Digital Technologies and Patterns of Distributed Innovation

Full Paper

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Abstract

In this conceptual essay we develop a framework for comparing different forms of organizational structures for distributed, innovative work. To develop this framework we identify two dimensions. The first distinguishes between organizational arrangements that are structured either in relation to a "container" organization, or those arrangements that are structured by the digital platforms upon which their ecosystems are based. The second dimension considers the degree to which the boundary spanning activity is more or less opaque, in terms of the degree to which collaborators interact in either an arm's length or a tightly coupled fashion. In developing and reflecting on this framework, we characterize four ideal types of organizational structures for distributed innovation: agent relationships; work teams; managed crowds; or open projects. We further utilize the framework to theorize about processes that might lead to transitions between structures.

Keywords

Innovation, distributed teams, virtual teams, open teams, crowds, organizational structure

Introduction

Innovation is increasingly distributed, taking place in virtual teams, across crowds, communities, and globally, and this distributed innovation is to no small extent enabled by digital technologies (Yoo et al. 2012). Digital technologies have reduced the costs of organizing across distance, enabling a variety of new ways to structure distributed work. Some new ways of distributed work closely resemble traditional organizational structures, whereas others are starkly different. In the various streams of literature on distributed organizing for the purpose of innovation, there is no comprehensive theoretical framework for comparing different approaches to distributed organizing.

This is problematic because the dynamics of contemporary distributed organizing can be fundamentally different than the sorts of organizational forms that are typically recognized by organizational scholars (Mintzberg 1993). Contemporary innovation can be highly digitally-dependent, cross-organizational, geographically and temporally distributed, and enabled by broad-based platforms and infrastructures (O'Leary and Cummings 2007; Tiwana et al. 2010; Yoo et al. 2012). In this conceptual essay, we draw upon existing literature to construct a theoretical framework through which we can compare different structures for organizing distributed innovation, with special attention to the digital technologies that enable this work. We look to take a step toward organizing disparate research streams related to distributed organizing for the purpose of comparison and theoretical development.

To do so, we identify and analyze literature on distributed organizing for innovation, including distributed (virtual) teams, off-shoring and outsourcing arrangements, crowdsourcing, open source, and online-communities. In analyzing this literature we identified two important dimensions along which distributed organizational structures differ. The first dimension is whether the activity is structured with respect to an organization, on one hand, or a platform, on the other. The second dimension is whether boundary spanning of the team is either tightly coupled or at arm's length. We develop a framework from these two

dimensions that highlights four ideal types of distributed work arrangements: agent relationships, work teams, managed crowds, and open projects. Such a framework clarifies different kinds of distributed organizing and therefore enables comparison to advance both research and practice.

Next, we briefly review the key dimensions along which we develop our theoretical framework. Then we introduce the framework, and use it to categorize different types of distributed organizing for innovation. We reflect on the implications of the framework, and theorize about potential transitions among the different organizational structures.

Distributed Organizing for Innovation

Digital technologies provide a variety of affordances for new and different ways of organizing (Kallinikos et al. 2013; Zammuto et al. 2007). Innovative teams enact these affordances across a variety of experiences at multiple levels (Yoo et al. 2012). At an organizational level, for example, digital systems enable teams to work across time and space to innovate in virtual, or distributed, teams (Cummings 2004; O'Leary and Cummings 2007) and enter into a variety of organizational arrangements for innovative activities that can be quite dynamic (Yoo et al. 2006). These dynamic arrangements can, for example, include features such as offshoring (Chakraborty et al. 2011; Leonardi and Bailey 2008) or electronic brokerage (Malone et al. 1987; Schultze and Orlikowski 2004).

