Studying Virtual Teams during Organizational Crisis from a Sociomaterial Perspective

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ABSTRACT

In this paper, we propose sociomaterialism as a theoretical lens for studying virtual team management during organizational crisis. In applying this lens, we propose the use of pattern theory as the method of choice for documenting effective practices for managing virtual teams in organizational crisis settings.

Keywords

Virtual team, sociomaterialism, organizational crisis, shared mental models, adaptive use of IT.

INTRODUCTION

An ability to prepare for and manage organizational crises is becoming increasingly important in our world today. Due to the emergence of advanced information technology (IT) and the inherent nature of crisis settings, virtual teams (VTs) play a crucial role in managing many types of organizational crisis. Though significant knowledge has been accumulated about VTs in the past two decades, our knowledge of how VTs are effectively used in dealing with crisis events is lacking in terms of generalizable findings (Stachowski, Kaplan, & Waller, 2009).

Prior studies suggest virtual teams rely on team mental models (TMM), i.e. shared understanding of the team members on the task, the teams, and the technology, as an important mechanism through which VT performs tasks (Mathieu, Heffner, Goodwin, Salas, & Cannonbowers, 2000). In particular, IT as an integral part of VT, is used as a means to share information, communicate, and coordinate tasks; however, the consequences of adapting IT are often "associated with a range of organizational outcomes, many of which are emergent and unanticipated" (Orlikowski & Scott, 2009, p.436). In the case of VTs in crisis settings, with ambiguity of cause and effects and negative feelings, such as fear and anxiety by the VT members, the challenge rests in developing an understanding of the interaction between VT members' TMM and the IT capabilities they adaptively use in the time of crisis.

The notion of "sociomateriality" originally proposed by Orlikowski and Scott (2009) is a useful lens for examining VT's effectiveness in crisis with developing understanding on the complicated interplay of IT use and VT's TMM development. This perspective, in fact, is suggest to be the "promising stream of research" and the recommended approach to be taken by researchers in IS and organizations, especially in this increasingly digital world, to unfold the "black box" of IT adaptive use in organizations. By taking the sociomaterial view, it means a shift of focus from the impacts of IT on human to the boundless connections between IT and human activities and relations. The human-technology relationship within organizations can be understood better by recognizing the importance of both the material and social aspects. Further, sociomaterialists search for recurrent patterns in organizations relating to the entanglement of IT within organizations and believe that identifying such patterns can be useful knowledge about comprehending the organizations' functioning.

Thus, the primary goal of this paper is to introduce the notion of sociomateriality and examine its applicability on virtual team research, especially within the context of organizational crisis. Specifically, we propose to adopt a sociomaterial perspective to understand the interplay between the human's team mental model (TMM) and the non-human IT capabilities adaptation (AUIT) during crisis. Understanding this requires examining the entirety of the interactional context – human and non-human, virtual and face to face. A secondary goal of this paper is to

identify an appropriate approach, i.e. a research method, for capturing the potential patterns of the sociomaterial assemblages of IT in virtual teams during crisis. Our paper contributes to both the virtual team and the crisis literature in providing a new perspective for studying crisis phenomenon and introducing a novel approach ("the pattern theory method") for capturing the interplay between technology and non-technology processes for virtual teams in crisis settings.

In the remaining sections of the paper, we first discuss some of the fundamental concepts. Then we present a discussion about the connection between organizational crisis research and sociomateriality. Next, we further examine how the sociomaterial view can be applicable to studying virtual teams in organizational crisis by presenting three implications of sociomateriality. In the last section, we present a promising method for describing the patterns to describe sociomaterial assemblages in organizational crisis. We conclude the paper with some implications of the proposed approach..

BACKGROUND

Organization Crisis and Virtual Teams

The multidisciplinary nature of the crisis domain has resulted in the participation of researchers from organizational behavior, organizational psychology, social cognition and information systems to examine various aspects of crisis. These topics range from the nature of crisis, crisis' origin, factors contributing to more effective crisis management, and impacts of crisis on organizations. Particularly, studies have found that the following factors can affect crisis management: crisis communication (both verbal and nonverbal), leadership style, manager's expectation, teams' shared understanding, members' interoperability, sense-making, situational awareness of organization members (Berggren, Johansson, & Ekström, 2016; Robinson, Maddock, & Starbird, 2015; Saoutal, Matta, & Cahier, 2015; Weick, 1988). In addition, recent studies suggest that power, politics and stakeholders' role in crisis management is also important (Doern, 2014).

