

IDENTIFICATION OF CHALLENGES DURING REQUIREMENTS IMPLEMENTATION IN GLOBAL SOFTWARE DEVELOPMENT: A SYSTEMATIC LITERATURE REVIEW

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ABSTRACT

Context: Global Software Development (GSD) is the development across the globe in which the stakeholders are distributed geographically. In GSD, requirements gathering becomes difficult due to the distribution of clients and vendors. The study is related to challenges during requirements implementation in the context of GSD.

Objective: There is a need to address challenges during Requirements Implementation (RI) in GSD. The aim of the proposed research is to analyze these challenges in GSD.

Method: To achieve the goals, a Systematic Literature Review (SLR) is used as research methodology. In this study, all the SLR steps are performed, such as the protocol development, initial selection, final selection, quality assessment, data extraction and data synthesis.

Results: The list of identified challenges are “effective communication”, “collaboration and coordination”, “knowledge sharing”, “requirement management” and “organizational changes” which are more critical. The factors are analyzed using different continents such as, software company sizes and through different experimental methodologies. The identified factors like; “effective communication” and “organizational differences” are critically common in all sub continents, software company size and research methodologies.

Keywords: global software development; critical challenges; systematic literature review; requirement engineering; requirement implementation;

1. INTRODUCTION

Requirement Engineering (RE) is a disciplinary way of collecting user requirements for a software product [1][2][3]. The quality of software depends on how better the requirements are implemented [4]. RE is a critical phase of software engineering and if the reason of software failure is traced back to RE then it becomes very difficult and costly to fix changes back in software and thus proper implementation of RE is necessary. There are four phases of RE, i.e. 1) requirement elicitation, 2) requirement analysis, 3) requirement specification and, 3) requirement validation. Elicitation is important and critical phase of RE especially when development is done globally [5]. During elicitation phase, requirements are collected from clients. Proper and timely communication is needed between vendors and clients during elicitation, however in Global Software Development (GSD) this factor is a big challenge due to difference in terminologies, culture and geographical distance [6][7][8]. Requirements implementation become much difficult in GSD due to the stated challenges and we need proper practices and solutions to overcome the challenges [1][9][10][11]. RE is a problem of coordination because requirement gathering is not a job of only one person but in fact it requires the collaboration of many people.

Initial findings are presented in IEEE international conference on open source system and technologies (ICOST 2015)[12]. The published paper includes only one analysis while this paper presents an extension of our findings sand more analysis based on continent, company size and study strategy used. The challenges are discussed in more detail with suitable references.

This paper is organized as follows. Section II describes the motivation and related work. In section III, the design of research methodology is explained. The results of SLR are discussed in section IV while limitations of current work are discussed in section V and at the end, research is concluded in section VI.

2. BACKGROUND STUDY

Different authors identified the challenges during RE in the context of GSD like culture difference, physical distance and lack of face to face meeting, difference in languages, terminologies and time zones. The aforementioned challenges are the source of other challenges like improper communication, improper negotiations and lack of collaboration, coordination.

Culture diversity is a big challenge during RE as different cultures have different beliefs and way of representation. Due to culture differences, collaboration among vendors and clients belong to different nations becomes difficult. Moreover, some of the researchers have revealed that mistrust may come to mind due to change in cultures [4][13]. Language or terminology is very important during requirement elicitation because it affects knowledge transfer and effective communication which depends totally on proper language usage. In GSD this factor is a big challenge because mostly the clients and vendors face difficulties to fully cope the terminologies of other languages [14]. In GSD there exists timing difference between two countries and sometime this difference increases and, in this context, parties communicate asynchronously using email or fax. Time zone difference is a challenge for both sides in GSD and it needs proper practices and solutions [15]. There is a close relationship between culture and communication. This shows that culture difference is a barrier in effective communication and collaboration between two parties [16]. Lack of communication skills leads to elicitation problems and for which the author proposes a framework to reduce this challenge. The first step in this model is to take interview in depth from various software industries and compare the results with results identified by research group. Theoretical modeling of requirements uncertainty and elicitation dimensions is the next step and the last step is the validation of model from different software organizations [17]. Lack of common understanding of requirements and reduce level of trust can affect collaboration among the team members. The author also suggests practices to reduce the effect of challenges during elicitation [18].