On the level of industry ecosystems, digital platforms have enabled new forms of organizing that democratize and distribute certain forms of organizing for innovation (Boudreau 2010; Boudreau et al. 2011; Tiwana et al. 2010). These organizational forms include open source software (Crowston and Howison 2006; Fitzgerald 2006), online community innovation (Blood 2004; Majchrzak 2009), and crowd sourcing (Boudreau and Lakhani 2013). From this brief review we clearly see two broad types of distributed organizational arrangements—those that take place in relation to a particular organization or set of organizations, and those that take place somehow outside of any particular organization, and are instead enabled by digital platforms. This distinction forms the basis of our first dimension, whether the consequent structure primarily references the organizational "container" (Winter et al. 2014) or "platforms" (Tiwana et al. 2010).

Organizations & Platforms

Distributed organizing can either take place in reference to specific organizations, or independent of any particular organizational context (Winter et al. 2014). In the first case, the relevant organization itself contributes to the structuring of organizational activity. Within the firm's organizational container, distributed organizational units maintain access to—and are constrained by—resources, knowledge flows, and tasks. In relation to the organization, particular activities "inherit" the control structures and coordination mechanisms of the organization, to a degree (Winter et al. 2014). However, in situations such as open source software, online communities, and crowdsourcing, there is no particular reference container. Activities which fall outside of the traditional organizations instead rely on information systems platforms as the basis for structuring work (Tiwana et al. 2010).

Organizations & Distributed Coordination

One notable benefit of a formal organization is coordination of production (Coase 1937), including resource allocation and incentives, and task assignment. In these senses, both offshore work and distributed organizational teams clearly exist with reference to particular preexisting organizational structures. Such organizing need not stay within the bounds of a particular organization; semi-independent innovation teams, new ventures, outsourcing arrangements, and independent business units still exist in relation to an organization (Teece 1996). In each of these instances, the reference organization enables innovation through access to knowledge held by subject matter experts within the organizational network, which is in turn enables the distributed organization through the allocation of resources. In a sense, the distributed form inherits the structures and relational networks of the reference organization (Winter et al 2014). For example, Majchrzak et al. (2000) found that innovations were enabled by distributed team members' access to experts within the parent organizations, but external to the team.

Members of organizational innovation teams may be distributed spatially, but also distributed configurationally and temporally (O'Leary and Cummings 2007). However, organizational structure is subject to significant change over time, especially in cross-organizational teams and during early stages when group norms are negotiated (Majchrzak et al. 2000). Over time, changes in structure reduce as team members become more accustomed to distributed coordination practices. For example, members may take time to adjust to sharing more information with the entire team, rather than with specific participants, as they might in collocated teams (Majchrzak et al. 2000; Malhotra et al. 2001). But once this pattern is established, it can remain stable throughout the collaboration.

Patterns of organizing for innovation with reference to specific organizations are enabled by digital technologies for coordination and knowledge sharing (Yoo et al. 2012), but they get their structure in no small part from the preexisting organizational forms. Digital technologies do, however, change the way these forms are enacted because they streamline communication and enhance coordination within and across organizational boundaries (Sahaym et al. 2007). Indeed, digital technologies bridge existing modes of organizing to newer forms, based on open, crowd-enabled innovation which are enabled not by reference organizations, but through information platforms (Boudreau and Lakhani 2013; Crowston and Howison 2006; Winter et al. 2014).

Platforms & Distributed Coordination

In contrast, crowdsourcing and online community arrangements for innovation exist outside any particular organizational container. Certainly, one of the major draws to these forms of organizing involves leveraging innovation beyond the boundaries of the firm (Chesbrough 2003). Indeed, GoldCorp (Tapscott and Williams 2008) and Netflix (Lohr 2009), both of which offered prize money for innovations, are prime examples of engaging wider participation in innovation rooted in digital platforms. Numerous open source initiatives (e.g., Howison and Crowston 2014) also engage in innovation without reference to traditional organizational structures and rely instead on open platforms as the basis upon which work is structured. Such arrangements do not have the benefits of being within an organization. This is largely intentional, since these work design choices exist, in part, to escape the constraints and inertia of the organization (Chesbrough 2003). New organizations may eventually emerge organically, but these organizations spring up in relation to existing work taking place around digital platforms (Crowston and Howison 2006; Winter et al. 2014); the work and the infrastructure precedes the organization rather than the other way around.

