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AGILE GLOBAL SOFTWARE DEVELOPMENT COMMUNICATION CHALLENGES: A SYSTEMATIC REVIEW

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Abstract

Organizations have shown a significant interest in adopting human and communication-oriented agile practices for Global Software Development (GSD). Agile practices originated in the context of small and medium co-located project teams present a number of communication challenges when they are applied to the distributed GSD. There is a need to understand the underlying communication challenges of agile GSD environment. This paper adopts a Systematic Literature Review (SLR) approach and reports communication challenges in the agile GSD context. A customized literature search and selection criteria was first developed and then applied to initially identify a set of 449 papers. Finally, 22 of 449 papers, relevant to this research, were selected for this study. These final 22 papers were reviewed and 7 major categories of communication challenges were identified in the context of agile GSD. The review results of this paper are expected to help researchers and practitioners to understand communication challenges of agile GSD and develop tools, techniques and strategies to deal with these challenges. This paper is limited to the number of reviewed studies from selected databases.

Keywords: Global software development, Communication challenges, Agile approaches, Systematic literature review.

1 INTRODUCTION

Agile principles and practices (Agile Manifesto 2001) combined with Global Software Development (GSD) seem to offer several benefits such as lower production cost, around the clock development, faster time to market and the liberty of involving the most talented developers around the world (Herbsleb & Mockus 2003). Despite these lucrative benefits, agile GSD has its own challenges. One of the most important challenges is the effective and efficient communication between distributed teams and customers (Herbsleb & Moitra 2001; Korkala & Abrahamsson 2007; Paasivaara & Lassenius 2010). One of the major risks to agile GSD is that of poor communication (e.g., delivering an incomplete, inaccurate, or inadequate message) (Herbsleb & Moitra 2001). Gill and Bunker (2013) stated that human communication and knowledge sharing is a primary concern of distributed global agile development environments. GSD communication is criticized with its too much dependence on technology (Korkala & Abrahamsson 2007).

Agile development focuses on active face-to-face communication among co-located teams as contrary to geographically dispersed GSD teams (Korkala & Abrahamsson 2007). Agility brings both benefits and challenges to GSD such as of communication challenge. As the interest of using agile approaches in GSD has been increasing, the literature on communication challenges as well as communication techniques and strategies of using agile GSD have been increasing as well. There is a need to study communication challenges in agile GSD and develop or use tools, techniques and strategies to address them (e.g., Gill, Bunker & Seltsikas 2012; Layman et al. 2006).

The objective of this research paper is to address the above gap through identifying, synthesizing and presenting the communication challenges of agile GSD. This paper addresses the following research question:

RQ: What is currently known about the communication challenges in the context of agile GSD?

This paper adopts the well-known Systematic Literature Review (SLR) method to identify and synthesize communication challenges in agile GSD. SLR provides a structured and systematic approach to identify, select and synthesize recent literature relevant to the research question, which is being addressed in this paper (Kitchenham & Charters 2007).

This paper is organized as follows. Firstly, it presents the research background. Secondly, it discusses the research method. Thirdly, it presents and discusses the research findings. Finally, it discusses research limitations before concluding in section 7.

2 BACK GROUND

Agile approaches depend heavily on face-to-face active communication and coordination among co-located team members and customers (Qumer & Henderson-Sellers 2006). This kind of communication (i.e. agile communication), in the co-location and local context, results in saving time, effort and reducing documentation for increasing customer satisfaction and benefits (Qumer & Henderson-Sellers 2008). The success of agile in small and medium environments encourages large software development organizations to adopt agile approaches in GSD environment. However, applying agile in GSD is not straightforward and possesses many challenges especially communication related challenges. Herbsleb and Mockus (2003) argue that an agile project in GSD takes 2.5 times more than the same project in the local agile context. However, it is not practical to assume that every project can or should be delivered using co-located agile teams. Hence, no wonder that many researchers and practitioners are showing interest in investigating the issue of agile communication in GSD.

