

Research Article

Communication Risks and Best Practices in Global Software Development during Requirements Change Management: A Systematic Literature Review Protocol

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Abstract: Currently, software systems are becoming an essential part of business in the world. The majority of the software production companies are adopting Global Software Development (GSD) and it is incessantly getting faster. Most of the software development organisations are trying to globalize their study worldwide in order to get the different benefits. However, GSD is not a simple task and the organizations face various challenges. But communication is a major issue and it becomes more complicated during the Requirements Change Management (RCM) in the context of GSD. This research will explore communication risks, their causes, negative effects and those mitigation practices which can be used to allay communication risks during the RCM process. A Systematic Literature Review (SLR) protocol has been developed and the implementation of the protocol is in process. The SLR protocol provides in depth and more comprehensive results than common literature review.

Keywords: Communication, global software development, requirements change management, systematic literature review

INTRODUCTION

Recently most of the software organizations are globalizing their software development activities (Khan *et al.*, 2012). In GSD the organizations performed the software development under various boundaries such as temporal, geographical and socio-cultural distances (Helena *et al.*, 2006; Smite *et al.*, 2008). Nowadays GSD is the necessity of software development organizations. Proximity to market, access to skilled labor pool, improving time to market and low labor cost have motivated different organizations to globalize their studies (Bass *et al.*, 2009; Helena *et al.*, 2006; Herbsleb *et al.*, 2005; Smite *et al.*, 2008).

Along with the different benefits GSD also faces different challenges. Some of the researchers stated that 3 Cs-Coordination, Communication and Control are the three main factors for the failure of global software projects (Bass *et al.*, 2009; Herbsleb, 2007; Herbsleb and Mockus, 2003; Herbsleb *et al.*, 2005). Due to these three factors GSD has become risky and more challenging (Carmel, 1999; Korkala and Abrahamsson, 2007).

In GSD requirements continuously change during the software development life cycle. Requirements Change Management (RCM) process is one of the most serious activities and it poses significant difficulties

with distributed software development teams (Sengupta *et al.*, 2006). The lack of proper RCM may lead to software failure or even loss of business as well however managing change is rewarding but challenging at the same time (Ramzan and Ikram, 2005).

It is very difficult to manage change requirements due to certain communication and coordination challenges.

Communication is one of the major issues during RCM in global software projects due to temporal, geographical and cultural distances (Casey and Richardson, 2008; Huang and Trauth, 2007; Moe and Šmite, 2008). In GSD during RCM, communication process is low as compare to collocated single site software development (Bass, 2006) and there is a lack of face to face communication in GSD (Moe and Šmite, 2008).

Different studies have discussed communication risks and their mitigation practices in GSD but those studies are not focused on the causes and effects of those risks (Smite *et al.*, 2010).

So there is a need to identify risks that causes communication challenges during RCM in GSD. The objectives of this research are to explore different communication risks and their mitigation strategies by conducting SLR. A SLR is a distinct way of

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categorizing, assessing and analyzing the published studies in order to explore a specific research question.

There are two research questions that have been developed in order to find out the different communication risks.

RQ1: What are the communication risks, their causes and negative effects in GSD during RCM?

RQ2: What are the recommendations that can help GSD organization to avoid the communication risks during RCM?

LITERATURE REVIEW

Globally distributed software development was introduced very earlier on before the word GSD. According to Lee *et al.* (2000) in 1970's the "contract programming" method was introduced in which some part of the software system was outsourced to another organizations for development. In 1990's due to the shortage of work force, the US software development organizations start another trend of global software development which became very popular between the software development organizations (Aspray *et al.*, 2006). In GSD the software development organisations relocated their development process in other countries in order to get more benefits (Sangwan *et al.*, 2006). Most of the organizations are globalizing their studies in different other countries where the workers' wages are low. By doing this the organizations get very fast and cheap software development. In GSD the organizations can get access to the skilled work forces throughout world. Similarly in GSD the people from different cultural backgrounds work together and share their ideas which can result in new innovative ideas and practices which might be useful for the organizations (Eoin *et al.*, 2006; Herbsleb and Mockus, 2003; Herbsleb and Moitra, 2001; Smite *et al.*, 2010).

Beside various benefits, GSD is affected from three different factors i.e., the temporal distance, geographical distance and socio cultural distance. GSD is affected from these three factors and faces three main challenges i.e., communication, coordination and control during RCM. In these three challenges Communication is important in any development process and communication issues lead to coordination and collaboration issues (Helena *et al.*, 2006). In GSD the communication frequency is low as compare to the collocated software development.

