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# Improvisation and Performance in Software Development Teams: The Role of Geographic Dispersion

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# IMPROVISATION AND PERFORMANCE IN SOFTWARE DEVELOPMENT TEAMS: THE ROLE OF GEOGRAPHIC DISPERSION

*Improvisation et performance dans les équipes de développement de logiciels : le rôle de la dispersion géographique*

*Completed Research Paper*

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## Abstract

*Software development teams are increasingly faced with unanticipated obstacles to effectiveness that require extemporaneous actions. Team improvisation has been identified as an important team situated response to emergent challenges to team effectiveness. However, the efficacy of team improvisation is not well understood in the context of software development teams—which perform complex, knowledge intensive tasks. We examine the efficacy of team improvisation in enhancing team effectiveness and identify team geographic dispersion as an important boundary condition. We test our hypotheses using data from 299 team leaders and members belonging to 71 teams. We find that team improvisation positively affects team performance, and that the degree of team geographic dispersion moderates the relationship between improvisation and team effectiveness. Theoretical and practical implications are offered.*

**Keywords:** Team improvisation, geographical dispersion, virtual teams, software development.

## Résumé

*Cette étude examine le rôle de l'improvisation collective dans l'amélioration de la performance d'une équipe et considère la dispersion géographique des membres de l'équipe comme une condition importante. Nous testons nos hypothèses en observant 299 leaders et membres de 71 équipes. Les résultats montrent que l'improvisation collective influe positivement sur la performance de l'équipe et que le degré de dispersion géographique modère la relation entre l'improvisation et la performance de l'équipe.*

## Introduction

Software development projects are widely characterized by obstacles to effectiveness such as changing requirements (Iansiti and MacCormack 1997). The occurrence and significance of these changes is often difficult to predict a priori. Despite high quality project planning and management, project requirements (e.g., customer specifications) may change or software testing might reveal unforeseen issues. Consequently, software development teams frequently find themselves under pressure to rapidly craft responses to emerging challenges over the course of a project while also adhering to strict deadlines. Previous research has noted the perils of blindly following established routines and processes in the face of complex and uncertain project conditions (Kamoche and Pina e Cunha 2001; Lyytinen and Robey 1999). Therefore, it is important for software development teams to be able to engage in timely adaptive behaviors. Team improvisation describes this capacity for spontaneous creative problem-solving (Gerwin and Moffat 1997; Kamoche and Pina e Cunha 2001).

Although improvisation has been studied in the context of work teams (Kamoche and Pina e Cunha, 2001; Vera and Crossan, 2005), its efficacy is not well understood in the context of teams engaged in complex knowledge-intensive work. Moreover, research on improvisation thus far has not considered an increasingly prevalent and influential characteristic of software development teams, i.e., geographic dispersion (Boh et al. 2007; Hoegl et al. 2007). Various considerations drive organizations to employ dispersed (or virtual) teams, where collaboration is (at least in part) conducted via communication technology (Hoegl and Proserpio 2004). In using teams with this design, companies may be aiming to draw on specialized expertise from remote locations, capture comparative labor cost advantages, or simply utilize the flexibility of including available personnel capacity at its distributed software development operations (Boh et al., 2007; Kankanhalli et al. 2007).

Team member dispersion presents an important boundary condition for team improvisation, which has not been examined in the extant literature. Hence, the purpose of this research is to examine the role of improvisation in facilitating performance in software development teams, given various degrees of team member dispersion. As such, we develop a contingency model of team geographical dispersion and improvisation. Such contingency models are important since relationships among team constructs often differ when different types of teams are considered (Barrick et al. 2007). For instance, geographically dispersed teams are characterized by a more effortful communication process due to team members' reliance on technology-mediated communication (Hoegl and Proserpio 2004). Additionally, team members in geographically dispersed teams suffer a lack of first-hand and "real-time" observation of their teammates. These characteristics of geographically dispersed teams are critical in studying the improvisation domain, since improvisation is more likely to occur within the framework of social interaction among team members (Crossan and Sorrenti 1997).

The investigation of improvisation and dispersion in software development teams offers several theoretical contributions. First, although prior research has recognized the importance of expertise in facilitating better performance in software development teams (Faraj and Sproull 2000), prior literature has not sufficiently engaged the process by which teams in action react to emerging challenges to performance. Second, improvisation—as a creative and spontaneous process—has not been examined in the context of software development teams. Given the inherent complexities and environmental uncertainty that software development teams face, this marks a significant departure from research that has examined improvisation in work teams. Third, improvisation studies have generally focused on only co-located teams (e.g. Vera and Crossan 2005). Comparatively less attention has been paid to the occurrence of spontaneous behaviors in conditions characterized by increased geographical dispersion among team members.

We believe that software development projects are an ideal setting in which to investigate the performance-impact of improvisation in dispersed teams for several reasons (Elbanna 2006). First, development projects require a high degree of unplanned action by organizational actors (Gerwin and Moffat 1997). While basic requirements are established a priori, project success derives from the ability to fulfil emergent needs and requests for customization; and capture and integrate the extemporaneous ideas that emerge from implementers and end users (Ciborra and Lanzara 1990; Truex et al. 2000). Indeed, software development projects rely on heuristic processes without a clear and readily identifiable path to the solution (Lee and Xia 2005), require a high degree of unplanned action by organizational actors (Avison and Fitzgerald 1999; Ciborra 1999a; Gerwin and Moffat 1997; Lyytinen and Robey 1999), and force team members to regularly engage in creative problem-solving (Elbanna 2006). Second, development projects are considered inherently creative because they involve the generation and evaluation of new ideas and solutions to business problems (Tiwana and McLean 2005). Through a creative process that allows for the development of novel and useful solutions, improvisation enables individuals to continuously adjust to

environmental conditions that require flexibility and rapid responses to emergent obstacles (Crossan et al. 2005; Smith et al. 1994). Third, the nature of software development projects lends itself to dispersed teamwork, where the nature of the product developed (i.e., software code) is intangible and can more easily be shared via communication media than physical products (Hoegl and Proserpio 2004).

