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Routine dynamics in virtual teams: the role of technological artifacts

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Abstract

Purpose – In this paper, the authors extend their understanding of the internal dynamics of routines in contexts characterized by increased levels of virtuality. In particular, the authors focus on the role of routine artifacts in the internal dynamics of routines to answer the question: How does extensive reliance on information and communication technologies (ICTs) due to physical distance influence the internal dynamics of the new product development (NPD) routine (i.e. interactions between performative, ostensive and artifacts of routines) enacted by a virtual team?

Design/methodology/approach – This paper is based on an 18-month ethnographic study of the NPD routine performed by a virtual team. The authors relied predominantly on qualitative, ethnographic data collection and analysis methods, using semi-structured interviews, non-participant observation, and the collection of archival data and company documents (formal procedures, guidelines, application designs etc). Qualitative research offers a valuable means to investigate dynamic processes in organizations due to its sensitivity to the organizational context and potential to focus on activities as they unfold.

Findings – The findings highlight the central role of routine artifacts (ICTs) in the routine dynamics of the NPD routine performed by virtual team. In particular, the authors show how the particular types of ICT team members used in their daily work enabled them to confidently and meaningfully relate to the overall routine activity and coordinate their actions in a context characterized by physical distance and extensive reliance on communication and collaboration technologies.

Originality/value – The paper sheds light into role of routine artifacts in the routine dynamics in a context characterized by a high degree of virtuality. This work contributes to the literature on routine dynamics by theorizing about the processes through which routine artifacts (ICTs) afforded routine participants the ability to act confidently and meaningfully to the present and dynamically coordinate their actions with their fellow routine participants.

Keywords Case study, Virtual team, Knowledge-based community, E-collaboration, Electronic mediated environment, Information workers

Paper type Research paper

1. Introduction

Organizational routines, defined as “repetitive, recognizable pattern[s] of interdependent actions, involving multiple actors” (Feldman and Pentland, 2003, p. 96), have been regarded as the primary means through which organizations accomplish much of what they do (March and Simon, 1958; Nelson and Winter, 1982). Routines, among other things, constitute an important coordination and learning mechanism (e.g. Levitt and March, 1988; Nelson and Winter, 1982; Okhuysen and Bechky, 2009), and a foundational component of higher-level capabilities (Nelson and Winter, 1982; Zollo and Winter, 2002); they also help reducing uncertainty and economizing on cognitive resources and improve the control and efficiency of work activities (e.g. Cyert and March, 1963; March and Simon, 1958). While early work promoted a view of routines as a source of stability and inertia in organizations, subsequent research focused on their internal dynamics, highlighting their effortful and emergent nature (Feldman, 2000; Feldman and Pentland, 2003; Pentland and Reuter, 1994), as well as the

integral role of artifacts (e.g. rules, standard operational procedures [SOPs], manuals, software applications and technology) in routine performance (D'Adderio, 2011; Feldman *et al.*, 2016).

In particular, research in routine dynamics (Feldman *et al.*, 2016) adopts a practice-based view (Bourdieu, 1990; Giddens, 1994) of routines as processes to focus on their internal dynamics, conceptualized as recursive relations between specific performances (performative aspect), abstract, generalized patterns of actions (ostensive aspect) and artifacts (D'Adderio, 2011; Feldman and Pentland, 2003; Pentland and Feldman, 2005; Feldman *et al.*, 2016). This stream of research has contributed significantly to our understanding of the dynamic nature of routines by bringing agency back to the study of routines (Feldman, 2000; Feldman and Pentland, 2003) and focusing research attention to the endogenous sources of stability and change in routines. Moreover, because routines are inherently context-dependent (Cohen *et al.*, 1996; Nelson and Winter, 1982), routine dynamics theorizing has provided a useful lens to explore the influence of the broader context in the internal workings and performance of routines (e.g. Howard-Grenville, 2005; Rerup and Feldman, 2011), as well as the role of various artifacts (e.g. rules, SOPs, tools, machinery and software) in the creation, reproduction and change of routines (e.g. Cacciatory, 2012; D'Adderio, 2008, 2011; Glaser, 2017; Howard-Grenville, 2005; Turner and Rindova, 2012).

Despite these important theoretical developments and the broad acknowledgement of the significant role that context and artifacts play in the internal dynamics and performance of routines, the impact of workplace trends toward globalization and distributed work (e.g. Gibson *et al.*, 2014; Gilson *et al.*, 2015) on routine dynamics has not been explicitly addressed. These trends have resulted in organizations relying increasingly on virtual teams, the members of which are geographically dispersed and depend heavily on information and communication technologies (ICTs) to communicate and coordinate their work (e.g. Gibbs *et al.*, 2017; Gibson and Gibbs, 2006; Gilson *et al.*, 2015; Martins *et al.*, 2004). These characteristics of virtual teams are likely to have a significant impact on the internal dynamics and performance of routines, that is, on the mutually constitutive relationships between performative and ostensive aspects and related artifacts (Feldman *et al.*, 2016; Howard-Grenville and Rerup, 2017). For instance, routine participants in a virtual setting may never meet in person and must rely predominantly on technological artifacts (ICTs) to communicate and coordinate, conditions that change the nature of their interactions and represent major challenges to the performance of virtual teams (e.g. Gilson *et al.*, 2015; Howard-Grenville and Rerup, 2017; Morrison-Smith and Ruiz, 2020). As Howard-Grenville and Rerup (2017, p. 335) suggest in their recent review of the literature on routines, routines performed in virtual settings involve people and artifacts connected through electronic means and consequently, the nature of their interactions “differs and should be understood.”

To extend our understanding of routine dynamics in contexts characterized by increasing levels of virtuality, we conducted an ethnographic study of the new product development (NPD) routine carried out by a virtual team whose members were divided in two different regions of Europe, to answer question: *How does extensive reliance on ICTs due to physical distance influence the internal dynamics of the NPD routine (i.e. interactions between performative, ostensive and artifacts of routines) enacted by a virtual team?* The paper is organized as follows. First, we review the literature on routine dynamics with a focus on the role of technological artifacts in the performance of routines; we also draw upon the literature on virtual teams, which over the last two decades, has shed light into the challenges associated with the performance of virtual teams. Then, we present the organizational setting and discuss our methods and findings. We conclude with a discussion of our contributions to the literature on routine dynamics and the implications of our findings for research and practice.

2. Theoretical background

2.1 Routine dynamics and the role of artifacts

Contemporary work on routines has sought to reorient research to the endogenous dynamics of routine creation, stability and change that take agency seriously into account. More specifically, Feldman and Pentland (Feldman, 2000; Feldman and Pentland, 2003) have developed a practice-based (Feldman and Orlikowski, 2011) perspective according to which, routines embody a duality of agency and structure (Giddens, 1984) or correspondingly, performative and ostensive aspects (Feldman and Pentland, 2003). The performative aspect refers to “the specific actions taken by specific people at specific times,” whereas the ostensive is “the abstract, generalized idea of the routine or the routine in principle” (Feldman and Pentland, 2003, p. 101). The two aspects are mutually constitutive. In particular, as participants perform routines they create, maintain and modify the ostensive aspect, and they use the ostensive to guide their actions, account for what they are doing, and refer to patterns of activity that would otherwise be incomprehensible (Feldman and Pentland, 2003, p. 107). This work has been highly influential and gave rise to a new branch of research, “routine dynamics,” which is based on the idea that routines are practices with internal dynamics (Feldman *et al.*, 2016).

