The Role of Temporal Coordination for the Fuzzy Front-End of Innovation in Virtual Teams

Petros Chamakiotis, Achilleas Boukis, Niki Panteli, Thanos Papadopoulos

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ABSTRACT

In this paper, we study the role of temporal coordination in managing the early stages of innovation (aka fuzzy front-end) in the context of virtual teams. Following a comparative case study approach, we detail the role of temporal coordination through the study of two contrasting virtual teams—one with a 24-hour lifespan, and one with a five-month lifespan—from two Industry-Academia open innovation projects. Our approach was longitudinal capturing virtual team activities from start to end of each project, and involved multiple data collection methods, including observations and interviews. The findings reveal that the virtual team lifespan influences the type of temporal coordination that emerges. In virtual teams with short lifespans, *tight coordination* with frequent communication can help to reduce the uncertainty characterizing the fuzzy front-end. On the other hand, in virtual teams with longer lifespans, *loose coordination* allows dispersed members to work simultaneously on different, complementary aspects of the task at hand. These findings extend scholarly understanding around how innovation activities are coordinated in technology-mediated environments, such as virtual teams. Finally, we discuss theoretical and managerial implications.

KEYWORDS

Virtual teams; fuzzy front-end; innovation; temporal coordination.

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1. INTRODUCTION

There is widespread recognition that innovation related projects take place in geographically dispersed, technology-mediated, thus virtual teams (VTs) (Chamakiotis & Panteli, 2017; Olaisen & Revang, 2017). Within this context, researchers have studied how innovation develops (e.g. Gibson & Gibbs, 2006; Kratzer, Leenders, & Van Engelen, 2006), shedding light on various aspects of innovation including the impact of anonymity on idea generation (Chen, Zhang, & Latimer, 2014), creativity and ideation in the technology-mediated setting (Chamakiotis, Dekoninck, & Panteli, 2013) as well as the coordination of VT processes (Peñarroja, Orengo, Zornoza, & Hernández, 2013), and VT interactions (Baruch & Lin, 2012). Despite these studies, limited knowledge exists on how the temporal aspect of VTs, i.e. their short lifecycle, may influence innovation.

Temporary organizing constitutes a unique organizational form, which influences task and team processes (Bakker, DeFillippi, Schwab, & Sydow, 2016; Burke & Morley, 2016). In the VT context, temporary VTs appear to have a typically short and predefined lifespan (Panteli & Davison, 2005; Saunders & Ahuja, 2006). Such short VT lifecycle is not without challenges; it may have an adverse effect on the quality of relationships and interactions among team members, especially on the development of trust and team cohesion (Crisp & Jarvenpaa, 2013; Gibbs, Sivunen, & Boyraz, 2017); and also on teams' ability to innovate and meet their goals, by challenging team climate and enhancing outcome uncertainty (Halbesleben, Novicevic, Harvey, & Buckley, 2003; Nisula & Kianto, 2016). As innovation efforts nowadays are increasingly

conducted in temporary (e.g. Bakker, Boroş, Kenis, & Oerlemans, 2013) and virtual (e.g. Olaisen & Revang, 2017) environments, it becomes vital for project managers to understand how innovation plays out within the temporary VT context.

In particular, our study takes a focus on the fuzzy front-end (FFE) of innovation, whose importance has been seen as burgeoning in the innovation literature (Takey & Carvalho, 2016; Spieth & Joachim, 2017). The FFE represents the early phase of the innovation process, where ideas are generated and evaluated, potential concepts are formulated, and further development is initially planned (Kock, Heising, & Gemünden, 2015; Oliveira & Rozenfeld, 2010). Studying the impact of the temporary VTs on the FFE is essential for two reasons. First, the highly unstructured and complex nature of FFE activities—combined with the temporary and virtual nature of contemporary innovation teams—could significantly influence the overall development cost and project success (Verworn, Herstatt, & Nagahira, 2008; Yoo, Boland, Lyytinen, & Majchrzak, 2012). Also, members of temporary VTs may not have the opportunity to develop strong interpersonal relationships or trust, which may have an impact on their level of creativity (Gibbs et al., 2017). Hence, we argue that VTs with a short lifespan and limited potential for relationship building require different coordination practices to meet the same innovation objectives as permanent VTs, or temporary ones with a longer lifespan. Though the challenging nature of the FFE has been recognized in the innovation field (Christiansen & Gasparin, 2016; Spieth & Joachim, 2017; Tran, Goulding, & Shiu, 2018), scarce evidence exists around the temporary character of VTs in relation to the FFE or the innovation literature more generally.

Following from the above, our research question is: How does the temporary character of VTs influence the coordination of the FFE activities in the VT context?

To address our research question, we adopt a comparative case study approach with two contrasting temporary VTs from different Industry-Academia projects representing two extremes of a temporal continuum. We use qualitative methods (e.g. observations, interviews) and contribute to the literature on VTs by exploring how temporality influences the coordination of VTs in the FFE of innovation extending prior relevant work (e.g. Montoya-Weiss, Massey, & Song, 2001). The study offers valuable insights to project managers on effective coordination practices that may be adopted within technology-mediated environments, such as VTs.

We start by reviewing relevant literature, and then turn to the presentation of our research sites and findings from the two cases. We subsequently bring the two cases together, and discuss the ensuing findings, as well as their theoretical and managerial implications.

2. Virtual Teams and Temporal Coordination

There is agreement in the VT literature that VTs are different from traditional, physically collocated teams because of their unique characteristics: they are technology-dependent and dispersed in terms of *geography* (comprising geographically dispersed members), *organization* (comprising members of different parent organizations), and *temporal differences*. VTs, irrespective of their lifespan, may constitute ideal environments for innovation, due to their potential to access geographically dispersed talent, thus connecting members with expertise which is not

available locally (Chamakiotis et al., 2013; Chamakiotis & Panteli, 2017; Chen et al., 2014; De Leede, Kraan, Den Hengst & van Hooff, 2008; Kratzer et al., 2006). Thus, VTs can be highly creative due to the interdependencies that are formed among the specialized team members, like other temporary project teams (Manning & Sydow, 2007). Further, members' dispersion across different time zones and the opportunity to work 'following the sun' may enhance speed and quality that can aid innovation (Colazo & Fang, 2010).

Nevertheless, the very same characteristics that provide such opportunities for innovation have also been recognized as discontinuities (Chudoba, Wynn, Lu, & Watson-Manheim, 2005), bringing inconsistencies to VT operations. In particular, temporary VTs, due to their short and intense lifecycle, have been seen as creating challenges for their management, levels of cohesion, trust development, internal team conflict, and ultimately, their performance (Gibbs et al., 2017; Massey, Montoya-Weiss, & Hung, 2003; Montoya-Weiss et al., 2001).