SYSTEMATIC LITERATURE REVIEW PROTOCOL FOR COMMUNICATION RISKS DURING RCM IN GSD

According to Kitchenham and Charters (2007) there are three main steps in order to perform SLR i.e., planning the review, conducting the review and reporting the review. In this research only the first step of the SLR will be describe in order to define the SLR

protocol. The SLR protocol will define the purpose and the procedure for the literature review. SLR protocol will be use as a guide line for remaining steps of the SLR.

DEVELOPING SEARCH STRINGS

The following detail will help in designing search strings relevant to our research questions.

- **Targeted population:** The population of this study includes all functional groups involved in GSD projects, such as project management, analysis and design, coding and testing.
- **Intervention:** Communication risks or issues or problems.
- **Outcome of relevance:** Best practices in context of Global Software Development (GSD) during Requirements Change Management (RCM).
- **Experimental design:** Exploratory study, Empirical study.

Our research questions contain the following above information.

RQ1: [What are the communication risks, their causes and negative effects?] "INTERVENTION" in [GSD] "POPULATION" during [RCM] "OUTCOME OF RELEVANCE".

RQ2: [What are the recommendations?] "OUTCOME OF RELIVENCE" that can help [GSD organizations] "POPULATION" to avoid [communication risks during RCM] "INTERVENTION".

SEARCH STRATEGY

Identifying search terms: The Following strategy has been developed in order to construct search terms:

- Derive the major terms from the research questions, by identifying population, intervention and outcome of relevance
- To derive the major terms, search for alternative spellings and synonyms
- verify the keywords in any relevant papers
- If the database allow, use Boolean "OR" operator to integrate alternative spellings and synonyms and use the "AND" operator to integrate the major terms

Results for 1:

RQ1: Communication risks, causes, negative effects, Global Software Development, Requirements Change Management

RQ2: Recommendations, Global Software Development organization, communication risks, Requirements Change Management.

Results for 2:

RQ1:

Communication Risk: (“Communication Risk” OR “Communication issue” OR “Problem in Communication” OR “Risk Communication” OR “Communication threats” OR “Communication barriers”).

Cause: (“Causes” OR “reason” OR “root” OR “basis” OR “source” OR “origin”).

Negative effect: (“negative effect” OR “harmful impact” OR “relationship breakup” OR “weak consequences” OR “disappointment” OR “dissatisfaction” OR “unhappiness” OR “dire effect” OR “lack of trust” OR “negative response” OR “unconfident” OR “conflict”).

Global software development: (“Global Software Development” OR “offshore Software Development” OR “nearshore outsourcing” OR “Software outsourcing” OR “distributed software development” OR “dispersed software development” OR “multi site software development” OR “virtual team development” OR “onshore software development”).

Requirements Change Management: (“Requirements Change Management” OR “change management” OR “change management system” OR “requirements change management engineering” OR “change management process”)

RQ2:

Recommendations: (“recommendations” OR “practices” OR “mitigation practices” OR “improvements” OR “best practices” OR “safeguard” OR “alleviate OR “suggestions”)

Global software development organization: (“Global Software Development organization” OR “distributed software development companies” OR “offshore software development companies” OR “nearshore outsourcing industry” OR “multi site software development association” OR “onshore software development organization” OR “dispersed software development companies” OR “Information system outsourcing industry”)

Communication risk: (“Communication Risk” OR “Communication issue” OR “Problem in Communication” OR “Risk Communication” OR “Communication threats” OR “Communication barriers”)

Requirements change management: (“Requirements Change Management” OR “change management” OR “change management system” OR “requirements change management engineering” OR “change management process”)

• **Results for 3:** Communication, global software engineering, distributed software development

• **Results for 4:**

RQ1: (“Communication Risk” OR “Communication issue” OR “Problem in Communication” OR “Risk Communication” OR “Communication threats” OR “Communication barriers”) AND (“Causes” OR “reason” OR “root” OR “basis” OR “source” OR “origin”) AND (“negative effect” OR “negative impact” OR “relationship breakup” OR “weak consequences” OR “disappointment” OR “dissatisfaction” OR “unhappiness” OR “dire effect” OR “lack of trust” OR “negative response” OR “unconfident” OR “conflict”) AND (“Global Software Development” OR “offshore Software Development” OR “nearshore outsourcing” OR “Software outsourcing” OR “distributed software development” OR “dispersed software development” OR “multi site software development” OR “virtual team development” OR “onshore software development”) AND (“Requirements Change Management” OR “change management” OR “change management system” OR “requirements change management engineering” OR “change management process”)

RQ2: (“recommendations” OR “practices” OR “mitigation practices” OR “improvements” OR “best practices” OR “safeguard” OR “alleviate OR “suggestions”) AND (“Global Software Development organization” OR “distributed software development companies” OR “offshore software development companies” OR “nearshore outsourcing industry” OR “multi site software development association” OR “onshore software development organization” OR “dispersed software development companies” OR “Information system outsourcing industry”) AND (“Communication Risk” OR “Communication issue” OR “Problem in Communication” OR “Risk Communication” OR “Communication threats” OR “Communication barriers”) AND (“Requirements Change Management” OR “change management” OR “change management system” OR “requirements change management engineering” OR “change management process”)

RESOURCES TO BE SEARCHED

Different databases were selected in order to identify relevant articles, journals, conference papers etc. Data bases were choose on preceding research experience, personal knowledge, preferences or suggested by other researchers (Chen *et al.*, 2010). The databases selected in this research study are listed below.