Subsequent research has focused on the role of the broader context of routine performance, including various artifacts enrolled, and its influence on the internal dynamics of routines (e.g. Feldman, 2003; Howard-Grenville, 2003; Rerup and Feldman, 2011). For instance, Howard-Grenville (2005) in her study of the roadmapping routine of a chip manufacturing company shows that by being embedded in the broader organizational context, routines are enacted simultaneously with other structures (e.g. technological, coordination and cultural structures), which generate artifacts and expectations that guide and constrain the actions of routine participants and contribute significantly to the persistent or flexible performance of routines.

The role of routine artifacts (e.g. written rules and procedures, tools, software and computers), in particular, has received increasing attention from scholars who examined the recursive relationship between artifacts and the performative and ostensive aspects of routines and demonstrated the inseparability of materiality and action in practice (e.g. Cacciatory, 2012; D’Adderio, 2008, 2011, 2014; Glaser, 2017; Orlikowski and Scott, 2008). Artifacts may represent either the performative (e.g. a transaction history or tracking database) or the ostensive aspect of a routine (written procedure or guidelines describing the overall pattern of the routine) (Pentland and Feldman, 2008). Early work on routine dynamics focused on the role of artifacts as “physical manifestations of routines ... that enable and constrain organizational routines” (Pentland and Feldman, 2005, p. 797) paying particular attention to representational artifacts like formal rules and SOPs and the extent to which they enforce rule, following (thereby promoting stable performances) or fail to do so (e.g. D’Adderio, 2003, 2008; Hales and Tidd, 2009; Pentland and Feldman, 2008). Moreover, by being embedded in software and other technological artifacts, rules and procedures may facilitate control and coordination in organizations and, by encoding the intentions of managers or designers, shape routine performances (Bapuji *et al.*, 2012; D’Adderio, 2003, 2008, 2011; Howard-Grenville, 2005; Pentland and Feldman, 2005). Nevertheless, they do not determine actions, as routine participants may interpret rules and procedures differently and engage in workarounds or reinvent them (D’Adderio, 2008; Pentland and Feldman, 2008; Pentland and Hærem, 2015; Reynaud, 2005); consequently, they do not necessarily operate in accordance with designers’ expectations (Pentland and Feldman, 2008). Empirical research conducted from a routine dynamics perspective has also demonstrated that different kinds of artifacts (or sets of artifacts) may contribute to both the stability and flexibility in routine performances in a variety of organizational settings (e.g. D’Adderio, 2014; Howard-Grenville, 2005; Turner and Rindova, 2012; Spee *et al.*, 2016), a central theme in routine dynamics

research (Feldman *et al.*, 2016). Finally, artifacts may actively participate in routines as actors by taking specific actions (Pentland *et al.*, 2011; Ribes *et al.*, 2013). For example, in a study of invoice processing routines, Pentland *et al.* (2011) found that 35% of the actions were carried out by the computerized workflow system (e.g. routing information to the human decision makers, making approval decisions according to predefined rules).

Concluding, artifacts have moved progressively from the periphery to the center of routine dynamics, promoting a notion of routines as “sociomaterial assemblages” consisting of material artifacts and individual participants that are inseparable and equally agentic (D’Adderio, 2011; Feldman, 2016; Orlikowski and Scott, 2008; Suchman, 2007). Our understanding of the role of artifacts in the internal dynamics of routines has progressed significantly and routine scholars now recognize that artifacts may both enable and constrain agency and shape routine dynamics and performance (e.g. D’Adderio, 2011, 2014; Howard-Grenville and Rerup, 2017; Leonardi, 2011); moreover, artifacts themselves are not flexible or inflexible, but their properties and affordances are reconfigurable to support different goals (D’Adderio, 2014).

Despite these significant contributions, the high context-specificity of routine performance (Cohen *et al.*, 1996; Parmigiani and Howard-Grenville, 2011) and the great variety of artifacts or systems of artifacts (Cacciatory, 2012) enrolled by participants in different types of routines suggest that we are at the beginning of understanding the multiple and complex ways through which artifacts influence the nature of interactions between performative and ostensive aspects of routines and shape routine performance (for related reviews see Howard-Grenville and Rerup, 2017; Parmigiani and Howard-Grenville, 2011). For example, empirical studies suggest that in some contexts artifacts like software are powerful guides to behavior (e.g. D’Adderio, 2008), while in others they have little influence on routine performances (e.g. Hales and Tidd, 2009). As Parmigiani and Howard-Grenville (2011, p. 439) note, because “not all artifacts are equal; and not all contexts or routines enroll them equally” there is a need to “parse artifacts by type in order to advance theoretical development on their role in routines.” More importantly, Howard-Grenville and Rerup (2017) in their recent review of the literature on routines, note that while some routines involve face-to-face interactions others, by being performed in virtual space, may involve no such interactions, with people and artifacts being connected through electronic means. They suggest that the nature of these interactions “differs and should be understood” (Howard-Grenville and Rerup, 2017, p. 335). The literature on virtual teams, to which we now turn, confirms that “technological advancements continue to change the way team members interact” (Gilson *et al.*, 2015, p. 1331) and over the last two decades has investigated the challenges associated with the operations of virtual teams and the role of technological artifacts.

2.2 The challenges of virtual teams and the role of ICTs

Virtual teams have become increasingly common in organizations due to workplace trends toward globalization, distributed work, flexible work arrangements and significant advancements in ICTs (e.g. Gibbs *et al.*, 2017). Research on virtual teams, therefore, has garnered significant attention over the past few decades, with some scholars referring to virtual work as “the new normal” (Raghuram *et al.*, 2019, p. 308). Although virtuality has been defined in a variety of ways, its most frequently studied dimensions are geographical dispersion and electronic communication dependence with the latter being common to all existing virtuality constructs (Gibbs *et al.*, 2017; Gibson *et al.*, 2014). In fact, many scholars suggest that the major determinant of virtualness is “the amount of time that members spend working through computer-mediated communication instead of face-to-face communication” (e.g. Berry, 2011, p. 188; Gibson *et al.*, 2011; Kirkman *et al.*, 2002) or consider geographical dispersion to be an antecedent of virtuality that positively influences the extent of reliance on

technology-mediated communication (e.g. Kirkman and Mathieu, 2005). Most teams, therefore, are at least to some degree virtual and it is more appropriate to refer to different degrees of virtuality (Kirkman *et al.*, 2012; Gilson *et al.*, 2015). Because of our interest in understanding the impact of technological artifacts on the internal dynamics of routines in virtual teams, we focus here on research related to the influence of ICT on the interactions of team members.