Through temporal coordination mechanisms, these challenges, such as the ones noted above, can be overcome (Ancona, Okhuysen, & Perlow, 2001) and turn to opportunities for creativity and innovation. Temporal coordination has been defined as a process structure aiming to intervene and direct patterns, timing and content of communication in a group (Montoya-Weiss et al., 2001). This form of coordination is important in VTs as it seeks to structure activities across time and space and thus achieve integration of inter-dependent activities in the technology-mediated context. Within VTs, coordination can be achieved through temporal symmetry, thus the

synchronization of activities or temporal complementarity which entails first the division of activities and then their synthesis (Im, Yates, & Orlikowski, 2005). Some literature looks into the impact of temporal coordination on managing conflict and performance within VTs, though the focus of these studies has often been on asynchronous VTs in contrived experimental environments (i.e. Chen et al., 2014; Montoya-Weiss et al., 2001; Massey et al., 2003). Limited insights therefore exist in the literature on the temporal coordination in other types of technology-mediated settings (Shen, Lyytinen, & Yoo, 2014). We will be exploring this issue by examining how temporal coordination unfolds in the FFE phase of innovation within VTs.

3. The Fuzzy Front-End of Innovation

The innovation stream has gradually shifted from viewing the management of innovation process as a whole into two distinct but interrelated streams, due the diverse nature of the tasks performed and objectives set in each one, namely the front-end phase, or FFE, and the late, or back-end phase, innovation (Kim & Wilemon, 2002; Oliveira & Rozenfeld, 2010). Whereas the back-end phase relates to the actual development of the product/idea, its financial viability and market launch (Khurana & Rosenthal, 1998), the FFE begins *"when an opportunity is first considered worthy of further ideation, exploration, and assessment and ends when a firm decides to invest in the idea, commit significant resources to its development"* (Kim & Wilemon, 2002; p. 270).

Key FFE activities include: preliminary market assessment, opportunity identification and assessment, idea generation, concept testing, product definition and project planning (Khurana & Rosenthal, 1998). As these activities span between the first consideration of an idea to the actual beginning of the product development process, key decisions are required during FFE; from organizing a multifunctional development team, to setting clear phase goals and to allocating scarce resources for product development (Khurana & Rosenthal, 1998). Hitherto, as FFE can have a strong impact on sequential innovation stages, managers need to focus on the most attractive products for customers and terminate the less viable ones as early as possible (Kock et al., 2015).

Due to these diverse and often resource-depleting phases, the FFE remains highly labyrinthine, unstructured and uncertain (Frishammar, Florén, & Wincent, 2011), featuring as the most vital phase of the innovation process to manage (e.g. Thanasopon, Papadopoulos, & Vidgen, 2016; Spieth & Joachim, 2017). The extant literature has examined how various organizational conditions (e.g. climate) contribute to FFE quality and front-end success (Bertels, Kleinschmidt, & Koen, 2011), addresses the impact of task execution proficiency and decision criteria on following FFE activities and product development success (Khurana & Rosenthal, 1998; Verworn et al., 2008); investigates the role of technical uncertainty during the front-end phases (Spieth & Joackim, 2017; Verworn et al., 2008); and advises on how the early stages of radical and incremental innovations should be differently managed (Salomo, Keinschmidt, & De Brentani, 2010). More recently, the literature has focused on

'openness competence' within the FFE (Thanasopon et al., 2016), and on the resources' requirements and creativity during FFE, with researchers shedding light on: collaboration and coordination practices within the FFE (Takey & Carvalho, 2016); how ideas can be created, selected and successfully implemented (Kock et al., 2015); and on top management's participation in the FFE (Globocnik & Salomo, 2015).

Despite the usefulness of the aforementioned insights, the temporary character of VTs is likely to challenge the prescriptions of the VT literature for three reasons (Watson-Manheim, Chudoba, & Crowston, 2012). First, the idea generation phase might be compromised, due to limited brainstorming and higher communication barriers between members from multiple functions with diverse background in FFE teams (Kock et al., 2015; van den Ende, Frederiksen, & Prencipe, 2015). Second, decision-making uncertainty could be escalated, due to the increased pressure and role conflict experienced from FFE participants in meeting project deadlines instigated by the temporary character of VTs (de Brentani & Reid, 2012). Third, understanding other participants' perspective becomes harder due to limited face time and lack of personal interactions (O'Leary & Mortensen, 2010), which might discourage the advancement of radical ideas (Tran et al., 2018).

4. RESEARCH APPROACH

We adopted a qualitative, comparative case study approach (Yin, 2008). Though our approach may not generalize to other cases necessarily, qualitative research generalizes to theory (Myers, 2013). Case studies, in particular, allow for the adoption of multiple data collection methods which can lead to in-depth

understanding of the phenomenon under study within a single setting (e.g. Cavaye, 1996). Case studies have been considered ideal for the study of the FFE, given the perplexing and iterative interactions required in most innovation projects (Börjesson, Dahlsten, & Williander, 2006). We isolated and used material from a larger dataset which involved a number of VTs working on different projects. Specifically, our approach involved two contrasting temporary VTs from two different Industry-Academia collaboration projects presented next.

4.1 The Two Cases

The two cases from two Industry-Academia collaboration projects were selected as two extreme examples of temporary VTs—one lasting only for 24 hours, whereas the other one for five months.

Case 1: Our first VT took part in a project organized by a European university which every year invites engineers (and other professionals) from across the world to partake (either virtually or F2F) in a 24-hour project with the aim of designing a prototype selected from a list of preselected design briefs (a recycling object for the office). Winning prototypes are commercially exploited by the sponsoring companies. Involved in the project are professionals from the sponsoring companies, though the participating teams receive minimal supervision. The VT comprised ten, equally dispersed between the Country A and Country B, junior engineers with up to one-year professional experience. Due to the very short lifespan of the project (i.e. 24 hours), we were able to capture most interactions between the VT members, as we explain in the next section.

Case 2: Our second VT took part in a similar project organized by a European University (different to Case 1) for a period of five months with the aim of designing a pre-defined prototype (a kitchen utensil for men). The project was broken down to four phases, with Phases 1-3 being completely virtual, and Phase 4 in a F2F environment in Country C. Two global companies were involved in the project, which selected the best prototypes for production and commercialization. The VT comprised five mechanical engineers and three industrial designers (n=8) dispersed across Country C, Country D, Country E and Country A. During Phases 1-3, team members held formal virtual meetings twice a week on a prescribed video-conferencing system (VCS) and then met in a F2F environment during the last phase in order to put their prototypes together.