In the next section, we provide an overview of the improvisation and team dispersion literatures. We then develop a research model that incorporates the roles of improvisation and team dispersion in influencing software development team performance. This is followed by a description of a field study—involving 299 developers and team leaders in 71 software development teams—that was conducted to test the hypotheses outlined in the research model. The paper concludes with a discussion of results and implications for research and practice.

## **Theoretical Background**

### ***Improvisation***

Research on improvisation in organizational settings can be traced back to metaphors pertaining to jazz music, theatre, sports, and public speaking (Cornelissen 2006; Kamoche et al. 2003; Pina e Cunha et al. 1999). In organizational research the notion of improvisation has been studied in domains as different as organizational learning (Miner et al. 2001), technology implementation (Orlikowski and Hofman 1997), and new product development (Kamoche and Pina e Cunha 2001). Improvisation has been defined as a form of intuition which guides action in a spontaneous manner (Crossan and Sorrenti 1997), or as “the conception of action as it unfolds – acting without the benefit of elaborate prior planning” (Kamoche and Pina e Cunha 2001: 735), and “drawing on available cognitive, affective, social and material resources” (Kamoche et al. 2003: 2025). These definitions essentially focus on the temporal sequence of two distinct activities, planning and acting, and on the need to react to particular stimuli by relying on immediately-available resources, recombining them in a “bricolage” action (Ciborra 1996; Pina e Cunha et al. 1999). The reduction of the distance between planning and acting can be originated by either internal or external organizational sources that can be traced back to temporal pressure, complexity and uncertainty, which increase the chance of improvisational activities (Pina e Cunha et al. 1999; Weick 1998). Following Vera and Crossan (2005), we focus on the elements of spontaneity and creativity, defining individual improvisation as the creative and spontaneous process of trying to achieve an objective in a new way by recombining immediately-available resources. As a spontaneous process, improvisation is extemporaneous, unpremeditated, and unplanned. As a creative process, it attempts to develop something new and useful to the situation. Consequently, the improvisation process can essentially be viewed as the convergence of two main theoretical frameworks—spontaneity and creativity. The spontaneity aspect focuses on the immediate temporal sequence of two distinct activities, planning and acting, and on the need to react to particular stimuli by recombining immediately available resources (Ciborra, 1996; Pina e Cunha et al. 1999) Individuals respond to situations on the spur of the moment, in essence composing their actions as they are executing them (Moorman and Miner 1998). The creative dimension of improvisation refers to the attempt to take novel action in situations that are complex and ambiguous (Drazin et al. 1999). According to Miner et al. 2001, the basic definition of improvisation refers to the simultaneous occurrence of these two elements, a consideration which, they argue, allows researchers to distinguish improvisation from other concepts that may be related to the improvisation process. For instance, improvisation is distinct from coordination because coordination neither necessarily requires creative elements nor is it necessarily related to spontaneity. Though conceptually distinct, coordination may be related to improvisation in teams to the degree that it facilitates carefully sequenced action among multiple actors. Improvisation is also distinct from team expertise and awareness. Expertise is a necessary condition for effective improvisation, because individuals rely on their existing knowledge when attempting to develop new solutions in a short time frame. However, improvisation is a process, while expertise reflects a capability. Similarly, awareness is an important factor for successful improvisation. However, being aware of the occurrence of unexpected events may not necessarily trigger the improvisation process. Even if team members are aware that the exploration of new pathways to problem-solving may lead to better outcomes, they may consciously decide to follow routines, or they may be constrained to follow routines because of managers’ leadership style.

Improvisation can be deliberate or extemporaneous (Pina e Cunha et al. 1999) and it should not necessarily be regarded as the result of idiosyncratic events such as organizational crises (Ciborra 1999b; Vera and Crossan 2004). On the contrary, improvisation is thought to occur along a continuum between totally planned action and spur-of-the-moment activities (Pina e Cunha et al. 1999). Accordingly, individuals and groups may incrementally or radically improvise, by adjusting current procedures, as well as by swiftly responding to dramatic events (Vera and

Crossan 2004). Finally, although there is a general assumption in much of the literature that improvisation always leads to positive outcomes and better performance, recent research points out that improvisation is not an inherently positive or negative phenomenon (Crossan et al. 2005; Miner et al. 2001). This stems from the fact that improvisation is evaluated as a process rather than an outcome (Vera and Crossan 2005). Hence, outcomes of improvisation can only be understood by taking contextual factors into account (Vera and Crossan 2005).

### ***Virtualness and Dispersion in Teams***

Traditional views on virtualness have tended to view teams as being either co-located or virtual (Bell and Kozlowski 2002; Kirkman and Mathieu 2005). In fact, much of the empirical work on virtual teams has focused on contrasting process (e.g., Bhappu et al. 1997; Chattopadhyay et al. forthcoming; Hiltz et al. 1986; Jarvenpaa et al. 1988; McDonough et al. 2001; Straus 1996) and performance (e.g., Andres 2002; Graetz et al. 1998; Hollingshead et al. 1993; Potter and Balthazard 2002; Straus and McGrath 1994) in virtual versus co-located teams. The cumulative results in this corpus of research have been mixed, with some studies finding that face-to-face teams outperform virtual teams while others suggest no performance differences between the two types of team (Martins et al. 2004). While this body of research has done much to improve our understanding of how virtual teams operate and perform in comparison to co-located teams, recent literature suggests that such a dichotomous view is limited and does not reflect the true state of organizational teams. Consequently there has been a move toward understanding the implications of finer gradations of team virtualness. Such finer gradations are believed to result in meaningful differences in team dynamics and outcomes (Griffith et al. 2003; Kirkman and Mathieu 2005; O'Leary and Cummings 2007).