ICT, defined as “any electronic device or technology that has the ability to gather, store, or send information” (Day *et al.*, 2012, p. 473), is commonly acknowledged as an enabler of virtual teamwork; however, most research in the field suggests it is a poor substitute for face-to-face interaction and either impairs or has no effect on virtual team performance (for a related review see Gilson *et al.*, 2015). For instance, extensive reliance on ICT is shown to have negative implications, among others, for building trust (e.g. Hill *et al.*, 2009; Wilson *et al.*, 2006), giving and interpreting feedback (Gibson *et al.*, 2011), conflict (Hinds and Bailey, 2003; Hinds and Mortensen, 2005), shared understanding (Cramton, 2001; Griffith *et al.*, 2003), the development of group cohesion and satisfaction (Warkentin *et al.*, 1997) and may be insufficient to bridge discontinuities related to cultural differences (Maznevski and Chudoba, 2000; Sarker and Sahay, 2004). Despite this emphasis on the negative effects of reliance on ICT, some studies have shown that there are also advantages associated with their use. For example, asynchronous technology (e.g. text-based tools) allows team members to take their time when asking a question or preparing a response (Walsh and Maloney, 2007), promoting more efficient, focused conversations (Kraut *et al.*, 2002). Computer-mediated communication also increases participation among team members, facilitates unique ideas, reduces the number of dominant members (Gibson *et al.*, 2014; Rains, 2005) and may be helpful in blocking the transmission of social status cues that can lead to bias against lower status team members (Driskell *et al.*, 2003).

These conflicting findings created a “conundrum” (Malhotra and Majchrzak, 2014, p. 391) in the literature on virtual teams that made scholars suggest that “the type of technology is not uniformly better or worse” (Hacker *et al.*, 2019, p. 11; Wang *et al.*, 2020). This in turn, oriented research to the study of the fit of specific technologies and their features to the specific characteristics of the team and its task (e.g. Dennis *et al.*, 2008; Gibbs *et al.*, 2017; Lippert and Dulewicz, 2017; Malhotra and Majchrzak, 2014; Maruping and Agarwal, 2004), as well as to their use in practice by team members (Orlikowski and Scott, 2008; Wang *et al.*, 2020). For example, Malhotra and Majchrzak (2014) in their study of 54 geographically dispersed teams that relied exclusively on ICTs to communicate and collaborate found that ICTs improved performance only when their type of use met the specific coordination needs imposed by team and task characteristics.

This orientation is consistent with a broader trend in the information systems literature toward studying ICT as inseparable from the users, their work and the broader context in which they are embedded. For instance, Leonardi (2011, p. 147) argues about the benefits of studying human and material agencies as “imbricated,” that is, interlocked in particular sequences and together producing, sustaining or changing either routines or technologies. Similarly, Wang *et al.* (2020) build on the work design perspective to suggest that we can better understand the conflicting findings of research on the outcomes of ICT use by studying the ICT-induced changes in job demands, job autonomy and relational aspects of work. Recent reviews of the literature on virtual teams also point to the need for future research in the applications of new communication and collaboration technologies which, although they continue to grow, the norm within research remains to examine older, traditional tools like email, instant messaging and videoconferencing (Garo Abarca *et al.*, 2020; Gilson *et al.*, 2015; Raghuram *et al.*, 2019).

Concluding, our review of the literatures on routine dynamics and virtual teams suggests that although researchers in the two streams seem to be having parallel conversations, these

conversations converge with scholars in both fields acknowledging the inseparability of the human/social and technological aspects of work and its promise for better understanding the nature of their mutually constitutive relationship and complex outcomes. Moreover, because “[c]ontext dependence is fundamental” (Sidney Winter in [Cohen et al., 1996](#), p. 66; [Parmigiani and Howard-Grenville, 2011](#)) and the nature of interactions between routine participants in a virtual context is much likely to differ from contexts involving mainly face-to-face interactions ([Howard-Grenville and Rerup, 2017](#)), paying closer attention to how routines are performed in virtual settings is likely to advance significantly our understanding of routine dynamics and, in particular, the role of artifacts in routine dynamics and performance.

3. Methods

3.1 Research setting

This paper is based on an 18-month ethnographic study ([Van Maanen, 2011](#); [Yin, 2009](#)) of the NPD routine performed by a virtual team. The team consisted of six members who were geographically based in Southern-Europe (SE – three members) and Northern-Europe (NE – three members). People who were based in SE worked for Alpha (pseudonyms are used to preserve anonymity), a creative mobile agency that delivers digital solutions for marketing and advertising purposes. Team members who were based in NE worked for Beta, a company that designs and develops multiplatform mobile applications. The team at the time of the study had a working history of 15 months and had successfully completed several projects. Members of both teams were fluent in English and the two sites were separated by only two time zones, thereby reducing possible influences stemming from such differences ([Espinosa et al., 2007](#)). The team members working for Alpha had never met face-to-face with Beta members and their interactions were carried out through multiple types of ICT. Synchronous and asynchronous communication consisted of weekly *Skype* meetings, emails, and phone calls. The team also relied extensively in two ICTs, namely *Box* and *Basecamp*. *Box* (www.box.com) is an online content sharing platform that team members used to create, upload, share and synchronously modify various types of large files (e.g. documents, presentations, designs etc). *Box* allows comments and discussions around a document, folder or task and maintains a historical record of all changes made on stored content for future retrieval and reference. *Basecamp* (www.basecamp.com), a project management and communication application, allowed team members creating and sharing events and dialogue threads, assigning tasks, responsibilities and deadlines, and monitoring the progress achieved in projects.

The specific project assigned to the virtual team during the period of the study was the design and development of a new mobile application called *FindTaxi* for Delta, an innovative communication and content services company located in SE. This application provided potential customers with real-time information about their location and nearest taxi drivers and allowed them to select a specific vehicle and driver based on evaluations from previous users of the service.

3.2 Data collection

We relied predominantly on qualitative, ethnographic data collection and analysis methods ([Miles and Huberman, 1994](#); [Van Maanen, 1979](#)), using semi-structured interviews, non-participant observation and collecting archival data and company documents (formal procedures, guidelines, application designs etc). Qualitative research offers a valuable means to investigate dynamic processes in organizations due to its sensitivity to the organizational context and potential to focus on activities as they unfold ([Maitlis, 2005](#)). Fieldwork was conducted from May 2015 to January 2017 and allowed us to immerse in the collected data

and familiarize with the depth and breadth of the context in order to develop a rich understanding of the operations of the virtual team and, in particular, of the role of ICTs in the internal dynamics of the NPD routine (Lincoln and Guba, 1985; Miles and Huberman, 1994).