The two VTs share a number of similarities. For example, both VTs are global, involving members based in different countries, and they are both inter-organizational in nature, involving members from different parent organizations (or universities) (Panteli & Davison, 2005). They are also temporary with no working history or expectation to work together again in the future. Though they might differ in terms of number of countries involved or exact team size, they are still similar at the dimension level, for example both teams are globally (instead of locally) dispersed, and both are inter- (rather than intra-)organizational. Despite the above similarities, the two VTs differed significantly in terms of lifespan, with one lasting for one day only (i.e. 24 hours) and the other for five months (see Table 1 for more details). Our approach was longitudinal, allowing us to study the two teams from start to end.

Table 1. Similarities and differences between the two cases

		Case 1	Case 2
Similarities	**Geographical dispersion**	Global (2 European countries)	Global (4 European countries)
	Diversity	• 3 different nationalities • 3 different native languages • Educational/professional diversity	• 4 different nationalities • 4 different native languages • Educational/professional diversity
	Relation to organization	Inter-organizational (1 company, 2 institutions)	Inter-organizational (1 company, 4 institutions)
	Level of continuity	Temporary (project-based)	
	Team size	<10 members	
	Type of project	Industry-Academia collaboration projects	
	Type of task	Project-based: Product design	
Differences	**Lifespan**	24 hours	5 months

4.2 Data Collection and Analysis

We adopted multiple data collection methods for the purpose of completeness, in line with the interpretive, qualitative approach (e.g. Oyegoke, 2011). Non-participant observations and semi-structured interviews constituted the two main ones, which were complemented by review of relevant documentation and team outputs (outlined in Table 2). The first author was present at the Country A site

throughout the 24 hours and captured most activity (including the VCS sessions with Country B participants) on video (Case 1). For Case 2, the first author observed Phases 1, 2 and 4 of the project and recorded all interactions, including VCS sessions, in a logbook (rather than on video), first, because it was not possible to capture all team interactions for five months, and second, because of issues of confidentiality. Observations proved useful in capturing participants' interactions as they occurred, overcoming limitations characterizing interviews, such as memory biases. In the logbook, the activities that took place were recorded, as well as questions about issues that were unclear, which were then investigated further during the interviews. The advantage of collecting video footage (Case 1) was that we watched everything at our own pace which we did in order to take similar notes after the end of the project. Our observations, whether video- or directly logbook-recorded, served the same purpose(s) for both cases: (a) they provided us with a better understanding of the two projects and a rich account of the activities that took place in each phase; (b) they informed our interview design as we included interview questions that helped us shed light on issues unclear to us; and (c) they helped us to make sense of the ensued interview data.

Interviews were semi-structured in both cases and lasted on average an hour each. For Case 1, the first author had several informal chats both prior to, and during, the project. These helped to gain a better understanding about the expectations and activities during the project and helped the first author to conduct more focused observations. Each of the five participants based in Country A were then formally

interviewed on completion of the project. They were asked to share their experiences about how temporality influenced the coordination of innovation-related activities, and to elaborate on issues that were identified during the observations. For Case 2, two members were interviewed in a focus group environment where detailed accounts of the activities that took place in Phase 1 were shared. These were later followed up by individual interviews in Phases 2 and 3 by the same and additional members who explained how innovation played out as the project unfolded. In Phase 4, six members were interviewed in a focus environment and asked to share their experiences about all four phases, and to reflect on incidents picked during the observations. The lead author had several informal chats with the VT coach in Case 2 throughout the project; these helped to answer questions that emerged and shed light on issues needing clarification.

Other data included relevant project documentation, which provided additional context about both projects, as well as communication outputs (e.g. email communications) and design outputs at various stages of the project. These data played a complementary purpose and were either collected in person (Case 1) or electronically (Case 2) as the projects unfolded, and they helped us to picture what the participants referred to in their interviews. Such data were reviewed for both projects.

Table 2. Data collection

	Case 1	**Case 2**
Observations (video- or logbook-recorded)	• 24 hours of Country A subgroup activity • 13 video-conference/Skype sessions (5 hours)	• 1 video-conference session (2 hours) in Phase 1 • 1 video-conference session (2 hours) in Phase 2 • 1 week (40 hours) of F2F work in Phase 4
Interviews (individual and focus groups)	• Informal chats prior to, and during, the project • 5 individual interviews after the project • 5 informal chats before the project	• Informal chats with team coach throughout the project • 2 members interviewed in focus groups in Phase 1 • 4 individual interviews in Phases 2 and 3 • 6 members interviewed in a focus group in Phase 4 in Country C
Other data	• Project documentation • Country A subgroup design outputs (on flipchart, electronically) • Photographs of team working together and design outputs • Communication outputs (e.g. emails)	• Project documentation • Reviews and evaluation forms at each phase • Design outputs (electronically) • Photographs of team working together (on VCS and F2F) and design outputs

Analysis was inductive and performed separately for each project. It was organized in the following stages:

Stage 1: Mapping the FFE activities. All observation-related data were reviewed systematically until we identified the boundaries of the FFE phase and mapped all FFE activities that took place in each project. This process was performed manually and we were able to map the collected design outputs and photographs we had taken on a chronological axis. This process was helped us isolate the interview data that referred to those activities.

Stage 2: Analysing the interview data. Once transcribed, all interview data were inserted into two separate NVivo files for each project. We tracked all conversations that developed around the issue of coordination and elicited a number of themes (e.g. technology selection, communication frequency) that were found to be associated with the temporary character of the two VTs. This stage was Informed by Braun and Clarke's (2006) principles of thematic analysis.

Stage 3: Linking themes with FFE activities. At this stage, we linked the themes that emerged from our thematic analysis to the specific FFE activities identified earlier which enabled an understanding of how the temporary character of VTs influenced the coordination of the FFE activities.

Stage 4: Comparative analysis. At this final stage, we carried out a cross-case comparison and identified the similarities and differences relative to the coordination practices that developed in the two projects.

5. FINDINGS

We start by presenting our analysis of the two cases separately and provide illustrations from our data, including limited photographic material to give readers a real feel of what the two projects look like. We then bring the two cases together.

5.1 Case 1 Findings

The one-day project lasted for 24 hours, starting at 13:00 in Country A with a Skype meeting whereby all participating teams were briefed on the project regulations and expectations, and were given the design briefs. The team under study encountered significant problems during its early ***project planning*** activities, including technical and language-related difficulties:

> *"Skype intro—mostly in [language spoken in Country B]—not very successful—connection problems—different Skype accounts created—Skype crashing because of numerous users trying to connect—trying to find who the other half of the team are."* (logbook notes)

The first sign of enthusiasm was noted at 14:45 when the team met on the VCS for the first time. During the first two VCS meetings (14:45-15:15 and 15:45-16:30), personal introductions were made and clarifications of the nature of the task were sought with one of the organizers who was present for a limited amount of time in the Country B site.