Knowledge sharing is difficult and a big challenge in GSD[18]. In addition to this Šmite also argues that poor software requirement specification reflects that the knowledge management was not better [19]. Requirements negotiation and discussion in GSD is an essential challenge to be overcome. Some requirements need to be discussed properly but due to challenges proper negotiation is difficult [20]. Trust is challenge in GSD and trust should be established in GSD because without trust no team is possible and without team no collaboration is possible and without collaboration and trust a success is achieved only by luck [21].

Although, enough studies have been conducted to dig out factors that are barriers during successful RE but no systematic review has been conducted to identify all challenges from literature and to analyze all factors in different continents, in different company sizes and in different research methodologies. This study addresses this gap in the existing research.

3. RESEARCH 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. 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 [22].

3.1 Research questions

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

RQ1. What are the challenges, as identified in the literature, involved from software vendor's perspective in implementing RE processes throughout organizations in context of GSD?

RQ2. Do the identified factors vary from continent to continent?

RQ3. How are these factors related to the study strategies used?

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

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 analysing 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.

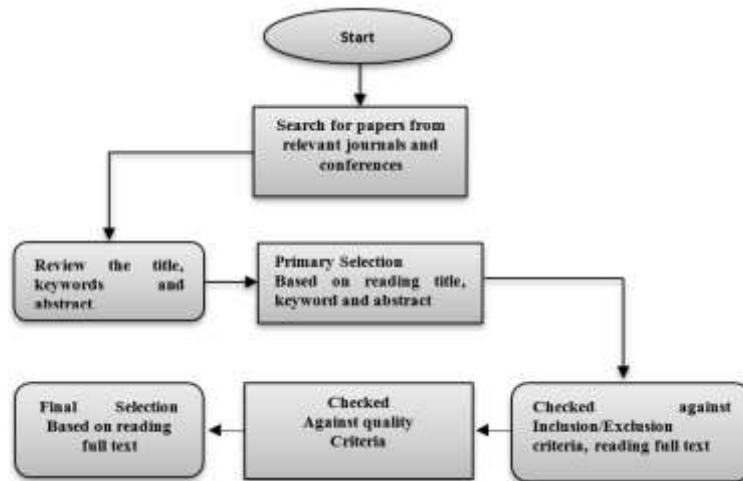


Figure. 1 Publication selection process

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 item 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 71 papers as shown in Table 1, where the duplicate papers have been removed from the finally selected list of papers.

Table1. 1 Final selected papers

Resource	Total Results	Primary selection	Final selection
IEEE explore	1139	60	36
ACM	1200	15	07
Science Direct	2735	23	06
Springer Link	500	18	06
Others	2500	55	16
Total	8074	171	71

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 71 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 [22]. 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).

4. RESULTS

In this section, the results related to research questions are discussed. In Subsections 4.1-4.4 we have answered RQ1, RQ2, RQ3 and RQ4 respectively. Due to the ordinal nature of the data we have used the linear by linear association chi-square test in order to find significant differences in factors identified in different contents, research strategies and software company size. The linear by linear association test is preferred when testing the significant difference between ordinal variables because it is more powerful than Pearson chi-square test [22]. If the value of 'p' after chi-square test become less than 0.05, this means there is significant difference in particular factor. The reasons of this significant difference should be stated.

4.1. Factors identified through SLR

In order to answer RQ1, table 2 shows a list of challenges identified through the SLR. Figure 2 shows the summary of all factors with frequency of occurrence. A factor with high frequency/percentage from literature means that it is more important and needs more practice to remove that barrier.

