Exploring the Emergence of Collaborative Practices in Globally Distributed Agile Software Development

Full Paper

Sunila Modi
Brunel University London
Sunila.Modi@brunel.ac.uk

Pamela Abbott
University of Sheffield
p.y.abbott@sheffield.ac.uk

Steve Counsell
Brunel University London
Steve.Counsell@brunel.ac.uk

Abstract

In light of increasing use of agile methods within globally distributed settings, having an appreciation of how collaborative practices and shared understandings are developed has become even more critical. This paper draws on the concepts of boundary objects and Pickering's mangle of practice as combined critical lenses to examine emergent collaborative practices in such contexts. We investigated one longitudinal case within a global financial bank using semi-structured interviews and observations. Our relational analysis demonstrates that collaborative practices within globally distributed contexts tend not to develop from pre-set expectations of how agile practices should work or from pre-set distributed agile processes, but are temporally emergent. Team members have to adapt agile methods through an ongoing process of mutual "tuning" within their situated contexts in order to attain temporary stable periods of effective communication and coordination. The study concludes by proposing a conceptual framework, which could be applied in similar settings.

Keywords

Agile methods, collaborative practices, global software development, boundary objects, mangle of practice

Introduction

Agile methods have significantly altered how software development is practiced within many organizations (Neurer et al., 2005; Dyba & Dingosyr, 2008; Dingsgsoyr et al., 2012). There has been a transition from plan-driven waterfall methods to more flexible, iterative agile methods. Agile methods are popular because they provide flexibility and foster close communication with users. They also minimise risk, since working software is delivered in increments and priorities can be re-evaluated at the end of each cycle. Agile methods were originally intended for collocated environments where the team members could easily communicate and collaborate with each other; the core values are set out in the Agile Manifesto. [1] Underlying the Agile Manifesto are twelve agile principles, which can be seen as recommendations for good practice for agile teams.

More recently, an interesting development has been emerging where agile methods are applied in globally distributed settings. Where software teams are set-up to work on projects at different sites, to address the need for accelerated deadlines in dynamic business environments and reducing expenditure by assigning work to countries with lower labour costs and increasing market proximity (Ramesh et al., 2006; Batra, 2009). A recent survey reported that from 2012 to 2014 the percentage of respondents with geographically distributed teams practicing agile methods had jumped from 35% to 80% (VersionOne 2014). Globally distributed teams have an additional set of challenges usually due to time and space

---

[1] http://agilemanifesto.org/

separation, cultural differences and knowledge gaps; working in a collaborative manner becomes much more difficult or, in some cases, impossible to accomplish. These can be due to a number of different factors for globally distributed team members such as communication misunderstandings, having less knowledge about the business users' contextual environments and having less information about their team counterparts. Although there have been previous studies in globally distributed agile, there has been little research which examines the complexities of developing ongoing collaborative practices and building shared understandings in such settings (Jalali & Wohlin,2012).

In this paper, we adopt a qualitative approach to explore how one globally distributed agile team based in two separate geographical locations faced ongoing challenges and how these were overcome in practice. We seek to unpack and provide insight into this phenomenon and how team members achieve a sense of stability through their complex interactions and how working practices unfold over time. The paper proposes a theoretical framework of a "collaborative tuning approach", which conceptually represents these complexities through interconnecting the theoretical lenses of boundary objects and the mangle of practice. Our research question is: *how does a globally distributed agile team collaborate on an on-going basis to achieve a sense of stability and how can we conceptualize these practices to better understand the underlying issues and challenges the globally distributed agile team faces?* The empirical work is based on an exploratory case study of one large agile globally distributed team, between London and India, within a global financial bank.

In the next section, we provide an overview of the two interlinking theoretical concepts of boundary objects and mangle of practice, which are used as a combined theoretical lens for this study. Next, we outline our methodology and present our findings and analysis of the case through the combined conceptual lens. This is followed by a discussion and conclusion where we argue that our work contributes to existing literature on globally distributed agile teams and present key insights gained from this research.

Theoretical Perspectives

We draw on the concepts of boundary objects (Star and Griesemer 1989) and Pickering's (1995) 'mangle of practice' for our study. We use these two theoretical concepts as a pluralistic conceptual lens for our study as it provides us with deeper insights into how collaborative practices are developed in globally distributed agile settings.

