How Can Agile Practices Minimize Global Software Development Co-ordination Challenges?

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Abstract. Project stakeholder distribution in Global Software Development (GSD) projects causes significant project communication, coordination and collaboration challenges. There is a growing interest in applying agile practices in GSD projects in order to leverage the advantages of both approaches; in some cases, GSD project managers use agile practices to reduce project distribution challenges. We use an existing coordination framework to identify GSD coordination problems due to temporal, geographical and socio-cultural distance. An industry-based case study is used to describe, explore and explain how the use of agile practices reduces various challenges that impact GSD coordination. For example, our case study findings reveal that the agile practice “Daily Scrum meetings” with distributed project stakeholder participation through video-conferencing helped to reduce challenges related to GSD coordination. We conclude with comments on future research.

Keywords: Agile, Global Software Development, Coordinating mechanisms

1 Introduction

Rapid advances in computer networks, telecommunications and internet technologies have provided an infrastructure that supports Global Software Development (GSD) as a new development paradigm. GSD has gained significant popularity; it is promoted as a means of reducing time to market, increasing productivity, improving quality and gaining cost effectiveness and efficiency [1]. Despite the expected benefits of GSD, there are a number of challenges in practice [2]. In particular, GSD is normally characterized by stakeholders with different national and organizational cultures, located in separate geographic locations and time zones, using information and
communication technologies to collaborate. Such conditions create major challenges related to team communication, coordination, control, infrastructure incompatibility, conflicting expectations, and difficulty in building trust [3]. Thus, a GSD project manager needs a number of strategies to assist in managing such a project.

Agile Software Development (ASD) has gained significant popularity because it promises to handle requirements changes throughout the development life cycle, promotes extensive collaboration between customers and developers, and supports early and frequent delivery of a product [5]. A major reason for the success of agile methods is the development team members’ physical collocation [5]. Some project managers are however, using agile practices to minimize GSD challenges [9-11], even though researchers note that agile practices are difficult to scale up to support distributed arrangements [6]. Although project stakeholder distribution creates challenges to using agile practices, we found some instances of success in the literature when agile practices were used with distributed teams [7].

However, current research provides limited evidence of the effective use of agile practices in minimizing challenges of GSD processes. To address this research gap, our research focuses on GSD coordination processes. To understand GSD coordination difficulties, we use an existing widely known coordination framework called the Mintzberg work coordination framework [14]. In addition we conduct an industry-based GSD case study in order to investigate the impact of using agile practices to reduce coordination difficulties. We suggest that the results of using a framework-based case study will contribute to the body of knowledge regarding the usefulness of agile practices in minimizing challenges that impact GSD coordination.

We begin by providing the background to our research and our motivation. Section 3 briefly discusses coordination processes in software development. This section also presents the Mintzberg framework [14] and provides a summary of the challenges that impact on GSD coordination processes. We then describe our research methodology in section 4. In section 5 we present the results from our industry case study. Section 6 discusses the limitations of the case study. We conclude with section 7, which discusses future research.

2 Background and Motivation

In this section, we briefly discuss agile approaches in GSD and summarize the effectiveness of agile practices in reducing GSD challenges based on existing research.

2.1 Agile Approaches in GSD

Though both ASD and GSD appear to share several objectives such as reduced delivery time and cost, and increased quality, there are certain differences that are expected to pose serious problems in any effort to introduce agile practices in distributed teams. For example, agile methods emphasize frequent interaction and communication within collocated teams and pay less attention to upfront detailed design and heavy documentation [5]. Hence the agile community advocates the importance of close proximity and relationships between development team members, continuously turning-out working software, customer-developer collaboration, and
quick response to requirements changes [1]. Such agile method requirements are difficult to satisfy in a geographically distributed project. Despite apparent significant differences between the fundamental principles of agile development and GSD methods, there is a growing interest in assessing the viability of using agile practices for GSD projects [7]. Our literature review shows that careful use of agile practices in a globally distributed project can provide a number of benefits including increased project communication, improved project management, improved productivity, increased trust, increased team motivation, increased project visibility, increased team morale, improved knowledge sharing, and improved customer focus etc [33].

