Distributed Knowledge Model:
Clusters of Interactions for Organizations' Competitive Advantage

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Abstract

Organizational growth has always been a crucial topic for researches and managers. The rapid diffusion of internet based technologies, the increased competition, and the growing importance of intangible resources (e.g. knowledge and innovative capabilities) make urgent to reconsider firms' growth strategies, taking into consideration those new and pervasive factors that deeply influence most of business environments. Several researches recognize the importance of knowledge sharing and collaborative practices as means to increase firms' competitive advantage and to foster innovation. However, how to exploit the potentialities of the modern technologies and managerial practices in order to manage effectively knowledge processes is still unclear and open to debate.
This paper develops a theoretical framework focused on how knowledge-intense processes can take place among different communities of practice, both at organizational or inter-organizational level. The model integrates the role of managerial activities and organizational artifacts, discussing the potentialities for an organization to develop technology based environment where knowledge exchange can be supported and fostered.

Keywords: Distributed Knowledge Model; Communities of practice; Action theory; Technology role in managerial knowledge practices.

Introduction

"What a firm should do depends on its particular circumstances, which in turn reflect the company's stage of evolution. Strategic advice that fails to put an organization in its proper historical and environmental context runs the risk of being dangerous advice." (Cusumano and Makides 2001, p. 3). In a period characterized by continuous economic and scientific changes, several companies are interested in reconsidering and updating their decision processes and strategies in order to embrace emerging factors (e.g. new potentialities triggered by innovative technologies) that are progressively influencing their business. The rapid and pervasive diffusion of internet-based technologies, the increased competition in the markets, and the growing importance of intangible resources (e.g. knowledge and innovative capabilities) are clearly reshaping business environment, forcing the organizations to compete on the basis of new strategic options. Among those, intangible resources and assets are becoming elements increasingly important for firms' success: *human capital*, as the set of employee's skill, talent and knowledge; *information capital*, as the database, information systems and technology infrastructure; and *organizational capital*, as knowledge management procedures, culture, leadership style and collaborative practices, can provide a broad example of intangible assets crucial for firm's growth (Kaplan and Norton 2004, p.13). Several researches recognize the importance of knowledge sharing and collaborative practices as means to increase firms' competitive advantage and to foster innovation (Penrose 1959, Grant 1996, Kogut and Zander 1992, Nag and Gioia 2012). However, how to exploit the potentialities of the modern technologies and managerial practices in order to manage effectively knowledge processes is still unclear and open to debate.

This paper develops a theoretical framework focused on how knowledge-intense processes can take place in distributed settings, both at organizational or inter-organizational level. The model integrates the role of managerial activities and organizational artifacts, discussing the potentialities for an organization to develop technology-based environment where knowledge exchange can be supported and fostered. Considering communities of practice as key factors, this paper focuses on the dynamics emerging between actors and technology to provide a better understanding of distributed knowledge processes. Using a social-practice perspective, it underlines the technology role in a socially distributed activity system. A revisited theoretical graphical model is proposed to support the analyses and to describe the social and technological interaction within organizational knowledge process.

Distributed Knowledge Processes as Strategic Option

Managerial studies have always considered knowledge as a key competitive factor (Druker 1993, Penrose 1959) and some scholars have even further developed its crucial role into the organizations designing a *knowledge based view* of the firm (Kogut e Zander 1992, Grant 1996, Miller and Shamsie 1996). Knowledge definition, interpretation and characteristics have been topics of intense and continuous debate: some researchers state that learning is a pure individual capability and that "all knowledge resides in human heads" (Simon 1991, p. 176), others recognize in groups and organization the ability to generate collective learning processes (Argote 1999, Weick e Roberts 1993); some studies are focused on the tacit and intangible nature of knowledge (Foss 1996, Nonaka 1994), others attribute more importance to the practices of building and sharing common artifacts (Boland and Tenkasi 1998, Haragadon and Sutton 1997). For the scope of this paper, we embrace and extend the concept of knowledge as embedded in behavioral patterns (Weick and Roberts, 1993), avoiding the dichotomy of knowledge as individual representation or physical factor[1]. We propose a model in which knowledge is interpreted and enriched by individuals, but also shared and transmitted through technological objects as well as through social channels (e.g. face to face interactions or practices). Our model aims to explain the interactions between technological artifacts and social factors increasingly diffused in distributed network structures, where knowledge can be created, managed and distributed in a variety of forms, often involving both technical and soft aspects.