The study went through the three general phases suggested by Lincoln and Guba (1985, pp. 235–236), namely, the “orientation and overview,” “focused exploration” and “member check” phases and was informed by the latest developments in routine dynamics research that places artifacts at the center of routines (D’Adderio, 2011; Feldman *et al.*, 2016). During the *orientation and overview* or “initial diagnosis” (Labianca *et al.*, 2000, p. 100) phase, we conducted an initial round of interviews with members of Alpha, including John, the project manager and CEO of Alpha. The purpose of these interviews was to familiarize ourselves with the types of activities of the team and the types of ICTs available to its members. The initial interview protocol included questions such as, “Describe the key steps involved in a typical performance of the NPD routine from your perspective/role,” “What is your role in the process?” and “What communication and information technologies do you use to accomplish your work?” The interviews ranged from 1 to 2 h, with an average length of 90 min. Most interviews were recorded and transcribed within 24 h. Table 1 presents information about the team members, their location and their roles as well as the number of interviews we conducted with each member.

In parallel, we collected rich background information about the three companies involved in the specific project (Alpha, Beta and Delta) in order to develop a comprehensive understanding of the context within which the team operated and performed its routines. Due to our interest in studying routine performance in the context of the operations of a virtual team, one of our first research goals had been to construct a representation of the generalized pattern of the NPD routine based on accounts of team members (i.e. the ostensive understandings of the routine) who had performed the routine several times in the past (e.g. Feldman and Pentland, 2003; Turner and Rindova, 2012).

During the *focused exploration phase*, observations and interview questions became progressively more focused and were informed by routine dynamics research that pays particular attention to the reciprocal interactions between performative and ostensive aspects and related artifacts (Feldman *et al.*, 2016), as well as by research on virtual teams and in particular the common challenges that team members face (e.g. lack of physical presence, coordination challenges, use of communication technologies etc). During observations and interviews, therefore, particular attention was paid to the day-to-day interactions of the team members as the NPD routine unfolded in time, how members used in practice the ICTs available to them, the perceived challenges during routine performance and how they dealt with them, and the affordances or constraints they perceived in interacting with these technologies and each other (e.g. D’Adderio, 2011, 2014; Leonardi, 2011; Feldman *et al.*, 2016).

Team members	Location	Title/Role	Number of interviews
John	SE/Alpha	CEO of Alpha company, project manager	4
George	SE/Alpha	Team member, software developer, debugging/testing	3
Peter	SE/Apha	Team member, back-end software developer	2
Kostas	NE/Beta	Project manager Beta	3
Mary	NE/Beta	Team member, UX/UI designer	2
Andrew	NE/Beta	Team member, front-end software developer	2
			Total: 16

Table 1.
Virtual team composition

Field observation allowed us to engage with the everyday life of team members with the objective to uncover and explicate the ways in which they “come to understand, account for, take action, and otherwise manage their day-to-day situation” (Van Maanen, 1979, p. 540). The advantage of direct observation is that it provides here-and-now experience of what the actors really do and how routines are actually performed (Feldman and Orlikowski, 2011; Lincoln and Guba, 1985). Non-participant observation also involved the first author shadowing John, Alpha’s CEO and the project manager of the FindTaxi application, as he interacted with other team members using several ICTs (emails, Skype, phone, box, basecamp etc.) as well as attending ten synchronous Skype meetings of the team during the period of fieldwork. Meetings lasted from 2 to 4 hours on different weekdays. Interviews and meetings were complemented with rich field notes about frequent informal discussions that became part of the observations (Spradley, 1979). Given that communication between team members was extensively mediated by various technologies, a great part of those interactions was accessible for retrieval and analysis (emails, entries in box and basecamp).

Finally, during the *member check* phase, we created a report summarizing our findings, which we shared and discussed with the CEO of Alpha and two team members to obtain confirmation that our findings had captured the data as perceived and interpreted by them to enhance trustworthiness (Lincoln and Guba, 1985). Overall, throughout the period of the field study, we conducted 16 interviews with all six team members (Table 1), collected field notes from meetings and field observations that yielded 65 pages of text, as well as company documents and archival data.

3.3 Data analysis

The analysis of data started early in the study and fed into research design and data collection stages (Eisenhardt, 1989; Lincoln and Guba, 1985; Miles and Huberman, 1994). We used analytical techniques for qualitative content analysis to analyze our data (Miles and Huberman, 1994), informed by our overall interest in routine dynamics. Our approach in the analysis of our data was to circle back and forth between data collection, interpretation and related literature, which is in line with other qualitative studies on routines (e.g. Dittrich *et al.*, 2016; Howard-Grenville, 2005; Rerup and Feldman, 2011).

To highlight emergent concepts and recurrent themes, both researchers systematically analyzed and coded the data collected through observations and interviews using an inductive approach (e.g. Miles and Huberman, 1994; Locke, 2001). We performed a “first-order analysis” to capture team members’ understandings about their daily activities in terms they were meaningful to them and a “second-order analysis” to move our findings to a theoretical level by developing the theoretical concepts and relationships that underlie the first-order findings (Gioia and Chittipeddi, 1991; Van Maanen, 1979). Examples of first-order codes that emerged from the analysis of observations and interviews about the use of ICTs include “historicity,” “shareability” and “transparency,” which we grouped in our second-order analysis under the category “ICT affordances.” (Gibson, 1986; Leonardi, 2011).

Analysis of data collected during the orientation and overview fed into and guided subsequent rounds of data collection and analyses, and helped us to focus our observations and interview questions on salient themes. As data accumulated during the focused exploration phase, second-order codes started emerging as an outcome of the iterative process of engaging with data collected, first-order codes and theoretical insights from related literatures. For example, our analysis revealed team members attributed their ability to coordinate effectively as a team and engage meaningfully and confidently with the NPD routine, to the use of both Box and Basecamp, which provided them at any time with a historical record of all communications, decisions and documents related to the NPD routine. Inspired by this finding, we engaged in reading about organizational coordination and the

role of routines and their artifacts as a coordination mechanism (Jarzabkowski *et al.*, 2012; Nelson and Winter, 1982; Okhuysen and Betchky, 2009), as well as on the temporal nature of human agency and experience (e.g. George and Jones, 2000; Emibrayer and Miche, 1998; Langley and Tsoukas, 2017). This iterative process of circling between data and theory helped us ensure that the concepts that emerged from our analysis remained faithful to our data. For example, during interviews and field observations, team members frequently referred to the importance of knowing who was responsible for specific elements of the overall task at any time, what is the next important milestone of the project, and of sharing of all information and knowledge related to the NPD routine and its progress, themes that fitted neatly with the three integrating conditions for coordination proposed by Okhuysen and Bechky (2009, p. 483): accountability, predictability and common understanding (see also Table 2).