Boundary Objects

At the broadest level, the concept of boundary objects refers to "information vehicles", which are flexible enough to aid communication and interactions across heterogeneous communities. The concept was originally coined by Star and Griesemer (1989) were they are viewed as sufficiently flexible to be adapted to local requirements and constraints of the actors, but they can also helpful when actors are trying to use them across communities. In interpreting Star and Griesemer's work, Wenger (1998) exemplifies boundary objects as "*artefacts, documents, terms, concepts, and other forms of reification around which communities of practice can organise their interconnections*". Carlile (2002, 2004) applied the concept of boundary objects within the area of new product development such that they facilitated in the transfer, translation and transformation of knowledge that exists at boundaries and he proposed a framework for different types of knowledge boundaries. Whilst Levina and Vaast (2005) differentiated between two types of boundary objects: (i) *designated boundary objects,* which are artefacts that are supposed to be valuable in accomplishing boundary interactions due to their design and properties; (ii) *boundary objects-in-use,* which are artefacts that have been actually useful in a joint field of practice. Barrett and Oborn (2010) took a different perspective and examined the role of boundary objects within cross-cultural software teams where boundary objects at one point facilitated collaboration across knowledge boundaries and yet contributed to conflict at other points, which inhibited knowledge sharing. Nicolini et al. (2012, p.614) defined boundary objects "*by their capacity to serve as bridges between intersecting social and cultural worlds...they create the conditions for collaboration while, by way of their interpretive flexibility*". They argued that although boundary objects is a very powerful concept, it has increasingly been stretched to explain "*all types of work performed by material and symbolic entities*" across boundaries. They proposed that a pluralistic approach should be taken, where a number of other theoretical concepts should be used alongside boundary objects to gain a greater insight into cross-

disciplinary collaborative work. According to Vakkayil (2014), the popularity of the boundary objects concept has resulted in the concept being applied over time in various disciplinary fields of inquiry, where studies have focused on different empirical contexts. However, he draws attention to three predominant themes within the literature that focus on the use of boundary objects as: (i) enabling coordination; (ii) aiding knowledge flows and (iii) facilitating differences in collaboration. Next, we turn our attention to the second theoretical concept that we incorporate in our theoretical lens.

Pickering's Concept of Mangle of Practice

The concept of mangle of practice was developed by Andrew Pickering (1995), where he proposed an alternative way to understand scientific practice. According to Pickering, scientific practice should not be explained just as facts or observations, but more from a relational standpoint where a practice unfolds over time and is open-ended. This means moving away from human-centered perspectives on what scientific practice means to examine the relations between human (social) and non-human (technology) agency. Pickering posits that human and material agencies are intertwined and are temporally emergent in ongoing practice, producing a *"mangle of practice"* (Pickering, 1995). The work refers to this intertwining of unanticipated conditions and consequences as an *"intrinsically temporal dance of agency"* (Pickering, 1995, p.21). As the intertwining is a dynamic process, it is seen as *"dialectic of resistance and accommodation"*, where the material agency such as material artefacts and technologies can offer resistance to actors' intentions and destabilize existing practices in unexpected ways. In turn, actors have to accommodate this resistance by revising their goals and by adapting practices.

Before complex interactions take place in real-time emergent practice there is an experience that begins with *"human intentionality"*- in other words, human actors have a plan or goal. Actors do not know if that particular interaction will succeed or not and deliver the expected outcome. The next instance of the interaction may deliver the expected outcome, or not. Actors set their goals to aid the accomplishment of their interaction; however, if they face blockages then these become instances of resistance, and then actors revise their goals or create workarounds – in other words, they are accommodating the resistances. Attempts to accommodate allow actors to diverge into a gradation of new or modified goals or even new areas. Therefore, these interactions between the social and material are always seen as experiments, where a nuanced pattern of resistance and accommodation starts to develop in order to achieve an intended goal. Additionally, Pickering proposes the metaphor of *"tuning"* similar to tuning a car radio to articulate the process through which human and material agencies mutually adapt and thus interactively stabilize over time when actors' goals are aligned (Pickering, 1995). Overall, the mangle of practice places an emphasis on real-time practice as an evolving ongoing emergent process.