Publisher’s site: Publishers sites include published research study from their own database (Chen *et al.*, 2010). Followings are our selected publisher’s sites.

- Wiley Inter Science
- IEEE X plore
- Science Direct
- ACM Digital Library
- Business Source Premier
- Springer Link

Index engines: Index Engines consists of index or listing of data published at other published sites (Chen *et al.*, 2010). Following index sites were included in this research study:

- Inspec
- Cite Seer
- Compendex
- Google Scholar
- ISI Web of Science
- Scopus

SEARCH DACOUMENTATION

- During systematic literature review, the explored results should be well reported. Accurate search results documentation is necessary because it will make the search process precise and also makes it replicable (Kitchenham and Charters, 2007).

So for the proper documentation of the SLR results the following data will be recorded:

- Serial No
- Data Base
- Date of search
- Search strategy
- Search query
- Years:
- 2000 (e.g.,)

- Present
- NO of publications Found
- Initial Selection Decision
- Final Selection Decision

STUDY SELECTION PROCEDURE AND CRITERIA

- **Inclusion criteria:** The Inclusion criteria used in this study is to determine which part of literature will be used for the data extraction. In this research only those research studies, research papers and technical reports will be consider which are related to GSD and specifically focus on communication risks in during RCM. The criteria are listed below:
 - Studies that describe Global Software Development
 - Studies that discuss RCM in GSD
 - Studies that describe communication risks, their causes and effects during RCM in GSD Studies that discuss best practices to mitigate the communication risks.

Exclusion criteria: Exclusion criteria used in this study to determine which part of literature should be barred /ignored. The following exclusion criteria were developed:

- Research work that does not focus on Global Software Development
- Studies that do not describe RCM in GSD
- Research work that does not highlight communication issues in GSD
- Studies other than GSD
- **Selecting primary sources:** Primary study will be reviewed on the basis of the following criteria i.e. uniqueness,
- Relevance and full text selection criteria (Table 1).

Publication quality assessment: The quality assessment of the selected research studies will be performed after the final selection of the publication.

Table 1: Review of primary study

Relevance Analysis Phase	Inclusion or Exclusion Criteria
Uniqueness	Check uniqueness of the articles Articles are written in English and published since 1990 Replication not allowed
Relevance	After reading title and abstract expressed the relevancy of the studies to communication issues and mitigation practices in global software development if title or abstract show ambiguity in relevancy than study conclusion and introduction of the articles
Full text selection criteria	Include the studies on the basis of full text reading

Table 2: Data synthesis

Search Area	Paper Title	Authors	Years	Frequency	Percentage
Communication Risks	Title-1	Author-1	-----	Freq-1	-----
	Title-2	Author-2		Freq-2	
	.	.		.	
	.	.		.	
	Title-n	Author-n		Freq-n	
Causes	-----	-----	-----	-----	-----
Effects	-----	-----	-----	-----	-----
Practices	-----	-----	-----	-----	-----

The quality assessment of the selected publications will be done parallel with the data extraction phase. For publication quality assessment the following research questions have been developed:

- Is it clear how communication risks, their causes and effects were evaluated in GSD?
- Is it clear how mitigation practices were identified in GSD?

Each of the above factors will be marked as “yes” or “NO” or “partial”.

- **Data extraction phase:** During data extraction phase a data extraction form will be used, to collect the data from primary selected studies. For this purpose a data extraction form will be developed (Hossain *et al.*, 2009; Smite *et al.*, 2010). This is so that the main elements from each selected study can be easily extracted according to data extraction form. Before going to the actual data extraction phase, author will perform pilot data extraction

DATA SYNTHESIS

The data synthesis is categorized into four parts. The first part will contain the communication risks, second part will contain the cause of those communication risks and the third part will contain the negative effects of the risks. The last part will contain the best practices used to mitigate those communication risks.

The data for both of these parts will be synthesized by constructing a Table 2 having the columns (search area, titles, authors, years, frequency, Percentages).

CONCLUSION AND RECOMMENDATIONS

Various studies have discussed communication risks and their mitigation practices in GSD but so far no SLR method has been conducted for the identification of communication risks and best practices in GSD during RCM. In this study the study plan for the identification of communication risks and best practices is developed in the form of the SLR protocol. This SLR protocol will be used to identify various communication risks, their causes, negative effects and the best practices used to mitigate those communication risks. After conducting the SLR the empirical study will be conducted in the GSD industry in order to validate the findings from literature and identify additional communication risks and their mitigation practices from industry.