Integrative condition	Representative quotes from interviews and field notes
Accountability	<p>"The more thorough and clearer the initial analysis of client's requirements and their translation to design specifications, the less the misunderstandings and things requiring clarification during implementation and therefore, the need for ad hoc communication between members to resolve them during the development process." <i>(Interview, project manager, Alpha)</i></p> <p>"It helps to clarify who does what, you know, it saves time and makes things easier." <i>(Field notes, Team member, Alpha)</i></p> <p>"I am given my tasks and I know what I have to do, with whom I need to collaborate, when I need to deliver, it is all clear, it makes our work quite efficient, you know." <i>(Interview, team member, Beta)</i></p>
Predictability	<p>"Every day I go to the office the first thing to do is to check my dialogue threads in Basecamp to update myself about the current status of the project, whether there have been any developments or changes in the schedule and make sure that I am aligned with the broader task and deadlines. That makes me feel much more confident about what my priorities should be on the specific day, what is needed to move ahead." <i>(Interview, team member, Beta)</i></p> <p>"The two systems [Box and Basecamp] help in increasing transparency, historicity, and shareability of project work, something that in turn, reduces potential misunderstandings between team members, the need for frequent ad hoc communication to clarify issues, and therefore, improves significantly the efficiency and speed of the design and development process. Team members know what is required to do next and what to expect from others at any moment in the process." <i>(Interview, Project Manager, Alpha)</i></p> <p>"This is really useful you know, my work is so much easier when I know every morning what I have to do and how it relates to what others do." <i>(Field notes, team member, Alpha)</i></p>
Common understanding	<p>"Sharing dynamically is very important for us to ensure that we are always synchronized. Each of us can do his/her own work at his/her own time, but it is important to use technology to upload and share this work dynamically and to have access to all work instantly." <i>(Interview, team member, Beta)</i></p> <p>"While you are not in the same office, you know at any point who is doing what, but you depend largely on everyone else to keep work synchronized. It gives you the ability to share everything you do dynamically, we could not really work without that." <i>(Interview, team member, Alpha)</i></p> <p>"By documenting everything, we have records of all tasks, requests, decisions and documents that can be shared and agreed by everyone in the team." <i>(Field notes, team member, Alpha)</i></p> <p>"As all teams we have our disagreements, but since everything is written and accessible to all, it is easier to resolve any problem and be on the same page. The two systems constitute the single source of truth for us." <i>(Interview, project manager, Beta)</i></p>

Table 2. Supporting evidence for the fulfillment of the integrative conditions for coordination

4. Findings

4.1 The new product development routine

During the orientation and overview phase of our research, we focused on creating a representation of the generalized pattern of the NPD routine by drawing on participants' accounts (i.e. ostensive understandings) that summarized multiple performances of the routine (e.g. Pentland and Feldman, 2005; Turner and Rindova, 2012). According to the team members interviewed, the NPD routine encompasses the following five basic phases or steps (see Figure 1)

(1) The initial meeting with prospective client in which, if agreement is reached about the details of the project (e.g. overall approach, time and costs), a contract is signed; (2) conducting a workshop with the client's key stakeholders to develop shared expectations about the project, define a high-level application requirements list (see Figure 2 for an example for the FindTaxi application) and define the features of a minimum viable product (MVP); (3) the design and development of the application, which is broken down to several sub-steps ("sprints") during which particular functionalities of the product are designed and developed and feedback from the client is received; (4) the launching of MVP, testing and debugging; and (5) the launching of the product, support, maintenance and new releases.

John, the project manager for Alpha and responsible for managing the relationship with the client (Delta), emphasized the significance of the early phases of the NPD routine: *"the more thorough and clearer the initial analysis of client's requirements and their translation to design specifications, the less the misunderstandings and things requiring clarification during implementation and therefore, the need for ad hoc communication between members to resolve them during the development process"* (Interview, project manager, Alpha).

Just before the beginning of the implementation phase, John organizes a Skype kick-off meeting with all team members to discuss the overall project plan with the team, assign tasks and responsibilities, develop shared expectations among team members, answer to questions and set some ground rules that relate to coordination among team members. Among those rules, one that immediately captured our attention had been what John called the "documentation rule," according to which all interactions, communications and documentation (client's requirements, application designs, process maps etc.) related to the project had to be uploaded on Box, while project schedules, assigned tasks, roles and responsibilities, milestones and deadlines and communication between team members in the form of discussion threads, on Basecamp. A John noted, *"Documentation increases*

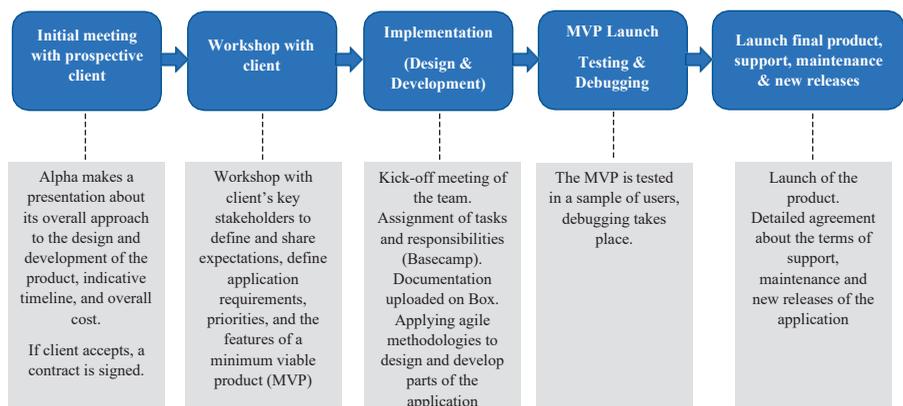


Figure 1.
The new product development routine

FindTAXI process

Customer/driver version

A. Application first launch

Point 1.

1. User can have access to the app without being registered. If user tries to book or reserve a taxi without being registered then we ask him to register first in order to continue.
2. During registration we ask user to complete his mobile number and email as prerequisites. Name, surname and username will be optional.
3. After completing mobile number and email an SMS confirmation (4 digits) will be send. If user gives wrong number for 3 times, app will be locked for 5 minutes.
4. Together with the SMS confirmation a welcome email will be send containing user details as well as an option to register to FindTAXI newsletter.
5. If user submits correct tel number and confirmation number then a welcome message will appear

Point 2.

Location detection as well as push notification alert will be asked only 1 time.

B. Application subsequent launches

Point 1.

Tutorial will be user initiated. The format will be similar to Taxibeat. The proposed flow of the information will look as an infographic

Point 2.

When user starts typing an address a smart box will be shown below the data entry indicating past entries sorted by popularity (most used)

C. Search for taxi now

Point 1.

Call taxi process

1. User's location is picked up from phone's GPS and plotted on the map
2. User's geolocation is translated into an address via reverse geocoding
3. If address isn't available user can manually move the locator
4. Application retrieves available drivers in close proximity and radius increases till it includes at least 4 drivers

D. Book a taxinow

Point 1.