A number of recent studies have been reported that discuss the issue of agile communication in GSD (e.g., Ali Babar et al. 2009; Kuusinen et al. 2012). Ali Babar et al. (2009) argue that the biggest problem of agile communication in GSD is the cross-teams' communication and the ideal way to solve this issue can be through reducing the cross-teams' communication. Kuusinen et al. (2012)

argue that the main problems that agile team face in distributed environment were due to process management and communication. The problem of communication in GSD may be due to the inability to have face-to-face conversation, lack of frequent feedback between user experience designer and the architect teams, and lack of synchronization between different distributed teams (Kuusinen et al. 2012). The ineffective communication may lead to issues such as lack of cooperation between different distributed teams, and lack of understanding of the customer requirements (Kuusinen et al. 2012). Also, it was mentioned that communication can be challenging for multiple projects engagement for one developer, when the responsibilities are not clear, or when the stakeholders expect written formal documents (Hummel et al. 2013). However, other studies reported that agile way of informal communication in complex distributed GSD projects is problematic when it is compared to simple co-located agile projects (Korkala & Abrahamsson 2007). Moreover, too much informal communication represents a challenge especially with weak communication skills of the project members, and also inadequate technology that can hinder communication with external parties or teams (Hummel et al. 2013). There is a need to systematically study and address communication challenges of agile GSD. There are no such studies (such as proposed here using SLR) published in the public domain that discuss the communication challenges of agile GSD. Therefore, this research paper aims to fill this literature gap and uses SLR to explore and investigate the challenges that impact communication among teams working in the agile GSD environment. It also explores the current techniques and strategies that can be used to reduce the negative impact of or address the identified agile GSD communication challenges.

3 RESEARCH METHOD

This paper adopted Kitchenham and Charters (2007) guidelines for conducting SLR. SLR includes several activities such as literature review procedure, selecting the primary studies, synthesizing selected studies' data and introducing the final SLR results. These guidelines were followed in this paper. The main objective of this paper was to answer the following questions:

RQ: What is currently known about the communication of agile GSD? (Main Research Question)

This study focuses on the following two sub questions related to the main research question:

RQ1. What are the challenges or factors that limit the communication in GSD?

RQ2. What strategies, techniques or practices are being used to deal with these challenges to enhance communication in agile GSD?

Papers that were written in English language were searched through available online electronic databases. Electronic databases were searched as well as some of conference proceedings on the use of agile approaches in GSD being manually searched. The following electronic databases were used.

- IEEEXplore (www.ieeexplore.ieee.org/Xplore/)
- ACM Digital library (www.portal.acm.org/dl.cfm)
- Elsevier Science Direct (www.sciencedirect.com/)
- SpringerLink (www.springerlink.com/)
- Google Scholar (<http://scholar.google.com.au/>)

The reviewed papers range from experience (i.e. industry), theoretical literature, empirical (interviews or surveys) and experimental academic papers. Table 1 shows the terms and keywords that were used to run the first stage of the search. All items from the first category (i.e. "Communication Practice") were combined with the second category (i.e. "Global Software Development") by using the Boolean "AND" operator, which entails that an article that focuses on both "Communication Practices" and "Global Software Development", will be retrieved.

Following the citation procedure reported by Dybå and Dingsøyr (2008), second and final stages of searching are shown in table 2. This table summarizes the assessment method and criteria for each stage. As there is a lack of existing empirical studies, we also considered experience opinion, literature review and work shop papers that address the GSD communication. To ensure that reviewed

paper addresses the research title, screening criteria was used. The paper will be included in this study if it discusses the communication challenges in agile GSD context. The 5 criteria, in the final stage, provided a measure of the extent to which we could be confident that a selected study could make a valuable contribution to our review.

| Search Category | Keywords |
|-----------------------------|---|
| Communication Practice | Agile communication, Software communication, Team communication, Cross-team communication, Offshore communication, Outsourcing communication, Customer communication, Social media communication, Communication tool, Communication technology |
| Global Software Development | Distributed agile, Multi-sites agile, Global agile development, Multi-team agile, Distributed software development, Distributed development, Distributed development teams, Global software development, Global development, Global software engineering, Offshore development, Outsourcing development, Multi-sites development, Global software engineering, Off shoring, Dispersed teams |