Within the IS field, Jones (1998) advanced Pickering's concept to a *"double mangle"* of practice, where he emphasized that given the relationship between IT and contemporary organizational forms we need to examine specific interactions within situated contexts. Jones suggests that within IS there is a *"double mangling"* where *"human actors seek to channel material agency in order to shape the actions of other human actors"*. This double mangle model is emergent in nature, in terms of the dialectic accommodation and resistance between human and material agency, and thus the interactions are explored within the situated social/social and the social/technical context. Previous studies have adopted the concept of mangle of practice in IS studies to examine how materiality of IS emerges and how it is configured and re-configured over time (Chae and Poole, 2005; Orlikowski, 2007; Orlikowski and Scott, 2008; Barrett et al.,2012; and Venters et al.,2014). This paradigm shift in examining the role of social and technological entanglement concurrently within a situated context allows us to acquire a deeper understanding of how collaborative practices develop with globally distributed settings where socio-technical configurations exist, and social and technical interactions are taking place in accomplishing the set goal of software development. This theoretical concept can be used as an analytical tool to examine how collaborative team practices unfold over time within globally distributed settings.

We adopted the theoretical concepts of mangle of practice and boundary objects, as a pluralistic conceptual lens to analyse the collaborative challenges actors face in the joint field of practice within globally distributed agile software development settings.

Research Methodology

A broadly interpretive approach was adopted for this study as guided by Walsham (2006), using one in-depth case study, drawing on extensive interview data and observations to gain richer insights (Jones,2014) into how a globally distributed team developed collaborative practices over time and how they overcame on-going challenges. A longitudinal approach was adopted for the study, which involved spending time with team members, attending and observing various daily and weekly meetings. In addition, time was spent interacting with the team members to understand team dynamics and team culture. The intention of the study was to gain a deeper insight of contemporary distributed agile software development settings. Unpacking and understanding the data from the participants' perspectives required appreciating their views on the challenges they were undergoing in adopting agile methods and how these were overcome.

Project Context

Our study was based in a global bank, with offices in London and India. For this study, we were introduced to a software development team, which was the first team to adopt agile methods within the bank. The team was called the Operational Data Cache (ODC) team and was setup in 2010, its main goal being to develop a real-time backend central database system for all the bank's transactions – one 'golden copy' of the bank's business activities. The project involved connecting all the bank's subsystems and migrating data from the subsystems correctly to the ODC system without any duplication. ODC was core and critical for the bank since a number of the bank's subsystems would rely on its data outputs. The ODC team was setup across the two sites of London and India. The IT infrastructure of the bank was set up so that software teams in London consisted of senior and more experienced personnel who would work closely with the users in gathering the requirements and writing technical specifications. At the start of the project, the senior team members in London comprised the project manager, the business analysts and the senior developers. In India, the team members consisted of junior developers and testers. Since the ODC project was fundamental to the bank, the project held an ongoing backlog of user stories or requirements, which needed to be developed.

Data Collection and Analysis Approach

The data collection was carried out over two years (2012-2014), with 45 interviews carried out across both locations using a semi-structured approach and more than 30 observations of meetings and events collected over the same period. We also conducted a number of repeat interviews with some senior team members over the period in order to examine changes in ongoing collaborative practices and to explore the underlying reasons for perceived challenges. All the interviews were recorded and notes were taken of important and interesting points made by the participants. The research focus was based on Walsham's guidelines (2006, p.325) of conducting interpretive case studies, where he describes a "looser approach" of doing interpretive research. Therefore after each set of interviews, where we would examine the data, reflect and review on what we have learnt, and create a more organised set of themes or issues which we wanted to explore for the next session of interviews. Using this method was beneficial and invaluable in developing the data-theory link later on in the process, and did not bind us to any particular themes; it also allowed us to explore all emerging themes equally. The qualitative data analysis was conducted using thematic analysis (Braun & Clarke, 2006) assisted by Nvivo software. Through the analysis of the interview data and observations, we were able to draw out and present extracts that captured how team members faced and overcame challenges and developed collaborative working patterns in adopting agile practices. The analysis of the case was carried out in two stages, first through the concept of boundary objects and their use by the team members across the two geographical sites. We were then interested in exploring the interplay between: (i) the different actors and (ii) between the actors and technology infrastructure provided to the teams to find out what situations created the challenges and the tensions and how they were overcome? In other words, our research focus progressed from a general interest on how artefacts supported collaboration to a more nuanced understanding of: (1) how those collaborative relationships evolved in the joint field of practice; and (2) how team members' cultivated collaborative relationships in order develop shared understandings around agile practices. Therefore, our second stage of theoretical analysis entailed combining the conceptual lens of boundary objects and mangle of practice.

