A Field Study of Structures, Affordances, and Coordination Mechanisms of a Cross-Organizational Extended Team in Global Software Development

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Abstrakt

Context: Growing popularity of Global Software Development (GSD) has resulted in an increasing number of cross-organizational teams that are formed according to Extended Team Model (ETM). There is little empirical body of knowledge about the structures (work, social, and communication) that may exist in these types of teams and the potential strengths and weaknesses of these structures in dealing with GSD challenges.

Objective: This research has been motivated by the need of studying the types of work, communication and social structures designed and implemented for a cross-organizational extended GSD team and the kinds of collaborative affordances available to support GSD teams. Moreover, this research also aimed at identifying and understanding the interdependencies created by the existing structures and the coordination mechanisms provided to deal with the interdependencies and how they can contribute to alleviate or exacerbate GSD challenges.

Method: We used the case study research methodology in the context of a cross-organizational ETM consisting of multiple nationalities and multiple sites. We used semi-structured interview as our main data collection approach. We carried out 12 interviews with both onshore and offshore team members. We applied qualitative data analysis approach called thematic analysis for finding the answers to our key research questions.

Results: Our study has identified that the current work structure of ETM create several kinds of interdependencies for which they have introduced dens communication and social structures that appear to afford several means of collaboration for performing the interdependent software development activities by building the feeling of togetherness and high level of trust, and making ease of initiating conversations, establishing common understandings and maintaining task and team awareness. However, the existing structures do not help resolve the difficulties associated with communication gap, delayed feedback, and requirements related challenges. We also found that the coordination mechanisms being used for dealing with the interdependencies may directly or indirectly impact the challenges that globally distributed teams are expected to face.
**Conclusion:** This study has revealed that whilst the identified structures of the studied cross-organizational extended GSD team can help deal with different kinds of GSD challenges, these structures and the affordances and coordination mechanisms associated with them may also have certain types of challenges inherent in them. We make a few recommendations for improving the current structures to deal with the observed challenges. Our findings are expected to provide practitioners with useful insights into the types of structures and associated challenges for implementing cross-organizational ETM in GSD and researchers with some potential venues for further research in the areas of structures, affordances, and coordination mechanisms for effectively implementing cross-organizational extended GSD teams.

**Keywords:** Global Software Development, Global Software Engineering, Knowledge management, information acquisition and sharing
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1. Introduction

Global Software Development (GSD) has become a popular paradigm of developing software with teams who are expected to be affected by distribution factors (such as temporal, geographically, socio-cultural, knowledge, and processes). Organizations adopt GSD through various models such as outsourcing, offshore development centers, global sourcing, and virtual teams [30]. An increasing number of organizations have been moving from outsourcing mode of GSD to collaborative form where they enter into long term partnerships through which they extend their onshore software development teams with the software development resources provided by a vendor, usually located offshore. Such cross-organizational teams are considered to follow a so-called Extended Team Model (ETM) [38],[32], which is increasingly become popular model of forming collaborative partnerships with software development vendors rather than outsourcing model. The ETM is especially suitable to the circumstances of Small-to-Medium Sized Enterprises (SMEs) that usually have limited resources for outsourcing governance and fluctuating demand for developing software to support their business processes. This model is similar to virtual teams [27] but has several subtle but important differences. There is little known about the kinds of structures (e.g., work, social, and communication) that may be required for ETM, the kinds of interdependencies that may characterize these types of teams, and the collaborative affordances, and coordination mechanisms required to support the interdependencies and address the known GSD challenges. We assert that suitably designed structures can afford ways and means of addressing the GSD challenges caused by the distribution factors (i.e., geographical, temporal, cultural, and organizational). It is also important to determine and understand the types of interdependencies created and the coordination mechanisms provided by certain types of structures being used by ETM.

One of the major sources of GSD problems is work items interdependencies that needs to be managed by appropriate coordination mechanisms [24]. Work items interdependencies usually results from assigning interdependent modules to distributed sites, non-unified processes, lack of shared understandings and conflicts between team members. Lack of identification and management of technical interdependencies among modules can cause coordination breakdowns resulting in serious integration problems. That is why it has been argued that management of interdependency among tasks needs appropriate combination of
organizational structure, processes, communication, and coordination mechanisms [6]. Mockus and Herbsleb discuss de-coupling of the work and creation of virtual site as two approaches that can help reduce the problems associated with coordination of distributed work [24]. Given the dynamics of software development work, coordinating the distributed teams’ activities can be influenced by critical decisions about division of interdependencies between locations on one hand, and the mechanisms needed for supporting communication and collaboration among heterogeneous teams on the other hand. Hence, it becomes clear that the nature and a combination of structures (work, social, and communication) can have positive or negative impact on globally distributed software development teams. Hinds and McGrath [14] note that while the interplay between the work, social, and communication structures can influence the effectiveness of coordination efforts, there has been little systematic research to investigate the relation between coordination ease and work, communication and social arrangements. We argue that it is important to empirically study the existing structures of globally distributed software development ETM teams in order to increase our understanding of their nature and appropriateness for different types of configurations of GSD teams. This research aims to contribute to an evidence-based body of knowledge about the interplay between different types of structures and the associated coordination mechanisms and collaborative affordances to support GSD teams.

This report proceeds by providing a short description of the key theoretical concepts that have motivated the reported research by critically discussing their role and importance in studying GSD teams. We present the detailed design and logistical arrangements of a case study research. Then we present and discuss the findings that have been obtained by analyzing the data gathered through interviews and analyzed using the theoretical concepts outlined and discussed in the following Sub-sections. At the end, we make some recommendations about how to address some of the well-known GSD challenges by appropriately designing and implementing appropriate structures (i.e., work, social, and communication) that can provide suitable collaborative affordances and coordination mechanisms for managing the interdependencies caused by the work assignments according to the team’s characteristics and work structure.
2. Background and Motivation

This Section provides a critical discussion on the key theoretical concepts that have provided the theoretical framework for our research on studying the structures of cross-organizational ETM, the interdependencies created and the coordination mechanisms used by the existing structures. We briefly define each of the theoretical concepts in the context of GSD and how the theoretical frameworks from different disciplines can contribute to understanding and improve the GSD research and practice.

2.1. Extended Team Model (ETM)

We draw the definition of Extended Team Model (ETM) in GSD as customized offshore outsourcing model that is shaped by building extended arm of client towards the offshore vendor development site and booking a set of skilled resources for long-term corporation [32],[29],[38],[37],[35]. The following characteristics can help to describe ETM:

- **Safe business model:** ETM is considered as a safer business model that involves a long-term relationship with a client as it can reduce the risk and upfront cost for a client company compared with a normal outsourcing. ETM provides high visibility, more control and different pricing mode (i.e. pay as you go). A client can directly utilize the available resources for different projects and conduct the processes and practices that are already in place at its internal software development unit, also called onshore site.

- **Dynamic size of team:** the size of the software development team at offshore site can vary based on the demand and availability from a single resource to several dozens of developers, technical leads, architect, and project manager.

- **Dynamic allocation of tasks:** ETM is usually implemented with a principle of applying no specific criteria for the types of tasks to be allocated to the members of the extended team offshore considering the offshore-team as booked resources, they would be utilized based on the needs of onshore company and getting involved in different type of tasks such as starting new projects, enhancement of existing projects in terms of functionality or new sub system, bug fixing.

- **Offshore project manager:** ETM emphasizes the role of offshore project manager who is responsible for ensuring the achievement of the agreed upon tasks with the required
quality. The offshore project manager should be completely trusted by the onshore team (i.e., client side team) and the management of the client.

- **High Visibility**: one of the significant characteristics of ETM is a high visibility of the task status and progress on the work assigned to the offshore team. It is quite different to assigning the work to a vendor in usual offshore outsourcing arrangement, according to which a client usually has a very low visibility into the staff allocation, work distribution, and work quality and status.

- **Macro management**: the extended arm of a vendor’s team is assumed to be self-organizing and self-reliant. Hence, a client does not try to do any kind of micro management; rather a macro management strategy is applied that is sufficient to provide a client with the required visibility of the work progress.

### 2.2. Structures (Work, Communication, Social)

Structure refers to a framework of identifiable entities and relationships among them, also called the elements of a structure. There can be several kinds of structures in software development teams such as management structure, social structure, and work structure. It has been shown that the interplay between work, communication and social structures can influence effective coordination of work of geographically distributed teams [14]. This work is mainly focused on three types of structures: work, social, and communication. In the following sub-sections, we briefly explain each of them in order to help understand their role in GSD teams for providing affordances to support collaboration and coordination and the importance of their interplay for addressing GSD challenges.