Table 1. Search terms

| Filtration stage | Method | Assessment Criteria |
|-----------------------|----------------------|---|
| 1st Search Filtration | Explore the title | Title = search term (s) Yes = accepted No = rejected |
| 2nd Filtration | Explore the abstract | Abstract = communication Yes = accepted No = rejected |
| Final Filtration | Explore the content | Address GSD communication Well-referenced Objective is clear Well- presented argument and justified Clearly stated findings (Yes= accepted, No = rejected) |

Table 2. Assessment method

The search excluded the discussion comments, article, news, summaries, tutorials and panels. Many papers were excluded after the first and second filtrations. Table 3 summarizes each stage papers' numbers and the final selected papers. Only papers that satisfied all criteria (i.e. graded as all “yes”) were accepted. We excluded a number of papers that were published in conferences and extended as journal papers. We only included the comprehensive recently published papers.

| Database | 1st Search Filtration | 2nd Filtration | Final Count |
|---------------------|-----------------------|----------------|-------------|
| IEEEExplore | 196 | 48 | 9 |
| ACM Digital library | 92 | 23 | 5 |
| SpringerLink | 86 | 19 | 4 |
| Google Scholar | 50 | 12 | 3 |
| Science Direct | 25 | 10 | 1 |
| Total | 449 | 112 | 22 |

Table 3. Search results

4 FINDINGS

The findings of this study have been presented in two stages. The first stage has presented, quantitatively, the focus of selected studies as shown in table 4 and the number of selected studies that

used a specific strategy as shown in table 5. In this stage, data was synthesized from each paper using a number of variables: type of article (i.e. journal, conference or workshop), aims of the paper, bibliographic reference (i.e. title, author's name, year and source), study strategy (e.g., experience, literature, workshop, and so on), and study focus (i.e. empirical or not empirical). Table 4 shows that the percentage of empirical studies is 54 %, which shows the importance of studying communication issue of agile GSD. This research also found that most of the selected studies were started after 2009. Most of the selected studies were conducted on one or more of agile methods. Table 5 shows that the highest number was 9 papers for interview strategy as the preferred strategy in empirical agile studies. The second highest number was 8 papers of literature review.

| Study Focus | Number of Papers | Percentage | Authors |
|--|------------------|------------|----------|
| Empirical Study (Interview, survey, implementation, analysing) | 12 | 54 % | S1- S12 |
| Literature Experience Workshop | 10 | 46 % | S13- S22 |

| Study Strategy | Count |
|-----------------------------------|-------|
| Interview | 9 |
| Literature review | 8 |
| Experience | 4 |
| Observation | 2 |
| Analyzing files (Logs, Email, IM) | 2 |
| Implementation | 1 |
| Survey | 1 |
| Workshop | 1 |

Table 4. Focus of selected studies

Table 5. Strategy of selected studies

The second stage has analyzed and interpreted the data from the selected studies in order to answer the research questions, and presented the categories of communication challenges in the context of agile GSD as shown in table 6. Data was extracted from each of the 22 primary studies included in this systematic review using the *Grounded Theory* coding techniques (Glaser 1978). 21 agile GSD communication challenges were identified. Some challenges were combined if they had same definition. For example, "organizational structure" and "organizational distance" were both defined as the difference in distributed teams/ organisations' structure even though they are part of the same mother organisation. Here we merged both challenges under organizational structure. These 21 challenges then coded into 7 categories. Each category has one or more challenges. These categories as well as the statistics in table 6 are discussed in the following paragraphs.

| Challenges | Sources | Frequency (number of studies) | Percentage |
|-------------------------------|--|-------------------------------|------------|
| People Differences | S13, S1, S2, S3, S18, S19, S20, S6, S7, S8, S21, S11, S12, S22 | 14 | 64% |
| Distance Differences | S13, S16, S2, S3, S18, S19, S20, S6, S8, S21, S12, S22 | 12 | 55% |
| Team Issues | S14, S1, S15, S17, S3, S4, S18, S20, S11 | 9 | 41% |
| Technology Issues | S3, S5, S19, S8, S21, S10, S11 | 7 | 32% |
| Architectural Issues | S14, S18, S6, S11, S12 | 5 | 23% |
| Processes Issues | S21, S11, S22 | 3 | 14% |
| Customer Communication | S21, S9, S10 | 3 | 14% |