Case Findings and Analysis

This section of the paper presents the key findings in terms of the aforementioned theoretical concepts. Although the findings are presented under separate headings – see Table 1, they should not be considered in isolation rather, there is interconnectivity and linkage between them, reflecting a more holistic conceptual perspective.

Theoretical concepts	
Boundary Objects	**Mangle of practice**
• Assisting in coordination • Supporting knowledge flows • Enabling collaboration	• Human intentionality • Resistance and accommodation • Temporal emergent patterns • Ongoing process of tuning • Leading to interactive stability

Table 1: Key concepts of boundary objects and mangle of practice

Boundary Objects

Assisting in coordination

One of the important characteristics within this study was that the majority of the coordination activities carried out between the actors onshore and offshore were focused around digital artefacts shared by the actors either through a digital platform or via the use of emails. The ODC team used the JIRA issues tracking tool, a software platform that creates a digitally mediated environment, or in other words an intra-organisation space where all the actors can coordinate their activities easily through this platform. The JIRA platform could be viewed as a digital infrastructure supporting boundary objects, providing real-time visibility. It allowed actors to access a number of tools to create and modify digital artefacts which, through their deployment as a means of coordinating activities between the team members, became "boundary objects-in-use" (Levina and Vaast, 2005) rather than stand-alone artefacts. For example, the team uses the JIRA tool to upload their user stories as issues, which are then modified as the issues become resolved and serve as relational elements to connect team members and coordinate activities between them. This is evident in the following:

"We use JIRA to cache our requirements, so we document what we are doing in the iteration so two-week iterations. I tend to meet with the BA and a few others and we go over the user stories. So we try and have a finite story that has the functional requirements for that piece of work. We use JIRA platform our story requirements so that they are viewable in India and the UK. It tracks the progress in terms of you start work on a story, you work on it, and you complete it." [TM1].

Supporting knowledge flows

At the start of the ODC project, the majority of the senior developers had over ten years' experience in the software development industry, whereas, in India, their counterparts were more junior developers, and were less familiar with the agile approach. The senior developers made a deliberate decision that they did not want to constrain the software development to one site and wanted to disseminate their knowledge beyond the London team members to the India team members as well. The JIRA platform was used to view and access all the user stories across the geographical sites, and they also shared the same code base. Therefore, the ODC team was employing a number of boundary objects to support knowledge flow across London and India. Software code also became a boundary object in-use (Levina and Vaast, 2005) through the practice of being used effectively as a communication tool. The quote below illustrates this:

"We use the code as a way to describe what it's doing. If you structure your code well enough it can describe exactly what it is, it can be a means of a communication mechanism, and it helps support the knowledge flows. Even if you change some code, checking it in the person at the other end of the line reading the code can see what it does from the fact by reading the actual code. So, I think we do value the code as the documentation quite highly as it helps spread the knowledge across the sites" [ODC team, TM2].

Enabling collaboration

The ODC team used a software tool called "Bridget" which allowed screen sharing from their desktop and the use of phones. The team members used this as one of the software tools to enable collaboration between team members across the geographical teams. One of the practices the team adopted was demonstrating the user story before it was passed on to the testing team (QA team). They would conduct these demos using the software tool to the business analyst (BA) and the QA tester. We can see that a number of boundary objects including the user story and the software build are being selected here to enable the collaboration process, as illustrated by:

".. when the developer has finished the story before we allow it to go into test, the developer must demonstrate what they have built and show that it is working and there is nothing obvious that is clearly broken, and these are again are phone call meetings, but with shared screens. So the developer might be based India, the QA might be India based, but the BA is over here [in London] and also there other people who depending on what part of the system it is. We have some people who are the technical lead, so we'd make sure they're involved, and sometimes the project stream managers are also interested in seeing that as well." [TM3].