**Work structure** represents the flow of work between team members that means work structure outlines interdependencies among different activities, tasks, and people. A highly dense work structure (i.e., too many interdependencies) is expected to require a huge amount of coordination effort in order to support a large number of interactions among team members. An organic work structure with highly interdependent tasks can provide a suitable infrastructure for sharing project knowledge; however, this kind of work structure needs to be supported by frequent communication for smooth collaboration, which not only depends on the provision of appropriate technologies and communication media but also involves human factors and barriers to motivate people to communicate with each other. Work
structures that make appropriate use of formal and informal hierarchies can support work coordination by centralizing the information and efficiency of communication, though it should not introduce additional barriers to seeking information [14]. In the context of GSD, loosely coupled tasks are expected to minimize the need of frequent interactions among members of a team. A project manager can create loosely coupled tasks based on different types of criteria such as different phases of development life cycle or system architecture. The work structure based on loose-coupling can be costly as a result of enormous cost of resolving integration difficulties and mismatches that can happen due to information masking, poor information sharing and sticking of project knowledge to specific locations. We argue that it is important that the organization involved in GSD project have appropriate work structure that afford means to deal with GSD challenges.

Social structure represents the formal or informal social networks (i.e., ties and interactions) that may exist within a project or an organization. It is asserted that the existence of strong social networks can help people to better coordinate their work activities and share knowledge. When people know each other they are more likely to emotionally feel close to each other and can be more comfortable to share relevant information [14]. Strengthening social ties can develop the feeling of team-ness that is usually lacking among the individuals who work in geographically distributed teams. While building social networks between people with high social capital (i.e. local teams) can be relatively easier, it can clearly be a costly undertaking to build and maintain a social network among people who are distant by geographical, temporal, linguistic and cultural borders. Whilst it is important that companies involved in GSD continuously work for bridging the social gap between remote colleagues by affording different types of opportunities and mechanisms to build new social ties, managers should also identify and leverage the existing social capitals when forming teams or new work structures.

Communication structure means a set up of formal and informal mechanisms and conventions to enable team members to communicate about work and personal matters. Building and maintaining communication structures for supporting work and social structures require extra work and cost. It has been reported that a thick communication structure can afford different opportunities for negotiation, clarification and obtaining common understanding. Appropriate communication structure also helps increase
awareness of work progress, build trust, and minimize the negative impact of physical distance. Whilst the communication patterns in a GSD team should assure that the people who need to talk to each other are put in touch for one-to-one communication, there should also be a centralized mechanism of information exchange in order to improve efficiency without introducing noise, information loss and impacting effectiveness. There is a significant interplay between work dependencies and communication networks. Introducing a new interdependency between two work tasks implies the need of communication between the people whom those tasks are assigned. The introduction of a new interdependency can also implicitly result in emerging communication networks to enable an individual to find the relevant information. However, the new work interdependencies can also be managed by leveraging the existing communication networks. An organization needs to provide appropriate technological support for affording GSD teams opportunities and mechanisms to establish and maintain formal and informal communication networks.

2.3. Affordances

The word affordance comes from a psychologist’s, J. J. Gibson, work on perceptual psychology [13], which resulted in the theory of affordances. According to J. J. Gibson, Affordances are relationships that exist, visibly or invisibly, between the world and an actor. Donald A. Norman has differentiated between real and perceptual affordances and their role in Graphical User Interface Design [25]. The concept of affordances has been applied to many disciplines, particularly where the focus is on how humans interact with other humans or machines in order to perform a particular task, e.g., Human Computer Interaction (HCI) and Computer Support Cooperative Work (CSCW). It has been claimed that well designed and effective computer supported work can afford different ways of social interactions for supporting collaboration and coordination in complex environments. The concept of affordances has also been used in Software Engineering by Scacchi to study the collaborative affordances available to Open Source Software (OSS) developers [33].

Without further discussing the theoretical foundations of the concept of affordances, we describe how we have used the concept for studying the structures (work, social, and communication) that exist to support collaboration and coordination among the members of a cross-organizational extended team in GSD. For this research, we consider the concept of
affordances as the relational properties between objects and actors in order to support interactions required to perform a particular task in a certain situation. Hence, our focus is on the affordances provided by the existing structures to support collaborative efforts of geographically distributed teams. We assert that well designed and effective structures (work, social, and communication) and associated technological support can afford appropriate means of interactions to support the collaboration and coordination required by geographically distributed teams for performing their tasks.

2.4. Coordination

Coordination can be defined as the act of managing interdependencies between activities performed to achieve a goal. The activities means Actors performing interdependent Tasks that require or create Resources [22], [9]. In context of software development, coordination means getting the people who are involved in software development activities agree on a common understanding of the system to be built and harmonize their tasks to achieve a common goal [19]. Wiredu discusses how socio-cultural, distance, and technological aspects of GSD can influence different dimensions of coordination [40]. His framework for studying coordination in GSD teams considers people, processes and technology as three main dimensions that define interdependencies and conflicts to be resolved. He describes information as the “lifeblood” that circulates among these three dimensions and facilitates coordination. According to Wiredu, while the interdependencies between tasks, artefacts, and modules can be explored under process category, the relations and conflicts between the actors as people-related and uncertainties as information-related interdependencies should be studied. Moreover, he advocates that analysts should explore the functional and structural role of technology in terms of its support for software development as well as human interactions so that the involved stakeholders can shape their psychological attributes such as perceptions, awareness, and trust. Carmel and Agarwal [5] argue that the negative impact of “Distance” affects coordination across distributed sites. Their study demonstrates that the more distributed teams share life-cycle efforts, the higher would be the coordination complexity. Ågerfalk and his colleagues have concluded that coordination complexities can be introduced by the factors such as reduced overlap between hours of collaboration, difficulties in synchronizing meetings, lack of domain knowledge, reduced trust, lack of
awareness and feeling of team-ness [1]. Mockus and Herbsleb [24] discuss de-coupling of the work and creation of virtual site as two approaches to reduce the problems associated with coordination of distributed work. While de-coupling focuses on modularization of the work and refining development models, creation of virtual site can be achieved by building common development environment to manage changes and tracking tests, provision of appropriate infrastructure to facilitate collaboration and communication, providing supportive tools for presence awareness such as shared calendars and instant messaging, providing the big picture of project information including project management, resources and locations via web pages and finally building social ties by travelling, frequent meetings.

Mintzberg’s theory of correlations between task complexities, and coordination mechanisms has been explored by different researchers [15], [34] in the context of GSD. According to Mintzberg’s mutual adjustment, direct supervision and standardization respectively can be suitable strategies to manage interdependent tasks varying from low to high complexities; nevertheless, when the tasks become extremely complicated the team members should actively interact with each other to keep the work coordinated (referred as mutual adjustment). Kotlarsky and her colleagues [18] distinguish between mechanisms that are targeting formal aspects of organizations and the ones which are reliant on informal and interpersonal aspects. Their framework classifies coordination mechanisms as social-based, work-based, organizational design and technological-based approaches. Whilst the social-based approach emphasizes human interactions and need of communication and socialization, the work-based approach focuses on standardization of work by having explicitly defined processes and appropriate documentation to minimize the need of communication. Organizational designs usually encompass the patterns in terms of hierarchical (e.g., point persons and liaisons) and flat structures (point-to-point communication) and make explicit the roles, responsibilities, and model of corporation. According to Kotlarsky and her colleagues, the technological-based approach attempts to replace the role of human by tools for work coordination. They have proposed the use of automated checking of conflicts, notifications regarding changes, use of digital calendars, and meeting requests. Most of these mechanisms are already being used by software development teams in general and global software development in particular. However, there has not been much work on systematically studying the negative or positive impact of
the collaborative affordances provided by the technological-based coordination mechanisms on global software development teams and their appropriateness for different kinds of structures (work, social, and communication) that require them.

3. Research Design

This study aims at identifying and understanding the structures (i.e., work, social, and communication) used by an implementation of a cross-organizational ETM in GSD and how these structures help address some of the GSD challenges. Since each implementation of an ETM is tailored to a particular context and organization, it is imperative to first understand what structures organizations have adopted to support an ETM in GSD. Having identified the nature of the implemented structures, we intended to focus on two points:

a) Determining the collaborative affordances provided by the implemented structures to address GSD challenges.

b) Identifying the types of interdependencies between software development activities had been created by the implemented structures and the mechanisms provided to coordinate the interdependencies and their associated challenges.

Thus, we meant to answer the following research questions:

RQ1: What are the structures (i.e., work, social, and communication) implemented for supporting a cross-organizational ETM? And what collaborative affordances these structures provide to address GSD challenges?

RQ2: What types of interdependencies these structures can introduce between software development activities and what coordination mechanisms they provide to support those interdependencies?