The most suitable domain for our model is the network organization structure, considered a privileged field where knowledge management tools and approaches can maximize their returns (Carlsson 2001). Network organizations present a large range of differences among departments, units, communities or even actors; those differences in work practices often conduct to epistemic, interpretative and analytical dissimilarities. Firm's ability to manage those differences and to coordinate knowledge produced by the interaction of different actors and communities (inside and outside organizational boundaries) represents a potential competitive advantage over the market (Brown and Duguid 2001).

Theoretical Background: Activity Theory

In this paper, we build our contribution on Activity Theory (Brown, Collins and Duguid 1989, Lave and Wenger 1991, Engestrom[2] 1987, 1993). There are different versions of Activity Theory but all propose a unified account of "knowing" and "doing", considering the nature of knowing as

[1] This contrast between two possible definitions is successfully illustrated by Pentlad's (1992) distinction of knowledge as "mind" – individual an tacit capability – and "body" – physical factor that can be encapsulated in artifacts –.

[2] In details, Engestrom's work avoids separating the individual from the collective, or the social from the technical. Fundamental to his approach is the unit of analysis ha adopts, namely, *the socially-distributed activity system.*

collective, *situated* and *tentative* (Blackler, 1995: p.1035). Following Star's (1992) explanation, cognitions can be considered: i) collective[3], as practice distributed socially and technologically and hence manifested in systems of language, technology and collaboration; ii) situated, located in time and space and specific to particular contexts; iii) tentative (forms of material practice), as they involve physical and interactional actions as well as internal manipulation of ideas. Moreover knowledge is also considered by activity theory as *provisional*, since it is constructed and constantly developed.

In this perspective knowledge in a complex organization is strictly connected to the practice (Brown and Duguid 1991, Lave and Wenger 1991), begins with actions (Weick and Roberts 1993, Tsoukas, 1996, Gherardi 2000) and its boundaries are fluid and overlapping. Hence we consider knowledge (or *knowing*) as a dynamic and interactive process rather than a permanent and abstract object. Therefore we avoid the idea of "managing knowledge" as a normal object that could be easily generated, captured, stored, retrieved and used. The contradictions between knowledge and management expressed by some authors (Styhre 2003, Alvesson and Karreman 2001) mainly lying in this definition of management as a kind of deterministic control on an object, also if knowledge for its nature cannot be crystallized. Instead, the present analysis concerns knowing as a flow, and investigates the possibilities and the conditions under which this underlying process could be influenced or managed. *Knowing* is considered as a multidimensional process that overlaps the traditional dichotomies (e.g. tacit vs. explicit; mind vs. body; individual vs. communities, etc.) and is characterized by a variety of changing peculiarities.

Some authors point out that knowledge is developed in the communities of practice (Brown and Duguid 1989, 1991, Lave and Wenger 1991) and that the organizations are interpretative social systems (Daft and Weick, 1984; Stern and Barley, 1996). Hence learning and knowing is a socially constructed understanding that emerges from practical collaboration. As Tsoukas (1996, p.13) points out: "[] firms are distributed knowledge systems in a strong sense: they are decentered systems. A firm's knowledge cannot be surveyed as a whole; it is not self-contained; it is inherently indeterminate and continually reconfiguring".