Mangle of Practice

Drawing on the Pickering's mangle of practice concept, the key findings are presented within the study.

Human Intentionality

The ODC team's goal was to adopt agile methods to provide the detail necessary for an unsettled environment at the bank where priorities could change at any time. They avoided creating upfront requirements specifications, opting instead for capturing requirements by analysing small units of functionality within user stories. This allowed them to be much more responsive to changing requirements and effective in the timely delivery of software iterations. Regardless of the challenges of adopting agile methods in these circumstances, it was still seen as a more advantageous option. From Pickering's perspective, this could be viewed as a long-term intentionality or goal. This quote divulges how the ODC team viewed agile as a way of achieving their outcomes:

"Our project is adopting the 'Agile way of working', we are trying to move away from lots of upfront analysis with a big wordy documents, that we can lob over, and say 'right you get on with that...comeback in a month's time and tell us what you've done about it'. There's no way you want to hold up your progress on developing... If we hadn't adopted this approach, it would have taken a long time before we got the first releases out, at least a year into the project. Whereas under this way of working we got our first version out there in 6 months, so I am sure for this project it was the better thing to do..."[L_SP].

Resistance and Accommodation

When the ODC team was formed, the London team members knew that their India counterparts were more junior and less familiar with the agile approach. Therefore, they decided to try to do pair-programming (P_P) sessions across locations by telephone calls and screen sharing software to develop and share their knowledge. However, the Indian software developers felt a certain sense of ambivalence regarding this agile practice, and it created many instances of resistance and accommodation. The adopted practice was only accommodated for a short time since it could not be sustained for a longer period, due to the friction and resistance it caused at many levels. From Pickering's this practice has a performative aspect - the dynamic interplay of instances of resistance and accommodation where the London team members intended to carry out agile practices across the sites but were thwarted by lack of cooperation and lack of a shared goal from the India site. The following illustrates:

"I'm sure it would benefit those with less experience, but the thing about P_P is that you are supposed to be worrying about stuff together, as you're typing in lines of code, your partner can comment. When you're pairing across locations, someone has already done 5½ hours of work before the other one has come in the office. Then you have a couple of hours of overlap therefore, I don't know how well pairing across a location would work..." [L_SP].

Temporal emergent patterns

Through the entanglement of human and non-human agency across the locations, some of the existing ODC team practices were restructured and temporal working patterns emerged. One agile practice that is important for agile teams are the daily stand-ups meetings or Scrums, since it provides all the team members with a daily update regarding the progress of the project (Schwabwer and Beedle, 2001). These are meant to enable communication, collaboration and reinforce a shared commitment from the team members. Within a distributed environment this becomes challenging due to geographical and temporal distances. When the ODC team was first formed, they started their remote daily stand-up meeting between London and India at 8:00 am (London time) with phone calls on a one-one basis. This then progressed into audio-conference calls where a number of key team members were involved in resolving issues raised by the India team members. Over time, the ODC team have fostered a temporal pattern where they have adapted the daily stand-up meeting to suit the needs of the team and their technological platforms/affordances. As the ODC team matured and team size grew, this temporal pattern evolved and now their daily stand-up takes place at 9:30 am London time with discussions based around user stories on the JIRA platform. Here, the project manager illustrates the main objective of the daily stand up and the importance of his role:

"In the daily meeting, my role is to ensure that I'm on top of the burning issues in any of the blockers on any of the stories, any cross consideration between particular stories where one may be blocking another or that one is dependent on another. If the discussion cannot be resolved, where the guys in India have a question about how they should be doing something… We would do on the back of that checkpoint call, there needs to be a follow-up call at 10 o'clock, once the appropriate London developer is in the office" [L_SC].