RQ3: What are the challenges that have been introduced or not addressed by the implemented structures?

3.1. Research Method

The selection of research method should be based on the nature of research question and state-of-the-art in the studied problem [11]. There has been little empirical research on structures of extended team model and how they can contribute to exacerbate or address
GSD challenges by creating interdependencies and providing collaborative affordances and coordination mechanisms. We decided to use case study as our research method. Case study is considered suitable research method to investigate a contemporary phenomenon within its real-life context [41]. Case studies can be descriptive, explanatory, exploratory or evaluatory [39]. Given the nature of our research, we conducted an exploratory case study that is used to uncover the “What” questions [41]. Apart from the guidelines for the design and execution of a case study provided by Yin [41], we also consulted the checklist provided by Kitchenham et al. [17]. The unit of analysis is a cross-organizational extended team consisting of team members from two organizations, which were client and vendor.

3.2. **Context**

We have carried out this research by studying an extended team consisting of software development professionals from two organizations who have been business partners for software development as client and vendor for more than 3 years. The client is based in Denmark and the vendor has a business development office in Denmark and a software development centre in Pakistan. The long term working relation enabled them to create an inter-organizational extended team whose members are drawn from both organizations. The team members located in Pakistan are considered an extended arm of the team in Denmark. Figure 1 shows the organizational arrangements for the studied extended team model. Whist different software development roles are assigned to team members in Denmark (called onshore team members) and Pakistan (called offshore team members), the offshore team members carry out the major development parts. The onshore team members are also involved in all phases of software development, however, they are also responsible for requirement elicitation and clarifications as they have easy access to the customers that are Danish: internal (i.e., business units of the client) or external customers who use the software systems being developed by the extended team.
3.3. Data collection

Our main data collection approach was semi-structured interviews [21] that help explore perceptions and experiences of practitioners and collect qualitative data. This report is based on the analysis of the data gathered through 12 in-depth interviews conducted with both offshore (7 out 12) and onshore (5 out of 12) members of an extended team. The interviewees had diverse roles varying from developers, technical leaders, architects to project managers, process manager and IT manager. The average work experience of the interviewees was 9.5 years (minimum 5 years and maximum 13 years). The semi-structured interviews enabled us to get involved in discussions with the interviewees while following the interview instruments and gather rich qualitative data. Each interview lasted around 60 minutes. The interviews were transcribed verbatim on 232 single space A4 size pages. Table 1 shows the distribution of the interviews based on the location, role and experience of interviewees. The anonymous names/IDs have been used for the sake of confidentiality.
Table 1: Distribution of interviews based on location, role and experience

<table>
<thead>
<tr>
<th>Id</th>
<th>Company</th>
<th>Role</th>
<th>Experience (years)</th>
</tr>
</thead>
<tbody>
<tr>
<td>M1</td>
<td>Vendor</td>
<td>Project manager/ Team Leader</td>
<td>9</td>
</tr>
<tr>
<td>M2</td>
<td>Vendor</td>
<td>Project manager</td>
<td>12</td>
</tr>
<tr>
<td>M3</td>
<td>Vendor</td>
<td>Developer</td>
<td>5</td>
</tr>
<tr>
<td>M4</td>
<td>Vendor</td>
<td>Developer</td>
<td>7</td>
</tr>
<tr>
<td>M5</td>
<td>Vendor</td>
<td>Technical leader/ Architect</td>
<td>6.5</td>
</tr>
<tr>
<td>M6</td>
<td>Vendor</td>
<td>Architect/ Developer</td>
<td>7</td>
</tr>
<tr>
<td>M7</td>
<td>Vendor</td>
<td>Senior developer</td>
<td>6</td>
</tr>
<tr>
<td>M8</td>
<td>Client</td>
<td>IT manager</td>
<td>7</td>
</tr>
<tr>
<td>M9</td>
<td>Client</td>
<td>Architect</td>
<td>9</td>
</tr>
<tr>
<td>M10</td>
<td>Client</td>
<td>Project manager</td>
<td>13</td>
</tr>
<tr>
<td>M11</td>
<td>Client</td>
<td>Process manager</td>
<td>10</td>
</tr>
<tr>
<td>M12</td>
<td>Client</td>
<td>Technical leader</td>
<td>10</td>
</tr>
</tbody>
</table>

We started to investigate our research question by studying the offshore center for 3 weeks. After giving an overview of the research purpose, the country manager of the company and senior project manager suggested the interviewees considering criticality of the role, experiences and availabilities. Then we gathered the demography information of suggested interviewees in order to ensure the suitability of the interviewees for our research as well as validation of our interpretation of discussions during the analysis. We prepared the summary of interview questions by highlighting the main high level questions and gave to the interviewees beforehand in order to giving them an opportunity to have a good thought of the focused areas and having more productive session. Both researchers conducted all the interviews in Pakistan, which was a good idea for semi-structured interviews to dig into the discussions while covering all the main points of our instrument; while one researcher was leading the discussion, the other one had the opportunity to look into the interview questionnaire and get ready for the next question. Getting permission from the interviewees, we recorded all the interviews for the sake of accuracy and being referable for multiple times. Spending time at offshore center, gave us an opportunity to observe the team dynamics, sitting arrangements and facilities in terms of meeting rooms and communication media as well as having informal short chats with the team members to enhance our understanding of the organizational context.
3.4. Data Analysis Approach

We adopted thematic analysis method based on the step-by-step guidelines provided by Braun and Clarke [3]. Braun and Clarke define thematic analysis as a qualitative data analysis approach to reporting the themes within data. While this approach can be done in both inductive (bottom-up) and deductive (top-down) ways, the bottom-up style resembles Grounded Theory (GT) in terms of connectivity of themes to data [3]. Both methods start from getting familiar with the data, emergent coding of data fragments, identifying patterns, categorizing the themes and reporting the results [3], [36], [7]. Nevertheless, GT differs from thematic analysis in terms of flexibility and being more theoretically bounded [3]. Strauss and Corbin [36], define grounded theory as a general methodology to develop theory based on systematically gathered and analyzed data; they particularly underline the major difference of the method with other approaches in theory generation.

Based on the above explanation, though our data analysis approach has many similarities with GT we consider it a thematic analysis since we did not have a systematic comparison of the codes over the data. While Strauss and Corbin [36] emphasize the importance of having code comparison, the GT process presented by Charmaz [7] categorizes the coding process of GT as initial coding (open coding) and focused coding. She describes initial coding as the phase of defining codes line by line or based on data fragments and focused coding as the process of extensive comparison of initial codes with data. We used open coding in order to analytically breaking down the data and interpreting the phenomenon reflected within data [8]. However, we have also applied axial coding [8] to identify the relations between different categories. We describe our analysis process based on Braun and Clarke guideline [3] as follows:

While we partially got familiar with the data by participating in the interviews (i.e. the interviews from offshore center were done with participation of both researchers while the onshore interviews were done by one of the researchers) and making transcriptions, we spent quite significant amount of time on reading each of the interviews in detail. Having our research question in mind, we were looking for high-level categories of communication, work, and social structures as well as challenges while performing initial coding and defining emergent labels. Though the basis of the thematic analysis and GT emphasize on not applying any predefined framework for the purpose of coding [3], [7], we believe that
we have not deviated the principles as these are very high level categories. In this step, which was the most time consuming phase, we selected quite big chunks of data (i.e. paragraphs) for labelling in the first go to keep the context; however, we have associated the “Key point” of the paragraph with the codes. At this stage, we could also identify preliminary relations between the high level categories wherever we noticed. The next three steps of the guidelines namely “searching for the themes”, “reviewing themes” and “Defining and naming themes” have been done iteratively. At this stage while we refined the initial codes (i.e. obviously our skill and ideas about the codes got gradually improved and matured from one interview to another) we also defined new codes under the categories and improved our findings in terms of realizing relations between categories specially challenges to different structures. Finally we come to the results by relating back the themes and codes to the research question as well as literature as the last phase of the guideline and producing the report.

4. Results and Analysis

In this section, we report the results from our analysis. Given our research purpose, our findings cover work, communication and social structures of the studied cross-organizational extended team in terms of the entities and their interrelationships. We also identify and discuss the collaborative affordances provided by the existing structures and associated technological support and how these structures contribute to address or exacerbate the known GSD challenges. Our analysis has also determined the interdependencies introduced by the current work structure and the coordination mechanisms provided by the identified structures and the kinds of challenges that can be addressed using the implemented coordination mechanisms.

4.1. Work structure

We present the findings related to the main elements of the work structure.