2.2 Prior Research

Communication, coordination, and collaboration processes are at the heart of much software development [10]. Temporal, geographical and socio-cultural distances can make GSD communication, coordination and control processes difficult [15] and research is needed to provide strategies to deal with these challenges [3]. Some project managers have attempted to use agile practices to reduce project stakeholder distribution challenges that impact on GSD communication, coordination and collaboration processes [23]. Xiaohu [5] mentions that the use of agile practices can minimize GSD communication delays and increase communication quality. Holmstrom et al [3] claim that using agile practices enhances project communication and, as a consequence reduces project distances. Mak and Krutchen [10] claim that agile practices improve the efficiency and quality of task coordination by encouraging frequent, lightweight informal communication in addition to formal communication. Holmstrom et al [3] note that the main challenge of a GSD project is to maintain good communication, and that, the careful incorporation of some agile practices can enhance project communication and reduce GSD challenges that impact communication, coordination and control processes. Despite this evidence, there is no clear description or understanding of how the use of agile practices can reduce the challenges that impact GSD processes. To address this current GSD research challenge, the broad objective of our research is to explore how the effective use of agile practices can reduce challenges that impact on GSD coordination processes.

3. Coordination

Coordination is considered to be a key organizational activity in any software development. A traditional co-located software development team usually builds up the coordination of their different tasks in a number of ways. A highly idealized traditional co-located development team has a shared view of work processes and coordination is achieved either because of shared defined processes, or by acquiring a common set of habits and vocabulary over time [12]. Herbsleb [12] suggests that through frequent formal and informal interactions, co-located team members have a clear idea of who has what sort of expertise, and how responsibilities are allocated throughout the development team. The development team uses informal communication along with formal instructions throughout the development process. But geographical, temporal and socio-cultural distances make GSD communication, coordination and control process difficult and they require more development time.
than their co-located development counterpart [13, 15]. Herbsleb et al [13] comment that a distributed environment changes the communication context away from an ideal face-to-face setting to a more complex technology-mediated environment. Therefore, a fundamental GSD problem is that many of the mechanisms that function to coordinate work in a co-located setting are absent or disrupted [12].

3.1 Coordination Framework

In this section we will discuss a work coordination framework considered to be stable and flexible enough to describe coordination issues; this is the widely known Mintzberg work coordination model. Mintzberg [14] argues that there are three basic coordinating mechanisms that describe the fundamental ways in which organizations coordinate their work. These are:

- **Mutual adjustment:** Mutual adjustment ensures that a software development project can achieve a suitable degree of coordination by the simple process of informal communication among project stakeholders. For example, work can be coordinated when two software developers informally discuss a particular task.

- **Direct supervision:** With direct supervision, coordination can be achieved through one person issuing orders and instructions to several other people whose work is interrelated. For example, when a team leader tells other team members what is to be done, one step at a time.

- **Standardization:** Standardization can be categorized as coordination by programme, where coordination is effected through instructions and plans generated beforehand [26]. Mintzberg [14] notes that there are four types of standardization: 1) work processes, 2) output, 3) skills (as well as knowledge) and 4) norms. Work process standards usually specify how development team members carry out their interrelated tasks. Standardization of output usually specifies the expected results for various development tasks. Standardization of skills ensures that the team has a set of skills that are enough to carry out the development tasks. Standardization of norms, within a software development project, ensures that everyone functions according to the same set of organizational beliefs.

3.2 GSD Coordinating Mechanism Implications

Herbsleb [12] argues that regardless of the project context or method used, a GSD project suffers a number of challenges related to work coordination. To investigate the impact of GSD project stakeholder distribution on the different coordinating mechanisms, we review a number of GSD projects from the literature. In Table 1 we summarize the key challenges due to the temporal, geographical and socio-cultural distances while using the three different coordinating mechanisms, standardization, direct supervision and mutual adjustment. In this table, for simplicity, we note the problem encountered, even though project context, for example, size, number of distributed teams, complexity, criticality, and project domain etc., can further exacerbate the difficulties encountered. In a later section, we discuss how the use of agile practices can reduce the major difficulties identified.
4. Research Methodology

In this section, we report on the findings of an industry-based exploratory case study that used some agile practices in a globally distributed project. The case study is considered a robust research method with a range of appropriate data collection approaches when a holistic in-depth investigation of a social phenomenon in its real life context is required [24]. To carry out our case study we carefully followed the guidelines suggested in [27]. In this research, we do not provide formal hypothesis testing or draw any general conclusions as GSD has many forms depending on project contextual factors (for example: size, collaboration modes, number of teams etc.). However, in our case study, we consider the research question, “how can the effective use of agile practices reduce coordination challenges in GSD?” The findings of this