Virtual team plays a vital role for organizations in crisis. Organizations can gain multiple benefits by using virtual teams in crisis, from low traveling costs to leveraging talent from around the world. For example, a few studies on online communities or social networks and crisis management has confirmed the significant positive role of virtual collaborations in managing crisis events (Jin, Liu, & Austin, 2014). At the same time, previous studies have also shown that organizations can experience greater amount of communication needs than usual and such communication can be intraorganizational, interorganizational, from organizations to the public, from the public to organizations, and within systems of organizations (Coombs, 2007; Dwyer & Hardy, 2016). In addition to the increased needs for communication, other common problems of crisis such as loss of control, new work assignment, perceived fear among organization members and lack of consensus also pose great challenges for virtual teams to maintain effectiveness during crisis (Jenkins & Goodman, 2015; Jung & Park, 2016; Pearson & Clair, 1998).

Previous studies on virtual teams have found that leadership, trust, and the emergent processes in virtual teams can be different from the traditional teams. For example, virtual teams tend to build "swift trust" in the team because of the short duration of the team and then this initially built "swift trust" may be reinforced or weakened because of the affective or capability based perceptions emerged later on (Jarvenpaa & Leidner, 1998). Further, leaders in virtual teams may exhibit less control and act more like a facilitator than in traditional face-to-face teams. Studies have also found that virtual teams rely on information technology (IT) capabilities for development of team mental models (similar concepts include shared mental models, shared understanding) (Mathieu et al., 2000).

While the findings summarized above are valid for virtual teams, we cannot easily generalize them for virtual teams in crisis situations. The key features associated with crisis, i.e. ambiguity, low probability and threat, make it distinct from other contexts in which VTs have been previously studied. In crisis, VTs may suffer from extreme stress, which may lead to a reduction in both individual and team level cognition and therefore changes in the emergent processes along with other aspects of virtual teams. A few studies have examined virtual teams in crisis situations. One such study found that teams that adopted a more flexible interaction pattern instead of a regular and predefined pattern show greater adaptability during crisis situation (Stachowski et al., 2009). Another study by Jenster and Steiler (2011) suggests that leaders in virtual teams during crisis should be more active instead of sitting silent so that members of the team have higher motivation throughout the "difficult time". Cheshin et al. (2009) suggest that virtual team members may face difficulties in correctly interpreting the emotions of their teammates through emails and other low-media richness communication tools. Further, such misunderstanding of peers' emotions can lead to inaccurate sensemaking and result in inaccurate team mental models development.

In summary, stress, high ambiguity, low probability, are critical issues associated with crisis that can affect one's emotion, cognition, and capability of using IT according to one's intention.

A Brief Summary of Socialmaterialism

The notion of "sociomateriality" was originally proposed by Orlikowski and Scott (2009). In their literature review on IT research in organizations, Orlikowski and Scott (2009) assert that there is an "inherent inseparability between the technical and the social" (Orlikowski & Scott, 2009, p.454) based on the notable unanticipated consequences of many "simple" technologies in organizations. They call for researcher's attention to move beyond examining technology, work, and organizations independently and focusing on the "emergent constitutive entanglement" (Orlikowski & Scott, 2009, p.457) among these three concepts. In other words, the sociomaterial view argues that human actors and technological objects emerge in the form of sociomaterial assemblages, which presumes that there are no independently existing entities with inherent characteristics. Sociomateriality draws on three intellectual approaches, i.e. sociotechnical systems, actor-network theory and practice theory (Cecezkecmanovic, Galliers, Henfridsson, Newell, & Vidgen, 2014).

Since the notion of sociomateriality was proposed, there has been debate over its relational ontology. In particular, the question of whether the technology and human entities only exist in relation to each other or exist physically no matter the interaction is highly contested (Jones, 2014). Considering the purpose of this paper, we do not delve deeper into this debates, and constrain our discussion of sociomateriality to its original form as proposed by Orlikowski and Scott (2009) with an emphasis on the examination of the entanglements of technology and human.