There are differing views on what exactly constitutes virtualness in teams. Such a divergence of views is to be expected given that understanding of this concept and its implications is still nascent. Kirkman and Mathieu (2005) define team virtuality as the extent to which team members use virtual tools to execute and coordinate processes, coupled with the informational utility of those tools, and the synchronicity of virtual interactions. This view of team virtuality allows for the possibility that even co-located teams can be virtual—to the degree that they use virtual tools such as email to coordinate some of their work. Team virtuality has also been viewed in terms of the degree to which teams engage in technology mediated versus face-to-face communication. For instance, Kirkman et al. (2004) examined the extent to which virtual teams met face-to-face in order to understand the performance implications of such meetings. Maznevski and Chudoba (2000) also recognize that virtual teams can differ in the extent to which they engage in face-to-face meetings. Griffith et al. (2003) note that teams vary in virtualness along three dimensions: physical dispersion, percentage of time spent apart on tasks, and the level of technological support for team interactions. A unifying theme across these varying views on team virtuality is that the degree of dispersion of team members plays a significant role in determining how much teams rely on technology for coordination and communication (O'Leary and Cummings 2007). Hence, the degree of dispersion of team members in virtual teams is an important feature of virtuality (Griffith et al. 2003).

Dispersion is defined as the physical distance between people (Hoegl and Proserpio 2004; Hoegl et al. 2007; Kiesler and Cummings 2002). In teams, team member dispersion can range anywhere from having all members working in the same room to having all members located in different parts of the world. Indeed, a few studies of virtual teams have explicitly captured the extent to which team membership was dispersed across geographic locations including buildings, cities, countries etc. (e.g., Cummings 2004; Finholt and Sproull 1990; Trevino et al. 2000). Many of these previous studies have viewed dispersion in a spatial sense. However, recent studies have adopted a more complex view of dispersion (e.g., Bell and Kozlowski 2002; Fiol and O'Connor 2005; Griffith et al. 2003; O'Leary and Cummings 2007; Rice and Aydin 1991). Most recently, O'Leary and Cummings (2007) defined team dispersion in spatial, temporal, and configurational terms. Whereas spatial dispersion deals with the geographic distance among team members, temporal dispersion reflects the extent to which team members work in different time zones, and configurational dispersion captures the location of team members across different sites. O'Leary and Cummings (2007) note that there is a fundamental difference between virtual teams with high spatial dispersion within the same time zone (where members are spatially dispersed in a vertical direction) and virtual teams with high spatial dispersion spanning time zones (where members are spatially dispersed in a horizontal direction). Temporal dispersion has important implications for virtual team members' ability to communicate synchronously and coordinate work efforts effectively (Cramton 2001; Maruping and Agarwal 2004; O'Leary and Cummings 2007). The locational configuration of virtual teams also has implications for team member coordination. It captures the extent to which different sources of expertise in a team are isolated versus co-located across geographic locations (Baba et al. 2004; Cramton 2001; O'Leary and Cummings 2007). In sum, these emerging views of dispersion

recognize that teams vary along a continuum of low to high virtuality and that this can have important implications for team processes and team performance. In this research, we focus on geographic dispersion because, as noted in the introduction, it has important implications for the efficacy of team improvisational efforts.

Theories and findings on the effects of team member dispersion in teams are mixed. On the one hand, high degrees of proximity facilitate spontaneous communication which can improve interpersonal relationships and promote the exchange of ideas around the proverbial water cooler (Kraut and Streeter 1995). When located at distances exceeding 30 meters, employees are less likely to engage in such interactions (Allen 1977; Kiesler and Cummings 2002; Kraut and Streeter 1995; Van den Bulte and Moenaert 1998). On the other hand, proximity can hamper performance on certain types of tasks (Dennis 1996; Dennis and Valacich 1993; Zajonc 1965). Being in close proximity can interfere with team members' ability to work autonomously. In addition, when team members are dispersed across geographic locations, the team itself can tap into a broader array of expertise—a fundamental *raison d'être* for virtual teams (Boh et al. 2007; Jarvenpaa and Ives 1994; Townsend et al. 1998).

The nature of the task is an important consideration in understanding the implications of team member dispersion for team functioning (Kiesler and Cummings 2002). Specifically, the extent to which proximity is critical for team functioning is predicated on the coordination needs of the task that the team is performing (Kmetz 1984). Tasks that are highly interdependent, complex, or knowledge intensive are more likely to necessitate extensive interaction among team members (Kmetz 1984; Thompson 1967; Boh et al. 2007; Espinosa et al. 2007a). Teams with a dispersed membership face significant challenges in managing tasks with such characteristics. This is especially true of geographically dispersed software development teams (Espinosa et al. 2007b; Kraut and Streeter 1995). Software development is an inherently complex task involving numerous interdependencies. Units of software code must be developed, tested, modified, and integrated by multiple individual developers (Curtis et al. 1988). Further, this must be accomplished within strict production deadlines. Coordination has proven to be a critical determinant of performance in software development (Faraj and Sproull 2000; Kraut and Streeter 1995). Kraut and Streeter (1995) observed that software developers were often able to solve problems through spontaneous communication at the water cooler or the coffee room. In a recent qualitative study, Espinosa et al. (2007b) found that geographically dispersed software development teams demonstrated significantly lower coordination capabilities compared to co-located software development teams. Other studies have commented on the coordination challenges presented by geographic dispersion in software development teams (Boh et al. 2007; Curtis et al. 1988; Herbsleb and Grinter 1999).

In sum, team member dispersion has important implications for successful team functioning. As such, it is a useful lens for understanding the effects of improvisation in software development teams. In the next section, we outline our key hypotheses relating to proximity, improvisation, and performance in software development teams.