Organization forms both within and external to the organization container leverage digital technologies, and participants in either instance both change their behavior around those technologies, and adjust the platform to fit their preferences (Howison and Crowston 2014; Majchrzak et al. 2000). However, open and crowd-based forms of organizing are critically dependent on digital platforms for coordination in a way that distributed innovation within the organizational container is not. This is in part due to the more fluid membership afforded by platform ecosystems, whereas forms within the organization container may rely on the structural coordination and membership pool afforded by a parent organization. Similarly, feedback (Desanctis and Monge 1998), and consequently, experimentation and improvisation (Gibson and Gibbs 2006), are also constrained in open-platform forms of coordination.

Certain affordances of platforms help overcome these potential disadvantages, including cultural elements of platform ecosystems. For example, Zammuto et al. (2007) identified mass collaboration as an affordance for the coordination of innovation. This is particularly critical outside of the organizational container, not just because membership may be fleeting and transient, but also because the participation of large numbers of people provides adequate feedback in the absence of organizational structures. Additionally, the platform-provided decomposition of tasks enables collaborators to implement small variations independently, conduct experiments and garner feedback, all without adversely affecting the work of others. In open source software (OSS), for example, coordination is structured and enabled by elements of the platform, including distributed version control systems (DVCS) such as the GitHub platform. A study by Brindescu et al. (2014) of over 350,000 commits to OSS projects showed that developers using DVCS made a many smaller commits and were more likely to reference issue tracking labels and other coordinating information, as compare with commits in more traditional version control systems. The improved coordination afforded by DVCS platforms may explain why GitHub quickly became the most popular open source repository, surpassing Source Forge and Google Code (Finley 2011).

The intertwined relationship between organizations and supporting information systems is present in distributed forms, both within and outside of the organizational container. In the first case, the organization is the stronger actor, and exerts a greater influence on the distributed work design, while in open forms the platform has primacy. These two influences, organization and platform act as an organizing substructure to patterns of distributed organization.

Up to this point we have highlighted one key distinction between different forms of distributed organizing for innovation—those that inherit structure from particular organizations and those that are structured in relation to digital platforms. This is not the only distinction among different forms of organizing—another distinction involves the division of labor, and the boundary relationships or "interfaces" among actors in a distributed organizational arrangement.

Boundary Spanning Interfaces

Organizational scholars have long highlighted how knowledge boundaries spring up due to division of labor, and that these boundaries must be spanned for effective coordination (Lawrence and Lorsch 1967). Different units in an organization have different capabilities and they form separate orientations. Boundary spanning activities and units form to coordinate activity among these different units. Boundary spanning activities may differ in terms of their strength and frequency. In situations such as offshoring and crowdsourcing, distributed innovation can be quite arm's length, with few boundary spanning connections. The inner workings of this sort of distributed organization are opaque to the parent organization, because communication and coordination occurs through narrow, pre-defined interfaces. On the other hand, in some structures, such as highly interactive distributed collaborations, each member might serve as a subject-matter expert and be highly involved in many details in the collaboration. In such a case, members directly coordinate with many others, and they might have strong relationships, thus entailing a distributed form that is not at all arm's length but is instead tightly coupled. Our second dimension is thus whether a distributed form includes interactions at arm's length or tightly coupled work.

These two dimensions, namely 1) whether distributed team exists with reference to an organization or a platform, and 2) the relative arm's length or tight coupling of boundary spanning interfaces, can be used to categorize distributed organizing for innovation in a framework.

