Effective communication as critical success factor during requirement elicitation in global software development

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Abstract — *Requirements implementation is difficult phase of software engineering. In Global Software Development (GSD) it becomes more difficult to collect user requirements. Effective and proper communication between clients and vendors in GSD has significant role in successful collection of requirements. There is need to analyze how role of effective communication varies for different company sizes, time period experimental methods and from continent to continent. Systematic Literature Review (SLR) is applied to achieve goals and objectives.*

Keywords - Global Software Development; Requirement Engineering; Systematic Literature Review;

I. INTRODUCTION

Requirement engineering (RE) is most significant phase of software engineering which deals with all aspects of software requirements [1]. At first, requirements are collected from users in requirements elicitation phase by applying various requirements elicitation techniques such as background study, interview, prototyping, apprenticing [2]. The collected requirements are analyzed from different perspective using various models such as use case model, sequence model, class diagram. After requirements are being clarified are specified in document known as requirements specification document (SRS). The last phase is verification phase in which requirements of software are checked for accuracy and completeness [3]. The quality of software system depends on the quality of SRS and quality of SRS depends on quality of elicitation phase. This means elicitation is considered to be most important and critical phase of RE. Elicitation phase is quite difficult especially when deal in GSD [4]. GSD is development of software system across the world in which clients are vendors are quite away from each other's and there exist geographical distance between vendors and clients [5][6]. Both vendors and clients face some critical challenges such as culture differences, language barriers, and time zone differences. Due to the stated critical challenges, proper negotiations and discussion on requirements become difficult and we need strong and effective collaborative and advance tools and systems that can facilitate effective communication in GSD [7][8].

II. BACKGROUND STUDY

'Effective and proper way of communication' is a big challenge in GSD. The geographical and physical difference, culture diversity and time zone are the basic source of reasons for miscommunication. According to Jo Hanisch [9] there is close relationship between culture and communication. The problems to culture diversity leads to communication issues. According to Jyoti M. Bhat [10], the reason for reduction in trust is also due to miss communication. The reason is that in GSD teams are separated and normally they communicate over email but this normally doesn't solve issues like face to face communication. According to Neetu Kumari.S [11] lack of communication skills leads to elicitation problems and for which he proposes a framework to reduce this challenge. According to Siva Dorairaj [12] the lack of proper communication is a big challenge and the main causes are lack of communication tools, time zone difference, language barriers, and lack of team work.

Culture diversity is almost the most critical challenge and almost cited as 79% important factor in terms of challenge. Different cultures have different beliefs and approaches. According to Yvonne Hsieh [13], one of the main causes for lack of collaboration is due to difference in culture behaviors. According to Jyoti M. Bhat resolving culture issues can make it very easy to keep team activities on a track [10]. According to Daniela Damian the reason of losing a trust relationship is due to different culture and behaviors and that's why sometime cause misinterpretation of different things [14].

Difference in terminology is also a big challenge and it should be resolved because it also impact the elicitation process. Good understanding to language leads to understanding of requirements. Daniela E. Damian says that customer language is critical activity because it impact requirement elicitation and validation because it affect the transfer of knowledge to developers [15].

Siva Dora raj explains two causes of communication failure are time zone and difference in language. We have mostly seen that client are mostly in UK and USA and vendors are almost in INDIA and time shift of 12 hours exists in these countries ,this is too much difference, Infarct when there is a night in one country there is day and office time in other country. This difference causes problems in proper communication [12].

III. RESEARCH METHOD

Systematic Literature Review (SLR) is being conducted to achieve the objectives. SLR is different from ordinary literature review as it is more planned and methodically executed because in ordinary literature review we randomly search publications without following any systematic and planned procedure [16]. In identifying, analyzing and summarizing all the available data on research questions, SLR provides a greater validity. Several other authors also used the same method to find achieved goals. In this research process, we followed the guidelines proposed by Kitchenham and Charters [17].

3.1 Research questions

To conduct the research and to analyse the challenges, the following questions are formulated.

RQ1. How much authors in their studies have mentioned effective communication system as critical success factor?

RQ2. How are these factors related to the study strategies used?

RQ3. How these factors are vary from one time period to another?

RQ4. Is there any relationship between identified factors and a software company size?

RQ5. Do the identified factors vary from continent to continent?