This 24-hour VT adopted an approach that included frequency of e-meetings, preference for synchronous technologies and tight timeframes. The team decided to meet on the VCS every few hours in order to catch up on progress, and they thus set specific times for these e-meetings:

> *"We will contact you again probably in 3 hours… that gives us time to develop more ideas, and then we can do concepts and more ideas, and then 'meet' again and see if we can do one thing together and get a general theme and we are not doing the same thing together."* (video excerpt)

VCS was the preferred method of communication, as, as all participants agreed, it would be more challenging to conduct all these FFE activities asynchronously due to the limited lifespan of the VT project:

> *"You can't just email every two minutes, yeh we've done that, because it would be too distracting"* (Craig, Country A, interview).

The team had their first brainstorming sessions separately in their two subgroups between the two VCS meetings (15:15-15:45) and agreed to exchange their ideas in their second VCS meeting. Brainstorming and ***preliminary idea evaluation*** within the subgroups was based on traditional methods, such as flipchart papers (Figure 1).

Figure 1. Performing brainstorming in the Country A site (photographic data)

In terms of ***idea generation, screening and selection***, we identified three brainstorming sessions throughout the VT lifespan (15:15-15:45, 17:20-19:00 and 21:30-22:45) and a total of 197 generated ideas across the team.

We noticed that the two subgroups followed different approaches to generating concept ideas as part of their idea generation process:

> *"[Country B members] came up with actual products, 2-3 ideas which didn't really work very well […] they only had one idea and then they'd really stick with it and didn't let themselves branch out and think […] outside the box […] we had […] probably 12 we worked with, but initially we had like 40 on post-it notes […] The other team went straight into: Is this going to work? […] they went straight into a product and not the elements of the product."* (Sean, Country A, interview)

In the VCS-mediated environment, linguistic differences influenced the ways in which **ideas were generated, assessed and refined** between the two subgroups. As the Country A participants argued, these challenges slowed down the idea selection process in particular:

> *"I think the language barrier did account for half of it, for example elegance of describing, they weren't able to, it wasn't their first […] because you're conscious of […] you have to speak much slower and use less, simple language to describe it, so normally for me at least, I go quickly through ideas, but then I had to slow down a lot."* (Dylan, Country A, interview)

Nonetheless, the synchronous, the video-enabled character of the VCS used allowed the participants to physically act out how they had envisaged their proposed object to act (Figure 2), thus overcoming these aforementioned linguistic challenges. Here, we saw the participants engage in ***idea selection*** and ***product definition*** by acting out their ideas on the VCS. Given, therefore, that synchronous technologies presented problems during the ***idea generation and evaluation*** activities (i.e. where the participants presented their ideas), preference was later given to asynchronous technologies (i.e. email).

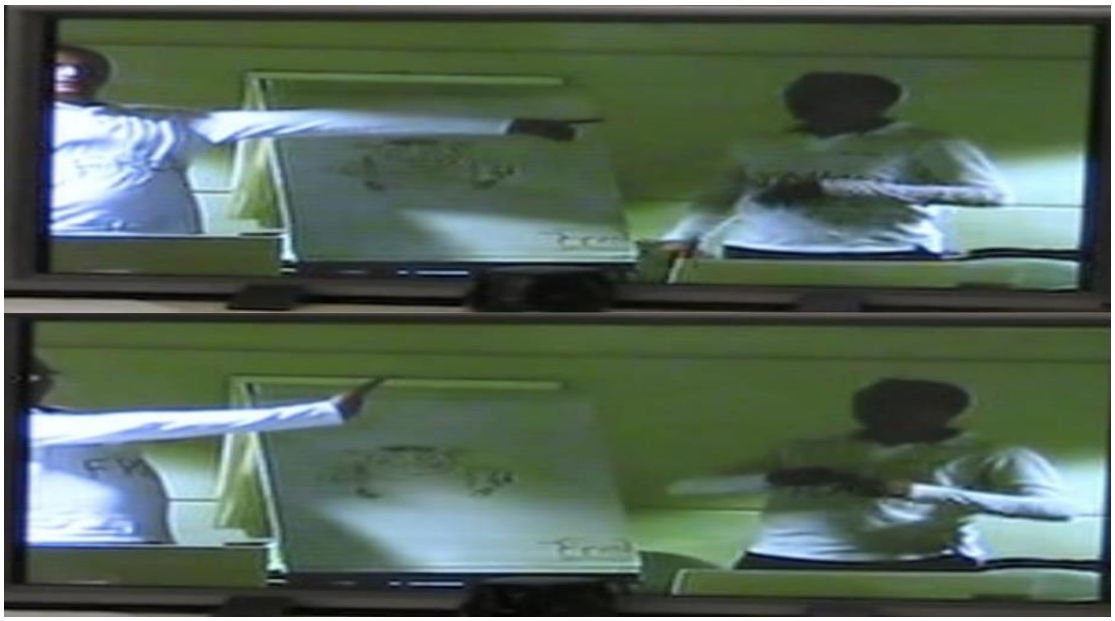

Figure 2. Country B subgroup acting out ideas on the VCS (video screenshot)

Despite the frequent contact on the VCS, geographical dispersion proved troublesome for some of the FFE activities. The heterogeneity of the VT, namely the fact that the Country B participants were all Country B nationals and spoke a different language, created perceptions of distance between the two subgroups during the ***preliminary market assessment and opportunity identification*** phases:

> *"[The Country A subgroup] believe distance is not an actual problem; they think they would be more creative as a team if the other subgroup were in [another city in Country A] instead of Country B."* (logbook notes)

However, we found that the VCS's artificial character inhibited the VT's quality of communication, for example by influencing the participants' spontaneity:

> *"We had to take turns to talk whereas in reality when you have a conversation, people jump in all the time, you sketch, you go around […] turns became more like, about going through an agenda, going through, stating, what we had done, but then not really having a discussion […] it was always from this fixed position […] you could [not] see what they were looking at […] they had one static camera and then they were zooming into the board, and we would miss all their facial expressions […] a lot of the time you have like a moment that comes to you very quickly and you either need to share it quickly or you can forget what you were thinking."* (Dylan, Country A, interview)

Geographical separation between the two subgroups accounted for significant FFE activities (i.e. ***idea evaluation and screening***, ***project planning***) being partially missed:

> *"You come up with a solution, but all the process you've gone through to arrive at that solution, you wouldn't actually share it, and lots of the time that information is more viable, or just as viable as your final solution, because they might have excluded something which we would have included."* (Dylan, Country A, interview)

However, we found that it is this geographical separation, or rather, the lack of direct pressure of the organizers due to their physical presence in the Country B site, that enhanced the spontaneity with which ideas were generated:

> *"Because we were isolated, we had this degree of separation we could be more courageous, and a lot more bold, in our approach and style. And then when they were standing in front of the crowd, they were a lot more conservative. Obviously, their creativity was much more muted, because they were being marked directly."* (Dylan, Country A, interview)

Another issue that influenced ***idea exchange*** between the two subgroups was the multidisciplinary dimension between the two subgroups, which led to different 'languages' being spoken in the VT. This slowed down the overall communication as the team engaged in ***decision-making***, ***idea evaluation*** and ***product definition*** activities:

> *"We came to get our idea across, which was more like a system, it was quite complex and difficult to explain, it was a whole function behind the product. Our culture is quite different to theirs in general. Informing people of waste, maybe they don't do that in Country B and maybe that's why they couldn't quite understand."* (Sean, Country A, interview)

As the hours went by, Country A participants began to voice concerns about the progress made by the Country B subgroup:

> *"Maybe we should let them talk first this time […] Now that we see what we each have… we will develop our ideas further and we will ring you back in two and a half hours and we should then be in a position to take things forward."* (video excerpt)

As the participants reflected later in their interviews, coordination of the different FFE activities proved difficult due to these boundaries of visibility between the two subgroups, to the extent that misunderstandings emerged and work was duplicated. This was particularly evident in the ***product definition*** and ***product strategy formulation*** tasks where the selected ideas had to be digested by both teams:

> *"We'll meet again in two hours' time and by then you might have gone off to a complete tangent, and then you come back and you're like, oh I think WE were doing this."* (Craig, Country A, interview)

Overall, the VT achieved their goals and developed a suitable prototype, as per the assessors' comments. However, large part of the work was done separately by the two subgroups who came together frequently on the VCS where they shared, and built on each other's, ideas:

> *"We were showing them one of my ideas, the time capsule, you flip it round, the sun goes up, and say if you don't recycle or put the rubbish somewhere then the earth is sinking, we didn't realize it would have been better to have one side*

> *half of it and the other side the other half. They had the ideas, you know when people look at your design and have more ideas, at the end they got it but it took like 10 minutes."* (Henry, Country A, interview)

Overall, this team developed an approach whereby the two subgroups would meet frequently, first using the VCS and then mostly by email. Some of the known VT challenges (e.g. geographical dispersion, linguistic differences) were found to influence the VT's coordination and technology choice, and ultimately, reduce uncertainty.

5.2 Case 2 Findings

The FFE activities in this project are positioned mainly within Phases 1 and 2 of the prescribed, four-phase innovation process of this project, though some FFE decisions were also made during Phase 3. In Phase 1, the aim was a ***preliminary market assessment and opportunities' exploration***, and to come up with a vision and the design problem. This would then serve as a basis for the following phases (e.g. idea generation, selection), while getting to know one another and developing trust.

The participants acknowledged the overall fuzziness of Phase 1, and agreed that virtual communication featured as the biggest challenge in relation to the FFE activities that had to be accomplished. Miro—the VT's formally appointed coach—shared a short story highlighting the multidimensionality of the communication-related challenges his team faced in Phase 1. These included the involvement of

different disciplines (i.e. mechanical engineers and industrial designers), different types of training received in different countries, technical difficulties, and language differences:

> *"You have industrial engineers, you have mechanical engineers, and then they have some different schooling systems […] So how to derive a morphological matrix […] And then it comes to some technical detail that somebody might not be familiar with […] Furthermore, you have lag on the connection, you know. And then, all these things just add up… sometimes you have to say things twice. Sometimes some people just won't understand you. Then there's the time, you know, getting everybody to be on VCS at the time you agreed to. The list of complications is really long."* (Miro, Country A, Phase 1, focus group)

Idea generation in terms of new concepts took place in Phase 2 of the project. Our data show evidence that this was done collaboratively at the team level through multiple iterations, typically with one participant pitching an idea and others contributing more ideas to it:

> *"We were able to come up with ideas, let's call it a pool of ideas where everyone just chipped in their ideas and then everyone was benefitting from that. So that was good."* (Jorge, Country A, Phase 2, interview)

Despite the high levels of creativity in terms of generated ideas, this was not without challenges. The technology-mediated character of collaborative work, mainly on the VCS but also elsewhere, coupled with linguistic challenges, rendered it difficult for the participants to make sense of each other's ideas, raising challenges for ***idea screening*** and ***product definition***. As a result, some participants took the initiative to draw up their sketches or to act out their ideas on the VCS in order to make themselves understood:

> *"Some guys would only draw a rough, rough sketch by hand or just in Paint, you know, when they were trying to explain how they imagined it […] a picture is really important […] [Sometimes] I got the main idea, but for some details I wasn't really sure how the other guy imagined it [and] he tried to show me with his hands on the VCS."* (Zagor, Country D, Phase 4, focus group)

We also found that the temporal constraints of the VCS sessions had a positive impact on information exchange during the evaluation of all new product ideas (i.e. ***idea generation***, ***product definition***), as they knew that the VCS was the only opportunity they could all be virtually together as a team during the virtual phases of the project:

> *"When you are in a [F2F] meeting, you know, you are aware of this, so you pay extra attention to what someone is saying. Like, okay, because you know that you are not going to see him in the next hour, and say: Hey let's talk about our morning assignment, I'm thinking now about a new idea. No, there's no time*

> *for that, so when someone is proposing an idea you really concentrate to give as much feedback as possible."* (Jorge, Country A, Phase 2, interview)

On the other hand, time between the biweekly VCS sessions acted as an inhibitor to the idea exchange process:

> *"For me, the biggest issue was that you see the guys at the meetings only once, twice a week […] So if you have an idea, let's say on Monday, and you want to share it, now you have to wait until Wednesday when you have a meeting, you know."* (Zagor, Country D, Phase 4, focus group)

Further to the VCS enabling ***idea exchange***, it was also asynchronous technologies that proved useful, specifically for feedback purposes on ***idea generation and evaluation***:

> *"[Nash] would draw [his ideas] on paper and he would just post them on Huddle, and everyone would comment on that. So, we would make comments, for example why do you have the stop here, why do you have the space there, etc. and that was really good."* (Jorge, Country A, Phase 3, interview)