Moreover, in a response to the call made by Jones to be serious in employing the sociomateriality instead of using sociomateriality as a "flag", we summarize key concepts related to the sociomaterial perspective in Table 1. We also include Jones' empirical study in critical care as an example to show how notions of socialmateriality can be addressed in IS research.

Table 1. Summary of Key Concepts in Sociomaterial Perspective (Adapted from Orlikowski & Scott, 2009)

Concepts	**Definition**	**Examples** (Jones, 2014)
Socialmaterial Assemblages	Examining how materiality is intrinsic to everyday activities and relations.	Introducing computer-based clinical information system (CIS) in critical care unit (CCU) is not just a change in materiality, but a change in an array of social and material relations. It opens new possibilities, but the realization of these is not a fixed outcome of either the technology or social relations.
Relationality	The social and the material are inherently inseparable.	The reality of the CCU are all products of particular, contingent sociomaterial intra-actions, albeit in many cases these take place outside the immediate context of the CCU itself.
Performativity and practice	Enactment and the recurrent patterns identified in the sociomaterial assemblages	The computer models which shows the computer-aid diagnosis of patients' situation. The recurrent emotional process occur within the CCU.

Adaptive Use of IT, Team Mental Model, and the Interplay of These Two Concepts

Adaptive use of IT (AUIT)

In this paper, IT is not viewed as an independent variable for crisis outcomes, nor considered as a moderating variable that variously influences relationships between organizational variables and crisis outcomes. We theorize IT as constitutive of team members either individually and collectively adaptive use of IT capabilities. To this end, we use the term adaptive use of IT (AUIT) based on our previous work. By AUIT, we "recognizes both the users' interactions through and with IT tools in accomplishing tasks and the inherent functional capabilities of the IT artifacts." AUIT in virtual teams can be defined as the process by which "a virtual team modifies the way it uses one or more communication and collaboration technology capabilities."

In crisis situation, VTs may need to use centralized or integrated information systems, which not all team members fully understand the IT various capabilities, to support their actions. Further, CMTs may experience information overload and need to adapt to new communication and coordination schemes via information technology capabilities (McNeill, Gkaniatsou, & Bundy, 2014). In some other circumstances, VTs may have to adapt to the reduced communication channel when major technology infrastructure is down or broken. In addition, VT members may come from various organizational departments, across organizations, and even across countries. Thus, the little experience working with each other may add more challenges to the teams to collaborate smoothly than regular face-to-face teams.

In summary, during crisis, virtual teams' AUITC is a complex and dynamic process and teams may follow different paths in using IT capabilities that support communication, interaction, and team process.

Team Mental Models

Growing attention is paid to how teams gain shared understanding. One manifestation of this concern is the notion of team mental model (TMM). In this stream of research, TMM is suggested as an emergent mechanism that enables the team functioning, adaptability towards team effectiveness. More specifically, TMM refers to "knowledge structures held by members of a team that enable them to form accurate explanations and expectations for the task, and in turn, to coordinate their actions and adapt their behavior to demands of [their unique domain]" (Cannon-Bowers & Salas, 1993, p.228). Research has shown that teams with shared TMMs have stronger adaptability than teams that do not (McNeill, Gkaniatsou, & Bundy, 2014; Turoff, Chumer, Van de Walle, & Yao, 2004).

Previous studies have also found that teams can form three types of mental models, i.e. information technology mental models, taskwork mental models, and teamwork mental models. A team's IT mental model is the knowledge structure and beliefs held by the team about the information technology capabilities, the usage of these capabilities, and the perceived effects of using these IT capabilities (Thomas & Bostrom, 2007). A team's taskwork mental model is the knowledge structure and beliefs held by the team about the task goals, steps to accomplish the tasks, and the technologies used to accomplish the tasks. The teamwork mental models refer to the knowledge structure and beliefs held by the team about the team interaction and team members' roles, skills, and knowledge. Assessment of shared mental models' convergence is mostly focused on measuring the degree to which knowledge structures overlap or are similar among the team members, i.e. SMM similarity (Mohammed, Ferzandi, & Hamilton, 2010).

According to the theory of mental models, all these three dimensions of team mental models influence how teams enact appropriate actions and decision-making in crisis. In addition, TMM development is influenced by the teams' overall experience in response to a crisis. For example, the teams may exhibit different styles of role structure adaptation during crisis.