3.2 Planning the Review

To discuss the plan for review, a systematic review protocol was defined. The plan of research is made on the basis of research questions. The major steps included in the proposed plan are:

- Determine the strategy of searching
- Doing the search for related studies
- To process the papers selection by defining inclusion and exclusion criteria
- Extraction and analyzing data

3.2.1 Review of the objectives

Due to advances in web technologies, GSD bears more importance in recent years. As from literature review we have come to know the significance of RE in GSD but due to the challenges and barriers it is difficult to implement RE successfully. Therefore, an attempt is needed to identify the critical challenges and should prioritize the challenges on the basis of their importance. Moreover, it also required to identify how these challenges vary from continent to continent and what is the effect of these challenges on company size and research methods.

3.2.2 Search strategy

Searching papers relevant to our goals is first step of any SLR. We have to define our search strategy for making SLR protocol. Search space should be defined for SLR, which includes electronic databases and printed proceedings. Initially through reference searches (snowballing) the papers were retrieved from different digital libraries and were studied. Search strings were made and applied for different digital libraries. Inclusion and exclusion criteria were defined for research papers and then finally got a set of finally selected papers.

3.2.3 Search criteria

Plan search strategy for SLR is;

Step1: Major terms derivation: For the derivation of major terms the research questions were used, by identifying population, intervention and outcome.

Step2: Finding the substitute spellings and synonyms for the major terms.

Step3: Using Boolean operators for combination if the library allows. Use "OR" in case of substitute spellings and synonyms and use "AND" in case of combination of major terms.

Results for (step1):

- Requirement engineering
- Factors
- GSD
- Vendors

Results for (step2):

- Requirement engineering: Requirement elicitation OR requirement analysis OR requirement specification OR requirement gathering OR requirement achieving OR requirement execution.
- Factors: Elements OR parameters OR characteristics OR drivers
- GSD: Global software development OR distributed software development OR multisite software development OR offshoring

Results for (step3):

((Requirements engineering OR requirements elicitation OR requirements analysis OR requirements specification OR requirements gathering OR requirements achieving OR requirements execution) AND (factors OR elements OR parameters OR characteristics OR drivers) AND (Global software development OR GSD OR distributed software development OR international software development OR multisite software development OR offshoring) AND (vendors OR "service-provider" OR developer)).

We made search strings for different libraries. Some libraries like IEEE do not take too long search string so we removed some words. Testing an initial search string we made for IEEE is given below:

Requirements engineering OR requirements elicitation OR requirements analysis OR requirements specification OR requirements gathering) AND distributed software development" OR "offshoring.

The final list of sources searched, their search terms, and the number of publications found for each resource are listed in following Table 1.

3.2.4 Publication selection

For selection of particular publication, we define inclusion and exclusion criteria for that. Figure 1 shows the detail of publication selection.

A. Inclusion Criteria: Inclusion criteria are used to determine which piece of literature (papers, technical reports, etc.) found by the search term will be used for the data extraction. We considered every paper related to GSD and RE. Initially we didn't limit our search related to challenges but we intended to have broader picture of RE and GSD. Then applied inclusion and excluded criteria to select limit number of papers. The criteria are listed below:

- Studies that are reported in English language only.
- Studies that describe factors for RE in GSD.
- Studies that discuss software RE process in GSD.
- Studies that evaluate vendor's capabilities for requirement implementation in GSD.

B. *Exclusion Criteria:* Exclusion criteria are used to determine which piece of literature is found by the search term will be excluded. The criteria are listed below:

- Published books will be extracted which are relevant to our studies.
- Studies which are not relevant to the research questions.
- Studies which do not describe the factors which causes continuation/termination/formation of the existing software outsourcing relationships.

C. *Selecting Primary Sources:* Table 1 shows final selected papers.

The planned selection process has two parts:

- Initial selection: It is performed by reviewing the title, keywords and abstract.
- Final Selection: It is performed by reviewing through full text of the papers.

D.   Inter-rater reliability test: In order to reduce the researcher's, bias the inter-rater reliability test was performed where the secondary reviewer selected 5 publications randomly from the list of "total results found" and performed the initial and final selection processes.

The results were compared with the results produced by the Primary reviewer and no disagreements were found.