Patterns of Distributed Organizing

Figure 1 describes four categories stemming from our distinction between types of boundary spanning interfaces, and the sources of coordination structuring (organization vs. platform). The resulting four types of structure for distributed organizing are: 1) the agent relationship, which encompasses

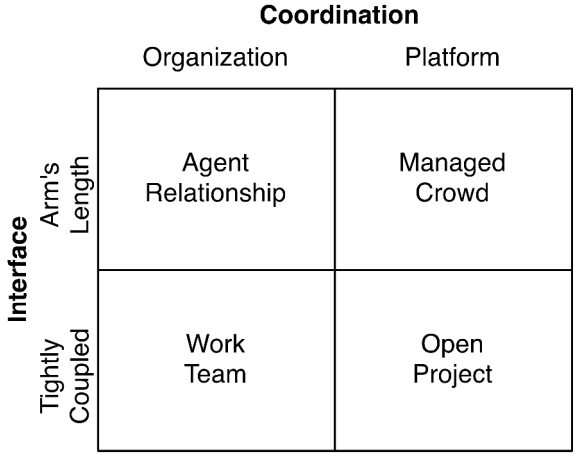

Figure 1: Patterns of Distributed Organizing

outsourcing, offshoring, and similar arm's length distributed interaction, 2) the work team, which is perhaps the most common conception of distributed or "virtual" teams, 3) the open project, which represents publicly accessible projects, such as Wikipedia, open source software, and other platform-enabled projects, and 4) the managed crowd, which represents crowd-sourced solutions. We discuss each of these in turn.

The ***agent relationship*** involves enacting a distributed arrangement that is structured similar to an outsourcing or offshoring team. At its core, an agent performs work for a parent organization (Schilling and Steensma 2001). Information flows are constrained to well-defined interfaces, such as a contract, yet do so in relation to a particular "principal" organization. One party in the distributed collaboration is the principal, and the other is its agent, essentially working for the principal. Agent relationships encompass both traditional long-term outsourcing arrangements, retaining of experts (e.g., attorneys, realtors), as well as contractors retained through online "crowd" marketplaces where participants bid for distributed work. These relationships are primarily managed based on agreed upon outcomes, which implies methods of achieving those outcomes are known. Innovation is most likely incremental. The agent relationship is typically distributed due to the simple expedient that the agent and principal are typically not co-located, although the spatial and temporal distances (Cummings et al. 2009) are likely less consequential as coordination is more constrained by the interface than by distance.

In contrast, the ***work team*** exists with respect to the boundaries of a particular organization. Work teams are common in project management (Pinto et al. 1993) and new product development (Edmondson and Nembhard 2009), and are typically cross-functional (Mohrman et al. 1995). By definition, work in teams is interdependent and often cross-functional (Powell et al. 2004) and coordinated in some combination of hierarchy and mutual adjustment (Mintzberg 1993). In contrast, single-function groups are typically coordinated by a hierarchically superior cross-functional integration team (Mohrman et al. 1995), which would then fall into the work team category described here. Indeed, multiple actors performing identical sets of tasks are more similar to repeated agent relationships than teams, so supporting information systems in that instance would necessary afford reduction, abstraction, and summarizing of data. Much of the virtual teams literature falls into the work team category (e.g., Martins et al. 2004; Powell et al. 2004). Some level of distribution in teams and work units is increasingly common, or even inevitable, particularly as work becomes digitized.

Where the agent relationship emphasizes boundaries, the work team seeks to remove or mitigate boundaries caused by distributed locations and configuration, differing functional specialties, or team/organization identity (O'Leary and Cummings 2007). Although co-location makes interaction, trust, and sharing situated knowledge easier (Gibson and Gibbs 2006), this limitation make be overcome in distributed teams through common methods of collaboration and knowledge sharing, such as through a common information system (Powell et al. 2004; Townsend et al. 1998).

