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# Colloboration as Success Factor during Requirement Elicitation in Global Software Development

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***Abstract***— Requirements collection is not easy process especially when clients and vendors are far away from one another. Collaboration and coordination between clients and vendors in GSD play role in requirement elicitation in GSD. In GSD, there exist critical challenges such as time zone differences, culture variations and language differences which makes it difficult to communicate properly. With collaboration and coordination in GSD, effect of challenges can be reduced. In this research work, importance of coordination and collaboration as success factor is discussed. To achieve goals and objectives, Systematic Literature Review (SLR) is conducted. Through SLR, 53 are finalized which discuss collaboration and coordination as critical success factor during requirements collection in GSD. Further, collaboration and coordination is analyzed on factors such as software company sizes, time period, experimental methods and continents.

***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 gathered for software systems 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. RELATED WORK

Collaboration and coordination is a critical challenge in GSD. As there exist geographical distance between clients and vendors and other problems such as lack of time differences and language barriers exist thus collaboration is required [9]. According to Jo Hanisch [10] there is close link between culture and coordination. In GSD, clients and vendors can have huge differences of cultures and thus collaboration is big challenge. In GSD, more and more coordination is necessary in clients and vendors. According to Jyoti M. Bhat [11], coordination problems in GSD become the reason of mistrust in GSD. According to Neetu Kumari.S [12] lack of coordination and collaboration can effect negotiation process between clients and vendors. According to Siva Dorairaj [13] the lack of collaboration is a big challenge in GSD and thus we need to implement more and more collaborative technologies and tools that can bring coordination. According to Yvonne Hsieh [14], effective communication in GSD can be possible only when there is collaboration and more coordination between clients and vendors. According to Jyoti M. Bhat, coordination in GSD will help to solve culture issues and keep team activities on track [11]. In GSD, need of coordination also increases because of differences of languages and terminologies of clients and vendors [15]. 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 [16]. Two main reasons of communication failure in GSD are time difference and language differences. Thus importance of coordination in

 

GSD become increases [13]. According to [17] , for collaboration, it is necessary to understand and respect each other's culture in GSD. Understanding what other people do and understand their way of dealings can increase collaboration among people belong to different cultures in GSD. In his study [18], author says that frequent interactions of clients with vendors and informal discussion can increase collaboration in them. With frequent interaction and informal communication, trust factor also increase which helps in successful implementation of requirements in GSD. Role of organizational structure and environment cannot be neglected. Organizations structure have positive impact on collaboration and thus project stakeholders on vendors side should do all possible activities such as workshops, trainings, frequent meetings of team members etc. such that there exist more and more collaboration among people [18].

## III. METHODOLOGY

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 [19]. 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 [20].

### *3.1 Research questions*

To conduct the research and to analyze the challenges, the following questions are formulated.
RQ1. How collaboration and coordination is related to the study strategies used?
RQ2. How collaboration and coordination vary from one time period to another?
RQ3. Is there any relationship between collaboration and coordination and a software company size?
RQ4. Do collaboration and coordination 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
- GSD

Results for (step2):

- Requirement engineering: Software requirements collection OR software requirements gathering
- GSD: Global software development OR distributed software development OR GSD

Results for (step3):
((Requirements engineering OR Software requirements collection OR software requirements gathering) AND (Global software development OR GSD OR distributed software development)).
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:

- Research papers written in English language only will be included
- Papers that is about software requirements collection in GSD only.

*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.

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

The planned process of selection consist of following two parts:

- Initial selection: It is done by studying the title, keywords and abstract of research papers.
- Final Selection: It is done by studying the whole text of the papers.

We have identified 53 papers as shown in Table 1, where the duplicate papers have been removed from the finally selected list of papers.

Table1: Digital resources and extraction of papers

| Resource | Total Results | Primary selection | Final selection |
|---|---|---|---|
| IEEE explore | 1139 | 60 | 24 |
| ACM | 1200 | 15 | 05 |
| Science Direct | 2735 | 23 | 04 |
| Springer Link | 500 | 18 | 02 |
| Others | 2500 | 55 | 17 |
| Total | 8074 | 171 | 53 |