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<th>Temporal Distance</th>
<th>Standardization</th>
<th>Direct Supervision</th>
<th>Mutual Adjustment</th>
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<td></td>
<td>Management of project artifacts may be subject to delays [15]</td>
<td>Reduced opportunities for synchronous communication [3, 15]</td>
<td>Reduced opportunities for synchronous communication [11,15]</td>
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<td>Lack of standardization of: definitions, common tools, norms, work process and practices [17]</td>
<td>Lack of transparency as work not visible to manager [16]</td>
<td>Lack of shared understanding, reduced trust [16,18]</td>
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<td>Lack of standardization of artifacts [17]</td>
<td>Difficulty in conveying vision and strategy [15]</td>
<td>Reduced informal contact due to difficulties of face to face meeting [15]</td>
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<td>Reduced trust because of: disparity in work practices, outputs, skills and norms [20]</td>
<td>Management coordination overhead [3,11,18]</td>
<td>Difficulty in establishing a feeling of trust and belonging [3, 17,19]</td>
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<th>Socio-cultural Distance</th>
<th>Standardization</th>
<th>Direct Supervision</th>
<th>Mutual Adjustment</th>
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<td>Lack of shared understanding [9]</td>
<td>Problems with project managers in adapting to distributed team norms and work culture [9]</td>
<td>Lack of shared understanding, reduced trust [22,23]</td>
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Table 1. Key Challenges for using coordinating mechanisms in GSD

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<td>Reduced opportunities for synchronous communication [3, 15]</td>
<td>Coordination complexity/breakdown due to reduced time overlap [11,15-16]</td>
<td>Lack of transparency as work not visible to manager [16]</td>
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single case study can help provide some understanding of the effectiveness of the agile practices used in reducing coordination problems in GSD.

Our primary data collection method was the interview, supplemented by a review of relevant project documentation, onsite demonstrations of the software and informal conversation. We performed two face-to-face interviews (one with a project manager and one with an actively involved customer); each interview lasted about two hours. We provided our interviewees with a brief research outline before the interview sessions. We asked our respondents about the facts of the matter, as well as gaining their opinions about the events that occurred. Project artifacts, such as documentation, are also used as an important data source. The system specifications, the project plans, testing scripts and the completed software were made available to the researchers. Documentary information was also used to corroborate and augment evidence found from the interviews and discussions that focused on the use of agile practices in reducing coordination challenges. A qualitative content analysis technique was used to identify the agile practices in the interview data that helped to reduce the challenges related to GSD coordination. This data analysis was done by the key author who coded both interviews, and developed separate codes for each of the practices. In this data analysis, our aim was to identify, describe and make sense of how agile practices were used to reduce the challenges that impacted the GSD coordination processes. To improve the quality of our interpretation, we reported our initial findings back to both the customer and project manager. They then provided feedback to identify omissions and rectify misunderstandings in our analysis.

4.1 Project Description

This section describes the development project. The organization, individuals and product developed are referred to by fictitious names in order to maintain the anonymity of the organizations concerned. “Alpha” is an Australian-based software development company that develops a range of software products using agile software development methodologies. For some time the company has had developers in Australia and Malaysia. The project we investigated is “Alpha-Global”. It is a service-based graphical software engineering tool that will be commercially used with external customers and developed by a distributed team. The project was relatively stable as regards requirements changes although there were a several initial changes due to very complex graphical requirements.

4.2 Team Description

The project involved a team that was distributed in two countries Australia and Malaysia. The customer was based in Australia and was actively involved in the development. The project manager was also based in Sydney. The Sydney team consisted of two full time developers and one part time test engineer. The Malaysian operation involved around 25 developers with one local development lead. The number of developers in the Malaysian site varied during the course of the project and though usually 3-5 developers were involved throughout. The engagement of the Malaysian developers varied. They were mostly involved in back end development work, while the Sydney developers implemented the user interfaces. The Malaysian
developers work was assigned based on skills and availability, as they were also involved in several other projects at the same time. All the project team members had previous distributed project development experience although this project was their first experience of using agile approaches in a distributed setting.