The ***open project*** is well-suited to complex, interdependent tasks, particularly those where outputs cannot be initially defined in specific terms or evaluative mechanisms are not in place. While open projects are typically considered in the context of open source software (Raymond 1999), creation and editing of content for Wikipedia (Kittur and Kraut 2008) is also an example of a complex task accomplished by an open project. Open projects are more likely to succeed when their work can be easily or pre-emptively modularized, especially in early stages (Baldwin and Clark 2006; Howison and Crowston 2014). Although the resulting work product whole is complex and interdependent as a whole, open projects prefer small, individual-level tasks that may be layered, or superimposed on each other, for effect, rather than tasks that require cooperative work (Howison and Crowston 2014). Many successful open projects use multiple modes of electronic communication, but more modern platforms offer ways to integrate problem identification, experimentation, evaluation, and resolution, which increases the usefulness of supporting information systems platforms.

Open projects work best when participants share knowledge openly (Boudreau and Lakhani 2013), so any particular organization is unlikely to be able to exert significant control without consensus. In a fully open project—where participants come and go as they choose—contributions are motivated by personal benefit and reputation as well as by ideology and altruism (Shah 2006). The uniformity of shared ideology among team members contributes to attracting and retaining members, but may also be detrimental to the output of the team (Stewart and Gosain 2006). However, open projects consistently value transparency, and their members tend to freely reveal innovations (von Hippel and von Krogh 2003). In addition, the

most successful open projects are composed of members who consume the work product (Raymond 1999; von Hippel and von Krogh 2003). These features of open projects suggest particular affordances that support open projects: low friction to transient membership, public knowledge sharing, and public distribution of work outcomes.

The ***managed crowd*** differs from the open project in a few ways. In an open project, members coordinate complex work by freely sharing information. In contrast, participants in a managed crowd are largely independent from each other, with little to no information sharing. Consequently, participants in a managed crowd tend to work on similar or repeated tasks. The managed crowd is suitable in two general instances: first when tasks are simple and numerous, such as work suitable for Mechanical Turk (Vakharia and Lease 2013), and second when an ideal solution can be described and measured, but the process for achieving the solution is unknown (Tapscott and Williams 2008). Of the two, the former has received more attention from researchers (Kittur et al. 2013; Kittur et al. 2011), and the latter is usually accompanies by contests. In either case, outputs are easily evaluated, and platforms that afford crowd work typically include evaluative mechanism. Use of the word "crowd" is muddled in literature (Kittur et al. 2013; Van Dijck and Nieborg 2009), encompassing projects like Wikipedia, which is more aptly described as an open project under our framework. While crowds can form from organizations' attempts to engage with their users, the managed crowd is more than a community of interest, but rather a conscious choice of the parent organization to shift work outside the boundaries of the organization. The focus of the managed crowd is work, what Kittur et al. (2013) called "crowd work."

Discussion

In each of the categories above, we have drawn from distinct streams of literature to offer insights into conceptually similar organizations. Some work previously considered crowd work may be more conceptually similar to open projects, and some distributed teams within a particular function may be more conceptually similar to repeated agent relationships than an integrated work team. This framework may have other implications. For example, the interaction of the strength of the organizational container and the richness of interfaces may be the cause of the lack of structural dynamism observed in some distributed teams (Gibson and Gibbs 2006).

Shifting Between Types

Having identified patterns of distributed organizing, we next use it as a lens to consider competing tensions between patterns, and propose conditions under which a particular organizational unit might evolve toward a different pattern. (Figure 2)

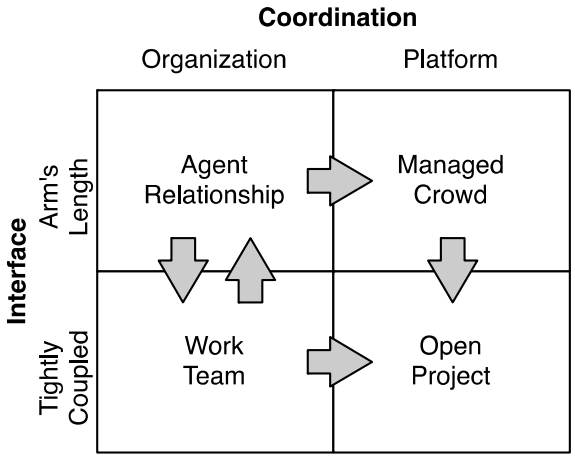

Figure 2: Transitions Between Patterns of Distributed Organizing

The transition effect is clearest along the interface dimension. The information asymmetries present in agent relationships may be overcome, in part, by spanning unit boundaries. This transition may be useful