## **Hypothesis Development**

### ***Dispersion in Software Development Teams***

Software development is a highly complex process requiring intense coordination of effort among developers (Curtis et al. 1988; Kraut and Streeter 1995; Xia and Lee 2005). Software developers must ensure that they understand what the software under production is supposed to do—which in itself requires them to have an accurate assessment of the business rules for which the software is being developed (Xia and Lee 2005). These business rules typically shape the dependences that exist between different units of software code (Lee and Xia 2005). Individually written units of code may not necessarily work well with units of code written by other developers (Curtis et al. 1988). Therefore, developers must coordinate their efforts to integrate various software components, a process that involves a collective understanding of technical specifications, configurations, and protocols (Curtis et al. 1988; Walz et al. 1993). Software developers are often faced with integration challenges such as code incompatibility and redundancy that affect the performance of the software (Walz et al. 1993). Finally, there are often temporal dependencies among various units of software code. A developer must often wait for a unit of software code to be completed before she can use it in her software code (Massey et al. 2003). These various factors add to the inherent complexity of the software development process. Software development teams, thus, need to have effective coordination in order to successfully manage this complex process.

When software development team members are in close proximity to each other there is more opportunity for them to interact and exchange ideas (Kraut and Streeter 1995). Interaction in close proximity provides for a rich environment for information exchange since developers are able to immediately verify information, clarify

inconsistencies in understanding, and provide supporting information when necessary (Herbsleb and Grinter 1999). When team members are in close proximity, developers can also more easily engage in spontaneous communication if an important question comes up or if feedback is needed on software code (Allen 1977). It is easier to coordinate development effort under such conditions. Software developers can share information about the intricacies of the software code (e.g., necessary data types, functionality of specific units of code etc.) more readily. In many cases such conversations can take place in front of a developer's workstation, making software integration easier. As team members become increasingly dispersed, the ability to coordinate development effort becomes more difficult (Espinosa et al. 2007b). Developers are less likely to engage in spontaneous communication when their teammates are geographically dispersed. Even though geographically dispersed teams can engage in rich communication via information and communication technologies such as videoconferencing, meetings have to be scheduled to ensure that all necessary parties are present for discussions. This affects developers' ability to receive timely feedback on important task-related issues (Massey et al. 2003). In some cases, if developers do not receive immediate responses to their inquiries, frustration can set in and they may proceed without the input of their teammates. Such uncoordinated task work can yield poor outcomes from the software development team. In light of these coordination challenges we expect that—other things being equal—greater dispersion among software development team members will yield lower team performance than greater proximity among software development team members.

H1: *Team members' dispersion will have a negative influence on performance in software development teams.*

### ***Improvisation in Software Development Teams***

Improvisation, as noted earlier, does not have an inherently positive or negative valuation with regard to outcomes (Vera and Crossan 2005). Rather, the outcome of improvisational action is, in large part, determined by contextual factors. Vera and Crossan (2005) note that, although spontaneity of action is a critical dimension of improvisation, there is a fair amount of planning and deliberateness that is required. Improvisation involves rules and routines that are pre-established. Thus, though spontaneous in characteristic, improvisational actions are, in many cases, rehearsed. Vera and Crossan (2005) linked this process to the improvisation demonstrated by jazz musicians or stage actors. Individual musicians have honed their skills over time to develop the capability of engaging in spontaneous and creative behavior. They are well aware of the musical rules involving notes, tempo, etc. When improvising, they bring these rehearsed rules and routines into action, and in so doing, are able to be spontaneous and creative during a live performance. Similarly, software developers hone their expertise on problem solving over time. They are well aware of the rules governing the development of code (e.g., variable scope, data types, and structure of relational databases). When developing novel solutions to a problem, they are able to bring their knowledge of these rules to bear (Faraj and Sproull 2000; Hoegl et al. 2007). Several studies suggest that an improvisation framework can be applied to organizational settings that require established knowledge and routines, and extemporaneous actions, such as strategic renewal (Crossan and Sorrenti, 1997) and new product/service development (Kamoche and Pina e Cunha 2001, Moorman and Miner 1998). For example, Vera and Crossan (2005) highlight an example in which IT employees were assigned to create a new system for organizational auditing. In defining the relationship between system characteristics and audit needs, the system developers relied on an *ad hoc* flexible approach involving continuous trial and error as well as ongoing negotiation to ensure that the end-product met the organization's IT and audit needs. The process included both planned actions and flexibility in trying different ways to solve emergent problems while developing the new system.

In the context of software development, improvisation can yield positive outcomes. The complexities embodied in software development, necessitate the effective utilization of expertise (Faraj and Sproull 2000). Although pre-established routines exist (embodied in software development processes) for software development, every project differs with respect to the specific requirements (e.g., functionality, platforms, business rules, and data types) that must be met. The rules and routines governing software development processes often speak to the management of the overall process, as opposed to the actual software code (Iivari et al. 1998). Given the idiosyncrasies associated with each software project, the ability to develop solutions to specific software requirements often requires some degree of creativity. Hence, software development teams must bring their expertise to bear in solving these problems. It is also well-established that the requirements for software projects often change during the project (MacCormack et al. 2001; Mathiassen et al. 2007). Software development teams must, therefore, expend additional effort to address these changes as they occur while adhering to established deadlines. The spontaneity embedded in improvisation becomes critical in ensuring that problems are addressed in a timely manner (Vera and Crossan 2005).

Creativity enables software developers to be novel, perhaps more efficient, in addressing the requirements that need to be addressed (Drazin et al. 1999; Gilson and Shalley 2004). Such creativity might be manifested in novel ways of marshalling existing resources, using new software development tools, or implementing software design. In sum, because software projects generally have such uncertainties and complexity, software development teams must have improvisational capabilities in order to perform well. Therefore, other things being equal, we expect software development teams that engage in more improvisation to be more effective and efficient than software development teams that engage in little or no improvisation. More formally:

*H2: Team improvisation will have a positive influence on performance in software development teams.*

### ***Team Dispersion and Team Improvisation***

Although team improvisation is expected to generally be beneficial for team performance, the geographic dispersion of team members can affect the extent to which software development teams are able to realize gains from such actions. Specifically, we believe that highly geographically dispersed software development teams face challenges in effectively engaging in improvisational actions. The challenges created by team member dispersion can be traced to two key characteristics of team improvisation: team member awareness and the spontaneity of activity. Both of these factors have important implications for a software development team's ability to coordinate collective action.