As social systems, different parts (layers) linked together compose knowledge-based organizations. Often the organizations, especially if focused on intangible assets, collect within (and without) themselves multiple communities of experts. Knowledge is distributed among these communities. Knowledge based organization, competing on intellectual work and learning capability, need to abandon the traditional coordination mechanism based on pure hierarchy and rules to design "self-managing" cooperation models where specialists directly interact and set their shared efforts in a

[3] Also if a single person could consider positive a specific knowledge, it have to be legitimized from other actors and institutions in order to become recognized as socially useful (Knorr Cetina, 1999).

common way (Blacker, Crump e McDonald 1999). This point is remarkable, since knowledge management literature still presents sharply contrasting views of knowledge. On the one hand organizations have to improve the flow of reluctant knowledge within the borders of the firms (and to attract external cognitive resources), at the other hand firm's competitive advantage consists in its ability to prevent knowledge from spontaneously overflowing across boundaries. Brown and Duguid (2001) analyze this contrast in the nature of knowledge presenting the paradox of sticky (inside organization) and leaky (across organization's boundaries) knowledge. They propose to solve the paradox through a sociocultural view of knowing based on the idea of "internal divisions and external connections highlighted by practice. These internal divisions, communal rather than individual in origin, help explain stickiness, while the external connections help explain leakiness" (p.209). In this perspective knowledge is generated inside the practices, but - at the same time - it is hard to clearly define the boundaries and the relationship between the different communities of practices. "Knowledge management then is primarily the dynamic process of turning an unreflective practice into a reflective on by elucidating the rules guiding the activities of the practice, by helping give a particular shape to collective understandings, and by facilitating the emergence of heuristic knowledge" (Tsoukas and Vladimirou, 2001, p.990). Hence managing knowledge consists more in sustaining and strengthening social practices, rather than simply managing hard bits of information through digitalization activities (Kreiner, 1999). *Knowing* is situated and socially constructed. The communities of practices and institution define what is knowledge and what is not. As noticed by Alvesson (2001, p.872) a person understands that another one has certain knowledge because credible institutions recognize that this is the case. An expert is part of a community of experts: authorization and belonging to the community are often considered as experience criteria.

Knowledge could produce, besides a firm's competitive advantage, also the so-called "core rigidities" (Leonard-Barton 1992, 1995) localized in the rigidity of some cognitions crystallized in some passive routines. To take some dominant practices, cognitions or believes as definitive, certain and stable leads to decrease the organizational capability in learning and changing their competences and processes. So the organizations, as social systems, have to balance the sharing and combining of knowledge (that could prevent the core rigidities) with their needs to maintain a competitive advantage in the market (and preserve their intellectual assets) through the managing of the communities of practice (as crucial element for knowing processes).

Communities of Practices and Technology

Distributed Activity System

To better understand the role of technology in the organizational knowing processes, we begin briefly describing Engestrom's (1987) general model of socially distributed activity systems shown in Figure 1.

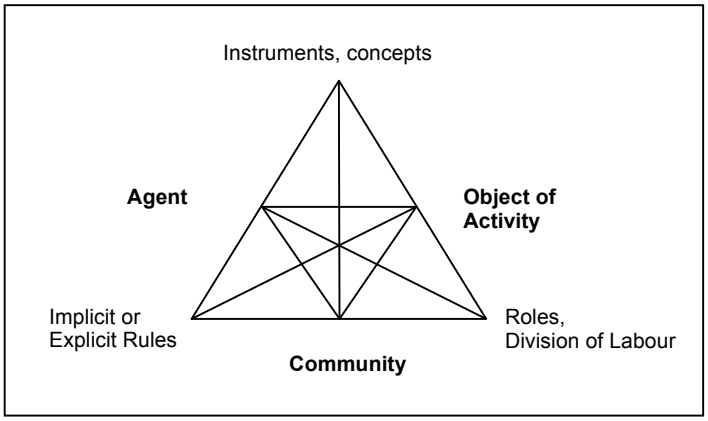

Figure 1 General Model of Socially-Distributed Activity Systems (Based on Engestrom 1987 and re-elaborated by Blackler 1995)

The main relationships in the systems are the links between agents, the communities of which they are members, and the conceptions they have of their activities. These relations are mediated by other elements, such as language and technologies adopted, implicit and explicit social rules shared between actors, and the division of labour accepted by the community.