We have identified 64 papers as shown in Table 1, where the duplicate papers have been removed from the finally selected list of papers.
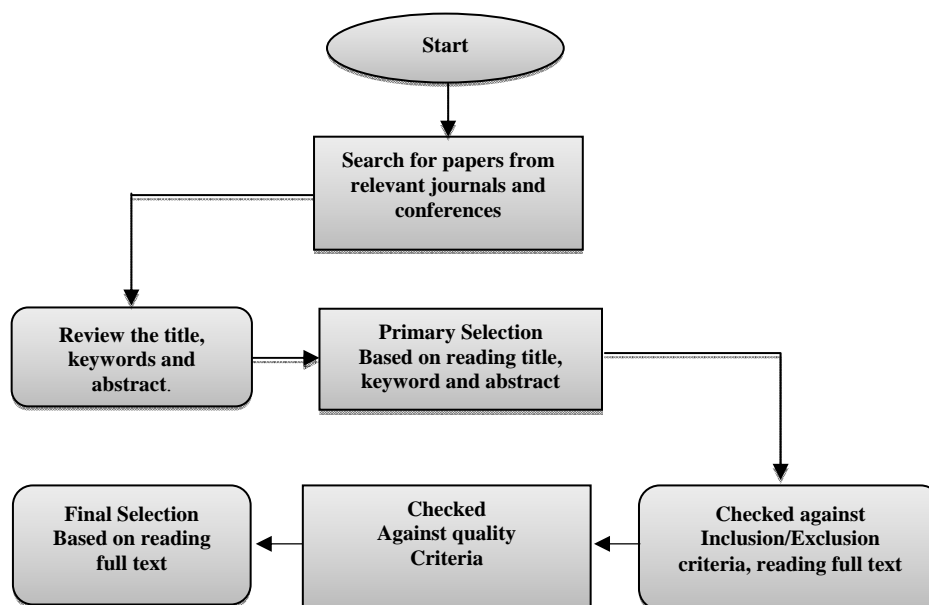

Figure 1: Publication selection process

Table1: Digital resources and extraction of papers

Resource	Total Results	Primary selection	Final selection
IEEE explore	1139	60	24
ACM	1200	15	04
Science Direct	2735	23	05
Springer Link	500	18	05
Others	2500	55	25
Total	8074	171	63

3.3. Conducting Review

The result of search study and retrieval of information from different digital sources are presented in this section.

3.3.1 Study search selection

By applying search strategy as explained in section 3.1.2, 8074 papers were extracted from different digital libraries. In first round, we studied the abstract and conclusion portion of the studies by applying inclusion criteria and this round was named as primary selection The paper that are related to RE in the context of GSD are all included after primary selection and a result we got 171 papers. Then in second round, we applied further exclusion criteria by reading full papers and total of 63 papers were finalized. In this round all those papers were excluded that didn't discuss any challenge.

3.3.2 Data extraction and synthesis

We identified related information from the final list of publications by following the guidelines of Kitchenham [17]. Before data extraction, we first set up a form to record the challenges during RE in GSD. The following data were extracted from each publication: (i) review date; (ii) title; (iii) authors; (iv) reference; (v) database; (vi) methodology (inter-view, case study, report, survey); (vii) data analysis; (xii) country/location of the analysis; and (xiii) year of publication; (ix) company size (small, medium, large).

IV. RESULTS

After execution of SLR protocol and applying inclusion and exclusion criteria 63 papers as given in appendix are finally selected. The studies of different authors are analyzed based on research questions discussed above.