Further to the VCS and Huddle, the flexibility in terms of technology selection proved also fruitful for ***idea generation*** at the team level:

> *"Another positive thing is the possibility of Skyping on a Sunday evening and getting some ideas across, that's a positive thing."* (Jorge, Country A, Phase 1, focus group)

Once a satisfactory number of ideas had been generated and exchanged, the next task for the team begun to bring those ideas together and eventually test the selected ones (***concept testing***). As the team leader explains, there were different approaches as to how this could be achieved:

> *"Some combined immediately all their ideas together and went straight to the principle solutions, whereas some others said: 'ok right, we're not satisfied enough, we want more'. These went for more brainstorming sessions and went through some crazy ideas."* (Miro, Country A, Phase 2, interview)

Idea selection was the next task for the participants, once all viable ideas had been gathered. The participants in this project were given clear instructions on how each phase should be managed, including methods for idea evaluation and selection, such as the development of morphological matrices and, subsequently, principle solutions:

> *"The further you come in the elaboration of a principle solution into a useful concept, the more important it is to consider the technical feasibility of the solution. You will end up with a concept that is based on the selected principle solution, that is feasible, that is attractive, etc. In this phase not all technical*

> *details will be solved, but you must be sure that they CAN BE solved."* (Document excerpt)

Despite the availability of the above methods—which helped the participants to rate their ideas and select three main concepts that would then be presented to the company members who would then decide on which ideas would be taken forward—unanticipated issues came into play which influenced the decision-making process. In particular, some participants felt that the selected concepts were ineffectively presented to the companies, because of difficulty articulating how these ideas would work in practice:

> *"[The company assessors] saw the idea and they saw what we were talking about, but they couldn't see beyond that. Okay, I give you an idea and I describe it to you, but… I don't think they were able to see how they could develop them further."* (Jorge, Country A, Phase 2, interview)

As the participants moved closer to completion of the FFE, they expressed concerns about the limited time during their ***project planning*** activities, which they would have to produce their prototypes in the F2F environment in Phase 4:

> *"I think the big concern now is just getting things done and hopefully if everything goes to plan then we will have our designs ready for the team. We are really waiting for the designs to come through and actually making the*

product [F2F in Country C in Phase 4] is going to be literally at the last minute when we go to the country." (Maria, Country E, Phase 4, focus group)

Our analysis here has shown that this team faced similar challenges to the previous team (e.g. artificial character of VCS, linguistic differences), yet developed a different approach to coordinating the FFE activities, which was looser, allowing dispersed members to engage in different, complementary aspects of the different FFE tasks.

5.3 Cross-Case Comparison

We identified the following FFE activities in both cases: preliminary market assessment, opportunity identification, idea generation/ refinement/ screening/ evaluation/ exchange, idea selection and concept testing, product strategy formulation, product definition, and project planning. The differences that emerged from our comparative analysis relate to two dimensions—the temporary character of the two teams and the temporal coordination practices that developed in each—and are extrapolated in Table 3.

Table 3. Cross-case analysis

Dimensions	Case 1 (24-hour)	Case 2 (5-month)
Temporary character	• Participants available to work on the project for its whole 24-hour lifespan. • Participants avoided working on other tasks or projects and devoted themselves fully to the project at hand.	• Participants did not work on the project full-time; they juggled numerous commitments outside the project. • Temporal 'luxury' of five months allowed for a flexible use of technologies, but did not soften any of the known VT discontinuities (e.g. temporal, organizational, and cultural).
Coordination (tight vs. loose)	• Completely flexible: no prescribed structure of the project or formally scheduled meetings; participants were free to choose e.g. how to coordinate their activities, how often to use the VCS, and which technology to use. • Most of the work was undertaken in the two geographically dispersed subgroups. They worked separately but got together frequently on the VCS in order to share ideas, discuss, and make important decisions. This type of coordination helped to reduce uncertainty characterizing the FFE.	• In two forms (formally and informally): First, there were the sponsor-prescribed phases which the teams used to coordinate their activities, including mandatory, formally scheduled VCS meetings. Second, participants were encouraged to arrange separate, informal initiatives (e.g. on Skype or asynchronously between two or more members) as they saw fit. • Improved collaboration overall, supplementing formal meetings and enabling a better distribution of the FFE activities and allowing dispersed members to work collaboratively together on complementary aspects of the FFE tasks at hand.

Our comparative analysis pinpoints two dissimilar temporal coordination practices in the two projects: *tight vs. loose* coordination practices. Tight coordination practices are those characterized by tasks being broken down to sub-tasks, specific and narrowed down guidelines, and with short timeframes and frequent deadlines in place. Tight coordination practices were evident In Case 1, where our participants agreed on frequent VCS meetings, due to the extremely short nature of the project. Overall, tight coordination practices point to a *coordinated* team effort for this team, in which the two subgroups conducted large part of the work separately in their subgroups.

In Case 2, however, the participants adopted a more flexible approach whereby temporal coordination was looser. Further to the prescribed bi-weekly VCS meetings, the participants were flexible enough to communicate with their virtual teammates when need be, either synchronously or asynchronously, for example, when ideas emerged by individuals at random times and regardless of others' availability. These are examples of loose coordination practices—defined as a team's flexible approach to technology choice, work distribution and frequency of e-meetings—which we found that work best in situations where there are no significant time pressures. Loose coordination practices in this case led to a more *collaborative* team effort, in which work was completed in a distributed fashion among the dispersed members of the VT.

6. DISCUSSION

The aim of this study was to explore how the temporary character of VTs influences the coordination of FFE activities. In what follows, we present the theoretical and managerial implications of the study.

6.1 Theoretical Implications

We contribute to the information systems field and the VT literature in particular (e.g. Olaisen & Revang, 2017) by showing how the temporary aspects of teamwork influence the development of coordination practices in the VT context, whilst also advancing the literature on FFE of innovation (e.g. Kock et al., 2015; Thanasopon et al., 2016).

Premised on the view that the temporary character of VTs may influence team activities differently in VTs with different lifespans (i.e. one day *vs.* five months), our study has shown that such temporary differences influence the development of temporal coordination. We thus extend literature on temporal coordination (e.g. Massey et al., 2003) by unpacking the role of temporal coordination of FFE activities accomplished in VTs which have the freedom of choice between technologies with varying levels of synchronicity, which is closer to practice. Specifically, two types of temporal coordination practices emerged: tight (Case 1) and loose (Case 2). A limited number of studies (Chen et al., 2014; Massey et al., 2003; Montoya-Weiss et al., 2001) explore how temporal coordination develops in VTs. This literature explains how the enactment of temporal coordination can help to overcome disruptions to VT operations caused by discontinuities (Chudoba et al., 2005) and ultimately lead to

higher performance in asynchronous VTs (e.g. Massey et al., 2003). Our study extends this to VTs with different lifespans, which are not limited to the use of asynchronous technologies. We thus add to this discourse by showing that tight coordination practices lead to a *coordinated* team effort, rather than a *collaborative* one which was evident in Case 2 where loose coordination practices emerged.