Table 6. Communication challenges of agile GSD

4.1 People Differences

4.1.1 Category Description

This category refers to the language, cultural, trust, personal skills, and personal attitude differences among the agile GSD teams and team's members. This category has been heavily referenced in the literature and makes up the highest percentage (i.e. 64%) in the selected studies.

4.1.2 Challenges

A number of people differences related issues have been identified and reported in this study: language misunderstanding and less mutual understanding (Agerfalk et al. 2005), confusion among the team (Hummel et al. 2013), work diversity (Jaanu et al. 2012), different interpretations to the negative and sensitive issues of the project (Kamaruddin et al. 2012), personal (or group) attitudes (Martini et al. 2013), and longer time for information and knowledge sharing (Boden et al. 2007).

4.1.3 Strategies/ Techniques or Practices

Authors have recommended some strategies to deal with the identified challenges(e.g., Hummel et al. 2013): forcing members to communicate, synchronizing working hours, distributing work within same time-zone, enhancing trusted relationships and shared understanding through exchanging visits, one team need to be physically co-located, using multiple communication modes, keeping the interaction to a minimum in GSD by splitting the project into small parts that can be implemented independently, and increasing the communication formality by using documentation such as architectural designs and project plans.

4.2 Distance Differences

4.2.1 Category Description

Most selected studies have described differences in geographical context and time-zones as "distances", however; some studies have grouped them together (e.g., Wu 2012). This study refers to different time-zones and different geographical contexts as "distance differences". Two common characteristics of distance differences have been defined in the context of GSD: time (temporal) and geographical distance (Agerfalk et al. 2005). Agerfalk et al. (2005) define temporal distance as the dislocation in time that is experienced by two actors wishing to interact. Geographical distance can be measured by the effort that paid by an actor to attend the other actors location (Agerfalk et al. 2005). This category has been paid a significant attention in the selected studies as a challenge for agile GSD, in general, and for GSD communication and collaboration specifically. This category makes up the second highest percentage (i.e. 55%) in the selected studies. Many studies have reported that the main issue of agile GSD is the communication due to the geographical distances and the time-zones differences (Korkala & Abrahamsson 2007; Korkala et al. 2009).

4.2.2 Challenges

The selected studies have mentioned that the differences in geographical context and time-zones adversely impact agile communication between agile GSD teams or team's members such as delayed feedback on work products (Agerfalk et al. 2005; Hossain et al. 2009), miscommunication between teams or team's members (Hummel et al. 2013), and limited communication and coordination between teams or team's members (Jaanu et al. 2012).

4.2.3 *Strategies/ Techniques or Practices*

This study also identified a number of strategies to address the issues related to distance differences: synchronize the work hours among the distributed team members, create local teams for each geographical or same time-zone area, increase the local meetings, hold strict meetings so that all members need to attend or share, reduce the number of the whole distributed project meetings, use asynchronous tools (e.g., wiki, email, and so on), use project management tools, use backlog management tools, use tracking systems, enhance regular visits and face-to-face communication, document key actions, split the project into small parts, and centralize the experts at home country (Agerfalk et al. 2005; Hossain et al. 2009; Hummel et al. 2013; Wu 2012).

4.3 **Team Issues**

4.3.1 *Category Description*

This category refers to team size, distribution (i.e. locations and number of teams), team-work (i.e. cross-teams' projects), and cross-teams' communication. This category has been given a medium attention in the selected studies. This category makes up 41% of the selected studies, which is the third highest percentage. However, other studies assumed this category as one of the distances or categorized under distances (i.e. time-zones and geographic). Ali Babar et al. (2009) argue that the biggest problem of agile approaches in GSD is the cross-teams' communication.