4.1.1. Interdependent tasks

The distribution of tasks across the sites tends to be interdependent caused by not only predefined way of work breakdown structure and the task allocation decisions, but can also
be done on ad-hoc basis as a result of changing requirements and bug fixing requests.
Whilst the data shows that no competency gap is perceived between offshore and onshore sites, the Work Items (WI) are structured based on skill sets, availability of resources and needs of required knowledge. One interviewee said:

“There are a lot of factors considered for task allocation...the skills and design, the workload and you know for example, how much consultancy you need...”

While the organization does not explicitly apply loose coupling strategies such as allocation of WI based on life-cycle phases, system architecture or complexity of modules, the distribution factors usually influence the way work for certain phases of software development has been structured. For example, due to the linguistic differences and proximity of the onshore team members to the customers, the tasks, which need more business side consultancy, are allocated to them. That is why they are mainly responsible for gathering requirements from customer (internal/external ones), prepare initial functional specifications and sending them to the offshore team members; the offshore team members are involved in analyzing requirements after receiving the specifications.

Given the use of iterative agile method, both sides attempt to maximize interaction while keeping the amount of documentation to a minimum. Rather than preparing extensive documentation for providing clarification and contextual information, a majority of the clarifications happens during kick-off meetings between two sites; there is always room for one-to-one discussion for further clarifications about the assigned WI. One interviewee said:

“…Normally we work upon the requirement document we get... the usability team would be doing the specification document; they look at it from end user’s perspective... if there are some backend functionality involved they get help from the developers or architects. We analyze the document to know if we need to produce a technical specification out of that... We set meetings for clarification of the things we are not sure about... so questions, clarifications and suggestions are done in meetings and once that is finalized we go to work break down and estimations.”

We observed that the requirements engineering activities (i.e., gathering, specifying, and validating) get assigned to different roles in different projects and it results in varying quality and amount of the specifications. Some projects would have extensive specifications
done by User Experienced (UX) team in close collaboration with customers; others are coming with high-level abstract specifications and mock-ups done by senior developers or project managers at onshore. This kind of work structure requires more effort for further clarifications through extensive interaction to be afforded by the social and communication structures. This makes the performance (in terms of quality and time) of the offshore team members dependent on the inputs provided by the onshore teammates and the process of getting clarifications.

We also found that the currently used tools and technologies for supporting the existing work structures also influence interdependencies between WI. For example, the distributed team members, onshore helpdesk staff and the End-Users make heavy use of bug tracking system based on a ticketing system that is used by the helpdesk staff to assign bugs and modification requests to team members without taking into consideration the priorities and complexities of the tasks the developers may be performing. Our study has made it clear that an ad-hoc network of interdependencies emerges in order to address a new ticket assigned to one or more developers. However, utilization of these technologies (i.e., Team Foundation Server (TSF), Bug tracking system, and project management tool) also affords different ways of connecting the people whose work are inter-related to each other, increase workplace and group-structure awareness [26], and facilitate work coordination.

4.1.2. Formal hierarchy of reporting

The studied extended team had also established formal hierarchies for coordinating the work interdependencies among distributed team members. Formal hierarchies can be described based on the existence of different hierarchical work structure with different roles and responsibilities defined. Whilst different individual teams are acting under the leadership of a technical leader, the Senior Project Manager (SPM) at offshore side is responsible for coordinating the activities between technical leads at both sides. Though the leadership of architecture group mainly act based on command and control strategy, the technical leaders mostly allocate tasks after consulting with developers. One of the developers at vendor side describes the task allocation as follows:

“Mainly our lead and us (developers) sit together and decide which resource is expert in which area; then when the resources are allocated to each chunk, each resource is
responsible to make the breakdown structure. The big level picture is designed by our team lead but in extended mode we design by ourselves.”

Another indicator of the formal hierarchical work structure is that the architects at onshore side are the first people who receive the requirements and start working on them for High Level Design (HLD) and work breakdown structure. The architects also prepare architectural documentation, identify the critical parts to be developed, and review the code in order to ensure that their architectural decisions are being followed by the developers who are expected to inform the architects if something needs to be changed. Though some interviewees have reported this pattern, this approach did not appear to be followed in all the projects being developed by the studied cross-organizational extended team. However, whenever the architectural documentation was available, it afforded developers a source of knowledge and interaction with the architecture group, project management, and team members. Work division process is also another activity, which is being done under shared supervision of two SPMs, onshore and offshore. This pattern demonstrates that the representatives of both sides, whom are expected to have a broad knowledge about the skill set of their team members, are having equal opportunity to influence the work division and the other team members would follow their decision.

It was also a protocol to keep the project manager and technical leads at both sites updated about the current state of the work, change requests, obstacles and difficulties. They were also responsible for ensuring the product and process quality. We call these roles “gatekeepers” who were holding critical position to manage the complex work interdependencies and keep the overall team effort coordinated. This role affords the team members several means of getting their work checked and questions clarified in order to avoid errors and mistakes caused by incomplete or incorrect information and understanding. According to one developer:

“...For each task we have to keep the project managers at both sites in the loop that if I’m having a problem or getting delayed; so no decision can be made without informing them because they might assign me another task without knowing the state of my current task.”

As part of the work structure, we also discovered another role that we call “information broker” as he/she receives and maintains a huge amount of knowledge about the WI assignments and their context over a long time period in order to facilitate collaboration and
coordination. This role is expected to have a high level of technical expertise and business domain knowledge; he/she is responsible to facilitate knowledge sharing between distributed teams. Hence, it is clear that while there is a formal hierarchy to support coordination of the work, the current work structure afford the extended team members on both sides several opportunities of consulting and seeking knowledge from designated roles like information broker, who facilitate the performance of WI through supporting information flow and knowledge sharing. Despite having a formal hierarchy of reporting, we also observed the existence of a culture of consulting senior people before making critical decisions without considering their official role; a practice that indicates that people also appreciate the importance of informal hierarchy based on seniority and knowledge. We also discovered that the interdependent work structure, distribution of project knowledge across the sites and the diverse nature of projects resulted in raising the importance and criticality of information sharing, coordination of projects knowledge and synchronization of design decisions and architectural styles. Thus, the management decided to build a knowledge sharing community for the extended team referred as “technical lead forum” which aims to afford project managers, architects, and senior developers an opportunity to informally interact and share their expertise and knowledge.

4.2. Communication structure

We present the findings related to the main elements of the communication structure found in the studied case.

4.2.1. Hybrid pattern of communication

A highly interdependent nature of the work structure within the extended team has resulted in the need of frequent interaction and high volume of communication among team members at both sites. In order to address this need, the management has introduced a flat communication structure which can afford the team members a culture where anyone can talk to anyone within the extend team. We found a pattern of frequent spontaneous initiation of communication by team members through Skype chats and emails to resolve the issues. There was also frequent formal communication between the senior members of the team on both sides as well as with developers to get updates about the progress and challenges.
Some examples of the means afforded to the team for formal communication include scrum meetings and updating burn down charts by developers on daily basis. Moreover, the existence of frequent informal communication between some managers, who seemed to be socially closer to each other, appeared to be useful for coordination and resolve conflicts. Because of the policy of “everybody talks to everybody” the offshore members of the extended team can easily approach their onshore peers, project managers, and infrastructure manager without any reservation. Though the flat communication pattern is assumed to be suitable for sharing knowledge and achieving common understanding of the requirements, it can also introduce inefficiency, overlap between discussions and more effort for control [14]. Our findings also revealed that the junior staff were supposed to keep the project manager and the technical lead in loop of emails and to send meeting minutes. This policy was designed to afford the key roles an opportunity to remain updated about the important points in the discussions even they were not present during the discussion. Thus, this communication structure appears to be a hybrid pattern with multiple central nodes in order to avoid messiness and improving communication efficiency.

4.2.2. Communication facilitator

Another key element of the current communication structure is the role of communication facilitator, who is responsible to facilitate communication between two parties in terms of accelerating response time and supporting the process of providing needed information to an individual. One interviewee described his role:

“I am supposed to be the facilitator...I have to make sure nobody is stuck...and I have to escalate things if needed. So overall I have to make sure our development team is working smoothly.”

This role existed at both sides; at the offshore side, a SPM acted as the communication facilitator in order to get quicker response for his team members from the clients by using different communication media such as email, Skype, and phone calls to the relevant people. The holder of this role is expected to have a broad knowledge about the projects, the resources, and the available skill sets; this knowledge enable him/her to identify the relevant resources to be allocated, this official role also gives him/her more freedom to contact the relevant people from the onshore side of the extended team to get the required things done. On the onshore side, the communication facilitator supports communication of the offshore
team members with different customers for whom the software is developed. While the process manager facilitates the communication of the UX team with the offshore side, an architect facilitates the communication between the offshore development team and different stakeholders in different departments of the client organization such as infrastructure and database teams. Hence, this role affords several means to support communication required for performing the assigned WI in a collaborative arrangement.