4.1. Analysis of effective communication on different research methods used

In order to answer RQ2, the papers are grouped on the basis of research methods used, i.e. case studies, interviews, surveys, experience report, experimental study and other (other than listed).
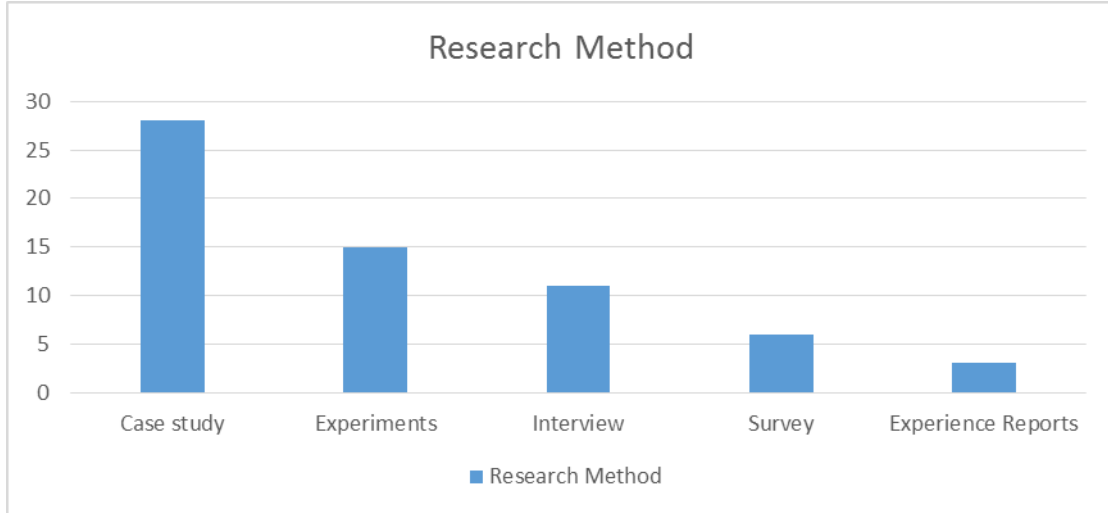

Figure 2: Analysis on different research methods

The highest percentage were found for case study i.e. 28 (44%), while studies conducting experiments were 15 (24%) interviews were 11(17%), questionnaire survey were 6 (9.5%) while 3 (4.7%) studies were based on experience reports as research methods. This shows the case studies and experiments comprise total of (68%). From different case studies and experiments, researcher identified role of effective and strong communication is very much necessary in GSD especially in elicitation phase. Figure 2 shows frequency of each research method from all studies.

4.2. Analysis of effective communication in different decades or period of time

In order to give answer of research RQ3, frequency of two different time periods in which the papers are published.

The results as given in figure 3 shows that in recent decade we have 68% work done on effective communication while 32% work done before 2007. This indicate that although in modern period of time, we have latest modern tools and technologies but still there is need to bring effective communication in organizations. There is given more attention on effective communication in recent last few years.
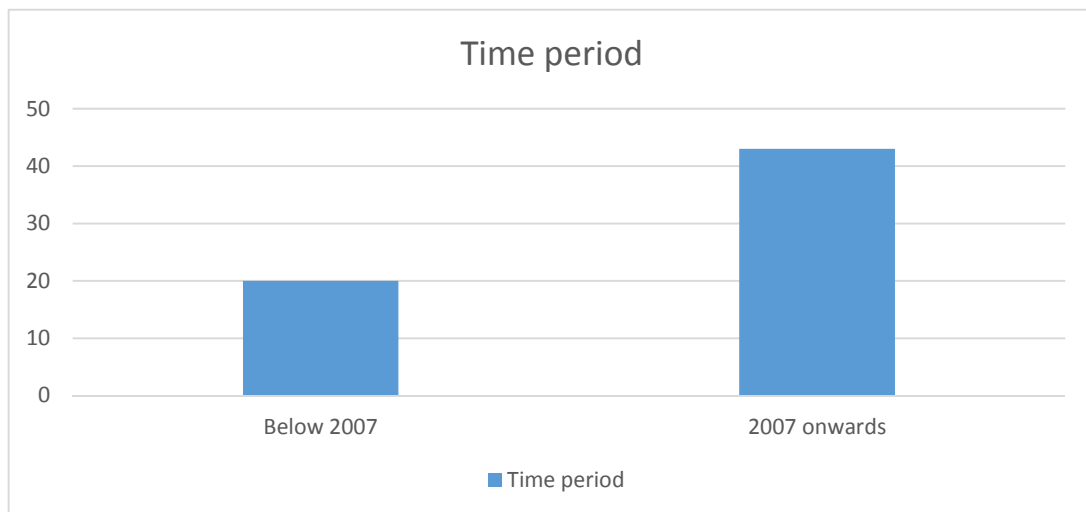