Ongoing process of tuning

As the ODC team continually attempts to align with their team members across the sites and with the technological infrastructure, they develop what Pickering refers to as a process of "tuning", where they tune into each other and mutually adjust through technology-mediated practices**.** Their interactions reveal a strong sense of performativity from all actors, human and non-human. For example, when the business analyst in London is trying ensure that the software developer in India is cognizant with the user requirements they introduce a practice called the story huddle. The senior business analyst in London introduced this practice since he was aware that the Indian software developers might not have a full understanding of the business context. This informal process was meant to support other agile practices, in order develop a shared understanding between the developer and tester as to what was required and what were the test criteria for the user story. The practice was a result of "tuning" between the two teams resulting in the development of shared practices that could perform the software development task better. However, the quote below also depicts that the process of tuning is more difficult and is affected by temporal differences:

"When a developer has picked up a story, we have a quick 'story huddle'. A quick 5-minute discussion to make sure we all has a shared understanding of what the story involves and that we are all on the same page. Then the developer can say you might think it was going to be implemented like this…You can make a quick decision if that's viable. This becomes very awkward I think when you have a developer in India and the BA is still in bed, so that has gone by the wayside a bit sometimes…" [L_BA1].

Achieving interactive stability

To achieve interactive stability, each of the processes discussed above eventually leads towards a type of team equilibrium or an interactive stability. The interactive stability is the representation of an ongoing plan. However, it may not be the end goal that was originally intended, and it may be the result of a workaround that the team have created. Pickering describes interactive stability occurring when social and material agencies "*emergently define and sustain each other*" (Pickering, 1995, p.17). In the case, interactive stability occurs through a continuing process, achieved through many frames of resistance and accommodation and through ongoing "tuning". Within the ODC team, a sense of interactive stability was being achieved amidst flux and change when there were snapshots of alignment between team members, as can be seen from this quote:

"Sometimes us fixing the code and then sending them an e-mail and saying that this was what happened and I think this way is better... Whenever they have someone junior or new member coming in they can actually work with them to just to share the knowledge, so between us, we are still communicating. I would actually say because of this, probably this is the best team I've worked with, in terms of partly quality of Indian developers over there" [L_G].

Discussion

The analysis demonstrates that boundary objects are needed to support coordination between the two dispersed teams, contributing to a joint field of practice across knowledge and geographical boundaries (Carlile, 2002, 2004; Levina & Vaast, 2005). Though the analysis identified that boundary objects were able to help in the ongoing collaborative process, it also revealed that in certain situations tensions and negotiations still arose. Our analysis demonstrates that it is as a result of the ongoing interactions with, and transformation of the boundary objects that understanding emerges. These practices take place within the context of social exchanges mediated by technology. The analysis shows that a relational understanding of the social (human) and technical (nonhuman) agencies inherent in these practices and how they are intertwined gives us richer insights as to how this mutual understanding emerges.

Pickering's mangle of practice allows such an analysis to be undertaken and moves the analysis beyond boundary objects facilitating knowledge flows. A relational analysis of the case reveals the following patterns of human/technical agency. The ODC team had the initial intention of adopting agile methods, though the team had to undergo several multiple occurrences of resistances and accommodations between the actors (social/social agencies) and between the actors and the technology (social/technological agencies) in order to achieve this goal. The technology could block a path and create resistance in achieving a goal, therefore the team members would need to explore and respond with workarounds or accommodations in order to accomplish their long-term goal. Within this case, a number of different factors caused these frames of resistances and accommodations namely: the technology, temporal differences, geographical distances and knowledge-based differences between the London and India team members. The case revealed for example, that whilst the pair–programming practice at a distance was being accommodated for a short period, it could not be eventually sustained for a long period time because of the number of resistances being faced by the team members. However, the initial long-term intention or goal of adopting agile methods through various collaborative practices was still intact, though alternative approaches needed to be considered, which would lead the team towards a sense of interactive stability.

Eventually, these processes lead to transformed practices, or "mangled" practices, since they are a consequence of the resistance and accommodation being made to both human and non-human practices. Through these transformations, new temporal patterns were created, they essentially represent hybrid practices that are not planned or known of in advance but are a result of the enactment of these transformed practices. This whole process is what Pickering refers to as mutual "tuning" which occurs between the human actors and technology, and also between technology-mediated human actors (double mangle).

