0.62	0.909	0.918	0.738
	HEMS	0.84***(13.08)	0.70			
	HEER	0.89***(7.47)	0.80			
	HEOS	0.92***(20.05)	0.84			
Innovativeness	INNO1	0.94***(9.97)	0.89	0.968	0.972	0.902
	INNO2	0.95***(9.11)	0.90			
	INNO3	0.97***(11.02)	0.95			
	INNO4	0.94***(7.82)	0.89			
Dissipative Structures	STRU1	0.94***(5.63)	0.88	0.961	0.969	0.863
	STRU2	0.98***(6.12)	0.95			
	STRU3	0.98***(5.40)	0.95			
	STRU4	0.88***(5.35)	0.77			
	STRU5	0.86***(4.72)	0.74			
Organizational Performance	PERF1	0.91*(1.98)	0.83	0.909	0.915	0.784
	PERF2	0.95**(3.21)	0.91			
	PERF3	0.79***(3.43)	0.62			

Goodness-of-Fit Statistics	χ^2_{249}=325,92 (P>0.01) ECVI=2.39 AIC=477.92 CAIC=804.97 NFI=0.98 NNFI=0.99 IFI=0.99 PGFI=0.55 PNFI=0.81 NCP=76.92 RFI=0.98 CFI=0.99 RMSEA=0.04

Loading = Standardized structural coefficient (t-students are shown in parentheses); R^2=Reliability; *p<.05; **p<.01; ***p<.001(two-tailed). Size and Sector are a single-item measure and are not included in this table.

Table 2.

Summary Statistics and Correlations (n = 201)

Variable	Mean	Std. Dev.	SM	CO	HE	INNO	STRU	PERF	SIZE	SEC-TOR
SM	3.95	1.47	1							
CO	3.49	1.34	0.66***	1						
HE	3.78	1.40	0.64***	0.72***	1					
INNO	3.91	1.85	0.54***	0.55***	0.54***	1				
STRU	4.05	1.52	0.71***	0.63***	0.60***	0.62***	1			
PERF	-0.02	0.38	0.19**	0.18**	0.16*	0.40***	0.21**	1		
SIZE	1.05	0.65	0.34***	0.39***	0.40***	0.41***	0.47***	0.16*	1	
SECTOR	0.30	0.46	0.01	0.20**	0.17*	0.14*	0.16*	0.06	0.29***	1

SM – Social Media; HE – Heterogeneous Agents; CO – Connections; INNO – Innovativeness; STRU – Dissipative Structures; PERF – Performance. *p<.05;**p<.01;***p<.001(two-tailed).

Table 3.

Structural Model Results

From	to	Direct Effect	t	Indirect Effect	t	Total Effect	t
SM	CO	0.34**	3.16	0.40***	3.46	0.74***	8.06
SM	HE	0.68***	7.06			0.68***	7.06
SM	INNO			0.46***	5.48	0.46***	5.48
SM	STRU			0.52***	4.30	0.52***	4.30
SM	PERF			0.23	1.91	0.23	1.91
CO	INNO	0.34**	3.05	0.28*	2.35	0.62***	10.50
CO	STRU	0.70***	7.38			0.70***	7.38
CO	PERF			0.30*	2.11	0.30*	2.11
HE	CO	0.59***	4.33			0.59***	4.33
HE	INNO			0.37***	3.79	0.37***	3.79
HE	STRU			0.41***	3.37	0.41***	3.37
HE	PERF			0.18	1.80	0.18	1.80
INNO	PERF	0.49*	2.23			0.49*	2.23
STRU	INNO	0.40**	2.53			0.40**	2.53
STRU	PERF			0.20	1.50	0.20	1.50
SIZE	PERF	-0.05	-0.62			-0.05	-0.62
SECTOR	PERF	0.04	0.73			0.04	0.73
R-squared			CO 0.74	HE 0.47	INNO 0.46	STRU 0.48	PERF 0.24
Goodness-of-Fit statistics		χ^2_{265}=403,67 (*P*>0.01) ECVI=2.62 AIC=523.67 CAIC=781.87 NFI=0.97 NNFI=0.99 IFI=0.99 PGFI=0.58 PNFI=0.86 NCP=138.67 RFI=0.97 CFI=0.99 RMSEA=0.05					

SM – Social Media; HE – Heterogeneous Agents; CO – Connections; INNO – Innovativeness; STRU – Dissipative Structures; PERF – Performance. *p<.05;**p<.01;***p<.001(two-tailed).

Table 4.

Model Fit Comparisons

Model	Description	χ^2	$\Delta\chi^2$	d.f.	Δ d.f.	RMSEA	ECVI	AIC	CFI	NNFI	NCP	SRMR
1	Proposed structural model	403.67		265		0.051	2.62	523.67	0.99	0.99	138.67	0.39
2	W.R. SM to CO	416.40	12.73	266	1	0.053	2.67	534.40	0.99	0.99	150.44	0.46
3	W.R. CO to INNO	410.11	6.44	266	1	0.052	2.64	528.11	0.99	0.99	144.11	0.06
4	W.R. HERO to CO	428.49	24.82	266	1	0.055	2.73	546.49	0.99	0.99	162.49	0.82

W.R.=Without Relationship; Δ The difference between the proposed structural model and alternative models.