During improvisational activity, it is important that team members be aware of their teammates' actions as well as how their own actions might affect those of their teammates. Successful improvisation is not carried out in isolation (Vera and Crossan 2005). Rather, team members must look out for each other (Spolin 1963; Vera and Crossan 2005). This can be accomplished by playing a supporting role when a team member is in the process of improvising. In the context of theater performance, Frost and Yarrow (1990) note that, in order for a production to be successful, actors must support each others' improvisational efforts, when on stage. Actors often rely on cues to understand how and when they need to support a fellow actor's improvisational efforts. After all, successful improvisation is the culmination of interdependent improvisational work (Spolin 1963). Similarly, successful improvisation in software development teams requires that team members support each other when necessary.

A certain level of awareness of what one's teammates are doing is required when improvising. However, other team members must also be aware of a developer's improvisational efforts so that they can adjust their activities accordingly if necessary. Espinosa et al. (2007b) note that such "awareness" is situation-specific and need only last until the situation reaches its end. Team awareness provides timely information about the task environment shared by developers within the team—ensuring that team members remain synchronized in their activities (Espinosa et al. 2007b). Important information about the task environment includes the sequence and timing of one's actions in relation to others' tasks (Espinosa et al. 2007b; Gutwin and Greenberg 2004). When a developer is improvising, other team members ought to provide the necessary resources to assist such efforts (e.g., by volunteering to write unit tests for the improvised solution). When team members are in close proximity to one another it is relatively easy to establish team awareness during an improvisation episode. Developers can engage in spontaneous action to provide necessary resources to support the team's improvisational effort. When team members are geographically dispersed, it is more difficult to develop an awareness of the team's status. Much of this coordination occurs through informal encounters, which occurs less when team members are geographically dispersed (Curtis et al. 1988; Espinosa et al. 2007b; Herbsleb and Grinter 1999; Hoegl et al. 2007). When improvising, developers may experience delays in getting responses to queries for clarification or help from teammates (Herbsleb and Grinter 1999). Without support from fellow developers on the team, efforts to improvise are likely to prove futile. In some cases, improvisation under such circumstances can prove detrimental to performance as developers may unknowingly undermine each other's development efforts by changing code or blocking access to needed resources (e.g., access to the central database for testing a unit of code).

As noted earlier, spontaneity is a critical aspect of improvisation. Although actors know that improvisation is going to occur during a performance—and, therefore, prepare for it—they cannot predict, a priori, when such improvisation will actually occur (Vera and Crossan 2005). Spontaneity incorporates temporal considerations into improvisation. Improvisation occurs in the spur of the moment and is a reaction to emergent, unanticipated, events (Moorman and Miner 1998; Vera and Crossan 2005; Weick 1998). Therefore, it becomes essential for team members to be ready to spring into action when improvisation occurs. Such spontaneity is necessary in creative problem-solving because software development teams must often deal with unanticipated contingencies while



continuing to adhere to established deadlines (MacCormack et al. 2001). When improvising, developers might need important information on other aspects of the software code that their teammates are more familiar with. Having immediate access to such information is critical to the developer's ability to successfully improvise. When the development team membership is in close geographic proximity it is easier to get immediate responses to queries or calls for assistance. Developers can get real-time responses to their needs while improvising. As team members become increasingly geographically dispersed it is less likely that developers will get immediate responses to their needs (Curtis et al. 1988; Herbsleb and Grinter 1999). Given the temporal sensitivity associated with improvisation, developers may become frustrated at a protracted response to their needs and proceed without input from their teammates. Such uncoordinated action may result in what Vera and Crossan (2005) refer to as chaotic improvisation, which yields little or no positive performance outcomes and can potentially lead to negative outcomes.

In sum, geographic dispersion erects numerous barriers to the coordination necessary for team improvisation to be successfully managed, thus rendering improvisational efforts ineffective. Consequently, we expect that as software development team geographic dispersion increases, team improvisation will be less effective and efficient in improving team performance. Formally:

*H3: Team members' dispersion will moderate the relationship between team improvisation and performance in software development teams such that the relationship will attenuate with increasing geographic dispersion.*

## Method

### *Research Setting and Participants*

To test our hypotheses, we conducted a field study of software development teams. Participation was solicited from two large technology consulting firms in Italy. Development teams in the participating firms primarily design and develop IT solutions, such as web-based applications and portals, supply chain management, systems integration, workflow management systems, and CRM for their clients. Developers who were working on projects had the flexibility to perform their day-to-day work from either company headquarters or at the client site. All the team members were located in Italy rather than being dispersed across different countries or time zones, and the project clients were located in different Italian cities. The teams were part of larger and complex consulting projects subdivided in smaller sub-projects. These sub-projects were not discrete, but rather they were integrated systems which have a high degree of complexity. Indeed, the work that team members were required to do was characterized by unexpected events and emergent requests, all of which had a high level of urgency. Since the sub-projects were not discrete, team members needed to interact with customers, managers and other teams that were working on other parts of the system. Therefore, team members needed to make continuous adjustment to satisfy emergent user needs and to solve problems related to the compatibility of their output with the broader system. Teams were appointed to accomplish those sub-projects and each team had its own team leader who was responsible for ensuring successful progress and accomplishment of the task. We selected those teams that had been formed for more than 3 months so that we could get participants who would be able to respond to the kind of questions presented in the survey. Team members at both firms had similar information and communication technology resources at their disposal to support team communication (e.g. e-mail, file sharing, chat, telephone, instant messaging, and telefax). Respondents' participation in this study was strictly voluntary. Data were gathered during the project through a standardized questionnaire containing five-point Likert-type scales (appendix A). In order to maximize the commitment to the study we engaged HR and line managers to identify those teams that satisfied the requirements and the team leaders interested in participating. Once the team leaders had been identified, the research goals were explained. We asked the team leaders to notify their teams of the research project. We assured participants that their responses would be strictly confidential and that research outputs would contain data in aggregated form without any individual identification. Of a total of 325 individuals involved, 299 usable surveys from 71 teams were completed (a 92 % response rate). Consistent with prior research, we required that at least three questionnaires be completed for each team (the team leader and at least two team members) in order to be considered usable. The high response rate supported the use of the data at the team level of analysis (Barrick et al. 2007).