REFERENCES

Aspray, W., F. Mayadas, M.Y. Vardi and A.F.C. Machinery, 2006. Globalization and off shoring of software. A Report of the ACM Job Migration Task Force, Association for Computing Machinery.

Bass, M., 2006. Monitoring GSD projects via shared mental models: A suggested approach. Proceedings of the 2006 International Workshop on Global Software Development for the Practitioner, Shanghai, China.

Bass, M., J.D. Herbsleb and C. Lescher, 2009. A Coordination risk analysis method for multi-site projects: Experience report. Proceeding of the 4th IEEE International Conference on Global Software Engineering (ICGSE), Limerick, pp: 31-40.

Carmel, E., 1999. Global Software Teams: Collaborating Across Borders and Time Zones. Prentice Hall, PTR.

Casey, V. and I. Richardson, 2008. Virtual teams: Understanding the impact of fear: Software process. Improvement and Practice, 13(6): 511-526.

Chen, L., M.A. Babar and H. Zhang, 2010. Towards an evidence-based understanding of electronic data sources. Proceedings of the 14th International Conference on Evaluation and Assessment in Software Engineering, UK.

Eoin, O.C., H. Helena, J.A. Par and F. Brian, 2006. Exploring the assumed benefits of global software development. International Conference on Global Software Engineering (ICGSE), Limerick, Ireland.

Helena, H., O.C. Eoin, J.A. Par and F. Brian, 2006. Global software development challenges: A case study on temporal, geographical and socio-cultural distance. International Conference on Global Software Engineering, Limerick, Ireland

Herbsleb, J.D., 2007. Global software engineering: The future of socio-technical coordination. Proceeding of Future Software Engineering (FOSE), Washington, DC, USA.

Herbsleb, J.D. and D. Moitra, 2001. Global software development. IEEE Software, 18(2): 16-20.

Herbsleb, J.D. and A. Mockus, 2003. An empirical study of speed and communication in globally distributed software development. IEEE Trans. Software Eng., 29(6): 481-494.

Herbsleb, J.D., D.J. Paulish and M. Bass, 2005. Global software development at Siemens: Experience from nine projects. Proceedings of 27th International Conference on Software Engineering, New York, USA.

Hossain, E., M.A. Babar and P. Hye-Young, 2009. Using scrum in global software development: A systematic literature review. 4th IEEE International Conference on Global Software Engineering, Limerick.

Huang, H. and E.M. Trauth, 2007. Cultural influences and globally distributed information systems development: Experiences from Chinese IT professionals. Proceedings of the 2007 ACM SIGMIS CPR Conference on Computer Personnel Research: The Global Information Technology Workforce, St. Louis, Missouri, USA.

- Khan, A.A., S. Basri and P.D.D. Dominic, 2012. A propose framework for requirement change management in global software development. International Conference on Computer and Information Science (ICCIS), Kuala Lumpur.
- Kitchenham, B. and S. Charters, 2007. Guidelines for performing systematic literature reviews in software engineering. Schol of Computer Science and Mathematics, Keele University. Technical Report 2, EBSE 2007-001.
- Korkala, M. and P. Abrahamsson, 2007. Communication in distributed agile development: A case study. 33rd Euro Micro Conference on Software Engineering and Advanced Applications, Lubeck.
- Lee, J.N., M.Q. Huynh, K.R. Chi-Wai and S.M. Pi, 2000. The evolution of outsourcing research: What is the next issue? Proceedings of the 33rd Hawaii International Conference on System Sciences, 7: 1-10.
- Moe, N.B. and D. Šmite, 2008. Understanding a lack of trust in global software teams: A multiple-case study. *Software Process. Improvement Pract.*, 3(3): 217-231.
- Ramzan, S. and N. Ikram, 2005. Making decision in requirement change management. 1st International Conference on Information and Communication Technologies (ICICT), pp: 309-312.
- Sangwan, R., N. Mullick and M. Bass, 2006. *Global Software Development Handbook*. Auerbach Publications, Boca Raton, FL.
- Sengupta, B., S. Chandra and V. Sinha, 2006. A research agenda for distributed software development. Proceedings of the 28th international Conference on Software Engineering, Shanghai, China.
- Smite, C.W., T. Gorschek and R. Feldt, 2010. Empirical evidence in global software engineering: A systematic review. *Empirical Softw. Eng.*, 15(1): 91-118.
- Smite, D., C. Wohlin, R. Feldt and T. Gorschek, 2008. Reporting empirical research in global software engineering: A classification scheme. IEEE International Conference on Global Software Engineering, Bangalore.