4.3. Social structure

We present the findings related to the main elements of the social structure found in the studied case.

4.3.1. Equality model

The complexities caused by different contexts (e.g., cultural and organizational) in which the members of the extended team work need high level of understanding and appreciation of each others’ position and perspective. In order to proactively deal with the socio-technical complexities inherent in GSD projects involving multiple stakeholders, the management has introduced “Equality Model (EM)” based on the egalitarianism commonly found in Scandinavian societies. The higher management believed that the equality model would help to improve collaboration across team members by building social ties aimed at fostering the feeling of mutual respect and cohesiveness. The equality model means that everyone in the team, irrespective of their geographically location, feels being treated equally; valuing openness and being comfortable to talk with colleagues about culture, religion and hobbies while respecting each other. This equality model affords the team members equal opportunity to participate in discussion and decision making by describing the solution and digging into domain knowledge. As a result, the team avoids the possibility of “blame game”; rather than pointing a single individual for problems, the whole team takes the responsibility for a problem. This level of collaboration can be achieved through “Open eyes” and “Thinking out of box”. One interviewee described:

“... So we invented the equality model... that’s basically the core value of the team. We are a team and as a team we look upon ourselves as a person and as a devotee. So
whenever something goes wrong and a lot of stuff can go wrong at all time, the team has messed up something…”

Our findings revealed that the introduction of “Equality Model” has been a significantly successful strategy to motivate team members to collaborate with each other. The feelings of being equal in the team on both sides has brought team members closer to each other and enabled them to initiate informal chats with peers by pinging on Skype, share the leave times beforehand (e.g., paternity/maternity leaves, picking up kids from daycares), and respect each other’s religious practices (e.g., a few hours time off in the middle of the day for Friday prayer). The quality model has also reduced the potential risk of “blame game” that can cause unnecessary emotional stress among developers in the face of tight deadlines and changing requirements.

4.3.2. Social ties champion

The social structure found in the studied extended GSD team has a backbone social network of senior managers. This social network has incorporated the “Social ties champion” role assumed by some members of the backbone social network. This role is expected to afford means of supporting the interaction needs of the work structure by leveraging his/her social ties. In that sense, the role of SPM at offshore site is particularly interesting as he has strong social ties with the senior managers at the onshore side (who happened to be from the client organization in the ETM) Moreover, he also has the domain and technical knowledge; hence, he was considered an appropriate person to assume the role of the champion of social ties between onshore and offshore sides. This role provided the offshore team members the confidence and comfort of having easy access to someone with significant social capital for guidelines and consultancy to deal with the challenges without being scared of any blame. The onshore team management had the confidence that he could manage the things and get the product delivered on time. The onsite architect describes the criticality of this role at offshore site to apply equality model as follows:

“He is very important for us when we place-in our equality model and working with that. So if he wasn’t there and we had to deal with a new guy, we would be in a very different level. We would be set years back. And maybe it wouldn’t be worth it anymore. So, he’s very critical to us.”
Thus, the social ties champion role was held by those who were familiar with each other and had work history that significantly helped them to build the required level of trust and rapport needed to support collaboration and coordination among team members located at two sites. The architect from the onshore site was playing this role as he interacted with the colleagues from other departments on the behalf of offshore team members, defend their actions, and prevent the start-up of rumours, which can damage social ties and hamper collaboration and coordination efforts.

4.4. Challenges

We report the key challenges that the existing structures do not help the members of the studied ETM to sufficiently address or may exacerbate the nature of the challenges.

4.4.1. Communication gap

One of the key observed challenges is communication gap that refers to communication difficulties caused by different reasons ranging from language barriers, cultural differences, knowledge distance, to limitations of the available technological support. Communication gap has been identified as a challenge by several interviewees on both sides from different angles. Whilst the senior managers and technical leads reported the shortcomings of the communication media being used for providing the possibilities to share mind and draw diagrams during video conference, the developers are mainly concerned about the problems they face in understanding the requirements and what they are asked to do by the onshore team members. One interviewee said:

“Sometime there are communication gaps, we don’t understand what they mean and they don’t understand our concerns.”

Language appears to be the main barrier to communication as none of the team members is a native English speaker; however, English is medium of communication in the team. Though the level of proficiency in English appears to be good on average at the offshore side, it seems to be a challenge to fluently explain the ideas and associated solutions and put questions in an easily understandable format. On the onshore side, it seems to be a similar scenario; the business people do not feel comfortable talking in English, hence, they prefer to have a middle-person who can translate their requirements which makes it impossible for
the developers to directly communicate with the customers for clarifications or resolving conflicts. For example, sometimes developers may receive a ticket for fixing a bug that is not in English and they may use Google translator to make sense as what to do about it or seek help from a colleague for translation.

The knowledge distance also causes communication difficulties. The offshore team members do not have sufficient business domain knowledge and the customers are unfamiliar with technical solutions. This situation requires more communication for clarifications and result in misunderstandings the expectations. Whilst the offshore team members complain about unclear and ambiguous requirements, the onshore team members reported the challenges of receiving the solutions that may not fulfil their customers’ needs.

4.4.2. Problems in requirements engineering

The members of the extended team on both sides reported problems in requirements gathering and specification activities and artefacts. The identified problems appear to be negatively impacting both sides in different ways. The process of gathering requirements and specifications vary from one project to another without any notion of standardized processes and artifacts. A general requirements gathering process involves an initial phase of elicitation, negotiation and analysis of functional requirements and preparing initial specifications by the onshore team members and then getting the offshore team members involved for further steps including technical analysis of specifications, clarification and getting the requirements signed off.

The offshore side faces difficulties in understanding the specifications, which have several ambiguities and unknown business terminologies that need to be explained to them. They reported variations in the quality of the specifications for different projects and wanted to have more detailed provided to them upfront. Due to the difficulties caused by incomplete requirements and poor quality of specifications, some interviewees at the offshore site pointed out their late involvements in the requirements engineering process and suggested that one of their representatives should be involved early in the requirements elicitation and prioritization process so that he/she can help to improve the specifications and transfer of the requirements.

Our study revealed that the onshore team members were aware of the challenges faced by their offshore team members while dealing with the poor quality specifications, they were
also having the challenge of working with non-unified specifications in terms of structure and level of details. For improving the situation, the onshore side decided to improve the process by having the UX team to start working closely with the customer for eliciting requirements and making specifications. This move was expected to help improve the quality of specifications. The UX team is more expert in the problem area rather than the team members from the solution area (e.g., project managers, senior developers). These people would also provide the opportunity to keep track of customers’ perspectives and satisfaction level. However, the onshore team members believe that the involvement of offshore site at earlier stages would be problematic and not preferable due to language barriers and uneasy feeling of the customers.

4.4.3. Delayed feedback

Delayed feedback was one of the most frequent reported challenges by the offshore members the ETM; they would need to seek feedback for different reasons such as requirements clarifications or verification of the suggested solution. Whilst the offshore development team are satisfied with the level of availability of their onshore colleagues for getting quick response to their enquiries, they face extended delays when the clarifications from the End-Users side is needed.

On the onshore side, it is difficult to locate the needed information because multiple stakeholders are distributed across different departments as well as external customers and this causes delays in providing the offshore team members with the required information. Hence, the offshore team members get an impression that their questions may not get high priority by the end users and they cannot contact them directly. This situation causes task switching and frustration. Whilst senior developers can mitigate the delay by being proactive in identifying and seeking the required inputs beforehand, most of the developers suffer from the extra effort that they need to put to deliver according to the plan. One of the developers described the problem as follows:

“…Due to some hidden information our estimates don’t work exactly like what we want [...] if we get delayed feedback it would disturb the plan for the next months or the months ago and we have to do extra work and put extra effort to deliver according to the plan...”
4.4.4. Tight deadlines and context switching

Tight deadlines or unrealistic project plan is an issue that has been mentioned from different angles by the interviewees from both sides. Offshore side is dealing with tight deadlines as a result of their tendency to accommodate the expectations by making efficient use of resources and minimizing wastage of time and asking the developers to give estimation on the black boxes and start implementation as soon as possible. The onshore side raises the issues regarding the need of talking aloud and communicating more realistic vision of the capabilities in terms of needed resources and time. Two project managers described the situation:

“...We don’t have the luxury of delaying things because something is not clear; we try to start actual work, implementation, as soon as possible and a lot of things we might have over looked at meeting time which came forward when we were actually implementing them so we would rather contact the relevant person on Skype or mail to get quicker reply” Offshore

“...We have cases, projects where we need the offshore Team to be much more not eager to please. Tell me if what you don’t-....or what you have is not good enough for you to work on. You know, instead of saying, “we will manage”, because we are all going to end up with something that’s not quite good at the end [...] I think sometimes, they are doing a lot of magic, to get hours.” Onshore

We observed that one way of dealing with tight deadlines is allocating developers to multiple projects/tasks for optimizing the resources. Though this practice is perceived to be a reasonable solution to deal with the delayed information and optimizing resources by project manager, this solution introduces a phenomenon that we call “Context Switching.”