These findings relate to the notions of *temporal symmetry* and *temporal complementarity* within the VT context (Im et al., 2005). The two coordination practices that emerged in our study show how symmetry and complementarity play out when coordinating the different FFE tasks in VTs. For example, in Case 1 we saw VT members engage in the same FFE activity simultaneously when the two subgroups conducted their brainstorming sessions at the same time and then converged to share their ideas. In Case 2, however, wherein looser temporal coordination was evident, we witnessed both approaches—temporal symmetry and temporal complementarity—whereby certain participants also engaged in different, complementary aspects of the tasks at hand. Adding therefore to Im et al.'s (2005) study, we argue that depending on the VTs' lifespan and task at hand, VT participants can engage with the same FFE activity simultaneously or in different, complementary aspects of the tasks at hand.

Our findings also advance the FFE literature and indicate that the temporary character of VTs influences significantly their management and organization during the early innovation phases. Echoing prior work that highlights the need for uncertainty-reduction practices in FFE (e.g. Verworn et al., 2008; Takey and Carvalho,

2016), this study confirms that tight coordination practices contribute to the reduction of uncertainty by establishing frequent communication within the VT. Moreover, findings shed light on the most critical challenges that team members have to deal with while engaging in various FFE tasks as well as the impact of temporality on these challenges. Third, this study provides a preliminary view of how different FFE tasks and activities are executed in a virtual setting, in light of the idiosyncrasies that emerge from unique VT characteristics.

6.2 Managerial Implications

Our findings can offer actionable items for VT managers and members. In VTs with short lifespans, VT managers should focus particularly on integrating early diverse team members, especially during the idea generation and screening process, to overcome linguistic, geographical and background-derived barriers. Tight coordination, as enacted in Case 1, was proved useful in terms of reducing uncertainty, but did not allow for high levels of collaboration, which practitioners should incite in their own VTs. In VTs with longer lifespans, VT managers should aim at establishing clear communication norms and protocols as well as select the (synchronous or asynchronous) technologies that will enable a participation of all dispersed practitioners. Loose coordination practices can further allow practitioners to work collaboratively together by concentrating on complementary aspects of the different FFE tasks.

7. CONCLUSION, LIMITATIONS AND DIRECTIONS FOR FUTURE RESEARCH

Motivated by a need to understand how temporary aspects of VTs influence the coordination of the FFE in VTs, our study has shown that the VT lifespan defines how VTs coordinate the different FFE activities. In VTs with short lifespans, tight coordination practices, involving frequent communication and deadlines, help to reduce the uncertainty that is embedded in the FFE of innovation. In VTs with longer lifespans, loose coordination practices, characterized by more time luxury and flexibility, can lead to a more collaborative effort, encouraging participants to work on different, complementary aspects of the FFE task at hand.

Our study has limitations which give rise to directions for future research. As expected in any Industry-Academia project, our participants were primarily students whose motive in participating was to gain some industry experience. Thus, industry-only projects may bring members who have significantly more experience working in similar projects with short timespans. Our study here has looked at the FFE phase in particular; future studies could aim to examine the process of innovation from start to end in the VT context. From a methodological viewpoint, the virtual character of the projects did not allow us to capture equally all activities performed by the geographically dispersed members. Future research could adopt alternative methodologies, e.g. ethnographies allowing researchers to have more hands-on involvement, as well as stronger video methodologies which might help to capture all VT interactions irrespective of the degree of geographical dispersion.

REFERENCES

Ancona, D. G., Okhuysen, G. A., & Perlow, L. A. (2001). Taking time to integrate temporal research. Academy of Management Review, 26, 512-529.

Bakker, R. M., Boroş, S., Kenis, P., & Oerlemans, L. A. (2013). It's only temporary: time frame and the dynamics of creative project teams. *British Journal of Management,* 24, 383-397.

Bakker, R. M., DeFillippi, R. J., Schwab, A., & Sydow, J. (2016). Temporary Organizing: Promises, Processes. Problems, *Organization Studies,* 37, 1703-1719.

Baruch, Y., & Lin, C.-P. (2012). All for one, one for all: Coopetition and virtual team performance. *Technological Forecasting and Social Change,* 79, 1155–1168.

Bertels, H. M., Kleinschmidt, E. J., & Koen, P. A. (2011). Communities of Practice versus Organizational Climate: Which One Matters More to Dispersed Collaboration in the Front End of Innovation? *Journal of Product Innovation Management,* 28, 757-772.

Börjesson, S., Dahlsten, F., & Williander, M. (2006). Innovative scanning experiences from an idea generation project at Volvo Cars. *Technovation,* 26, 775-783.

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology,* 3, 77-101.

Burke, C. M., & Morley, M. J. (2016). On temporary organizations: A review, synthesis and research agenda. *Human relations, 69*, 1235-1258.

Cavaye, A. L. M. (1996). Case study research: a multi-faceted research approach for IS. *Information Systems Journal,* 6, 227–242.

Chamakiotis, P., Dekoninck, E. A., & Panteli, N. (2013). Factors influencing creativity in virtual design teams: An interplay between technology, teams and individuals. *Creativity and Innovation Management,* 22, 265-279.

Chamakiotis, P., & Panteli, N. (2017). Leading the creative process: The case of virtual product design. *New Technology, Work & Employment,* 32, 28-42.

Chen, F., Zhang, L., & Latimer, J. (2014). How much has my co-worker contributed? The impact of anonymity and feedback on social loafing in asynchronous virtual collaboration. *International Journal of Information Management,* 34, 652-659.

Chudoba, K. M., Wynn, E., Lu, M., & Watson-Manheim, M. B. (2005). How virtual are we? Measuring virtuality and understanding its impact in a global organization. *Information Systems Journal*, 15, 279-306.

Colazo, J. A., & Fang, Y. (2010). Following the sun: Temporal dispersion and performance in open source software project teams. *Journal of the Association for Information Systems*, 11, 684-707.

Crisp, C. B., & Jarvenpaa, S. L. (2013). Swift Trust in Global Virtual Teams. *Journal of Personnel Psychology,* 12, 45-56.

Christiansen, J. K., & Gasparin, M. (2016). Managing controversies in the fuzzy front end. *Creativity and Innovation Management*, 25, 500-514.