Table. 2 Challenges identified through SLR

S.NO	Challenges	Frequency N=71	%	Sources (List given at the Appendix)
1	Lack of effective and proper way of communication	58	82	1,2,3,5,6,7,9,10,11,12,13,14,15,16,17,18,19,20,21,22,24,25,27,28,29,30,32,33,35,36,37,38,39,40,42,43,44,45,46,47,48,49,50,51,52,53,54,55,56,57,61,64,65,66,67,68,69,71
2	Organizational changes	56	79	2,3,4,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,22,24,25,27,28,29,31,33,34,35,36,37,40,41,42,43,45,46,47,48,49,50,51,52,53,54,55,56,57,58,59,60,61,62,64,65,66,70
3	Lack of coordination and collaboration	39	55	1,2,3,4,6,7,8,9,11,13,15,17,18,19,20,25,27,28,30,31,32,34,36,37,38,39,44,45,46,47,48,50,57,61,64,66,67,68,70
4	Inter-organizational learning and Knowledge Sharing Management	37	52	2,3,6,7,8,11,13,14,15,16,17,18,19,21,22,23,25,28,29,33,41,43,45,46,49,50,53,55,56,57,58,60,62,65,66,67,69,70,71,72,73,76,79,80,82,84,85,86,88,89,91,92
5	Requirement management	32	45	3,5,7,10,11,13,17,18,20,21,22,23,24,25,26,27,28,32,33,35,38,40,41,44,45,47,50,52,53,56,58,67
6	Global project management issues	24	34	2,7,8,11,15,17,18,25,28,33,35,37,41,45,48,52,55,59,60,61,63,67,68,69
7	Trust building	23	33	3,14,17,18,19,27,28,31,32,35,37,40,42,43,46,47,48,49,56,59,61,68,70
8	Lack of face to face meeting	20	27	5,11,13,16,17,20,23,27,29,30,32,35,37,40,42,44,49,53,54,56
9	Lack of collaborative tools	19	27	4,5,7,8,11,15,16,20,26,31,36,38,39,41,42,48,58,66,67
10	Lack of proper negotiations and user involvement	17	24	2,5,8,11,12,15,17,18,25,28,32,33,42,45,48,54,61

11	Lack of Proper training and skills	14	20	1,9,19,21,25,26,31,34,35,37,40,41,45,61
12	Lack of process maturity	7	10	7,10,13,26,33,61,65
13	Labor cost	4	6	1,35,36,59
14	Human related problems	3	4	2,29,49
15	Technical infrastructure	2	3	4,6

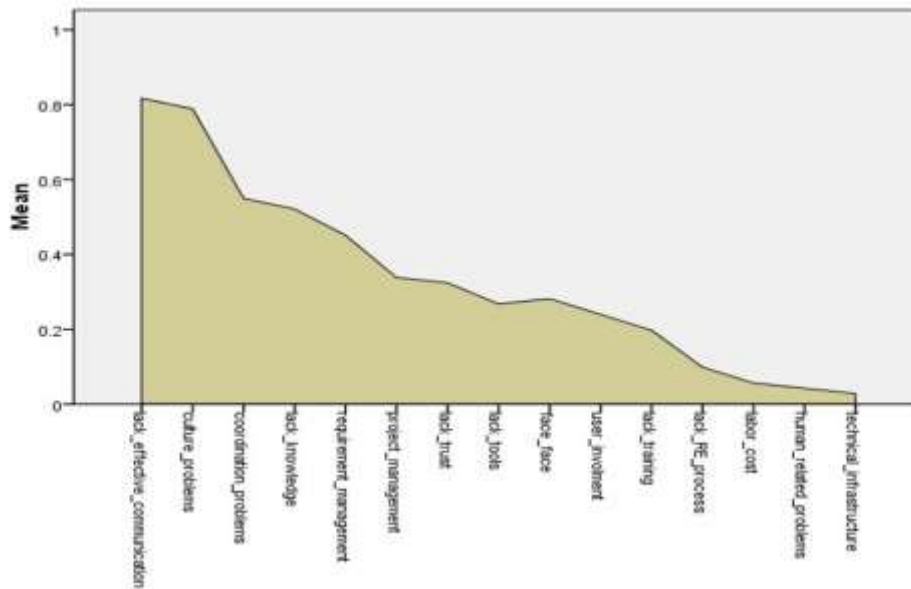


Figure. 2 Factors identified through SLR

We have identified 15 challenges. From our findings, we can see that percentages of 5 factors are greater than 45 (shown in Table 2). We can call the high frequency factor as critical. The other factors whose frequencies are greater than 30% are also important. Different authors in their papers also used the same criteria for calling the factor as critical when percentage is above 50 or 45 [22]. We can define our own criteria for calling a factor as critical e.g. a factor can be critical if its frequency of occurrence is above 30. While following the criteria of other authors we have marked five factors with percentage above than 45 and marked some of the factors as critical factors.