Book taxi process for both customer and driver

1. User declares his position (either automatically or manually)
2. Check available drivers
3. Sends book request to driver
4. Driver confirms the booking and a push notification is send to the user
- 4.1. If driver declines request user is also send a related pushnotification
5. Driver heads to pick up drive and user can see driver "moving" on the map. Distance is also reducing accordingly
6. When driver reaches address, he must press the button "I am here" and a push notification is send to the user indicating that the drives is there
- 6.1. A counter appears in the driver's screen with the following buttons: (i) Boarding, (ii) Not here (penalty to the customer), (iii) Cancel (penalty to the driver)
- 6.2. Customer's buttons will also change to (i) Boarding, (ii) Not here (penalty to the driver), (iii) Cancel (penalty to the customer)
- 6.3. If customer or driver decides to cancel the booking he is asked to state a reason and a push notification is send
7. When customer boards to taxi driver and customer must press button Boarding. When someone presses Boarding a push notification is being send to the other informing that "The driver/customer has confirmed a boarding. Do you as well ?
8. When customer/driver are on board, buttons change to End route. Their position in the map is changing as the taxi moves. Customer can rate the driver on their way to the destination. As soon as they reach the destination they must press the End route button and a rate option is available to the driver. Same rule on push notifications apply here as on Boarding

Figure 2.
Application requirements

F. Reserve taxi

Point 1.

As soon as a reservation request has been submitted, the driver's can view it from their mobile app.

Reservations will appear sorted by the distance of the driver that specific timeframe.

A bulk push notification will be send to the active drivers on predefined timeframes throughout the day (3) informing them about new reservations.

Drivers will have the option to enable /disable that notification through their mobile app. This feature will be default enabled

G. Reserve taxi

Point 1.

Everytime a reservation is cancelled from the customer a message must appear informing that the user rating changes everytime a reservation cancellation takes place. User will be also asked to state the reason for the cancellation

Figure 2.

transparency and clarity, reduces frictions between team members and accelerates the design and development process' (Interview, project manager, Alpha).

During the implementation phase, communication with the client was continuous and based on the delivery of smaller parts of the application on agreed upon deadlines. Feedback from the client was shared with the team via Box and Basecamp. If for instance, changes were required in the design of a specific functionality, John would post a "ticket" on Basecamp with a link to the related files on Box and the person who was responsible to take action. In the following sections, we discuss our findings that relate to interactions between team members and their use of routine artifacts (ICTs) throughout the performance of the NPD routine.

4.2 Acting in the present: ICT, temporality and temporal work

During our field observations of the enactment of the NPD routine, we paid close attention to how team members interacted using several technological artifacts and asked them to provide us with explanations about their actions and decisions. We observed that all team members followed the "documentation rule," according to which they had to keep historical records of all communications, decisions and documentation related to the performance of the NPD routine. All large files like architectural designs, process maps and application specifications were uploaded on Box so that all team members had at any time access to the latest versions of those documents and historical information about who uploaded a specific file and who made changes or revisions, when and why. Similarly, using Basecamp's related functionality, they created threads of discussions about different topics relating to different tasks in which they were involved. For instance, when Alpha's and Beta's team members worked on the development of a specific functionality of the FindTaxi application (e.g. a customer checks for available taxis in his/her area), they created a dialogue thread in Basecamp with links to related documents in Box (e.g. designs and specifications) in order to coordinate their actions (Discussion thread, "Finding a Taxi Functionality," and field notes). This allowed team members working at the two sites to work relatively independently, sometimes outside work hours, and still coordinate their actions with fellow team members by uploading comments and notes on Basecamp discussion threads about the specific subject.

As Peter noted, *"Every day I go to the office the first thing I do is to check my dialogue threads in Basecamp to update myself about the current status of the project, whether there have been any developments or changes in the schedule and make sure that I am aligned with the broader task and deadlines. That makes me feel much more confident about what my priorities should be on the specific day, what is needed to move ahead"* (Interview, team member, Beta).

Similarly, John said that the two ICTs (Box and Basecamp) help in “*increasing transparency, historicity, and shareability of project work, something that in turn, reduces potential misunderstandings between team members, the need for frequent ad hoc communication to clarify issues, and therefore, improves significantly the efficiency and speed of the design and development process. Team members know what is required to do next and what to expect from others at any moment in the process*” (Interview, project manager, Alpha).

Even when ad hoc communication took place through Skype or phone calls in order to resolve emergent issues, the person who initiated the meeting was responsible for uploading on Basecamp a summary of what had been discussed and the implications, if any, for the work of others. In this way, everybody was informed about all developments that related to project work.

All team members during fieldwork and interviews provided us with related comments about how the two routine artifacts enabled them to relate confidently with ongoing routine activities and navigate in the future. These comments prompted us to engage with the literature on the subjective experience of time, or temporality, that is, the experience of the relationship between the past, the present and the future (e.g. Emirbayer and Mische, 1998; George and Jones, 2000) as routines unfold in time. According to this literature, human agency and experience is inherently temporal, and people frequently draw upon both the past and the future in order to ascribe meaning to their present activities, particularly during emergent events or disruptions to their everyday activities (Emirbayer and Mische, 1998; Howard-Grenville, 2005; Langley and Tsoukas, 2010; Mead, 1932).

The notion of temporality resonated extremely well with team members' accounts, who emphasized the importance of mobilizing both the past (dialogue threads and related documentation) and the future (plans, schedules, milestones and deadlines) to ascribe meaning to the present situation and direct activities in the future (Avital, 2000; Mead, 1932; Shipp and Jansen, 2021). As Kostas remarked, “*the two systems constitute the single source of truth for us*” (Interview, project manager, Beta). This applied both to the level of individual and collective (team or routine) action. When, for instance, Jerry, the client representative unexpectedly requested a change in the specifications of the application, John called a Skype team meeting to find out a way to accommodate the request without compromising the budget and the deadlines of the project. The fact that all team members shared through the ICTs the same historical information, and future goals helped them to align their individual understandings about the situation and identify a solution that preserved the current trajectory of the project with relatively minor adjustments (field notes and discussion with John). Kaplan and Orlikowski (2013, p. 965) refer to this collective effort as “temporal work,” that is, the linking of “interpretations of the past, present, and future in ways that appear coherent, plausible, and acceptable.”

4.3 Coordinating routines in a virtual context: the role of artifacts (ICT)

Achieving continuous and effective coordination in the dynamic context of the NPD routine had been a continuous challenge and preoccupation of all participants, particularly John, the project manager. For John, two things were critical for the successful coordination of the NPD routine activities. The first, as mentioned earlier, was the clear and systematic allocation of tasks, roles, responsibilities and deadlines at the launch of the project. The second, as he said, was the continuous monitoring of the project's progress to ensure that all members work “in concert”: “*This is what I do every morning; I go into the system [basecamp] to identify the pending tasks and make sure that important milestones will be met. Complexity is high, problems you have not anticipated might occur and working at a distance does not help to make sure that the project moves forward as planned. If a team member feels he/she cannot complete a*

task on time, I need to know asap to take quick action. What really helps is that we are all informed about what needs to be done, when and by whom, and the need to keep all others informed about important issues that might derail the project" (Interview, project manager, Alpha).