This research resonates with Barrett et al.'s (2012) study, which proposes multiple modes of entanglement leading to various forms of interactive stability. Building on this perspective and taking it a step further, we propose a combined conceptual framework, which we have called "Collaborative Tuning" framework, which would allow researchers to examine the on-going collaborative practices of agile teams within globally distributed settings, see Figure 1 below. The Figure illustrates that four interactive and interdependent processes are co-occurring in a globally distributed agile team environment, viz.: human intentionality, resistance and accommodation, emergence of temporal patterns and ongoing processes of tuning where boundary objects (B.O. in the diagram) are integral to the functioning of these processes. The engagement of human and non-human actors in these processes leads over time to periods of interactive stability in which common, shared understanding can be achieved and hybrid agile practices can be adopted that work for that team in their particular work situations. It is through these periods of interactive stability that practices emerge as effective and useful and not through long-term planning. The tenets of agile methodologies can still be realised even within the context of dispersion, boundary issues and other coordination and communication problems related to globally distributed work.
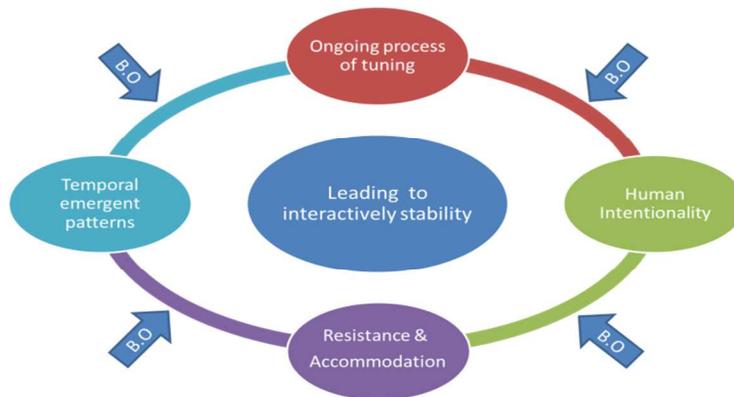
Figure 1: Collaborative Tuning Framework

Conclusion

Developing collaborative practices in a globally distributed environment is a complex and challenging process. We have argued that using a pluralistic conceptual framework offers us deeper insights and contributes from a practical standpoint. These practical insights are demonstrated in Table 2.

Practical insights into collaboration in globally distributed agile teams.	
Potential benefits	**Potential difficulties**
• Notion of a single team even with individual team members in different geographies. • Sharing a common purpose can "add value" to the organizational strategy by providing a more integrated and coordinated approach. • Can provide a collective focus and empower the team member to be more agile. • Increasing collaborative practices and informal communication can create empathy between the team members across locations. • Can increase the capability and knowledge base shared across locations. • Mutual support can be increased and team members can solicit their views without hesitancy. • Can help reduce risks and uncertainty when developing new and untested projects. • Could potentially provide financial savings to organisation. • Potentially the quality of the overall software developed can be improved.	• Managing greater collaborative practices across locations can potentially escalate the cost of software development. • Sustaining joint rather than separate team practices can be more time consuming. • Team members may face other external constraints that can affect collaborative practices. • Collaborative practices can create initial tensions between the team members. • Issues of power imbalance within the team can arise. • Coupling of tasks has to be considered and managed. • Coordination issues across the locations have to be resolved, so that collaborative practices can take place easily. • There is a period of uncertainty while new practices are developing. • Team leadership behaviour has to be modified to accommodate collaborative practices.

Table 2: Potential benefits and difficulties of developing collaborative practices

Although our study is based on a single longitudinal case study, our relational analysis highlights building collaborative practices is an ongoing and dynamic where the entanglement of social and technological configurations is essential to the forming of those practices. Our contributions from a practical perspective provide practitioners with critical insights into how one globally distributed agile team's collaborative practices were not pre-given but how they emerged through practice. From a theoretical perspective, the study offers researchers a unique insightful conceptual framework – "Collaborative Tuning" consisting of four interactive mutually dependent processes which be applied to further studies to shed more light on the complex and dynamic process of developing and maintain collaborative relationships within such contexts.

REFERENCES

Barrett, M., & Oborn, E. 2010. "Boundary object use in cross-cultural software development teams", *Human Relations*, *63*(8), pp.1199–1221

Barrett, M., Oborn, E., Orlikowski, W. J., & Yates, J. 2012. "Reconfiguring Boundary Relations: Robotic Innovations in Pharmacy Work", *Organization Science*, *23*(5), pp. 1448–1466.