4.3.2 *Challenges*

The selected studies have mentioned that the large distributed teams that depend on team-work adversely impact agile communication between agile GSD teams or team's members such as slowing down the communication speed, mismatching in processes, practices, values and attitudes (Martini et al. 2013), and less collaboration (Kamaruddin et al. 2012).

4.3.3 *Strategies/ Techniques or Practices*

A number of strategies were identified in this study to address the team issues (Ali Babar et al. 2009; da Silva et al. 2010; Downs et al. 2010; Martini et al. 2013): promote provision training on collaboration and coordination tools, provide multiple communication modes and tools including support to face-to-face synchronous communication, create communication protocols, promote informal interactions, apply agile practices (e.g., Scrum), deploy knowledge transfer mechanisms, promote visits among distributed sites, deploy and use a configuration management system, synchronize meetings (i.e. to set up meetings at times reasonable for most teams), start a new project with face-to-face meeting with all teams, reduce the cross-teams' communication, use architectural communication documentation, use monitoring systems that encourage collective and individual responsibilities, promote mutual trust among team members, and rotate the staff between different roles of agile project on a regular basis.

4.4 **Technology Issues**

4.4.1 *Category Description*

This category refers to the tools and infrastructure capabilities that support agile GSD communication needs. This category has been mentioned in 32% of the selected papers, however; tools that are used in GSD, either synchronous (e.g., phone, instant messaging IM) or asynchronous (e.g., email) (Kuusinen et al. 2012) have been given high attention in these 32% of the selected papers.

4.4.2 *Challenges*

A number of technology related issues were identified and reported in this study: unsuitable tools used by agile team, technical incompatibilities between different sites, unreliable with poor transmission tools (Kamaruddin et al. 2012), and conflicts on the preferred technology and delays due to incompatibility of artifacts (Martini et al. 2013). Recently, an empirical study was carried out by Gill and Bunker (2013) to develop a comprehensive tool to be used for agile GSD. The authors identified 14 categories (issues) that need to be taken into account for communication tools namely; (1) technology use case; (2) business value; (3) quality; (4) type; (5) constraint, (6) risk, (7) interface management, (8) mode, (9) access control, (10) semantic interoperability, (11) contingency and disaster recovery, (12) communication channel, (13) dependency and (14) recommendation. Using these 14 categories, agile practitioner can choose the most appropriate tool to be used for the best communication of agile GSD.

4.4.3 *Strategies/ Techniques or Practices*

This study also identified a number of strategies to address the technology issues through: offering different communication tools, promoting group chat and using communication models (Hossain et al. 2009; Lanubile et al. 2003). In addition, using communication technologies assessment tool (CTAT) can assist agile teams in GSD environment to self-assess and select the most appropriate tool to communicate with other teams or team's members (Gill & Bunker 2013).

4.5 Architectural Issues

4.5.1 *Category Description*

This category refers to architecture, organizational structure (i.e. distributed teams have different organizational structures), managerial structure (i.e. distributed teams have different managerial structures), and project domain. This category has been rarely mentioned in the literature. It makes up only 23% of the selected studies. Most of the findings have indirectly pointed to architecture. Martini et al. (2013) argue that the challenges in architectural issues are related to misunderstanding or an unnecessary flow of communication due to the definition of a system and software structure.

4.5.2 *Challenges*

The lack of appropriate architecture decreases the knowledge sharing and communication among agile GSD teams and team's members (Jaanu et al. 2012), and represents a communication barrier through misunderstanding or an unnecessary flow of communication due to the insufficient definition of a system and software structure (Martini et al. 2013).

4.5.3 *Strategies/ Techniques or Practices*

This study identified some strategies to deal with this problem through: increasing the trust among the globally distributed teams and members, increasing the transparency regarding a project, increasing common interest such as project and team goals, and providing organizational chart to all teams and members (Jaanu et al. 2012). Also, architectural issues can be addressed by using reference architecture and agreement on the project's requirements by all teams and members at the beginning of the project (Martini et al. 2013).