The interplay of AUIT and TMM

AUIT and TMM are two emergent and intertwined processes. In particular, virtual team members' individual or collective use of technologies are influenced by individual knowledge, previous experience with technology, and team mental models on IT capabilities and the fit between IT capabilities and tasks. Especially during crisis under high ambiguity and stress level, team mental models of IT capabilities and task and team can be instrumental in developing swift and effective responses. At the same time, when the organizational crisis lasts long, i.e. a month or longer, virtual teams can actually enhance their team mental models' similarity and accuracy about the IT capabilities, the task and the team process.

In a previous empirical study, the findings also show that virtual teams can vary in terms of their frequency of team interaction (e.g. communication through email) and the complexity of team interaction (e.g. the number of active team participants).

In summary, the interplay between AUIT and TMM is one important yet understudied mean for us to understand how virtual teams can be effective in crisis.

ORGANIZATIONAL CRISIS RESEARCH AND SOCIOMATERIALITY

Organizational crises happen in certain contexts, a school, a firm, a community, or a country. At the same time, given the advances and ubiquitous nature of information technology (IT), for any given context, IT, work and organizations are distinct but intricately integrated facets. Orlikowski and Scott (2009) assert that "attention has tended to focus on technological effects, occasions of change, or processes of sensemaking and interaction with little recognition of the deeply constitutive entanglement of humans and organizations with materiality." (p.466).

Moreover, technology tends to be invisible in the workplace, and this invisibility limits "our capacity to understand, monitor, reflect on, and change them." (p.467) Thus, consistent with the socialmaterial perspective, we believe that the dynamics of socialmateriality can account for the many far-reaching consequences of IT, and it provides a high-level framework that helps explicate the crisis phenomenon.

Given its origin in organizational studies, socialmateriality has a natural link to the organizational crisis literature. One can easily identify the relevance of the key notions of sociomateriality, e.g. relationality, performativity, and sociomaterial assembleages, in organizational crisis studies. Given the increasingly "digital world", embracing the sociomaterial perspective in studying crisis is an interesting and emerging research direction (Nan & Lu, 2014).

In reviewing the crisis literature, we identify one prominent area of crisis research that is especially suitable to be organized under the "umbrella" of the notion of "sociomateriality" - the notion of enacted sensemaking originally proposed by Weick (1988). In this view, Weick (1988, p.309) contends that "all crises have an enacted quality once a person takes the first action." By enactment, he means the social process by which a "material and symbolic record of action" (Smircich and Stubbart, 1985, p.726) is laid down. The outcomes of such enactment of human and technology are called "residuum" (p.307), which refers to "an orderly, material, social construction that is subject to multiple interpretations." At the same time, sensemaking is recognized as an important cognitive process that occurs during enactment and is defined as (Maitlis, Christianson, 2014, p.67) "a process, prompted by violated expectations, that involves attending to and bracketing cues in the environment, creating intersubjective meaning through cycles of interpretation and action, and thereby enacting a more ordered environment from which further cues can be drawn." Sensemaking can also help "reduce the equivocality of the novelty in that it helps to create shared understanding, making it possible to construct plausible explanations of what happened and why." (Dwyer & Hardy, 2016, p.59)

In the EST perspective, crisis is not managed through either the technology or the human, rather, can only be managed or prevented through an understanding of the entangled relationships between human actions, sense making process and the technology. The EST perspective argues that it is the entanglement between technology and human that cause the crisis and therefore, a good understanding of this entanglement will help to prevent the crisis through uncoupling humans' sensemaking process.

> *"Unwitting escalation of crises is especially likely when technologies are complex, highly interactive, non-routine, and poorly understood. The very action which enables people to gain some understanding of these complex technologies can also cause those technologies to escalate and kill." (Weick, p.308)*

Thus, we can see that in EST, crisis management is not simply a process of managing human factors or viewing technology as a deterministic factor, rather, the relationship between technology and human becomes the "theoretical foci and central explanatory vehicle" of understanding the crisis phenomenon (Orlikowski and Scott, p.456).