The unreasonable deadlines necessitate the start of implementation before getting requirements fully clarified. In this kind of scenarios, frequent need of requirements clarification and delays in feedback are unavoidable and as a result developers need to use their time by moving to another task. This type of switching between tasks is considered challenge in terms of difficulties in concentration. One of the interviewees describes the challenge as follows:

“...It is hard to focus on the project and it is very de-motivating when you start a project and you know you cannot finish it up because the requirements are not there [...] and
yes it is hard to focus, switching from a project that you were in the middle of coding and getting stuck in something that you need to know and you know you would not get the reply at least until tomorrow…”

We also found that the developers find it de-motivating to leave a task in the middle because they find it difficult to remember the state of a task/ ticket and need reading the whole history of that piece of work in order to refresh the memory that means getting concentration from one task out and putting into another task.

4.4.5. Socio-cultural issues

The existence of social network backbone and the continuous effort to build social ties to improve the feeling of team-ness appeared to be an effective strategy to deal with the main issues caused by the social-cultural distance. For example, employees are encouraged to talk about non-work related matters to learn about each others’ religious believes, respect each others’ dressing codes and culture. It was perceived by the offshore side team members that there was not much known about their culture and life style; however, they did not report many socio-cultural related challenges apart from the linguistic difficulties. The onshore side team members had several concerns related to culture. They felt that they were open to share knowledge and hear about the problems, they believe that their onshore teammates usually do not have enough confidence to criticize their proposals and decisions about the solutions. They also attributed the tendencies of “not saying No”, “over committing”, and “not thinking out of the box” among offshore team members due to their cultural training.

The tendency not to “think out of box” appears to be quite problematic as some requirements need to be specified in too much detail and verified multiple times to ensure that things are going in the right direction. Another issue caused by cultural differences is building relationships between the team members at offshore and the team members of other departments internal to the client organization (e.g. infrastructure team); it is expected to accelerate the clarification process. The offshore team members are more inclined to respect and listen to authorities, while the onshore employees’ cultural training is based on equality without giving extra credit and respect to their bosses.
5. Discussion

We discuss our findings with respect to the first research question “What are the structures (i.e., work, social, and communication) implemented for supporting a cross-organizational extended team model? And what affordances these structures provide to address GSD challenges?” in sub-section 5.1 where we also present our reflections about the existing structures (work, communication and social) found in a cross-organizational ETM and the affordances provided by those structures to support collaboration. Then, we discuss the findings with respect to the second research question “What types of interdependencies these structures can define between software development activities and what coordination mechanisms they can provide?” in sub-section 5.2 where we present the main dependency types that we found between software development activities of the studied case as a result of particular work, communication and social structures, the coordination mechanisms and their impact on well-known GSD challenges reported by interviewees. Section 5.3 is dedicated to discuss the findings with respect to our last research question “What are the challenges that have been introduced or not addressed by the existing structures?” and to provide an overall discussion about the GSD challenges that have been either addressed (or not addressed), or have had indirect negative impact.

5.1. Structures and affordances

One of the key business drivers to adopt Extended Team Model is access and utilization of software development resources through a long-term partnership with a vendor whose staff are completely integrated in the client’s software development team [32],[29],[38],[37]. This model promotes the relationship between client and vendor from outsourcing to collaborative. Such kind of arrangement is similar to inter-organizational virtual teams [12],[27],[16]. This model also supports a friction free alignment between the supply of trained and skilled technical resources at the vendor side with the demands of the diverse projects on the client side for allocating software development professionals to multiple small/large projects and to deal with the high number of interdependencies between the work items and processes. Though the dynamic interdependent work structure enables
agility and quick response to changes [14],[28], it requires high level of trust and collaborative spirit for sharing knowledge, which are being created through appropriate social and communication structures.

The social and communication structures for supporting ETM have helped team members to build a high level of trust based on the equality model that has introduced the feeling of respect, dignity, and openness necessary to be effectively work in an environment where uncertain requirements and task switching are a normal practice because of the nature of the work structure and certain socio-cultural differences. Hence, it is clear that this kind of work structure dynamicity needs to be supported by appropriate social and communication structures in order to achieve smooth flow of information and high level of collaboration.

Our findings demonstrate the existence of a thick flat communication pattern coordinated several senior roles between distributed team members. This kind of communication pattern is considered a supportive strategy for the dynamic interdependent work structure being used by the studied team [14]. Whilst the work structure implies the need of frequent interactions between distributed team members, the managerial support for social structure and the available infrastructure in terms of media (e.g., audio/ video conference, IM, desktop sharing) appear to have minimized some of the key communication challenges usually associated with GSD projects. We argue that the flat communication hierarchy and general encouragement for more communication helps build the feeling of team-ness, resolve misunderstandings, improve collaboration, and provide visibility of the status of the tasks and progress of the work in ETM arrangement. Moreover, this pattern enables agility across distributed teams by sharing knowledge through frequent conversations and emails rather than investing time and effort on preparing and reading extensive documentations.

Moreover, the policy of encouraging the team members to talk to each other, formally and informally, through available communication channels (e.g., IM over Skype, emails) has provided the team member with social affordances for building social ties that has enabled them to feel comfortable in initiating conversation for sharing technical and contextual information to keep each other aware of the context and work. These initiatives have helped team members to address the GSD challenges caused by lack of informal communication [1], [10],[20]. While many studies enumerate reduced trust [2, 20, 24] lack of awareness and team spirit [20] as difficulties associated with distance factors, our study demonstrates that the mechanisms to improve social structure such as equality model and “no blame game”,
making use of champions to resolve interpersonal conflicts have been successful to build the
feeling of team-ness and trust among the offshore and onshore team members. The unique
opportunity for the senior managers to have strong social network has significantly helped
build and maintain ETM based on the high level of trust that existed before the adoption of
ETM. The social ties between managerial staff trickled down to support the establishment of
extensive social ties between the members of the ETM who came from the client and the
vendor side to form an integrated team unit irrespective of their employment arrangement.
Hence, despite a work structure that introduces interdependencies, the supportive social
structure and communication structures have afforded the team members several
opportunities to informally interact and communicate on regular basis and it has enabled
them to build the feeling of team-ness, improve collaboration and move towards self-
organizing team format in order to support a highly dynamic work structure.

5.2. Structures and Dependencies

In this section, we describe the different types of dependencies [22], [9], [23] that we have
identified from the data. Table 2 shows the dependencies in terms of the type, how the
structures (work, communication, social) cause these dependencies, how these structures
provide supportive coordination mechanisms to manage these dependencies and what are
the challenges that are stemming from these arrangements.