The factor ‘lack of effective timely communication’ is a big challenge in GSD and 82% works have pointed out this problem as the most severe. Different collaborative tools and technologies can help organizations for effective and proper communication. In one of the studies, the researchers have developed the initial version of a CASE tool, called FLARE. FLARE is a RE environment composed of “Commercial Off The Shelf” (COTS) software tools tied together by the Internet. Experience of the author indicates that tools of this kind can be useful for collecting requirements from stakeholders at a variety of physical locations [16]. In another work authors have reported on an empirical study about the evaluation of supporting overhearing conversations in a distributed setting with technology. To do this the author deployed a tool with the help of which it is possible to overhear instant messaging conversations in an international software development company. The importance of collaborative tools is discussed in detail [23].

‘Organizational differences’ is identified as critical factor from literature and it includes culture diversity, language difference, time shift and physical and geographical changes. Geographical difference makes it difficult to communicate properly in GSD. In one of the works the authors discuss that even two actors within the same building but separated by long corridors and several floors will be impacted by geographical distance [24]. Language difference makes it difficult to communicate properly. In GSD, vendors and clients can have different language terminologies which makes it difficult to communicate properly. Firstly, customers’ language is a critical factor that directly impacts on activities such as requirements elicitation and validation since language barriers affect the transfer of knowledge of requirements to system analysts [25]. Difference in time shift makes it difficult to communicate effectively on time because sometimes if there is night in one country while the other country may have office time. Cultural difference involves national culture, organizational background, language, policies, and moral principles [26]. Culture difference increases when physical distance increases [24]. ‘Lack of collaboration and coordination’ is a critical challenge found in literature. GSD is a coordination-rich activity and

without collaboration between teams and clients it's difficult to manage requirements properly. Collaboration is must for establishing trust in GSD environment and trust is a big success factor [21].

In GSD, it becomes very difficult to manage and share knowledge effectively. Knowledge about requirements and its source is necessary but it's difficult to share it with developers because of the stated challenges e.g. organizational differences [18]. Knowledge sharing can help in increasing the coordination between teams to better gather and manage requirements [27].

Due to geographical distance and lack of effective communication, managing requirements in GSD becomes difficult. Requirement management is big challenge identified from literature. Managing requirements changes in GSD is difficult and needs requirement change management frameworks (RCM). Khan in his paper proposes a framework to manage the changes and to overcome the communication issues and risks [28]. Mehmood also proposed a framework for requirement change management in GSD [29].

Global project management is also a challenge (34%) in GSD. Effective project management always plays a big role in handling big projects especially in case where the development is across globe. Effective management can bring coordination in the team. Moreover, effective leadership in the management increases the chance of success more by bringing more advanced tools, technologies and frameworks and by encouraging the team but it becomes difficult due to the geographical distance and time zone difference management.

Trust factor is a challenge as face to face meetings in GSD is difficult. For trust development collaboration is necessary however, building trust is challenging task due to culture differences and lack of informal and face to face meetings [30].

"Lack of advance tools and technology" is a challenge in GSD as collaborative tools for communication in GSD are expensive and also difficult to train people on these tools due to which organizations sometimes don't implement such tools. Implementing collaborative tools is also identified as a challenge. Lack of proper trainings, process maturity is also challenging tasks in GSD [31].

4.2 Comparison of factors across different continents

In order to answer RQ2, table 3 presents the list of challenges identified in different continents along with its percentage of occurrence while Table 4 shows summary of critical challenges in different continents. The works are categorized on the basis of different continents where the studies were conducted. We have compared the challenges in three continents, i.e. Asia, America and Europe, plus mixed type (having combination of two or more continents e.g. in one of the works the author conducted his case study in two countries (India and Netherlands) [32]. Some other authors also conducted their studies in more than one country [15].

As the papers retrieved and studies conducted belongs to only four continents so we have only categorized the factors in these four continents only.