Similarly drawing on the relational ontology view of technology infrastructure as fast changing during crisis, Robinson, Maddock, Starbird (2015) examine the relationship between technical infrastructure and humans in the support of improvisation and communication among emergency workers. They acknowledged the fast changing and /or "under pressure to change" in the context of emergency response. Humans are viewed as "infrastructurers"—as designers of their own infrastructures. In their study, they identified human interoperability as one important concept that help explains variances in crisis response effectiveness. They report finding that people with the right tools and expertise provide the interoperability for the underlying information and have a greater chance of helping the team to develop more effective information sharing and attain effective improvisation in emergency response.

Working in the operational risk management domain in a financial organization, Hsu, Backhouse, Silva (2014) took a weak sociomaterial perspective on stressing more of the contextual influence on the relationship between IT and risk management in the financial industry. Basing their study on the Structuration Theory, they argue that the implementation of organizational practice, such as operational risk management (ORM), can be examined through the social structures which is influenced by both technology and organizations. In this study, the relationship between IT and risk management are viewed as entangled with each other. First, the authors recognize that there is an increasingly reliance on IT in the financial sector and such reliance on IT requires more attention to examining the management of operational risk with IT. They further acknowledge the increasing complexities in the use of IT for supporting key financial activities. However, the use of complex IT in financial settings not only prevents the risk but also at the same time can introduce new risks and changes to organizations, e.g. creating new roles and introducing new responsibilities. By examining the relationship between IT and operational risk and how organizations develop appropriate structures accordingly, they view the implementation of ORM as a process of "reflexive monitoring and restructuring of organizational practices" (p.68) and conclude that IT has contingent effects in ORM, particularly on the extant organizational structure and choice of risk management

approach.

In a related study on organizational crisis and online communities, Nan and Lu (2014) implicitly took the sociomaterial perspective by seeking to identify the patterns of organizational crisis processes in an online community. Particularly, they found that during crisis, the spontaneous, un-order-seeking individual interactions in response to crisis online communities eventually showed an orderly and rational crisis management process as commonly adopted and found in regular organization. In other words, as concluded by the authors, the micro-level interactions among people and technology can result in macro-level outcomes. Regarding relational ontology, the authors did not view IT as distinct material entities, rather, consistent with the online community research stream, they viewed "technology and humans as coevolving forces in emergency responses. In other words, the relevance of IT is perceived through its actualized affordance that is defined as the realized potential that arises from the relation between actor intentions and technology capabilities (Majchrzak, More, & Faraj, 2012). The authors concluded that IT, i.e. online forum, is more than a platform for information manipulation and decision making but also is an "evolving and generative force" that influence and shape users subsequent actions in response to crisis. Table 2 summarizes the three paper on the three dimensions of sociomateriality. The fourth dimension strong/weak is proposed by Jones (2014)

Table 2. Examples of Crisis Papers Using the Sociomaterial Perspective

	Sociomaterial assembleages	Relationality	Equivalence of IT and Human
Weick (1988)	Agree	NA	Agree
Robinson, Maddock, Starbird (2015)	Agree	Agree	Agree
Hsu, Backhouse, Silva (2014)	Agree	Not agree (contextual factors, such as regulatory matters)	Agree

APPLYING SOCIOMATERIAL PERSPECTIVE IN STUDYING VIRTUAL TEAMS IN CRISIS

"While this reality may be similar to those of other CCUs in other hospitals, the specific local interpenetration of the social and material means that each CCU varies in the activities it carries out, how it fits into the medical system, and its physical setting. Even with a common CIS, the different members of the national usergroup used it in different ways, with different functionalities and different attributes, reflecting such things as local IT infrastructure configurations, staff IT skills, and patient types. Nor were these configurations stable. Rather they continually evolved as social/material conditions changed …." (Jones, 2014, p.912-913)

We believe that the above scenarios also hold true in crisis settings, where virtual teams carry out crisis response activities and make critical decisions by adaptively using IT features, exploring IT tools and at the same time developing their shared understanding on task priorities, task contingencies, time situation, and assessment of crisis severity, etc. In addition, though various IT tools and systems have been developed and adopted by organizations for virtual teams to manage crisis, the outcomes of crises are not a single fixed function of IT and virtual teams, rather it is the product of the "contingent interplay of influences (that are themselves neither purely social or material) as these are enacted in situated practices." (Jones, 2014, p. 915)

Past research on virtual teams has shown that for any virtual team, there are at least exist two critical and emergent processes at play---the development of shared understanding among teams and members and the continuing use and adaptation of IT capabilities. First, teams that can successfully adapt IT tools to task needs can experience enhanced team communication and knowledge management efficacy. Second, virtual teams' development of shared understanding can result in unconscious collaborative activities during emergent events. The first process is referred to as adaptive use of IT (AUIT) and the second process is put under the notion of team mental models (TMM) in this paper. Both of these two processes have been found to significantly affect virtual team's capability in dealing with crisis. However, successful AUIT and TMM can be challenging in virtual teams during crisis due to the fast-moving crisis settings, fear, information overload, and reduced communication channels.