As the project stakeholders were distributed in Australia and Malaysia, the project involved geographical, temporal and socio-cultural distances. There was a two hours time difference (three hours in summer) between Sydney and Malaysia; hence we can argue that the project had a low temporal distance. Again, Malaysia and Australia are relatively closely located and there are convenient air links and regular flights between the two countries. Thus considering the ease and time of travel but a necessity for visas and permits, we can argue that the project had a moderate geographical distance. To understand the socio-cultural distances involved in the project we used Hofstede’s [28] definitions of cultural dimensions for Australia and Malaysia to identify national cultural differences. Hofstede’s study provides an index of power distance, individualism, masculinity, and uncertainty avoidance. The index range varies from 1-120. Based on this index we found the power distance and individualism are significantly different in the two countries and there are also some differences in masculinity and uncertainty avoidance. Thus we can claim that the project involved significant socio-cultural distances.

5. Result

Despite the project being developed in distributed locations, both customer and company considered the project was successful and it was delivered on time and within budget. In this GSD project, the project manager did not use any entire agile methodology rather he chose some XP practices for development and some Scrum practices to help with project management. In the following sections, we will discuss how the use of these agile practices helped to reduce the challenges impacting the GSD coordination processes. We discuss our case study findings based on Table 1 (which summarizes challenges that impact the coordination mechanisms, standardization, direct supervision and mutual adjustment in GSD projects).

**Standardization:** The use of the coordinating mechanism “standardization” is seriously affected by GSD project temporal, geographical and socio-cultural distances. GSD project temporal distance reduces overlapping work hours and synchronous communication between distributed teams. Thus, because of temporal distance, project stakeholders may misunderstand distributed team work processes, norms, practices and tools [15-17]. Geographical distance may also impact on the management of standard project artifacts and may reduce trust and commitment. Geographical distance can also create conflict if different teams have different standards for work processes, norms, skills and outputs. Socio-cultural distance may also poses challenges by introducing misunderstandings, misinterpretation of project standards desired by the project manager, and this may lead task conflicts and lack of shared understanding among distributed project stakeholders [7, 9-12]. Hence from the literature we conclude that maintaining a common standard definition of work process, skills, norms and outputs is difficult in a GSD project due to the project stakeholder’s distribution. However, our case study findings reveal that some of the
agile practices helped distributed project stakeholders to maintain a common set of standards throughout the development. These were:

- **The “Sprint planning meeting”** which provided close interaction among distributed project stakeholders that helped to minimize misunderstanding and misinterpretations about project standards.
- **“Retrospective meeting”** scheduled to assess teamwork in the completed sprints, helped to maintain a shared understanding of different project standards among distributed project stakeholders.
- **“Coding standards”** provided coding rules which were followed by both distributed teams; this also helped maintain common standards.
- **“Test Driven Development (TDD)”** also helped to maintain a shared standard development view, as a better understanding of what functionality was required from the client perspective was facilitated.
- **“Refactoring”** which restructures the system by removing duplication, improving communication, simplifying and adding flexibility, provided both teams with a better understanding of the project outputs.

**Direct Supervision:** The use of the coordinating mechanism “direct supervision” is also affected by GSD temporal, geographical and socio-cultural distances. Temporal distance reduces opportunities for synchronous communication and increases coordination overhead (for example: a project manager cannot provide urgent instructions) [3, 11, 15-16]. Geographical distance may also limit frequent visits to distributed team sites by the project manager. Thus it may be difficult to convey project vision and strategy to distributed sites [15]. Geographical distance also creates coordination overhead and project managers are heavily reliant on different tools for project coordination [3, 11, 15, 18]. Socio-cultural distances may also add some extra challenges to the direct supervision coordinating mechanism. The differences in work culture may introduce different expectations regarding leadership practices, frames of reference, different perceptions of authority/hierarchy, and norms etc [9, 11, 20]. Our case study findings also reveal that some agile practices can help to minimize challenges that impact on the use of the coordinating mechanism “direct supervision”.

These were:

- The agile practice **“Daily standup meetings”** with participation by distributed team members helped to minimize the possibility of coordination breakdown caused by temporal and geographical distance. In these meetings the project team members were informed what had been done thus far, and what needed to be done; any existing problems were also covered in these meetings. The meetings also helped to minimize some socio-cultural issues such as different perceptions of authority/hierarchy, different frames of references etc., and also conveyed vision and strategies to the project stakeholders as well as the development teams.
- **“Sprint review meeting”** attended by the project stakeholders increased project visibility and transparency and helped the project manager with more efficient project supervision.