Batra, D., & Dinesh. 2009. "Modified agile practices for outsourced software projects", *Communications of the ACM*, *52*(9), pp.143.

Braun, V., & Clarke, V. 2006. "Using thematic analysis in psychology," *Qualitative Research in Psychology*, *3*(2), pp.77–101

Carlile, P.R. 2002. "A Pragmatic View of Knowledge and Boundaries: Boundary Objects in New Product Development," *Organization Science*, *13*(4), pp. 442–455.

Carlile,P.R. 2004. "Transferring, Translating, and Transforming: An Integrative Framework for Managing Knowledge across Boundaries", *Organization Science*, *15*(5), pp.555–568.

Chae, B. & M. S. Poole. 2005. "Surface of emergence in systems development," *European Journal of Information Systems* 14: pp.19-36.

Dingsøyr, T., Nerur, S., Balijepally, V., & Moe, N. B. 2012. "A decade of agile methodologies: Towards explaining agile software development", *Journal of Systems and Software*, *85*(6), pp.1213–1221.

Dybå, T., & Dingsøyr, T. 2008. "Empirical studies of agile software development: A systematic review", *Information and Software Technology*, pp. *50*(9–10), pp. 833–859.

Jalali, S. & Wohlin, C. 2012, .Global software engineering and agile practices: a systematic review. Journal Software. Evolution. and Process. 24: pp. 643–659.

Jones, M., 1998. "Information Systems and the Double Mangle: Steering a course between the scylla of embedded structure and the charybdis of strong symmetry". in *Proceedings Information Systems: Current Issues and Future Challenges, Working Conference* (within WG 8.6), Helsinki, Finland.

Jones, M, .2014. Researching Organizations-The Practice of Organizational Fieldwork, London. Sage.

Levina, N.,&Vaast, E. 2005. "The Emergence of Boundary Spanning Competence in Practice: Implications for Implementation and Use of Information Systems". *MIS Quarterly, 29*(2), pp.335-363.

Nerur,S., Mahapatra, R., & Mangalaraj, G. 2005. "Challenges of migrating to agile methodologies. *Communications of the ACM*", *48*(5), 72–78.

Nicolini, D.,Mengis,J,& Swan,J.2012. "Understanding the Role of Objects in Cross-Disciplinary Collaboration. *Organization Science*", *23*(3), 612–629.

Orlikowski, W. J. 2007. "Sociomaterial Practices: Exploring Technology at Work". *Organization Studies*, *28*(9), 1435–1448.

Orlikowski, W. J., & Scott, S. V. 2008. "Sociomateriality: Challenging the Separation of Technology, Work and Organization." *The Academy of Management Annals*, *2*(1), 433–474.

Pickering, A. 1995. *The mangle of practice: Time, agency and science*. Chicago, IL: University of Chicago Press.

Ramesh, B., Cao, L., Mohan, K., & Xu, P. 2006. "Can distributed software development be agile?" *Communications of the ACM*, *49*(10), p. 41.

Schwaber, K., & Beedle, M. 2001. *Agile Software Development with SCRUM* (1st ed.). Prentice Hall.

Star,S.L.,& Griesemer,J.R. 1989. "Institutional Ecology, `Translations' and Boundary Objects: Amateurs and Professionals in Berkeley's Museum of Vertebrate Zoology," *Social Studies of Science*, *19*(3), pp.387–420.

Vakkayil J. 2014.Boundary Objects in *Boundary-spanning in Organizations: Network, Influence, and Conflict,* (Eds) by Janice Langan-Fox and Cary L. Cooper, Routledge, London, Chapter 2, pp.29-43

Venters, W, Oborn, E. and Barrett, M. 2014 "A trichordal temporal approach to digital coordination: the sociomaterial mangling of the CERN grid". MIS Quarterly: Management Information Systems, 38 (3). pp. 927-949.

VersionOne,2014."9th Annual State of Agile™ Survey Results", available at: www.versionone.com/pdf/state-of-agile-development-survey-ninth.pdf (accessed 1st February 2017).

Walsham, G. 2006. "Doing interpretive research". *European Journal of Information Systems*, *15*(3), pp.320–330.

Wenger E. 1998 *Communities of Practice: Learning Meaning and Identity* Cambridge University Press, Cambridge, U.K