Orlikowski and Scott (2009)'s called for researchers' attention on developing practice theory that identifies "recurrently enacted and patterned set of relations, reproduced over time and space." (p.462). Consistent with this call, in this paper we actualize the sociomaterial assembleages by examining the patterns of virtual teams' interplay between TMM and AUIT in crisis and its relationship with teams' crisis outcomes. Such patterns can

capture the regular reciprocal relationship between teams' IT capabilities adaptive use and development of team mental models in crisis. For example, an initial TMM guides the virtual team's choice of IT capabilities that could support the systematic, timely and secure storage and dissemination of information. After that, the continuing use of IT for sharing information influences the development of team mental models in virtual teams. To put it another way, virtual crisis management teams could adaptively use IT capabilities during communication, interaction, and information processing related activities, and therefore rely on IT adaptation to build shared understanding. The virtual teams' development of SMM can affect which IT capability will be used and for what purpose that particular IT capability is used.

Three Implications of the Sociomaterial View for Studying Virtual Teams during Organizational Crisis

We contend that the socialmaterial perspective has three important implications for IS research in crisis. First, the notion of relationality provides a novel ontological view of IT and its context of use. The central idea with a relational ontology is that the social and the material are inherently inseparable. Instead of viewing IT and human (organization) as separated entities, the socialmaterial perspective calls for dissolving the analytical boundaries between technologies and humans (Knorr-Certina, 1977; Latour, 2005; Pickering, 1995; Orlikowski & Scott, 2009, p.455). Further, in a relational ontology the technology and human only exist in relation to each other and acquire their "form, attributes, and capabilities through their interpenetration." (p.456) Following this notion of relationality, we view IT is an integral part of virtual teams functioning anywhere under any circumstances. IT and the human beings involved in virtual teams are inseperable during crisis situation. It is our contention that VTs develop team mental models through enactment of IT capabilities and the adaptive use of IT capabilities shape the development of team mental models during crisis.

A second implication is related to the term performativity, which refers to enactment. Instead of examining a virtual teams' performance, performativity calls our attention to how the assemblage of humans and technologies are "made to work" in a particular setting. A related concept is called practice. The socialmaterial perspective calls for more attention to practice theory - "the scholarly effort of understanding how boundaries and relations are enacted in recurrent activities (p. 462)". This implies that in socialmaterial research, any distinction of humans and technologies is analytical only, and done with the recognition that these entities necessarily entail each other in practice" (Orlikowski & Scott, 2009, p.455-456). From the practice lens, researchers recognize organizations as a "recurrently enacted and patterned set of relations, reproduced over time and space" (Orlikowski & Scott, 2009, p.462). Identifying an encompassing, systematic "practice theory" is suggested to be the most effective way of framing and orienting research. In our research, we contend that the dynamics of the entanglement of the IT and team in crisis reveals the reality which they describe. Our search for the patterns of such dynamics through an analysis of the interplay between VTs and the IT used will contribute to generate practice theory in crisis.

Finally, the notion of socialmaterial assembleages (rather than either discrete entities or mutually dependent ensembles) is the cornerstone of our research motivation that focuses on the interplay between AUIT and TMM development in crisis situations. In our research, we have found that IT capabilities and team mental model (TMM) development are entwined all together. Further, we hold the assumption that such entanglement between technology capabilities and team mental models development in crisis are varied in different virtual teams based on the type of crisis. We describe these socialmaterial assembleages of technology and humans (virtual team members), in terms of the notion of "interplay of AUIT and TMM". Following Orlikowskid & Scott, we describe this interplay in terms of interesting patterns set in the context of the crisis phenomenon.