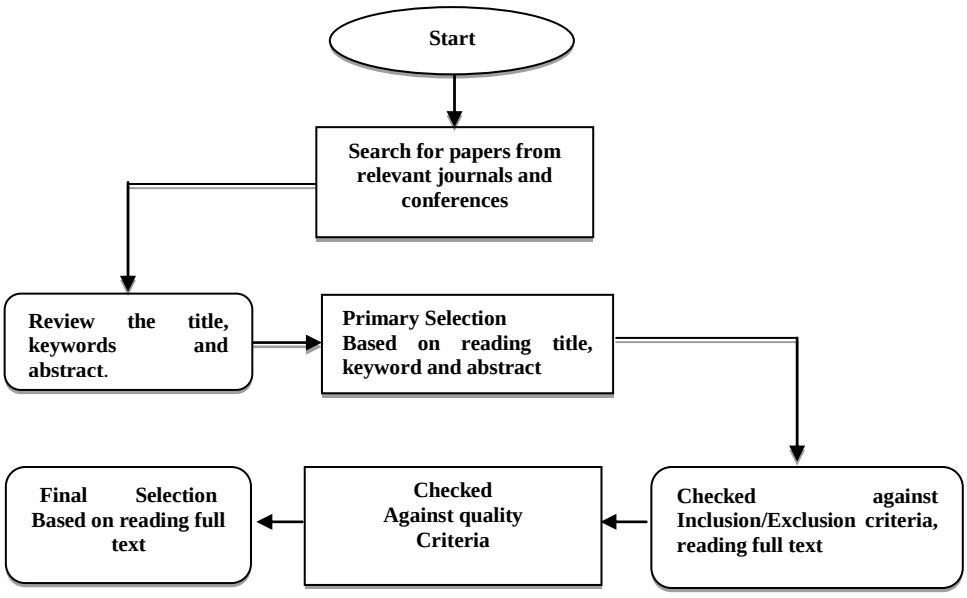


Figure 1: Publication selection process

 

*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 53 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 [20]. 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 53 papers as given in appendix are finally selected. The studies of different authors are analyzed based on research questions discussed above.

*4.1. Analysis on different research methods used*

In order to answer RQ1, 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).

The highest percentage were found for case study i.e. 25 (47%), while studies conducting experiments were 15 (28%), interviews were 6 (11%), questionnaire survey were 5 (9.5%) while 2 (3.7%) studies were based on experience reports as research methods. This shows the case studies and experiments comprise total of (75%). From different case studies and experiments, researcher identified role of coordination and collaboration is very much necessary in GSD especially in elicitation phase. Figure 2 shows frequency of each research method from all studies.

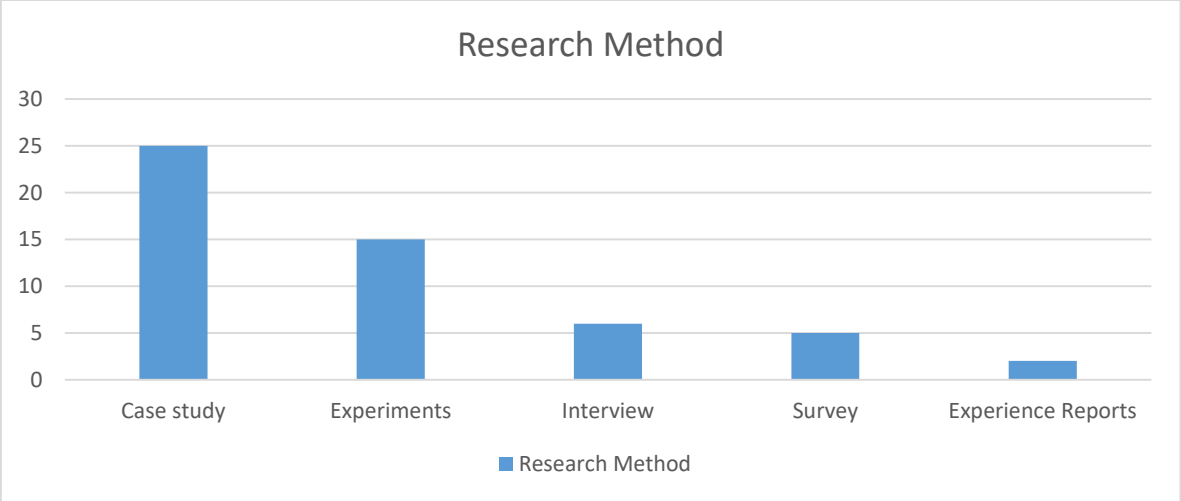


Figure 2: Analysis on different research methods

*4.2. Analysis of coordination and collaboration in different decades or period of time*

In order to give answer of research RQ2, 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 collaboration and coordination 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 coordination in organizations. There is given more attention on collaboration and coordination in recent last few years.

 