5.2.1. Producer-Consumer Dependency

This type of dependency describes a work arrangement when an output of one activity is
required for the next one [22]. This type of dependency is categorized under two sub-types
namely Transfer where the availability of output matters and Usability where the quality
and usability of the output is concerned [9], [23]. According to Crowston and Kammerer
[9], this type of interdependency can be realized at different level of abstractions during the
whole project life cycle. Our findings in this regard, analyzed these interdependencies at
high level of abstraction based on flow of the work and produced project artefacts that are
being produced and consumed by different parties.
<table>
<thead>
<tr>
<th>Dependency Type</th>
<th>Source of dependency</th>
<th>Coordination mechanisms</th>
<th>Potential Challenges</th>
</tr>
</thead>
<tbody>
<tr>
<td>Producer-Consumer</td>
<td>Work structure:</td>
<td>Communication structure</td>
<td>Communication gap in process of clarifications due to knowledge and linguistic distance.</td>
</tr>
<tr>
<td></td>
<td>o Requirement Engineering Process</td>
<td>o Hybrid Pattern</td>
<td>Delay in getting feedbacks and inputs from onshore site especially when there is a need to go back to the customer.</td>
</tr>
<tr>
<td></td>
<td>o Software development methodology</td>
<td>o Communication facilitator</td>
<td>Frustrations of developers in lacking the information needed and emotional stress of meeting deadlines.</td>
</tr>
<tr>
<td></td>
<td>(agility and minimal documentation preference)</td>
<td>o Openly use of synchronous (IM, Audio/Video call) and asynchronous (Emails, Minutes of meetings) communication media</td>
<td>Information lost due to poor requirement specifications.</td>
</tr>
<tr>
<td></td>
<td>Work structure:</td>
<td>o Formal hierarchies but tolerance for informalities (Monitoring and Code Review)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>o Communication structure</td>
<td>o Champions</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Social structure:</td>
<td>o Building the feeling of togetherness and motivation for talking to each other through equality model</td>
<td></td>
</tr>
<tr>
<td></td>
<td>o Communication facilitator</td>
<td>o Strengthening trust through social network backbone and champions</td>
<td></td>
</tr>
<tr>
<td>Simultaneity</td>
<td>Work structure:</td>
<td>Work structure:</td>
<td>Delay due to Time difference.</td>
</tr>
<tr>
<td></td>
<td>o Software development methodology</td>
<td>o Customized scrum meetings and updating burn down charts on daily basis.</td>
<td>Distractions due to handle unexpected requests.</td>
</tr>
<tr>
<td></td>
<td>o Agility: more communication less documentation</td>
<td>Communication structure</td>
<td></td>
</tr>
<tr>
<td></td>
<td>o Scrum meetings</td>
<td>o Using Emails (asynch media) at unavailability time spans.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Communication structure</td>
<td>o Communication facilitator to accelerate responding time.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>o Flat communication pattern</td>
<td>Social structure:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>encourage team members to approach colleagues easier and initiate contact on the spot without reservations.</td>
<td>o Building the culture of respecting the time and availability of each other and saying “NO” in case of being busy.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>o Massive use of synchronous communication media (IM, Audio/Video call).</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dependency Type</td>
<td>Source of dependency</td>
<td>Coordination mechanisms</td>
<td>Potential Challenges</td>
</tr>
<tr>
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</tr>
</tbody>
</table>
| Task-Actor (Identifying needed resources with expertise to fulfil a task) | Work structure  
  - Task allocation mainly through project management and leaders | Work structure  
  - The experience and information of formal hierarchies about the skill set of resources is mainly used to identify appropriate individual for a task (i.e. based on human memory and but not systematic approach).  
  - Local discussions about the work-items in small and bigger groups (i.e. leaders, developers, PMs) to identify the individuals with required expertise. | Lack of visibility of expertise and skill sets of resources to all team members and missing the knowledge of “who knows what” in more structured way. |
| Shared Resources (Identifying available resources) | Work structure  
  - Task allocation mainly through project management and leaders | Work structure  
  - The availability of resources is identified by project managers based on extensive monitoring of burn down charts and getting updated about progress of the work (i.e. manually but not systematically) | Lack of visibility of all available resources to the project management team and relying on human factors rather than more systematic information. |
We also agree that the producer-consumer relationship can be realized over the whole life cycle including requirement engineering, architecting, development, testing, deployment and delivery as each of these phases would result in the outcomes that are required for the next phase. However, we limit our discussion to the areas where we believe this type of dependency can introduce potential risks and challenges. We found that requirement engineering processes and practices as a part of work structure have shown the presence of this type of interdependency in the studied case. As described before, due to organizational arrangements and linguistic barriers, the onshore team is mainly responsible for requirement elicitation, initial analysis and preparation of specifications. The offshore team gets involved at the later stages for technical analysis of the requirements after receiving specifications. Any further questions to seek more details from the customers go through the onshore colleagues. We consider this arrangement as a strong dependency of the offshore side for the required inputs and clarifications for requirements both time-wise (Transfer) and quality-wise (Usability) on the onshore site [9], [23]. Given the applied methodology to be agile and the tendency of the management to minimize documentation and having more human interactions, shifting requirements to offshore is mainly happening during extensive video/audio conference kick-off meetings and follow-ups by point-to-point clarifications. Apart from the strategies of the company for close monitoring and reviewing the outputs by technical leaders and project managers in order to ensure everybody receives the required input, this pattern emphasis on coordinating the abovementioned dependency through provision of thick communication structure between offshore and onshore sites. Flat communication pattern and the ease of approaching colleagues despite hierarchical official roles, the practice of keeping immediate technical leaders and project managers in the loop of communication in order to keep them updated, introducing the role of a communication facilitator to accelerate the process of getting response can be considered as mechanisms in place for this purpose. Clearly, thick communication structure involves a lot of human interactions that need to be supported by social structure, which is being achieved by having the role of social ties champion, who identifies and resolves interpersonal conflicts. Nevertheless, this pattern is challenging in terms of introducing delay in getting feedbacks and inputs from customer side (i.e. related to transfer dependency type), the risk of information loss when travelling through different hops, communication gap (i.e. related to
usability dependency type) as well as frustrations due to socio-cultural and knowledge distances between the two parties. We argue that, although frequent communication provides good infrastructure for sharing knowledge, it needs extra cost and effort to build and maintain the infrastructure, managing unavoidable delay as well as dealing with misunderstandings and inter-personal conflicts. Having communication gap and delayed feedback as most frequently reported challenges by the offshore site represents the insufficiency of the mechanisms that are already in place. Thus, certain level of standardization in requirement gathering process to minimize the need of further clarifications especially with customer side can be more helpful for the arrangements with high level of task complexities (i.e. multiple stakeholders, multiple domains) on one hand and restrictions on having access to the customer on the other hand.

5.2.2. Simultaneity Dependency

This type of interdependency between activities refers to the need of occurring at the same time [9], [22], [23] such as meetings, phone calls and Instant Messaging(IM) that can be possible by concurrent participation of both ends. Obviously, this type of dependency can be realized in the situations when synchronous communication is necessitated that can result from work structure strategies as well as communication pattern. We argue that the use of agile methodologies (as part of work structure) influence this dependency type by emphasizing less documentation and more communication which means tending from use of asynchronous communication means (i.e., document) to more synchronous ones (i.e., audio/video calls, and IM). Agile practices such as scrum stand-up meeting can help enforce this type of dependency. The analysis of our case study shows that following agile practices and the tendency of managements at both sides to minimal the investments on extensive documentations have resulted in massive amount of communication between distributed team members through emails, Skype calls and IM and drastically increased simultaneity dependencies. Furthermore, the flat communication structure encourages the team members to easily initiate conversation with the other end without any reservation. While this pattern is quite useful to improve interactions across the teams and sharing concerns and information it can be challenging due to time difference between the sites. We found that the teams have been adapted to this pattern by supporting mechanisms in place. Customizing scrum meetings- locally on daily basis and jointly 2 times a week-, getting
updates on the progress of each individual (both onshore and offshore) over the burn down charts every day can be considered as examples of coordination mechanisms to mitigate simultaneity. The team members have come up with a sort of unwritten agreements about the availability time span (i.e. starting and finishing hours) of their colleagues when they can just simply ping each other over Skype and ask for a short meeting or sending emails in case of unavailability or the issues. Our observations show that the team members heavily use emails as communication media beside the Skype chats and video/ audio calls. We argue that while emails can support the possibility of easy conversation initiation they can relax the simultaneity dependency being asynchronous means.

We should also notice the importance of social structure to support this type of communication pattern. While motivation of the teams for more interactions and facilitating them through supportive flat pattern can be beneficial to build feeling of teamness and maintaining shared understanding, it can be also become a distraction when happens too frequently. Thus, building the culture of respecting time and availability of the other end, asking for availabilities and having the courage of saying “No” in case of being busy without feeling social pressure can be considered as critical factor.

5.2.3. “Task-Actor” and “Shared Resource” Dependencies

One of the significant categories of coordination defined by Malone and Crowston [23] is managing task assignments that includes four steps of identifying the needed resources, identifying available resources, selecting the resources and making assignment. Assigning tasks to actors can reflect two types of dependencies namely “Task-Actor” and “Shared Resource”. Crowston and Kammerer [9] define “Task-Actor” dependency type in the context of requirement engineering as identification of needed resources with required expertise to do a task. While this dependency type specifically targets the first step of the coordination process, the second step, identification of available resources, can be investigated by managing the shared resource dependency types. “Shared Resource” is defined as dependency between activities that require the same resource [23]. That means managing this dependency type would require the identification of available individuals (can be referred as Actor or Resource) with needed expertise to fulfill work items.

We explain these two dependency types over the task allocation process as part of work structure. We found that the formal hierarchies are the key roles that influence task
allocations. While the information and experience of technical leaders and project managers are the main references about the set of expertise at each site, discussing and consulting with the developers in small or large groups about the required skill set for a particular work items before task assignment are also noticeable as the other coordination approaches [9]. Though this pattern is justifiable for small-to-medium sized companies, it lacks the visibility of expertise to all the team members (including onshore and offshore sites) and keeps hidden the knowledge of “who knows what”. Given the explained characteristics of work and communication structures that encourage information seeking through interactions, we argue that putting this information in a structured format and making it available through a knowledge base can facilitate the team members to easily identify and contact the relevant people for seeking the required technical or domain knowledge.