Note that the relationships described in Engestrom's model are dynamic, changing and not unusually characterized by tensions. These potential conflicts within activity system could become a driving force for organizational change. As Blackler (1995, p. 1037-1038) underlines:

> "*The incoherencies and contradictions that feature within [the organizations] are obscured, however, partly no doubt by conventional imagery of the organization as a rational machine, but also by the skills of participants who learn to work within the situation in which they find themselves. New ways of knowing and doing can emerge if communities begin to rethink [...] the "false necessity" of everyday life, and to engage with the tensions in their activity systems. The complexity of socially distributed activity systems suggest that incoherencies and tensions are inevitable; the issue is not how can they be eradicated but how they should be treated."*

Following this perspective we consider technology as an active element in the socially distributed activity system. Hence we assume the idea proposed by Kakihara and Sørensen (2001, p.15) that "information systems in modern firms and organizations are not merely technological artifacts that

makes operation efficient and smooth but rather social institutions[4] that shape managers' strategic decision making process and the organizational form of the firms". Information systems should be also seen as social settings that shape the direction of the organizational knowledge creation and utilization.

Distributed Knowledge Model

Developments in information and communication technologies are combining with others changes (such new economic and organizational structures) and one consequence is that activity systems previously isolated are becoming interlinked and more complex. In the following schemas we will propose a preliminary representation of the information systems role in an activity system. The following model refers to the *knowing* process as a whole flow, also if it will be decomposed in steps for analytical clarity.

The general model, based on Bolici (2005) framework, describing the social and technological interaction in an activity system is shown in Figure 2.