All team members referred to the importance of sharing everything and having access to up-to-date information about developments in several interrelated tasks and documentation. For instance, developers trusted their fellow team members with uploading the latest versions of application designs and specifications at the designated folder on Box and all updates related to their current work (comments, requests, changes etc. in discussion threads) on Basecamp. As George said, "*There is no question about it; we do not share an office, we cannot see each other, so to work together as a team we all need to keep records of everything we do and make it available to the team. In this way we know where to find all information related to our work and synchronize our actions*" (Interview, team member, Alpha). This "dynamic sharing" our informants referred to was particularly important to team members who appreciated the flexibility to work on a task outside work hours. Mary, for instance, mentioned, "*When there is pressure to meet a deadline, I find it very efficient to work at nights, when everyone at home is sleeping. I can do this exactly because we keep everything shared and synchronized, otherwise it would have been impossible*" (Interview, team member, Beta).

The team dealt with unexpected events or disruptions, as mentioned earlier, with ad hoc meetings on Skype to find solutions to problems and realign actions according to the circumstances. Again, however, everything discussed and agreed upon had to be documented and stored by the member who called the meeting at Basecamp to secure common understanding and agreement (field notes, project manager and Alpha).

To make theoretical sense of our findings, we engaged with the literature on organizational coordination (e.g. Adler, 1995; Okhuysen and Bechky, 2009; March and Simon, 1958; Thompson, 1967). Consistently with recent research emphasizing the dynamic nature of coordinating processes and mechanisms (e.g. Faraj and Sproull, 2000; Faraj and Xiao, 2006; Jarzabkowski *et al.*, 2012; Okhuysen and Bechky, 2009), the participants of the NDP routine mobilized a variety of coordinating mechanisms to dynamically align their interdependent activities and adapt to conditions of uncertainty, including plans, schedules, rules and mutual adjustment (Thompson, 1967). As mentioned in the previous section, what emerged from the analysis of our findings was the persistent and consistent application of the "documentation rule," which according to team members was critical to coordinating their actions due to the lack of physical proximity between the members working for Alpha and Beta and the high degree of dependence on ICTs. To theorize about how this rule enabled routine participants to dynamically coordinate their activities, we followed Okhuysen and Bechky (2009, p. 483), who suggested that coordinating mechanisms help people collectively accomplish their interdependent tasks by fulfilling the three integrating conditions for coordination: *accountability*, *predictability* and *common understanding*.

In particular, Basecamp by promoting visibility about who was responsible for specific elements of the overall task at any time made team members *accountable* for their own individual contributions while also making others accountable for theirs. Ad hoc and scheduled Skype meetings as well as reminders issued by the project manager via Basecamp "tickets" also contributed to enhanced accountability. Because it makes responsibilities clear, accountability facilitates the alignment of individual actions among interdependent members (Ohrbuch, 1997, p. 463). Similarly, *predictability* was supported by the inscription of the generalized pattern of the NPD routine in Basecamp in the form a project plan consisting of completed actions and actions that remain to be accomplished as well as the timing or order in which they must happen and by whom. Predictability, therefore, allows people to fit their own individual tasks into the whole pattern of the NPD routine through anticipation of when others will do their work (Okhuysen and Bechky, 2009, p. 486) Finally, *common*

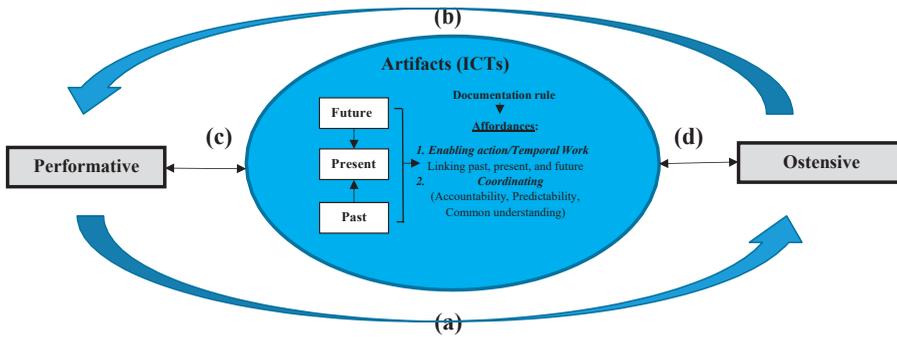


Figure 3.
Conceptual framework

understanding was achieved by enabling the sharing of all information and knowledge related to the NPD routine and its progress in the two systems and ensuring transparency and continuous access to all team members. For instance, team members could identify in Box the latest versions of all documents, including application designs and specifications, drawings, procedures and manuals along with a complete record of related comments and changes agreed upon with the customer or other team members. Table 2 provides supporting evidence to the fulfillment of the three integrative conditions for coordination.

Clearly, as discussed before, the content stored in the two ICTs incorporated different types of coordinating mechanisms in the form of digital artifacts that contributed to the alignment and integration of individual actions (e.g. schedules, plans, designs and specifications). Nevertheless, it was the consistent application of the documentation rule, requiring all these coordinating mechanisms to be inscribed in the ICTs that enabled their effective, efficient and dynamic application in the context of the NPD routine.

5. Discussion

5.1 Conceptual Framework: the role of artifacts (ICTs) in routine dynamics

Motivated by recent developments in routine dynamics research that brought to the center of attention the interactions between artifacts and performative and ostensive aspects of routines, in this study we set out to advance our understanding of how these interactions play out in the context of the NPD routine performed by a virtual team. Our findings revealed some unique insights that extend our understanding of the role of artifacts in shaping routine dynamics and performance. Figure 3 represents the theoretical framework that we developed from our empirical findings.

Figure 3 depicts the mutual constitutive relationships between the performative and ostensive aspects (arrows *a*, *b*) and related artifacts (arrows *c*, *d*) (Feldman *et al.*, 2016). Routine artifacts (ICTs) influence both the performative and the ostensive aspects (e.g. D'Adderio, 2011; Howard-Grenville, 2005; Pentland and Feldman, 2005; Pentland and Feldman, 2008; Turner and Rindova, 2012). In particular, our findings show that the two ICTs mediated and inscribed most interactions between routine participants (arrow *c*, performative → artifacts) and maintained a detailed record of past interactions and documentation related to the NPD routine (Figure 3, past).

ICTs also maintained a digital record of all artifacts representing the ostensive aspect of the NPD routine (e.g. manuals, contracts, specifications and schedules) (arrow *d*, ostensive →

artifacts), including those referring to future actions, goals and deadlines (Figure 1, future), which, by being continuously updated and shared among participants, promoted the alignment of participants' understandings (arrow *d*, artifacts → ostensive). Both the records of past interactions and those relating to future actions, afforded individual members and the virtual team as a collective the ability to ascribe meaning to the current situation, take action in the present and navigate in the future (Avital, 2000; Kaplan and Orlikowski, 2013; Leonardi, 2011) (Figure 3, Affordance 1; arrow *c*, artifacts → performative).