when two parties contract repeatedly over an extended period of time (Dyer and Singh 1998). Similarly, removing boundary spanning connections transitions a work team to an agent relationship. This tension is analogous to the progression of Transaction Cost Economics research streams, which focused first on contracting (Williamson 1999), then on relationship building (Dyer and Singh 1998), and eventually on a hybrid recognition between the pulls of arms-length opacity and rich connections (Poppo and Zenger 2002). Similarly, arm's length coordination may evolve into a period of intensely collaborative work teams, and after periods of intense collaboration, may revert to a new form of arm's length coordination (Berente et al. 2010).

In a similar way, in some circumstances the managed crowd may shift to behaving more like an open project, as connections beyond the organizational boundary are introduced. In the final days of the Netflix prize competition, for example, several teams consolidated into only a few teams, in an effort to achieve the million dollar prize target, believing they would not be as efficient apart. After meeting the specified goal, the top teams also publicly published their algorithms (Lohr 2009).

The dimension of organizations versus platforms operates similarly. As individuals seek to connect to knowledge and expertise, they may begin to make connections outside the traditional organizational boundary. The examples of Netflix and GoldCorp both illustrate situations where organizational teams had already been working on similar problems that were subsequently opened up to the crowd – in a way extending the original organizational teams. When such behavior is repeated sufficiently, organizational boundaries weaken and knowledge is shared and consumed more freely, just as with open projects.

The transition from agent relationship to managed crowd along the organizational dimension may also occur in a different way. At scale, a set of agent relationships begin to exhibit the characteristics of what Sinha and Van de Ven (2005) call a network problem, which is partially resolved by removing interdependencies between nodes in a network, and relying more on information systems. These strategies involve efforts to reduce demand for information processing. In this way, a set of repeated agent relationships adopts many of the characteristics of a managed crowd, and can be usefully considered in that light. These network relationships are handled similarly to a managed crowd, and may introduce competition between otherwise independent participants. Consider the example of remotely distributed customer service agents working from home. Individually, each is an agent relationship. There are transaction costs to begin the relationship (perhaps, transaction-specific assets, such as phone lines, or training), but as more agents are added, it is useful to leverage digital technologies to lessen such coordination costs. However, by so doing, there is a risk of lessening identification to the parent organization among participants (Fiol and O'Connor 2005). Because of this reduced identification with the organizational container and reliance on information systems over hierarchical organizational structures, from the perspective of both parties the relationship is perhaps more similar to a managed crowd than to a simple agent relationship.

There are also transitions evident from open forms of organizing toward the organizational container – leading some to conjecture that when organizations do not exist ex ante, they may be developed over time (Winter et al 2014). Examples include the Mozilla and Apache foundations, which began as open projects and grew to have enough organizational momentum, opportunities for specialization, and permanence of core membership that its work on some tasks is structured more similarly to a work team than an open project (Mockus et al. 2002). The salient point is that although categorizing organizational units with this framework has make sense for thinking about different forms of distributed organizing, such classifications are not static. Distributed innovation structures evolve over time.

Conclusion

The framework presented here serves to unify and clarify previously disparate streams of research into distributed organizing in the context of innovation. The dimensions we adopted, namely the organization–platform dimension and the boundary spanning interface dimension, permit comparing and contrasting patterns of distributed organizing. In building this framework, we highlighted conceptual ambiguity regarding crowd work, and attempted to resolve it by explaining that some work done by crowds is more theoretically similar to typical organization of open source software, such that these forms can be usefully considered together under the heading "open projects." We find further use for the

framework by using it in the context of organizational tensions to explain possible or likely paths of evolution between types as distributed organizations mature.

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