Twenty-nine percent of respondents were female; eighteen percent were less than 25 years old, thirty-one percent were 25-30 years old, twenty-eight percent were 31-35; twenty-three were more than 35; fourteen percent had high

school (or comparable) degree, eighty-six percent had university degree; Team size ranged from 3 to 10 members ( $M = 4.57$ ;  $SD = 1.68$ ).

### Measurement

To obtain reliable team-level ratings for the variables in the study and to avoid potential common source bias, we collected responses from multiple sources in each team, including the team leader.

*Team performance.* We used a three-item scale of team effectiveness from Hoegl and Gemuenden (2001). The reliability was .71 for this scale.

*Improvisation.* Team improvisation was measured using a six-item scale developed by Vera and Crossan (2005). The scale assesses the degree to which team members perform both creative and spontaneous behaviors. The scale had a reliability of .84.

*Team dispersion.* We measured team dispersion using a three-item scale from Hoegl and Proserpio (2004), which assesses the degree to which team members are easily accessible to each other and work within the direct vicinity. This scale had a reliability of .88.

*Control variables.* Following Hoegl et al. (2003), we included team size as a control variable. Larger team sizes have been associated with increased and decreased performance. Larger teams are argued to give team members access to a broader array of resources. Larger teams also present greater coordination complexity, thereby hindering the ability of individuals to collaborate and perform effectively.

Since the present study included 21 teams from Firm 1 and 50 teams from Firm 2, we controlled for possible organizational effects (i.e., dependencies between observations from one firm). Specifically, we regressed the independent variables and the dependent variable on firm and saved the standardized residuals. Then we used the standardized residuals obtained (“purified” from organizational effects) as the basis for further analysis (Hoegl et al. 2003). This procedure effectively controls for all constant and unmeasured differences across the firms that may affect the relationships examined

Table 1 shows the descriptive statistics, correlations, and scale reliabilities for the variables in the study.

Table 1. Descriptives, correlations and reliability							
Variables	Mean	SD	Reliability	Source	1	2	3
1.Team size	4.57	1.69	-	-	-		
2.Performance	3.99	.59	.71	Leader	-.01	-	
3.Dispersion	2.01	.69	.88	Members and leader	-.03	-.20*	-
4.Improvisation	3.68	.43	.84	Members and leader	.11	.28**	-.25*
Notes: n = 71. * p < .05; ** p < .01.							

## Analysis and Results

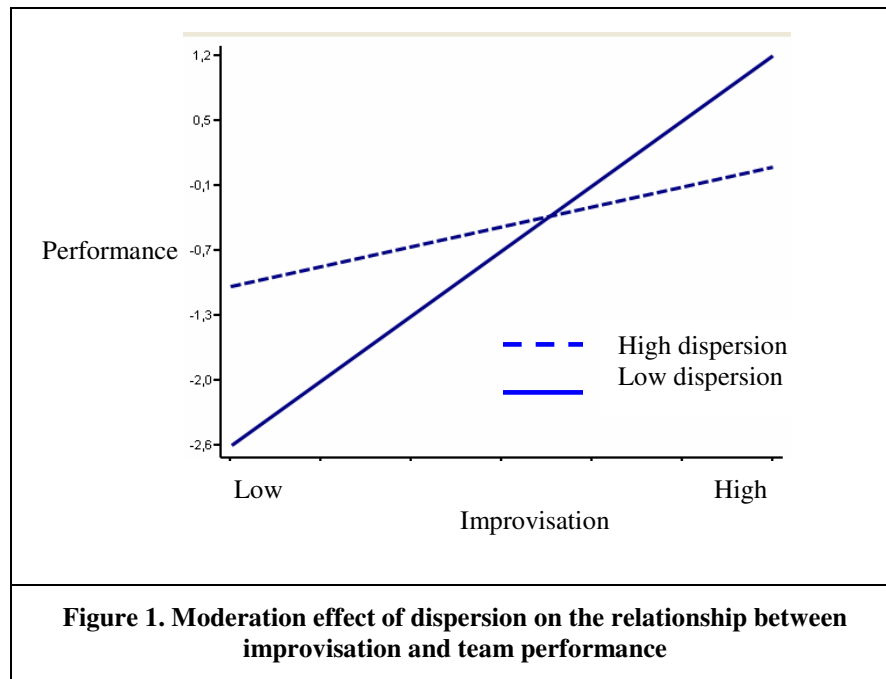
Because data from this team-level study were collected from multiple individuals within each team, it was necessary to justify the aggregation of individual-level within-team ratings to team-level scores (Hofmann 1997; Rousseau 1985). To accomplish this we examined the intraclass correlation coefficients for the team-level constructs. This included an analysis of variance (ANOVA) to test the between-group variation (Hofmann 1997), and the computation of ICC (1) to verify the between-group versus within-group variability in the individual level responses (Bliese 2000). The ICC (1) reflects the extent to which variation in individual-level ratings can be attributed to between-team differences (Bliese 2000). Results of the ANOVA indicated significant between-group differences for

all of the variables considered in our study: performance ( $F = 2.77$ ;  $p < .01$ ); improvisation ( $F = 4.28$ ;  $p < .01$ ); dispersion ( $F = 3.00$ ;  $p < .01$ ). The ICC (1) scores suggest that a significant amount of the variation in the individual-level scores could be attributed to team membership: improvisation ( $ICC1 = 0.42$ ); dispersion ( $ICC1 = 0.30$ ). We also calculated the ICC (2) for improvisation and dispersion. The ICC (2) reflects the stability of the team-level means: improvisation ( $ICC2 = 0.77$ ); dispersion ( $ICC2 = 0.66$ ). These results support the existence of a team-level phenomenon, thus, justifying the aggregation of our data to the team-level (Bliese 2000; Schneider et al. 1998).