A METHOD FOR DESCRIBING SOCIOMATERIAL ASSEMBLEAGES FOR VTs AND ORGANIZATIONAL CRISIS

A challenge of sociomaterialists lays in the balance of rigor and relevance when developing the "recurrent patterns" of IT and organizations. In fact, in their review of the sociomaterial approach studies, Cecez-Kecmanovic et al. (2014) found that most of the study predominantly describe the organizations while taking IT as a much more subordinate or even silent role in the "entanglement". They suggest that to fully capture the entanglements between human and technology following the sociomaterial view, one should avoid only using one single case study.

Two categories of promising research methods as suggest by Cecez-Kecmanovic et al. (2014) exist. One category is called the "flexible computational approach" that can integrate both digital traces and computational methods. The other approach is the "practice-oriented sociomaterial methodology", which aims at developing an appreciation and articulation of the dynamics of practice following an iterative process of "zooming in" and "zooming out" (cite). Both of these approaches emphasize the discovery of recurrent patterns. However, the challenge of applying the first category approach lay in the accessibility to large scale of valid and reliable digital-trace data and a careful operationalization of the constructs of interest to the variables. With regard to the second

approach, i.e. "practice-oriented sociomaterial methodology", as said by Cecez-Kecmanovic et al. (2014), there is no step-by-step action list for extracting and describing the patterns, instead, one should use as a general approach in guiding one's study in his/her own study context.

Considering the challenges of the above two approach and the purpose of our research interest, we propose an adaption of a systematic method for discovering effective patterns proposed by Khazanchi and Zigurs (2011). Adopting the grounded theory approach, i.e. a theory driven and bottom-up approach, Khazanchi and Zigurs (2009) identified a number of useful patterns for various types of virtual team projects (i.e. lean, hybrid, and extreme) with the aim of better understanding the effectiveness and ineffectiveness of virtual projects management and IT capabilities usage.

As a result of their study, they give specific suggestion on the contents of patterns as well as the methods for extracting these patterns. Specifically, patterns are made up of five components: "(1) the pattern's name-a descriptive word or phrase that captures its essence; (2) the context – a description of the situation to which the pattern applies; and (3) the problem – a question that captures the essence of the problem that the pattern addresses; (4) the solution – a prescription for dealing with the problem; and (5) an optional discussion – any additional information that might be useful in applying the pattern" (p.6). Khazanchi and Zigurs also propose five steps for systematically discover patterns. We summarize the five steps along with their explanations in Table 3.

Table 3. Five Steps for Discovering Patterns (Khazanchi and Zigurs, 2011)

Sequence of Step	Explanation
Step 1: Recognize and abstract candidate pattern	Examine the data collected and develop understanding on the meaning of the lessons learned from characteristics that result in effective virtual project management practices.
Step 2: Define recurring problem	Develop a simple question to address the specific feature or set of features solved in each of the candidate patterns generated in the first step one by one.
Step 3: Define context	For each of the candidate patterns, add the description of the situation to which the pattern frequently applies.
Step 4: Name and describe pattern	Name the pattern so that it can be explained to and shared with others.
Step 5: Validate and refine pattern	Validate the patterns in new context.

Consistent with the sociomaterial view, Cecez-Kecmanovic et al. (2014, p.821) argue that these are "not a few stable patterns but many unique patterns". Considering the interplay of AUIT and TMM development in virtual teams during crisis, we propose that the many unique patterns can be understood as effective practices within virtual teams entail decisions about how to best apply different technology capabilities for effectively develop team mental models during crisis. To this end, we believe that this practice-oriented method proposed by Khazanchi and Zigurs (2006) provides us a balanced method of rigor and relevance and can help us to develop the recurrent patterns of the interplay of AUIT and TMM with adequately addressing the crisis context where virtual teams reside in.

We believe that this approach is scalable and can be effectively used to describe the patterns of sociomaterial assembleages that occur during organizational crisis.

CONCLUSION

This paper identifies a new theoretical lens, i.e. sociomateriality to study distributed teams involved in managing organizational crises. In addition, we recommend using patterns to document and describe practices associated with the sociomaterial assemblages for virtual teams in crisis settings. We believe that this approach represents an important foundational step towards examining explicitly "constitutive entanglement" within a specific context, i.e. crisis domain. Based on our prior research on virtual teams, we posit that patterns of effective virtual team management in crisis settings can be identified and documenting using a sociomaterial lens. Our next goal is to conduct an empirical study in organizational settings.

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