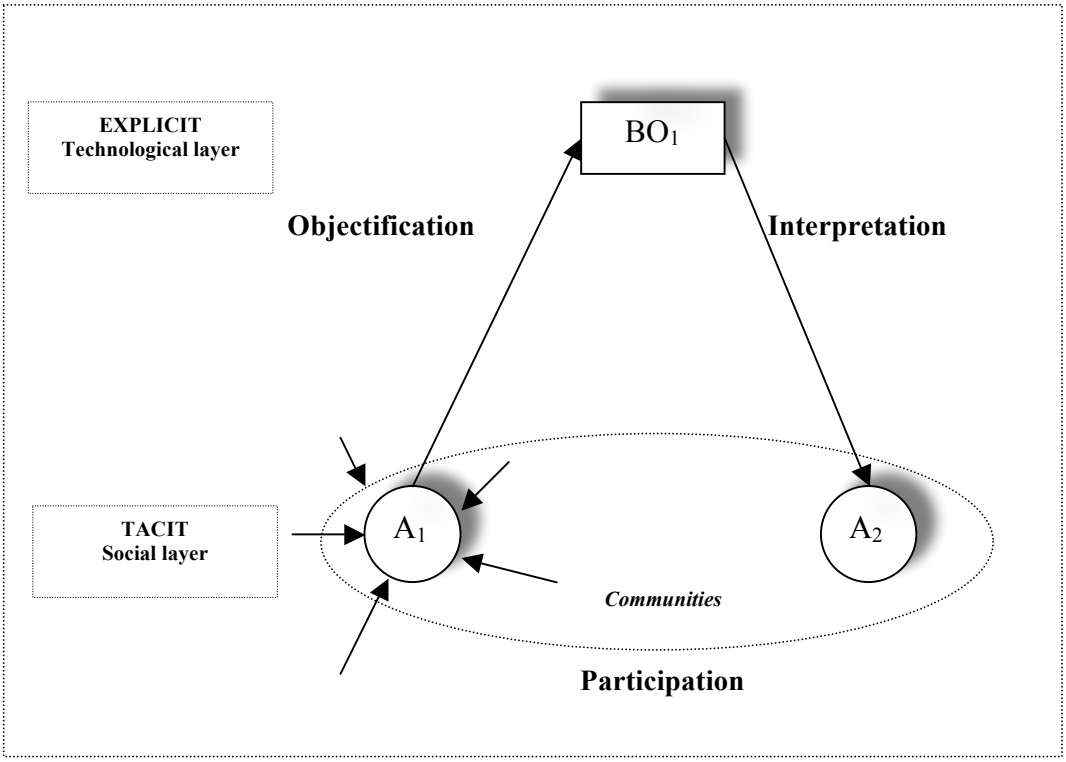

Figure 2 Distributed Knowledge Model between two actors (Bolici 2005*)*.

[4] Authors adopt North's (1986, 1990 p.3) concept of institution: "Institutions are the rules of the game in a society or, more formally, are the humanly devised constraints that shape human interaction. In consequence they structure incentives in human exchange, whether political, social or economic".

Initially, an actor (A1) individually experiences work practices and builds social ties within her organizational community. The actor, collecting and interpreting inputs and experiences from her specific environment, produces a tacit cognitive representation of her domain. This individual activity brings A1 to generate a first stock of knowledge, not codified and strictly related to the specific environment in which she established her relations (Polyani 1958, 1983). At this point A1 has two different options[5]: she can share her knowledge through social channels, *participating* in activities with other people of the community, or she can embed part of her cognitive factors into an artifact, called boundary object (BO1).

In the first scenario, the relationship between A1 and any other community member (e.g. A2) is mediated by shared institutions through social norms, recognized roles, routines and shared practices (DiMaggio and Powell 1991, Selznick 1949). From this perspective, the core of knowledge sharing process relies on social dynamics, while technology has only a mediating and facilitating role. It is interesting to underline that if A1 and A2 belong to different communities of practice, their relation is crossing the boundaries of their own groups. Referring to Wenger (1998) contribution, we stress the distinction between two different mechanisms of connections among communities: brokering (based on the participation process here described) and boundary objects (based on the reification process described in the following paragraph).

In the second scenario, the cognitions generated by A1 could be partially represented through the use of shared formalisms, and hence codified. A1 *objectifies*[6] some of her ideas in written documents or drawings, software code-lines, models, blueprints, videoclips, etc. often relying on technological tools. We can consider those technological artifacts as boundary objects (BO1) (Star 1989, Wenger 1998) where a portion of A1's experiences and cognitions are formalized and crystallized. One of the main reasons for creating and sharing boundary objects is to build a reference artifact around which the relation between different actors can be managed and through which other community members can have access to a representations of A1's experiences.

The subsequent step is the interpretation process done by another actor (A2) interested in that specific artifact (BO1). Through technological mediation A2 accesses the artifact and interprets it according to her own cognitions and experiences (this process is named *subjectification*). It is interesting to consider that A2's interpretation of BO1 could differ (in different degrees) from the meaning that A1 aimed to codify in the object. Moreover, A1 is rarely able to embed her whole knowledge in the artifact, because some portions of her cognitions cannot easily be transformed in explicit knowledge. Thus, it is not rare that the original knowledge (that originally belong to A1)

[5] This paper does not aim to investigate motivational aspects, thus we assume that actors are willing to share their knowledge.

[6] See Wenger's (1998) work, also referred as reification process.

could differ from the cognition received by A2 through her interpretation of the object. Thus, the simple transfer of an artifact is not enough to guarantee knowledge sharing and flow in a complex distributed organization. BO is an element that can facilitate the building of a common understanding and the sharing of ideas, especially when the artifact is part of a dynamic process based on social practices able to enrich the meaning of the object itself. In this phase the role of technologies is to improve the characteristics of the BO and to go beyond the limitations of time and space assuring the availability of the artifact for all the members every time and everywhere. Indeed, from a boundary object an actor could start a negation of meaning process with the author of the artifact sharing her cognitions and cooperating in the practice. This is one specific characteristic of the BO: to generate key points around which the negotiation of meaning becomes organized.