4.6 Process Issues

4.6.1 Category Description

This category refers to the communication processes (i.e. how communications are made between distributed teams), level of control, and commitment of developers when making communication in agile GSD. It has been noticed that this category has not been discussed enough in the available surveyed literature and mentioned only in 14% of the selected studies.

4.6.2 Challenges

A number of process issues have been identified and reported here: unclear responsibilities and confusion among the agile GSD teams (Wu 2012), less team spirit, less goals sharing and technical knowledge throughout the teams (Kamaruddin et al. 2012), unnecessary communication, no match between different processes, and lack of communication opportunities between members (Martini et al. 2013).

4.6.3 Strategies/ Techniques or Practices

Some strategies were identified here to deal with this problem: frequent face-to-face communication and coordination to discuss the strategic elements such as overall strategy and local processes (Martini et al. 2013), using documentation and standards for the common design and goals, and monitoring project's teams and members (Wu 2012).

4.7 Customer Communication

4.7.1 Category Description

This category refers to communication with customer (i.e. who makes requirement regarding a project). This category has not been given enough attention too. It makes up only 14% of the selected studies. In agile development, customers have to be involved in the development process and the project information must not be hidden from them (Korkala et al. 2010). However, in agile GSD environment, active customer communication might be difficult to achieve.

4.7.2 Challenges

The previous studies reported that lack of customers' involvement results in weak relationship with them and miscommunication of customer's requirements which may lead developers to either use their experience or guess the customer's requirements (Kamaruddin et al. 2012).

4.7.3 Strategies/ Techniques or Practices

This study also identified some of the strategies to address the issues related to customer communication: enhance the rapid communication, promote regular agile meeting and customer involvement (Korkala et al. 2010), and promote the existence of customer's representative who plays the role of the customer up front (Layman et al. 2006).

5 DISCUSSION

There is a growing interest in agile GSD, which marks the need for more empirical studies to understand the agile GSD related issues and solutions. It is arguable whether or not agile practices can be used in GSD environment due to the communication issue. However, the number of publications in

this topic is increasing. In this paper, most selected papers and empirical studies were published after 2009. All 12 selected empirical studies reported the possibility of overcoming agile GSD communication issue. Despite these possibilities and related successes, the communication mechanisms of reaching high communication efficiency are not well understood. These findings highlight a vital research gap that needs more attention. Hence, there is a need for more empirical studies in the field of agile GSD communication.

Our findings revealed that people differences and distance differences due to stakeholder's distribution were the most reported challenges' categories to agile GSD communication. Other challenges' categories were rarely reported although they may highly affect agile GSD communication. For example, architectural issues were reported only in 5 studies, 3 empirical studies were reported them out of the 5 studies. Only 2 empirical studies directly highlighted these issues and mentioned that the system and software architecture has an important role in enhancing agile GSD communication.

Our findings also revealed that the emerging cloud-based distributed and social technologies (e.g., Skype, Chatter, Yammer) can be used to support and enhance agile GSD communication (Gill and Bunker 2011). Agile GSD teams need to communicate in a distributed environment to carry out various tasks and meetings. Agile GSD teams, working in a distributed environment, may use some supporting distributed practices such as synchronizing work hours, creating local teams, increasing local meetings, using strict communication policy, reducing the number of distributed team's meetings and so on. To increase the team collaboration and reduce the cultural differences, agile GSD communication can be supported by some practices including team gathering at the beginning of each project, exchanging visits, mandatory presentation for all team's members, maintaining key documentation and so on.

Further, in future, the findings of this studies will be looked into from the perspectives of related IS theories such as *Activity Theory* (Engeström 1999), *Structuration Theory* (Giddens 1984), *Adaptive Enterprise Service Systems Theory* (Gill 2013). *Activity Theory* refers to human activities (e.g., communication) as complex and socially situated phenomena (Engeström 1999), which seems relevant and useful for studying agile GSD. *Structuration Theory* refers to creation and reproduction of social system (e.g., agile GSD communication system) based on the analysis of both "Structure" (i.e. patterned arrangements) and "Agents" (i.e. capacity of individuals to act independently) (Giddens 1984). *Adaptive Enterprise Service Systems Theory* refers to enterprise system (e.g., agile enterprise) as a multi-agent system of service systems (e.g., agile GSD communication system) that exhibits agility and focuses on the emerging service-centric view of the agile or adaptive enterprise (Gill 2013). This theory provides a framework for establishing an adaptive or agile GSD capability and its integration with other capabilities such as agile enterprise architecture, strategy, requirement, project and service management. The findings of this study will be further reviewed through the lens of these relevant theories for developing the new agile communication framework and models in the context of agile GSD.