Here the objective is to find whether these challenges differ from continent to continent or not. The factor may be critical in one continent and not in another continent.

"Lack of effective communication" and "collaboration and coordination" are two critical factors found in all continents. Further we see no significant difference in any factor which shows that all the factors are equally important for all the continents and there exists no difference in any factor. Figure 3 shows factors identified in different continents.

Table. 3 Challenges identified in different continents

Factors	Occurrence in SLR (n=71)										Chi-square Test (Linear-by-Linear Association)	
	Asia (N=17)		Europe (N=21)		America (N=9)		Mixed (N=16)		Australia (N=7)		X ²	p
	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%		
Lack of effective and proper communication	15	88	16	76	7	78	14	88	5	71	0.142	0.707
Organizational differences	11	65	15	71	8	89	16	100	5	71	3.525	0.060
Lack of collaboration and coordination	10	59	10	48	5	56	11	69	2	29	0.065	0.798

Knowledge sharing and management	5	29	14	67	4	44	10	63	3	43	0.750	0.386
Requirement management	9	53	10	48	2	22	6	38	5	71	0.010	0.919
Improper team management	3	18	7	33	3	33	7	44	3	43	2.430	0.119
Lack of trust	6	35	6	29	3	33	7	44	0	0	0.364	0.546
Lack of collaborative tools and technology	4	24	7	33	1	11	3	19	4	57	0.312	0.577
Lack of face to face relationship	7	41	5	23	2	22	3	19	2	29	1.092	0.296
Lack of discussion and negotiations	5	29	3	14	3	33	4	25	2	29	0.050	0.824
Lack of trainings and skills	3	18	4	19	3	33	2	13	1	14	0.097	0.756
Lack of RE process	2	12	1	5	2	22	2	13	0	0	0.022	0.882
High labor cost	1	6	1	5	1	11	1	6	0	0	0.048	0.826
Human related problems	0	0	2	10	1	11	0	0	0	0	0.167	0.683
Improper technical infrastructure	0	0	1	5	1	11	0	0	0	0	0.023	0.879

Table. 4 Summary of challenges in all continents

Continents	No. of challenges (cited in $\geq 50\%$ of the articles)
Asia (N=17)	We have identified the following three challenges: <ol style="list-style-type: none"> 1. Lack of effective and proper communication 2. Organizational differences 3. 3C (coordination, cooperation and collaboration)
Europe (N=21)	We have identified the following five challenges: <ol style="list-style-type: none"> 1. Lack of effective and proper communication 2. Organizational differences 3. 3C (coordination, cooperation and collaboration) 4. Lack of knowledge sharing and management 5. Lack of requirement management
America (N=09)	We have identified the following seven challenges: <ol style="list-style-type: none"> 1. Lack of effective and proper communication 2. Organizational differences 3. 3C (coordination, cooperation and collaboration) 4. Lack of knowledge sharing and management
Mixed (N=16)	We have identified the following five challenges: <ol style="list-style-type: none"> 1. Lack of effective and proper communication 2. Organizational differences 3. 3C (coordination, cooperation and collaboration) 4. Lack of knowledge sharing and management 5. Improper team management 6. Lack of trust
Australia (07)	<ol style="list-style-type: none"> 1. Lack of effective and proper communication 2. Organizational differences 3. Lack of collaborative tools