**Mutual Adjustment:** Reduced opportunities for synchronous communication due to temporal distance may impact on the use of the coordinating mechanism “mutual adjustment” in GSD projects. Temporal distance may introduce response delay [15], and as a result, project stakeholders may misunderstand and become confused [2-3,
Geographical distance may also limit face-to-face meetings; thus distributed project stakeholder communication is dependent on tools and team members feel a lack of “teamness” [3, 17, 19]. In addition, socio-cultural distances may create difficulties in information exchange [21] which creates barriers to building mutual understanding among distributed team members [23]. As a result, project stakeholders suffer misunderstandings, miscommunication and confusion [15] which ultimately reduces trust and commitment, and increases fear in distributed team members [23]. Our case study findings reveal that some agile practices helped to reduce the challenges of using the coordinating mechanism “mutual adjustment”. These were:

- The “Daily standup meetings” with participation by both sites provided the opportunity to establish mutual adjustment and build trust and “teamness” between the Sydney and Malaysian teams.
- The “Sprint planning meeting” with participation by all team members reduced misunderstandings and confusion among project stakeholders through collaboration and helped to build mutual adjustment.
- The “Sprint review meeting” attended by project stakeholders also helped to increase project communication and build relationships.
- “Retrospective meeting” scheduled to assess the teamwork in completed sprints also helped to build mutual understanding among distributed project stakeholders including the business user.
- “Code refactoring” restructured the system by removing duplication, and facilitated improved communication and better understanding among distributed team members by providing communication through the coding environment.

6. Case Study Limitations

The design of this case study is based upon the four criteria for judging the quality of research design recommended by Yin [24]. Construct validity, which involves establishing correct operational measures for the concepts being studied, was not a limitation in our study. We developed a sufficient operational set of measures for collecting data. As our case study is exploratory in nature, not explanatory or causal, we need not consider internal validity. Our study is also not concerned with external validity as our study findings are not generalized to other GSD projects. Our single case study initiates an exploration of the use of agile strategies in a GSD project. In this case study, we must consider reliability; data was collected based on the challenges identified in the literature that impact the coordinating mechanisms, standardization, direct supervision and mutual adjustment due to project stakeholder distribution. However we cannot exclude bias on the part of our interviewees who reported what they thought happened. However, we did use multiple sources of evidence (documentation, discussion, interaction etc) to help us ensure sufficient reliability.

7. Conclusions and Future Research
Our initial case findings reveal that the use of some agile practices did help to reduce some of the challenges that impact GSD coordination. In particular we found that:

- The “Daily stand up meeting” with participation by both the Sydney and Malaysian team members helped to minimize some of the challenges that impact on the use of the coordinating mechanisms direct supervision and mutual adjustment. Project coordination overhead was minimized as the project manager, who could discuss with both teams what had been done, and what needed to be done; existing problems were also covered. Daily stand up meetings with the aid of video conferencing facilitates a synchronous communication environment and helps to build mutual understanding among distributed project stakeholders.

- Similarly, the “Sprint planning meetings” and “Retrospective meetings” with participation by distributed project stakeholders helped to maintain project standards, and better project coordination; communication among project stakeholders was also facilitated.

- The practice “Sprint review meeting” attended by both site team members also helped to increase project visibility and helped the project manager to minimize the challenges impacting on using the coordinating mechanisms “direct supervision” and “mutual adjustment”.

- The practices “Test driven development”, “Coding standards”, and “Refactoring” also helped to maintain project standards and increased project communication as these practices usually support communication through the code.

Our research provides only a single case study and we cannot generalize our findings over all GSD projects as GSD takes many forms based on different project contextual factors (for example complexity, size, time zone differences, number of distributed teams, staff experience, etc.). A series of case studies can however, provide insight into the use of agile practices that help to reduce the challenges that impact on GSD coordination processes. We plan to carry out a set of case studies that will start to develop a body of knowledge to help identify effective agile practices able to minimize GSD work coordination challenges. In addition to case studies we also plan to carry out a detailed survey among experienced GSD project managers. This will allow us to investigate the effectiveness of agile practices in reducing the challenges that impact on GSD coordination. Our survey will mainly focus on the use of XP and Scrum practices. We will also investigate several important project contextual factors to identify the context of GSD projects able to take advantage of agile practices. Hence we expect our research will contribute to answering one current GSD research issue: “which agile practices will be effective to minimize project stakeholder distribution challenges?”

References