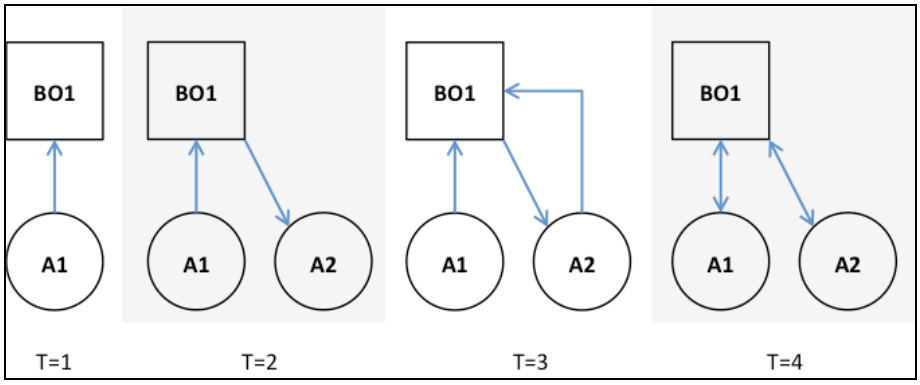

Figure 3 Evolution in Distributed Knowledge Model through boundary objects.

After that A2 interprets the artifact (BO1), several scenarios are possible: 1) A2 decides to directly contact A1 and both starts to cooperate in a common practice –in this case participation would follow the reification process–; 2) A2 decides to re-elaborate BO1 though her own interpretation and her cognitive background (Fig. 3) –thus, actors exchange knowledge through the shared artifact–; 3) A2 considers the artifact and its content useless, so simply starts again her search, or she has no interest in explicitly showing her cognitions connecting (through reification or participation) to the other actor. It is interesting to notice that, in the second scenario, the shared boundary object could receive contributions from multiple actors. This situation can potentially raise some issues about the artifacts ownerships: in absence of an *ex-ante* agreements among the different actors it can be challenging to establish which actor (contributor) has the rights to access, modify, exploit, distributed and sell it. This dilemma has been long debated in some domains, as for example software development (e.g. Open Source Software, Creative Commons) and research fields.

Distributed Knowledge Model with Multiple Actors

In the previous paragraphs, the distributed knowledge model has been described considering two actors; in this section we describe the model when multiple actors are involved in distributed knowledge sharing processes. As showed in Fig. 4, different actors can access each boundary object, and each person can modify the artifacts (according to her individual access rights)[7].

The colored inner circle represents the technological layer, where the artifacts are stored, accessed and transferred, with almost no limitation of time and space[8]; on the other side, the social interactions among people of the different community of practices are represented by the dashed ovals.

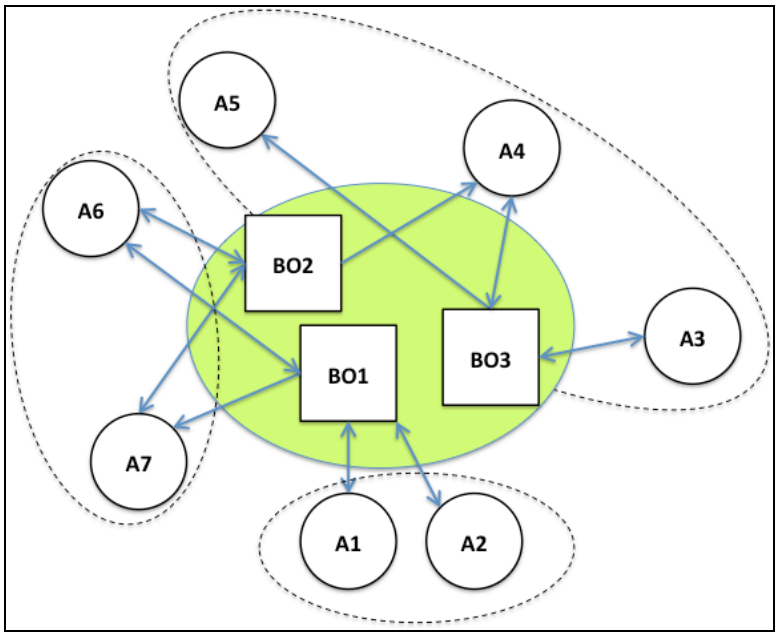

Figure 4 Distributed Knowledge Model with multiple actors.