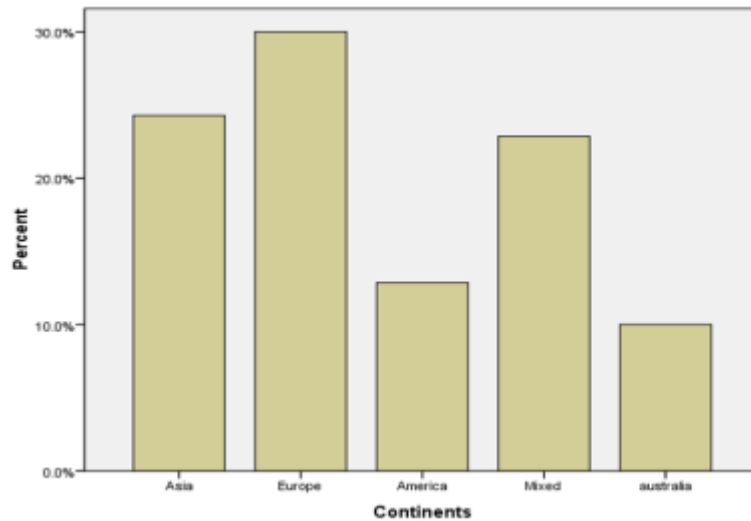


Figure. 3 Comparison of factors in different continents

4.3 Comparisons of factors in different Research methods

In order to answer RQ3, table 5 gives list of challenges identified through different research methods and Table 6 shows the summary of critical challenges based on different research methodologies. For RQ3 we have grouped papers based on the study strategies used, i.e. case studies (CS), interviews (I), surveys (S), literature reviews (LR), systematic literature reviews (SLR), These findings can be used to identify the importance of the different study strategies i.e. which study strategy is more Powerful for generating knowledge, which may assist researchers in the field of empirical software engineering in the construction of their research design.

We have found significant difference only in two factors i.e. “lack of face to face meetings” and “human related problems”. The bold values in Table 5 i.e. “Lack of face to face relationship” and “Human related problems” show that these factors have significant differences.

Further we see that “lack of effective communication” and “collaboration and coordination” are the factors that are found critical through all methodologies. Figure 4 below shows factors identified in different research methods.

Table. 5 Distribution of challenges across various study strategies

Factors	Occurrence in SLR (n=71)									Chi-square Test (Linear-by-Linear Association)	
	Study strategy									Value	p
	CS n=24	I n=11	S n=7	SLR n=4	LR n=6	ER n=3	Q n=3	ES n=12	O n=1		
	%	%	%	%	%	%	%	%	%		
Lack of effective and proper communication	75	64	100	75	83	100	100	92	100	3.276	0.070
Organizational differences	83	73	86	100	50	100	100	67	100	0.371	0.542
Lack of collaboration and coordination	67	27	57	100	50	67	33	42	100	0.512	0.474
Lack of knowledge sharing and management	54	46	29	50	83	67	33	58	0	0.072	0.789
Lack of requirement management	46	55	29	25	0	67	67	67	0	0.395	0.530
Improper team management	25	55	29	25	50	67	33	25	0	0.006	0.936
Lack of trust	33	18	29	25	50	67	100	17	0	0.065	0.798
Lack of collaborative tools and technology	33	18	43	50	0	0	0	33	0	0.586	0.444

Lack of face to face relationship	17	27	43	25	0	0	67	58	0	3.988	0.046
Lack of discussion and negotiations	25	9	14	25	17	33	33	42	0	1.372	0.241
Lack of trainings and skills	21	27	14	0	7%	33	33	8	100	0.034	0.854
Lack of RE process	21	0	0	0	0	33	0	8	0	0.859	0.354
High labor cost	4	18	14	0	0	0	0	0	0	1.501	0.221
Human related problems	0	0	0	0	17	0	33	8	0	3.924	0.048
Improper technical infrastructure	4	9	0	0	0	0	0	0	0	1.248	0.264

Table. 6 Summary of challenges based on study strategies

Study strategies	No of factors	No. of challenges (cited in $\geq 50\%$ of the articles)
Case study N=24	14	1. Lack of effective and proper communication 2. 3C (coordination, cooperation and collaboration) 3. Organizational differences 4. Lack of knowledge sharing and management
Interview N=11	13	1. Lack of effective and proper communication 2. Organizational differences 3. Lack of requirement management 4. Improper team management
Survey N=7	12	1. Lack of effective and proper communication 2. Organizational differences 3. Lack of collaboration and coordination
SLR N=4	10	1. Lack of effective and proper communication Knowledge sharing 2. Organizational differences 3. Lack of collaboration and coordination 4. Lack of knowledge sharing and management
Literature review N=6	09	1. Lack of effective and proper communication 2. Organizational differences 3. Lack of collaboration and coordination 4. Lack of knowledge sharing and management
Experience report N=3	10	1. Lack of effective and proper communication 2. Organizational differences 3. Lack of collaboration and coordination 4. Lack of knowledge sharing and management 5. Lack of requirement management 6. 3C (Coordination, Cooperation and Collaboration) 7. Improper team management 8. Lack of trust
Experimental Study N=12	13	1. Lack of effective and proper communication 2. Organizational differences 3. Lack of requirement management 4. Lack of knowledge sharing and management
Questionnaire N=1	11	1. Lack of effective and proper communication 2. Organizational differences 3. Lack of requirement management 4. Lack of trust 5. Lack of face to face relationship