De Brentani, U., & Reid, S. E. (2012). The fuzzy front-end of discontinuous innovation: Insights for research and management. *Journal of Product Innovation Management*, 29, 70-87.

De Leede, J., Kraan, K. O., Den Hengst, M., & van Hooff, M. L. (2008). Conditions for innovation behaviour of virtual team members: a 'high-road'for internationally dispersed virtual teams. *The Journal of E-working,* 2, 22-46.

van den Ende, J., Frederiksen, L., & Prencipe, A. (2015). The front end of innovation: Organizing search for ideas. *Journal of Product Innovation Management*, 32, 482-487.

Frishammar, J., Florén, H., & Wincent, J. (2011). Beyond managing uncertainty: Insights from studying equivocality in the fuzzy front end of product and process innovation projects. *IEEE Transactions on Engineering Management,* 58, 551-563.

Gibbs, J. L., Sivunen, A., & Boyraz, M. (2017). Investigating the impacts of team type and design on virtual team processes. *Human Resource Management Review*, 27, 590-603.

Gibson, C. B., & Gibbs, J. L. (2006). Unpacking the concept of virtuality: The effects of geographic dispersion, electronic dependence, dynamic structure, and national diversity on team innovation. *Administrative Science Quarterly,* 51, 451-495.

Globocnik, D., & Salomo, S. (2015). Do formal management practices impact the emergence of bootlegging behavior? *Journal of Product Innovation Management,* 32, 505-521.

Halbesleben, J. R., Novicevic, M. M., Harvey, M. G., & Buckley, M. R. (2003). Awareness of temporal complexity in leadership of creativity and innovation: A competency-based model. *The Leadership Quarterly*, 14, 433-454.

Im, H. G., Yates, J., & Orlikowski, W. (2005). Temporal coordination through communication: using genres in a virtual start-up organization. *Information Technology & People,* 18, 89-119.

Khurana, A., & Rosenthal, S. R. (1998). Towards holistic "front ends" in new product development. *Journal of Product Innovation Management,* 15, 57-74.

Kim, J., & Wilemon, D. (2002). Focusing the fuzzy front–end in new product development. *R&D Management,* 32, 269-279.

Kock, A., Heising, W., & Gemünden, H. G. (2015). How Ideation Portfolio Management Influences Front-End Success. *Journal of Product Innovation Management,* 32, 539-555.

Kratzer, J., Leenders, R. T. A. J., & Van Engelen, J. M. (2006). Managing creative team performance in virtual environments: an empirical study in 44 R&D teams. *Technovation,* 26, 42-49.

Manning, S., & Sydow, J. (2007). Transforming creative potential in project networks: How TV movies are produced under network-based control. *Critical Sociology*, 33, 19-42.

Massey, A. P., Montoya-Weiss, M. M., & Hung, Y. T. (2003). Because time matters: Temporal coordination in global virtual project teams. *Journal of Management Information Systems,* 19, 129-155.

Montoya-Weiss, M. M., Massey, A. P., & Song, M. (2001). Getting it together: Temporal coordination and conflict management in global virtual teams. *Academy of Management Journal,* 44, 1251-1262.

Myers, M. D. (2013). *Qualitative research in business and management*. Sage.

Nisula, A. M., & Kianto, A. (2016). Group Climate and Creativity in Temporary Innovation Camp Settings. *Creativity and Innovation Management,* 25, 157-171.

O'Leary, M. B., & Mortensen, M. (2010). Go (con) figure: Subgroups, imbalance, and isolates in geographically dispersed teams. *Organization Science*, *21*, 115-131.

Olaisen, J., & Revang, O. (2017). Working smarter and greener: Collaborative knowledge sharing in virtual global project teams. *International Journal of Information Management,* 37, 1441-1448.

Oliveira, M. G., & Rozenfeld, H. (2010). Integrating technology roadmapping and portfolio management at the front-end of new product development. *Technological Forecasting and Social Change,* 77, 1339-1354.

Oyegoke, A. (2011). The constructive research approach in project management research. *International Journal of Managing Projects in Business,* 4, 573 – 595.

Panteli, N., & Davison, R. M. (2005). The Role of Subgroups in the Communication Patterns of Global Virtual Teams. *IEEE Transactions on Professional Communication*, 48, 191–200.

Peñarroja, V., Orengo, V., Zornoza, A., & Hernández, A. (2013). The effects of virtuality level on task-related collaborative behaviors: The mediating role of team trust. *Computers in Human Behavior,* 29, 967-974.

Salomo, S., Keinschmidt, E. J., & De Brentani, U. (2010). Managing new product development teams in a globally dispersed NPD program. *Journal of Product Innovation Management,* 27, 955-971.

Saunders, C. S., & Ahuja, M. K. (2006). Are all distributed teams the same? Differentiating between temporary and ongoing distributed teams. *Small Group Research*, 37, 662-700.

Shen, Z., Lyytinen, K., & Yoo, Y. (2014). Time and information technology in teams: a review of empirical research and future research directions. *European Journal of Information Systems*, 24, 1-27.

Spieth, P., & Joachim, V. (2017). Reducing front end uncertainties: How organisational characteristics influence the intensity of front end analysis. *Technological Forecasting and Social Change*, 123, 108-119.

Takey, S. M., & Carvalho, M. M. (2016). Fuzzy front end of systemic innovations: A conceptual framework based on a systematic literature review. *Technological Forecasting and Social Change,* 111, 97-109.

Thanasopon, B., Papadopoulos, T., & Vidgen, R. (2016). The role of openness in the fuzzy front-end of service innovation. *Technovation,* 47, 32-46.

Tran, M. K., Goulding, C., & Shiu, E. (2018). The orchestra of ideas: Using music to enhance the 'fuzzy front end' phase of product innovation. *Journal of Business Research,* 85, 504-513.

Verworn, B., Herstatt, C., & Nagahira, A. (2008). The fuzzy front end of Japanese new product development projects: impact on success and differences between incremental and radical projects. *R&D Management,* 38, 1-19.

Watson-Manheim, M. B., Chudoba, K. M., & Crowston, K. (2012). Perceived discontinuities and constructed continuities in virtual work: Discontinuities and continuities in virtual work. *Information Systems Journal,* 22, 29–52.

Yin, R. K. (2008). *Case study research: Design and methods*, Thousand Oaks, CA: Sage Publications, Inc.

Yoo, Y., Boland Jr, R. J., Lyytinen, K., & Majchrzak, A. (2012). Organizing for innovation in the digitized world. *Organization science*, 23*,* 1398-1408.