Figure 3: Analysis on different time periods

4.3. Analysis of factors in different software company sizes

In order to answer RQ4, the results as shown in figure 4 indicate that most of the work on effective communication as critical success factor is done in large size organizations (45%) while the frequency of medium size organization on which effective communication was identified is 30%. Thus large size and medium size organization comprises total of 75%.
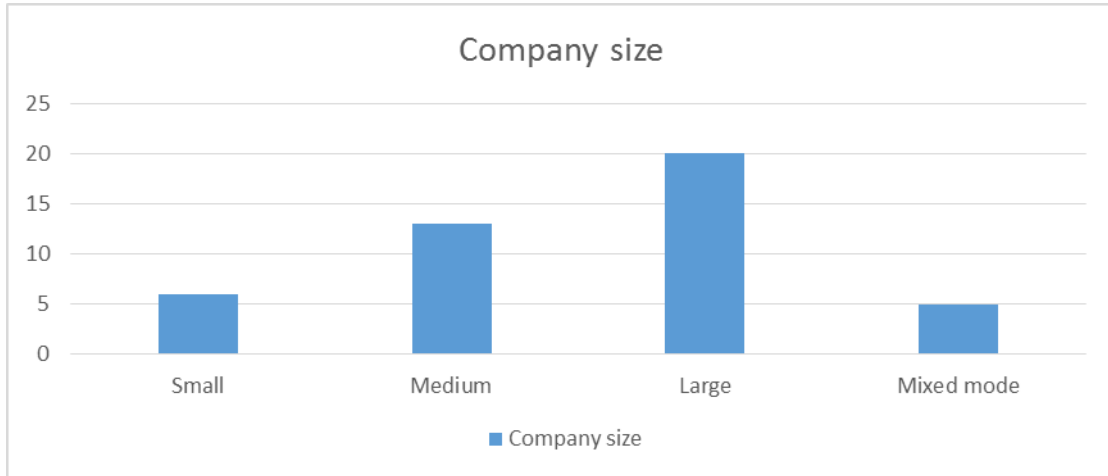

Figure 4: Analysis on different software company sizes

4.4. Analysis of success factors in different sub continents

In order to give answer of research RQ5, figure 5 shows a list of success factors in different sub-continents.
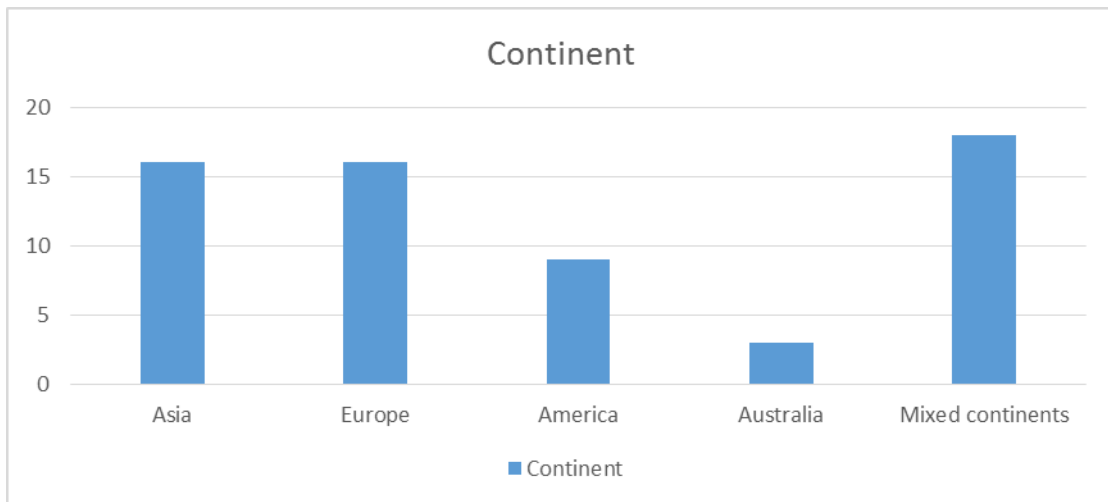

Figure 5: Analysis on different continents

From figure 5 we can see that high amount of work in GSD is done in Asia (25%) and Europe (25%). There can be many reasons for that but the main reason is that due to low labor cost, most of the vendors all over the world belong to Asia and clients mostly from Europe countries. Europe further contain many other countries.

V.   CONCLUSION

A systematic Literature Review was conducted to explore the importance of effective communication during requirement elicitation in GSD. 63 papers were retrieved as result of SLR. These were those papers that highlighted effective communication as critical success factor in GSD. We analyzed this factor on the basis of software company sizes, time period, research methods and sub continents. In future we aim to identify set of all practices and solutions needed for effective communication in GSD.

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