Finally, artifacts, and in particular Box and Basecamp, afforded routine participants the ability to coordinate their actions by fulfilling the three integrated conditions for coordination, namely, accountability, predictability, and common understanding (Figure 1, Affordance 2; artifacts → performative; artifacts → ostensive) (Okhuysen and Bechky, 2009). The inscription of coordination mechanisms in the form of digital artifacts (e.g. schedules, specifications, roles, deadlines etc.) as well as of information about past interactions and decisions in the two ICTs enabled NPD participants to align their actions dynamically according to the situation they were facing. Nevertheless, this was possible due to consistent application of another coordinating mechanism, the "documentation rule," according to which all participants were required to inscribe in the two ICTs all interactions, decisions, notifications and files relating to the performance of the NPD routine.

5.2 Contributions to research and practice

Our ethnographic study of the performance of the NPD routine by the members of a virtual team advances our understanding of the influence of a context characterized by high levels of virtuality on the performance of routines. As our findings suggest, in such a context, routine participants must rely extensively on ICTs to meet their communication and coordination needs, something that introduces unique challenges for participants and increases the centrality and significance of the role of technological artifacts in routine dynamics.

In particular, and consistently with recent advances in routine dynamics research that emphasize the inseparability of human and material agency (e.g. D'Adderio, 2011, 2014; Leonardi, 2011), our findings offer important insights about how the technological artifacts of the NPD routine shaped participants' agency and routine performance. First, the literature on routine dynamics suggests that artifacts may influence both the performative and the ostensive aspects and contribute to the balancing between stability and change in routine performance (e.g. D'Adderio, 2008; Howard-Grenville, 2005; Pentland and Feldman, 2005; Pentland and Feldman, 2008; Turner and Rindova, 2012). Our findings extend this understanding by showing how the ICTs in use mediated and augmented routine participants' agentic capacity to act in the present. Because human agency is inherently temporal (e.g. Emirbayer and Miche, 1998; George and Jones, 2000), participants' access to the content stored in the two ICTs enabled them to retrieve a faithful, updated and detailed record of the past and the anticipated future that helped them make informed, meaningful decisions about what needs to be done in the present and navigate in the uncertain future (Baumeister *et al.*, 2011; Emirbayer and Miche, 1998; George and Jones, 2000; Langley and Tsoukas, 2017; Mead, 1932). Moreover, the sharing of information among team members in real-time also promoted the alignment of their individual understandings with the broader pattern of the routine and the coordination of individual actions (Dionysiou and Tsoukas, 2013; Feldman and Rafaeli, 2002; Turner and Rindova, 2012). This alignment enabled also team members as a collective to take action in the face unanticipated, emergent situations by engaging in temporal work, that is, by linking "interpretations of the past, present, and future in ways that appear coherent, plausible, and acceptable." (Kaplan and Orlikowski, 2013, p. 965).

Second, and relatedly, our study contributes to our understanding of routines as a coordinating mechanism in organizations (Adler, 1995; Okhuysen and Bechky, 2009; March

and Simon, 1958; Nelson and Winter, 1982; Thompson, 1967) and, in particular, of the role of artifacts in the coordination of routine activities in a virtual context (e.g. D'Adderio, 2011; Jarzabkowski *et al.*, 2012; Pentland and Feldman, 2005; Turner and Rindova, 2012). The literature on routines suggests that routines coordinate by providing a template for task completion, defining specific sequences of actions that must be performed, bringing people together and helping them create a common perspective among participants (e.g. Okhuysen and Bechky, 2009; Feldman and Rafaeli, 2002; March and Simon, 1958; Nelson and Winter, 1982). Our study shows that, to meet their coordination needs, team members relied predominantly on the affordances of two ICTs: Box and Basecamp. These ICTs afforded team members the possibility to meet effectively the three integrating conditions for coordination, namely, *accountability*, *predictability* and *common understanding* (Bechky and Okhuysen, 2009).

Finally, our work answers to recent calls for research on the influence of new types of ICTs in the performance of virtual teams (e.g. Garo Abarca *et al.*, 2020; Gilson *et al.*, 2015; Raghuram *et al.*, 2019). Although a large number of different types of ICTs were available to the members of the team we studied (e.g. Skype, email and instant messaging), our study highlights how the affordances of two ICTs, Box and Basecamp, enabled team members to take actions that would have been very difficult or impossible to perform without them (Leonardi, 2011; Leonardi and Vaast, 2017). In particular, despite the common challenges associated with virtual work, our findings suggest that both ICTs strengthened team members' ability to coordinate their actions in the context of a complex routine and engage confidently as individual team members and collectively as a team with their daily activities. Although our qualitative research design does not allow us to make claims about causality, team members' accounts clearly point to the role of these ICTs in attenuating several of the commonly identified negative effects of virtuality, like, for instance, on trust (Hill *et al.*, 2009; Wilson *et al.*, 2006), conflict (Hinds and Bailey, 2003; Hinds and Mortensen, 2005) and shared understanding (Cramton, 2001; Griffith *et al.*, 2003).

From a practical perspective, our study offers useful insights about dealing with the challenges of managing routines in the case of distributed, virtual work. In particular, our findings demonstrate that by providing routine participants with updated information related to routine activities in real-time, ICTs may play an instrumental role in supporting both individual participants' ability to act independently and the coordination of interdependent actions. Although, as empirical studies in routine dynamics have demonstrated (e.g. Pentland and Feldman, 2008; Reynaud, 2005), participants can always interpret rules and procedures differently or bypass them, our findings suggest that by simply securing the inscription into the ICTs of all interactions, decisions and documentation – “the documentation rule” in our setting – and their availability upon demand, the potential benefits for individual and routine performance may be significant.

5.3 Limitations and directions for future research

This ethnographic study is based on the close observation of one type of routine performed by a small virtual team consisting of six members. Thus, we can only speculate about the transferability of our findings to other settings that differ significantly from the specific setting we studied. Still, as the degree of virtuality is continuously increasing in most business contexts (Gibson *et al.*, 2014; Gilson *et al.*, 2015), the specific affordances of ICTs may be generalizable to other types of routines, teams and organizational settings. For instance, we suspect that the benefits associated with effective and efficient coordination we identified in our study may be even more significant for larger, more complex organizations, routines and teams. As the study of new types of collaboration and communication technologies are still rare in the literatures of both routines and virtual teams (Gilson *et al.*, 2015; Raghuram

et al., 2019), future research should shed more light into how such technologies may help routine participants and members of virtual teams overcome the common challenges associated with virtual work.

Moreover, as mentioned earlier, due to our research focus on the role of the specific ICTs in the internal dynamics of the NPD routine, our empirical material does not allow us to assess the impact that other factors that may have had on the outcomes we observed. For instance, as research on virtual teams suggests, individual characteristics such as personality (e.g. Clark *et al.*, 2010), the stage of team development (e.g. Dennis *et al.*, 2008), team composition and nature of task (Malhorta and Majchrzak, 2104), leadership style (e.g. Henttonen and Blomqvist, 2005) and temporal distance (e.g. Gibbs *et al.*, 2017), among others, are also likely to have had an impact on the successful performance of the NPD routine and the efficient coordination of the team members' actions.

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