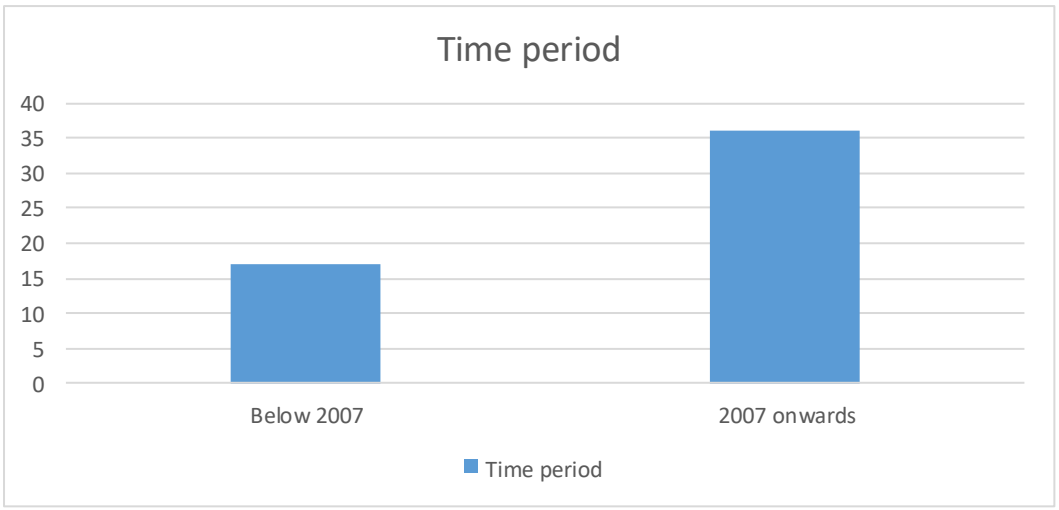


Figure 3: Analysis on different time periods

*4.3. Analysis of factors in different software company sizes*

In order to answer RQ3, the results as shown in figure 4 indicate that most of the work on coordination and collaboration as critical success factor is conducted in large size organizations (37%) while the frequency of medium size organization on which coordination and collaboration was identified is 20%. The frequency of coordination and collaboration is 9% in small size organization.

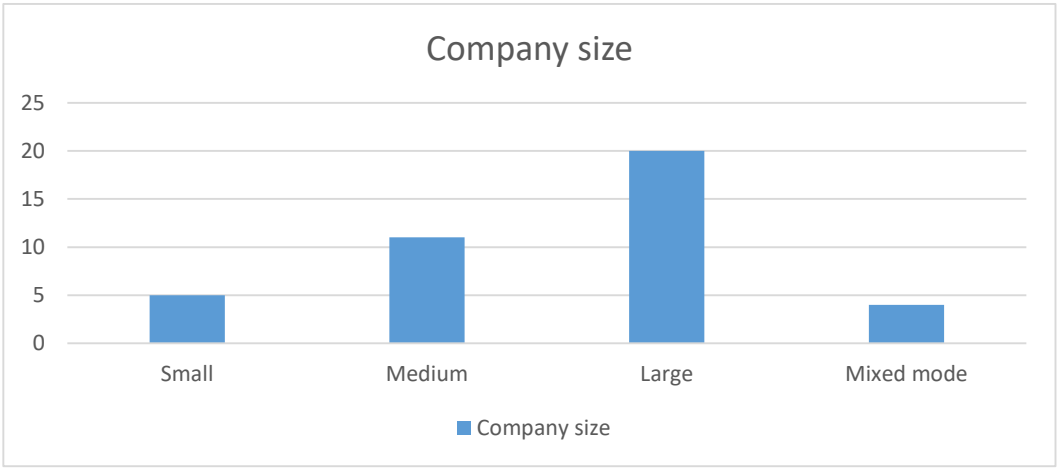


Figure 4: Analysis on different software company size

*4.4 Analysis of success factors in different sub continents*

In order to give answer of research RQ4, figure 5 shows frequency of work done on collaboration and coordination in different sub-continents. From figure 5 we can see that high amount of work in GSD one this factor is done in Asia (26%) and Europe (26%).

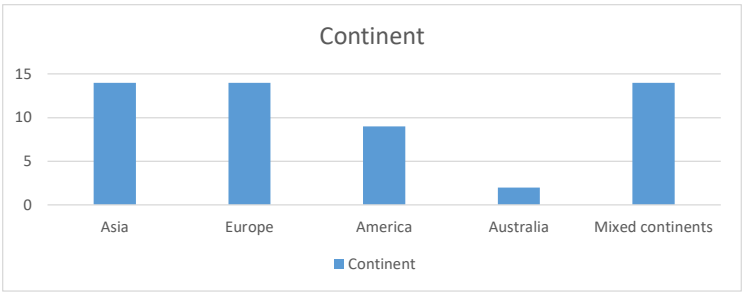


Figure 5: Analysis on different continents

 

## V. CONCLUSION AND FUTURE WORK

A systematic Literature Review was conducted to explore the importance of coordination and collaboration during requirement elicitation in GSD. 53 papers were finalized as result of SLR. These were those papers that highlighted coordination and collaboration as critical success factor in GSD. Collaboration and coordination was analyzed on the basis of software company sizes, time period, research methods and sub continents. The highest percentage were found for case study i.e. 25 (47%) which shows its importance because with case studies, we can explore any factor better in more depth. Analysis on time period shows that 68% of work is done in recent years on collaboration as success factor. Analysis on software company size shows that 37% of company sizes are large as compare to medium and small size company sizes. Analysis on sub-continents shows that most work on collaboration is conducted in Asia (26%). As vendors mostly belong to Asian countries, thus this shows that vendors in Asia have highlighted collaboration and coordination as more important and necessary for successful requirements implementation in GSD. In future we aim to identify set of all practices and solutions needed for coordination and collaboration in GSD.

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