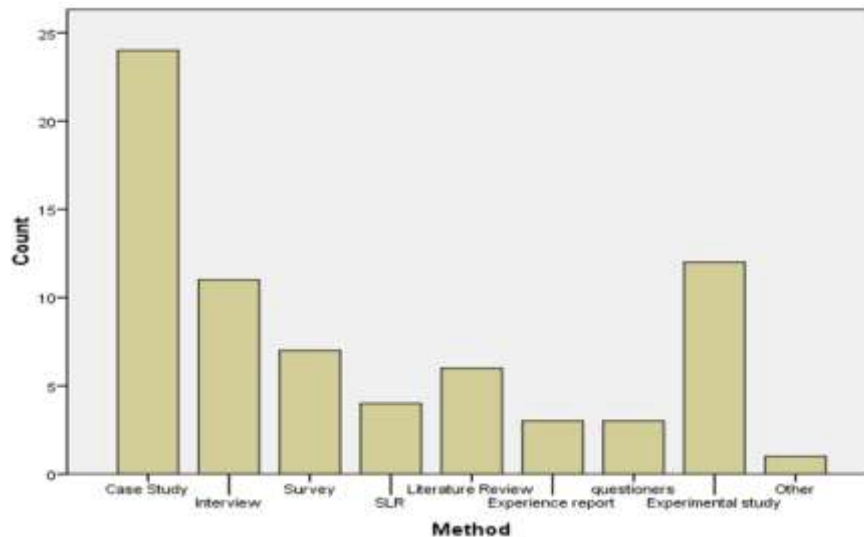


Figure. 4 Comparison of factors in different research methods

4.4 Comparison of factors in different company sizes

The results for RQ4 based on the software company sizes are tabulated in Table 7 and critical challenges are summarized in Table 8. We have divided organizations in small, medium and large software company sizes and analyzed our results accordingly. Organizations contain less than 20 members are categorized as small size. Medium contain 20 to 100 people and large company size contain more than 100. Other papers also used the same strategy for making categories of software organizations [33]. Out of 71 papers only 38 papers were found in which case studies and experimentations showed information’s about company sizes. Out of 38, three papers have conducted their studies in small organizations, 9 in medium and 25 in large organizations. The factors can vary from one company size to other. The factor may be critical for small company size and not for medium or large and vice versa. For example, it can be seen in Table 7 that “lack of proper requirement management system is critical for large organizations and not for small organizations”. Table 7 shows that lack of ‘effective and proper communication’ and ‘organizational differences’ are the two critical challenges (percentage is high) that are found in all types of organizations. It is also clear from the fact that either it is a small or large organization but in GSD all possess geographical difference, culture diversity, terminology differences etc. and due to these factors communication is also a big challenge equally in all types of organizations. ‘Lack of collaboration and coordination’ and ‘lack of knowledge sharing and management’ are also critical challenges in all types of organizations but if we notice the percentage is more in small as compare to medium and large. If we look to small organizations, it lacks communication technology normally so there exists this challenge more as compared to large ones and therefore problem of collaboration and knowledge sharing increases. Also, small organizations consist of people no more than 20 and they lack experience persons and there come problems of knowledge sharing.

We see only one significant difference in factor ‘requirement management’ and it is only critical for large company sizes and for small company sizes it is zero.

The reason is that GSD involves large organizations for taking big projects and managing it is not easy. Small organizations take small projects on free lancing and it doesn’t include that much of difficulties. “Improper team management” is also higher in large company sizes (40%) as in large organizations team sizes and projects sizes are larger as compared to small so this problem is more in large company size. “Lack of trust” is more critical in small size organizations. We argue that large organizations where employee size are greater than 200 are famous organizations and they use new technologies and tools for communication and collaboration so trust problem exist but it is more in small. Figure 5 below shows comparison of factors in different company sizes.