Similarly, the availability of team members is known by project managers as they are continuously get updates about the work progress of each single member of their respective teams. The practices such as updating burn down charts on daily basis and keeping the gate keepers in the loop of emails can be considered as the activities that can help project managers to stay updated about the status of the tasks and identify the team member who may have spare time to be utilized. Apart from the large amount of time and effort that project managers need to do extensive monitoring, this approach can also inhibit the efficient allocation of tasks as a result of dependencies on human factors. We argue that the provision of visibility on available resources to the project management team is especially useful for the onshore site to have precise perception of the team workload while making new agreements with customers. It can also help address the negative impact of socio-cultural issues (e.g. over commitment) in reflecting possibilities to the senior managers and safe the team members from becoming overwhelmed.

5.3. Challenges and suggested strategies

In this section, we provide an overall discussion on the relations between GSD challenges and the studied work, social and communication structures. As we have already discussed in section 5.1, the structures of the ETM appear to have helped team members to address some of the commonly known GSD challenges (e.g., lack of trust, reduced informal communication, and lack of awareness) to an extent where their negative impact is
manageable. However, our findings from section 5.2 have reported that these structures can cause different types of interdependencies among software development activities. Whilst these identified structures provide coordination mechanisms to deal with the known interdependencies, the structures and the coordination mechanisms associated with these structures can also cause certain kinds of challenges to a GSD team based on ETM.

Figure 2 shows the relations between the structures and GSD challenges at an abstract level in terms of a model that captures the relations between structures, the GSD challenges that these structures help alleviate, and the GSD challenges that these structures indirectly cause. The relation between the structures, in the middle of the diagram shown in Figure 2, shows that the design of communication and social structures are aimed to support the complexities and interdependencies of work structure. These arrangements provide collaborative affordances to alleviate some of well-known GSD challenges as can be seen on the right hand side of the diagram. However, this particular set-up and the coordination mechanisms in place appear to have also negatively impacted some other well-known GSD challenges as can be seen on the left hand side of the diagram.

Communication gap is considered a common GSD challenge reported in many studies. The participants of our study also reported this challenge despite having a communication structure that was designed to afford several mechanisms of formal and informal means of communication among team members in order to support the social structure and work structure. We find that there is a need of brining more alignment between the affordances
provided by the existing communication structure and associated technological support and the communication requirements of the work and the social structures based on the fact that the end-users are not able to interact with the offshore team members as a result of language barrier. One possible solution can be the provision of a technology that can afford the possibility of real-time translation [4] (or interpretation) to support direct communication between the end-users and offshore development team. One such technology can be Google-Translate, which is already being used by some developers in cases where they receive something non-English.

The management may also consider redesigning some parts of the work structure in order to minimize unnecessary interdependencies and taking into consideration their social ties as socially close people are expected to overcome the communication gap more easily. For example, putting the staff from the onshore infrastructure support department in direct contact with the offshore development team can be an incorrect work structure configuration as both sides appeared to be having a lot of difficulties and misunderstandings due to distribution factors and lack of close social ties. One potential redesign of the work structure can be to make the onshore team members responsible for dealing with the deployment related issues in order to decrease the need of communication between the onshore infrastructure and offshore development staff. This change will afford the onshore team several ways of gaining a better understanding of the deployment related problems and solve them by directly communicating with the infrastructure staff and the end-users without being affected by the distribution factors such as geographical, temporal, and socio-cultural differences.

Recently, there has been a change in the work structure in terms of making the UX team responsible to face the internal and external customers for requirements engineering activities. This strategy is aimed at introducing standardization and improving the quality of requirements elicitation and specifications. Whilst this change is expected to afford the UX team a centralized role between the development team (i.e., onshore and offshore) and customers and new opportunities to improve the quality of the process and artefacts (i.e., specification documents), it will also introduce new interdependencies between the whole development and UX teams. For the offshore development team, this redesigned work structure may introduce unavoidable delays and bottlenecks because of relatively smaller
size of the UX team without affording any new mechanism of addressing the issues related to the delayed feedback.

Distribution of business knowledge within several departments of the customers of the systems being developed, problems with the requirements engineering processes, and inability of the offshore development team result in a huge number of clarification queries, which are unlikely to be responded quickly. This situation causes long delays and context switching problems for the offshore team members. Though the existing communication structure’s role of communication facilitator and flat communication hierarchy appear to be helpful to some extent, there is an urgent need of adjusting the work and communication structures in order to afford the mechanisms aimed at reducing the delays and enabling the offshore development team and the internal customers to communicate directly for seeking clarifications and feedback.

The challenges related to tight deadlines and context switching appear to be caused by a tendency of being optimistic on the part of the offshore project management without sharing the information about the available technical resources, their skills sets, status of different projects, time needed on similar modules in the past with the onshore management. Hence, most of the decisions about the deliverable timeline get made based on the memory and experience of individual managers who may have different cultural and personal biases. We assert that one way of improving this situation can be to redesign the work structure in order to introduce new mechanisms of systematically gathering and sharing the important data points about the required efforts and the available technical resources with the onshore and offshore management of ETM before making decision in terms of matching the work items with the available resources. This kind of arrangement is expected to introduce realistic deliverable schedules and to reduce the context switching. The role of communication champion of social ties can also be instrumental in making both sides aware of the culture related tendencies of being optimistic and not saying “No” even when it is necessary to avoid any risk to a project. Moreover, the “equality model” appears to be a good strategy for letting the offshore developers feel confident and encouraging them to “think out of the box” for proposing and implementing solutions, there is also need of providing them with an infrastructure that can afford them different opportunities to acquire and share the information required for seeing their role in the big picture of the system being developed and being able to think beyond what has been given to them for implementation. One such
infrastructure can be an integrated environment for open and free discussions, brainstorming potential solutions, sharing views on different parts of the requirements and systems, and listening and appreciating others’ perspectives, especially from those who have an easy access to the business domain knowledge, i.e., onshore team members.

6. Limitations

The guidelines for conducting and reporting case study research in software engineering by Runeson and Host [31] distinguishes between four aspects of validity that should be taken into consideration as construct, internal, external and reliability. Construct validity is defined as common understanding and interpretation of interview questions by both researcher and interviewed persons. Most of the interviews (all of offshore interviews) are conducted with participation of both researchers where they have provided complimentary explanations to clarify the questions for the interviewee whenever it was needed to avoid misunderstandings. Moreover, the nature of semi-structured interview has provided us to ask for elaborative answers and getting into discussion with the interviewee to make sure the both parties are having the same understanding of the interview questions. As nature of case study research, results would be dependent to particular arrangements of the case. Thus, in terms of external validity, our findings cannot be generalized to all cases. However, they can be applicable to the cases with similar arrangements.

Runeson and Host [31], define reliability of analysis as to the extent another researcher can report the same results emphasizing particularly on the clarity of coded data and interview questionnaire. All of our interviews were audio recorded and transcribed for sake of validity and refer ability. However, as of qualitative research, the findings mainly result from researcher’s interpretation of the data[36], [7]. Although all the main findings have been discussed and verified by both researchers there are always rooms for biased interpretation of data. Moreover, our findings are mainly based on conducted interviews and are lacking triangulation of resources. However, we consider interview as rich source of data specially having interviews from both perspectives of onshore and offshore centres have also helped us to see the overall picture and collect quite rich data. We should note that, although we did not conduct any observation practice, spending time at offshore centre and having short
discussions with the team members helped us to leverage our understanding about the team atmosphere and putting our findings into right context.

7. **Implications for research and practice**

The research results provide empirically found information that can be useful for practitioners’ understanding about designing and implementing ETM in GSD with appropriate structures in terms of the provision of affording different means of supporting collaboration and coordination. Practitioners can take into account the formation of the studied structures and the roles introduced to support the implemented structures and the potential strengths and weaknesses of the strategies reported while considering the introduction of ETM for their GSD projects. The findings can also enable them to assess the extent to which the studied structures and the affordances provided by them could help address the GSD challenges. They can also collaborate with researchers, including us, to try the reported model and strategies and provide feedback in order to contribute to the body of knowledge on this topic. The researchers can use the results in several ways. For example, the results can provide a reference framework for further research on different aspects of ETM in GSD, especially the influence of the interplay among different structures (i.e., work, communication, and social) on enabling or hindering coordination and collaboration in ETM. Studies should also be conducted to determine if the social structure incorporating social networking technologies (e.g., Twitter, Facebook, and Linked In) could have positive or negative impact on work structures and productivity. It is also hoped that the results of this study will stimulate researchers to discover the underlying factors that lead to and/or influence the use of different structures for implementing ETM. Moreover, research is also needed to provide a framework for selecting appropriate GSD technologies for different types of structures for supporting ETM arrangements.

8. **Acknowledgement**

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9. References

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