To test our hypotheses, we conducted moderated regression analysis. In the first step, we entered the control variable for team size. In the second step, the main effect terms were entered into the model. In the third and final step, the interaction terms were entered into the model. Consistent with Aiken and West (1991), we mean-centered the variables before creating the interaction term for the analysis. This reduced the level of multicollinearity in the model. The results of the regression analysis are presented in Table 2. The main effects models explained 10% of the variance in team performance, while the interaction model explains 16% of the variance in team performance. In H1, we predicted that dispersion would have a negative influence on team performance. The coefficient for team dispersion is negative but not significant in predicting team performance. Thus, H1 does not receive support. H2 predicted a positive relationship between improvisation and team performance. Improvisation has a statistically significant influence on team performance ( $\beta = .25$ ,  $p < .05$ ) offering support for H2.

H3 predicted that team dispersion would moderate the relationship between improvisation and team performance. Support for the moderation hypotheses was assessed in several ways. First, we examined the significance of the additional variance explained when the interaction term was added to the regression model. Second, we examined the significance of the interaction coefficients. Finally, we examined the pattern of the interaction via a graphical plot. As the results in Table 2 (Model 3) indicate, the interaction between team dispersion and team improvisation explained an additional 6% of the variance in team performance over and above that explained by the main effects model (Model 2). The F-statistics suggest that this is a significant increase in the variance explained ( $F = 4.40$ ,  $p < .05$ ). This provides initial support for H3. The coefficient for the interaction between team dispersion and improvisation is negative and significant in the models predicting team performance ( $\beta = -.26$ ,  $p < .05$ ), providing additional support for H3. Finally, in order to understand the form of the moderation, we plotted the interaction effects following the guidelines outlined by Aiken and West (1991). Specifically, we plotted the relationship between improvisation and team performance at one standard deviation above and below the mean for team dispersion. As Figure 1 depicts, improvisation has a positive relationship with team performance when team dispersion is low. However, when team dispersion is high, the relationship between improvisation and team effectiveness is weaker.

<b>Table 2. Regression Models Predicting Team Performance</b>			
	<b>DV: Team Performance</b>		
	Model 1	Model 2	Model 3
<b>Control:</b>			
Team size	-.01	-.01	-.03
<b>Main effects:</b>			
Dispersion		-.14	-.17*
Improvisation		.25*	.33**
<b>Interaction effect:</b>			
Improvisation * Dispersion			-.26*
R <sup>2</sup>	.01	.10	.16
ΔR <sup>2</sup>		.09	.06
F		3.68*	4.40*
Notes: n = 71; † p < .10; * p < .05; ** p < .01. Standardized coefficients shown.			



## Discussion

The goal of this paper was to further understand how and why team improvisation and geographical distance influences team performance relying on two premises: (1) individuals' improvisation is critical for the accomplishment of complex tasks, and (2) many organizations today are relying on geographically dispersed teams to take advantage of specialized knowledge at multiple locations. Departing from the traditional over-reliance of metaphors as jazz music and theatre for studying organizational improvisation (Pina e Cunha, Vieira da Cunha, and Kamoche, 1999), we grounded our empirical research on software development teams. The present research shows that improvisation positively affects team performance, while geographical dispersion between team members attenuates such a positive relationship.

### *Theoretical implications*

From the perspective of theory advancement, our results corroborate previous literature concerning the importance of team improvisation. In particular, our research sheds new light on the mixed results about the improvisation-performance relationship (Vera and Crossan, 2005). Our findings showed team improvisation to be positively related to team performance in software development teams. This result suggests that team members have to favor the abandonment of routines and planned behaviors when facing emergent non-routine issues. However, according to Vera and Crossan (2005), it is important that team members are trained in dealing with improvised action. Indeed, improvisation skills can be learned and applied by members into a team-based context, and individuals can take advantage of improvisational skills in order to cope with emergent issues and achieve better performance.

Our findings also support the multilevel nature of improvisation. Indeed, while individual improvisation is the primary level at which improvisation occurs (Vera and Crossan, 2005), improvisation can be considered as a collective action occurring in teams, which relies on the joint activities of individuals for creating a collective system of improvisational action. From this perspective it is important that team members collectively develop a common understanding for generating creative and emergent solutions that can resolve problems and emergency situations.

As we expected, we found that geographical dispersion between team members negatively moderates the relationship between team improvisation and team performance. Our results show that there is a significant difference in performance between co-located teams that engage in improvised action and those teams that are

geographically dispersed. This result can be traced back to the fact that, as geographical dispersion increases, teams are less likely to rely on joint activities that allow team members to develop a shared understanding of the context for improvisational action. Thus, for teams that are more geographically dispersed it is more challenging to develop a collective sense of emergent needs in order to extemporaneous and creative action. When teams are more geographically dispersed, it appears that members are less likely to be able to continuously adapt and coordinate in response to unexpected needs. Indeed, as soon as team members face unexpected problems requiring quick action, they need to collaborate and to coordinate with the other team members in order to get the necessary information to solve the issue in a timely manner. However, team geographical dispersion may hinder this process of common sense development, limiting their ability to respond to emergent situations.

Contrary to our expectations, team performance is not affected by team member dispersion. We can only speculate as to possible reasons for this result. A possible explanation can be traced back to the fact that computer-mediated communication technologies may help individuals to deal with geographical dispersion. According to Hoegl and Proserpio (2007), computer-mediated communication can help teams in solving the communication and coordination problems associated with dispersion. This explanation is consistent with previous findings underscoring that communication effectiveness is more related to the context in which interaction occurs rather than to the media that is adopted for managing the interaction process (Markus 1994). In light of this result and the significant interaction effect of geographical dispersion on the relationship between improvisation and performance, it is possible to argue that effective exchange of information among team members is constrained by a contextual need of quick and emergent action. Thus, in contextual conditions that do not require team members to react in response to emergent needs, computer-mediated communication is sufficient for supporting the coordination of geographically dispersed team members.