Following the logic presented in the general model, each actor can choose between two different actions: to codify her knowledge into an artifact (thus creating or modifying a BO) or adopting social interactions in order to discuss her cognition with other people. At this point it is important to notice that these two options represent the two extreme cases of a certain range of potential behaviors. A1 can also decide to use both reification and participation in order to share her knowledge: for example so she could present in a meeting an artifact that she built (this is the case of prototyping and also of academic conferences with proceedings and presentations). Combining

[7] In the example presented in Fig. 4, A3 and A4 can access and modify BO3, while A5 can has only the right to read it, but does not have the clearance to contribute to it.

[8] For example an online document can be accessed at every time and from every location, as long as the actor has the necessary equipment (device and internet connection).

the artifact and the participation, A1 is reducing the risks associated with the use of standing alone solutions.

The reification allows overcoming most of time and space limitations: the artifacts can be stored in the shared system and used in anytime. Hence, information and communication technologies can be considered a crucial factor, enabling and facilitating the storage, categorization and flow of artifacts. On the other hand, reification is also characterized by some limitations. A document is subject to misunderstanding, especially when it is transmitted without any kind of contextualization or individual engagement. Moreover, the artifact usually is only a partial representation of the original knowledge: not everything can be codified, risking losing some information embedded in the actor or in the community. Following this reasoning, the combination of technological and social channels is possible for knowledge sharing, and even preferable in some scenarios. For example, shared boundary objects can be extremely useful in transmitting information, decreasing the level of uncertainty around a specific topic, reducing time needed to search some specific cognition, avoiding to repeat constantly the same contents and decrease the importance of geographical location. On the other hand, social dynamics often provide a more engaging experience, decrease the risks of misunderstanding, present a quick follow-up to ideas and have higher potentialities to generate innovative ideas.

Conclusions

This paper has investigated the knowledge dynamics emerging in distributed organizations, focusing on the interactions between technological and social aspects. We introduced the concept of boundary object, as results of *objectification* processes through which a partial representation of an actor's knowledge can be embedded and shared in an artifact. Technology can facilitate an efficient and fast exchange of codified representations of experiences, diminishing the influence of time and space on knowledge sharing processes. At the same time, a decontextualized artifact can easily be misunderstood and also be neglected lacking social commitment factors. Social dynamics can be richer than codified and static objects, providing a deeper representation of each other knowledge and allowing for simultaneous and direct discussion and negotiation of meaning.

The distributed knowledge model represents a theoretical attempt to provide guidelines to researchers and managers interested in analyzing the interaction between social practices and technological tools in networked organizations. While a further theoretical efforts is still needed, as well as empirical tests, we can briefly synthetize some initial propositions that can be investigated in future researches. First of all, in order to build an effective distributed knowledge system, the technological layer (inner colored oval in figure 4) has to be design to guarantee transparency of the

working practices. Actors can exchange knowledge and coordinate themselves through boundary objects as long as the shared artifacts are easy to access, always updated and easy to be interpreted. Secondly, artifacts can be extremely useful as reference point around which different actors' perspective can be negotiated. An accurate design of the artifact and a attentive management of its use can potentially lead to driving knowledge processes without directly interfere in social practices or to appeal to hierarchy. Finally, the model shows that, even if technology enables several favorable tools and processes for knowledge management, social practices still play a crucial role in organizations. What we could expect from future studies are empirical evidences that investigate the connection between the complexity of the tasks to accomplish, the structure of the organization and the typologies of knowledge management practices adopted.

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