6 LIMITATIONS

Similar to any other SLR studies, this study has some limitations. One may argue the use of limited number of selected search databases and a finite number of search strings. This study collected papers from well-known databases, and we have full confidence that the selected databases and search strings provided us with enough recent literature to review for identifying the current agile GSD communication challenges. The other important limitations of this SLR are the bias in the selection of publications and inaccuracy in data extraction. To help to ensure that the process of selection was unbiased, we developed a research questions, identified keywords and search terms that would enable us to identify the relevant literature. However, due to keywords and search strings used, there is a risk that relevant studies were omitted. To avoid selection bias, we followed a systematic review process (i.e., search strategy) in order to clarify weaknesses and refine the selection process. To further ensure the unbiased selection of papers, we utilized a multistage process for the inclusion and exclusion of

each paper. As a results of inclusion and exclusion criteria (as discussed earlier), only final 22 relevant studies matching to our research question were selected and reviewed in detail in this study.

7 CONCLUSIONS

This paper presented a SLR of communication challenges of agile GSD. This study identified a number of challenges that need to be addressed for establishing an effective and productive agile GSD. The findings of this study have been presented in two stages. Firstly, it reports the research focus and the number of selected papers. Secondly, it reports the data that was analyzed and interpreted from the selected studies in order to answer the research questions. This study enabled us to build the current state of the art about communication challenges of agile GSD. This study provides a knowledge-base to agile practitioners and researchers who have interest in agile GSD. The findings of this study will be further used in developing a comprehensive survey for empirical study in agile GSD. The empirical study results will be used to develop a comprehensive theoretical-based practical agile GSD communication framework. The empirical study results and the resultant agile GSD communication framework will be reported as an ongoing contribution to community.

Appendix A: Papers included in the review

- [S1] Ali Babar, M., Ihme, T. and Pikkarainen, M. (2009). An industrial case of exploiting product line architectures in agile software development. In Proceedings of the 13th International Software Product Line Conference, Carnegie Mellon University, 171-179.
- [S2] Boden, A., Nett, B. and Wulf, V. (2007). Coordination practices in distributed software development of small enterprises. Global Software Engineering, ICGSE 2007. Second IEEE International Conference on, IEEE, 235-246.
- [S3] Dorairaj, S., Noble, J. and Malik, P. (2011). Effective communication in distributed agile software development teams. Agile Processes in Software Engineering and Extreme Programming, Springer, 102-116.
- [S4] Downs, J., Hosking, J. and Plimmer, B. (2010). Status communication in agile software teams: A case study. Software Engineering Advances (ICSEA), 2010 Fifth International Conference on, IEEE, 82-87.
- [S5] Gill, A.Q. and Bunker, D. (2013). Towards the development of a cloud-based communication technologies assessment tool: An analysis of practitioners' perspectives. VINE, 43 (1), 57-77.
- [S6] Jaanu, T., Paasivaara, M. and Lassenius, C. (2012). Effects of four distances on communication processes in global software projects. Empirical Software Engineering and Measurement (ESEM), 2012 ACM-IEEE International Symposium on, IEEE, 231-234.
- [S7] Jensen, R.E. (2012). Communication breakdowns in global software development teams: Is knowledge creation the answer?. In Proceedings of the 17th ACM international conference on Supporting group work, ACM, 289-290.
- [S8] Junior, I.H., Azevedo, R.R.d., Moura, H.P.d. and Silva, D.S. (2012). Elicitation of communication inherent risks in distributed software development. Global Software Engineering Workshops (ICGSEW), 2012 IEEE Seventh International Conference on, IEEE, 37-42.
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