### ***Managerial Implications***

Our findings also have implications for managers. First, managers should be able to create an organizational environment which favors the occurrence of improvisation for facing emergent needs. Indeed, if improvisation is regarded as utterly unacceptable, and the team is not able to provide its members with the resources to face unexpected events, organizational members will not engage in creative and spontaneous endeavors. This would hinder teams' ability to identify new solutions in the face of unexpected events. The development of an improvisational environment can potentially create an important skill set that complements planning efforts for facing unexpected events (Vera and Crossan 2004). Because improvisation, as a process, involves some element of rehearsed action, it may be beneficial for managers to institute training programs that are aimed at equipping developers to deal with unexpected events. Such training programs may help individuals to develop key competences that enable them to effectively face such situations. Previous research suggests that individuals can learn to be more spontaneous and creative (e.g., Vera and Crossan 2005). Beyond spontaneity and creativity, it will be important for such training programs to emphasize key elements that facilitate effective improvisation, including the development of awareness so that individuals to consciously decide when there is the need to abandon routines. Indeed, without an awareness of the need for improvisation, or an understanding of what it entails, there will be little motivation to engage in it (Crossan and Sorrenti 1997). Further, training programs should alert individuals to the conditions under which improvisation is most desirable. For instance, managers should be aware that under certain circumstances where the software development is more constrained and rule-based, improvised actions should not occur. Thus, the design of training programs that allow the development of a high degree of awareness about improvisation may foster the ability of team members to recognize situations in which improvisation is needed.

Second, managers should take into account the role of improvisation in the context of geographical dispersion. Indeed, on one hand geographical dispersion may allow software development teams to exploit distributed knowledge, on the other hand it may hinder the team's ability to cope with emergent and unexpected events. Thus, consistent with Hoegl and Proserpio (2007) managers should make a deliberate choice regarding proximity when designing software development teams. The present study offers some insight for supporting the balance choice between the search for geographically dispersed expertise and the need to cope with emergent situations. In other words, managers should be aware that high levels of geographical dispersion come at a cost to team ability to effectively manage emergent situations.

Third, our results suggest that managers should pay particular attention to conditions that facilitate improvisation in geographically dispersed teams. We reasoned that such teams face tremendous coordination challenges in managing

improvisation. A significant part of that challenge is linked to effective communication. Previous research argues that communication media characteristics may affect the relationship between key team processes and team outcomes (Maruping and Agarwal 2004). Consistent with this view-point, we argue that specific communication technology functionalities may be better suited for supporting team improvisation. In particular we suggest that highly dispersed teams could see gains from improvising if their communication processes are managed via communication technologies that provide immediate feedback and high symbol variety (e.g., video conferencing). Such tools have been found to be effective in facilitating effective collaboration in distributed teams, particularly when facing non-routine situations.

### ***Limitations and Future Research Directions***

The findings of this research need to be interpreted in light of a few limitations in the study. In particular, common method bias could be a concern in the results because of the use of a survey method and the cross-sectional design of the study. To allay this concern we followed recommendations by Podsakoff et al. (2003). Specifically, we used multiple respondents within each team. We also used different respondents for the independent and dependent variables in the model.

In our theorizing and subsequent empirical work, we only examined the role of team members. However other studies underscore the pivotal role of leaders' behavior in managing geographically dispersed teams (Kirkman et al. 2002). A useful extension to this study would be to theorize about the relative effects of leaders' behaviors in influencing the relationship between improvisation and performance as geographical dispersion increases.

Moreover, future research should take into account the effects of dispersion and improvisation at different stages of team development. Indeed, previous research argued that team processes in a virtual setting vary depending on the team maturity stage (Maruping and Agarwal 2004). Furthermore, although our arguments are based on international scholarly work and empirical findings, the present study was conducted in the Italian setting. Thus, future research should be developed in order to understand if our results are generalizable across different countries and cultures. Our research design was cross-sectional rather than longitudinal. Therefore, causality cannot be inferred from the results, but mainly relies on the developed theoretical arguments.

Finally, although previous research notes the lack of influence of job characteristics on improvisation (Vera and Crossan, 2005), future research needs to examine the role of software project characteristics in affecting the influence of team improvisation. Project characteristics such as modularity, complexity, size, and volatility have been found to be critical in determining the success of software development projects (Banker et al. 1998). These characteristics could constitute important boundary conditions for the efficacy of team improvisation. Further, the underlying processes that are enabled by team improvisation need to be elucidated, for example through a further investigation of those actions that individuals take during the development of new and creative ideas in a spontaneous fashion.

### **Conclusion**

In this research, we sought to understand the relationship between team improvisation and effectiveness in software development teams. Team geographic dispersion was identified as an important boundary condition affecting the efficacy of team improvisation. Through a field study of software development teams, we found that team improvisation positively influences team effectiveness; and that geographic dispersion attenuates the relationship between team improvisation and team effectiveness. The findings make important contributions to the software development literature as well as the emerging literature on team improvisation.

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## APPENDIX A-QUESTIONNAIRE

### Improvisation

- The team deals with unanticipated events on the spot.
- Team members think on their feet when carrying out actions.
- The team responds in the moment to unexpected problems.
- The team tries new approaches to problems.
- The team identifies opportunities for new work processes.
- The team takes risks in terms of producing new ideas in doing its job.

### Effectiveness

- The quality of the output is high.
- This project can be regarded as successful
- The team is effective at satisfying customers' demands

### Dispersion

- Most members of my team work directly in the vicinity, so that they could visit each other without much effort
- Only a few team members are easily reachable on foot
- It is at times problematic to get the team members together in one place for spontaneous meetings (e.g., for discussions and decisions).