Table. 7 Distribution of challenges in different company sizes

Factors	Occurrence in SLR (n=71)					X ²	p
	Chi-square Test (Linear-by-Linear Association)						
	α = .05						
	Small (N=3)	Medium (N=9)	Large (N=25)	Mix (N=1)			

	Freq	%	Freq	%	Freq	%	Freq	%		
Lack of effective and proper communication	3	100	7	78	20	80	1	100	0.129	0.720
Organizational differences	2	67	7	78	21	84	0	0	0.001	0.975
Lack of collaboration and coordination	2	67	4	45	16	64	1	100	0.526	0.469
Lack of knowledge sharing and management	3	100	5	56	12	48	1	100	1.198	0.274
Lack of proper requirement management	0	0	3	33	15	60	1	100	5.781	0.016
Improper team management	1	33	2	22	10	40	0	0	0.160	0.689
Lack of trust	2	67	0	0	9	36	0	0	0.001	0.978
Lack of collaborative tools and technology	1	33	3	33	6	24	1	100	0.001	0.978
Lack of face to face relationship	0	0	4	45	7	28	0	0	0.001	0.978
Lack of discussion and negotiations	1	33	3	33	9	36	0	0	0.001	0.915
Lack of trainings and skills	1	33	2	22	6	24	0	0	0.150	0.699
Lack of RE process	1	33	2	22	3	12	0	0	1.392	0.238
High labor cost	0	0	1	11	0	0	0	0	0.900	0.343
Human related problems	0	0	0	0	1	4	0	0	0.306	0.580
Improper technical infrastructure	0	0	1	11	0	0	0	0	0.900	0.343

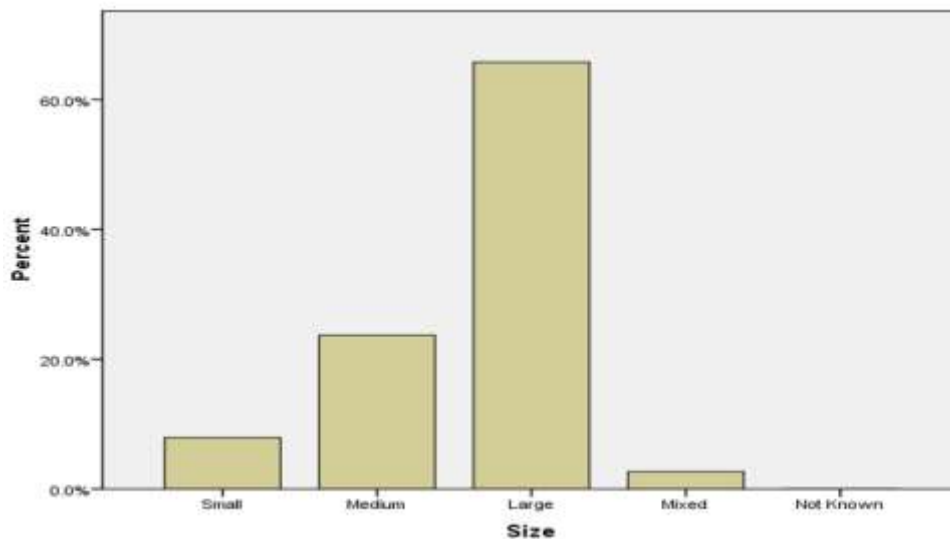


Figure. 5 Comparison of factors in different company size

Table. 8 Summary of challenges based on company size

Company size	No of Factors	No. of challenges (cited in >=50% of the articles)
Small	10	<ol style="list-style-type: none"> 1. Lack of effective and proper communication 2. Organizational differences 3. Lack of collaboration and coordination 4. Lack of knowledge sharing and management 5. Lack of trust
Medium	13	<ol style="list-style-type: none"> 1. Lack of effective and proper communication 2. Organizational differences 3. Lack of knowledge sharing and management Quality production 4. 3C (coordination, cooperation and collaboration)
Large	13	<ol style="list-style-type: none"> 1. Lack of effective communication 2. Organizational differences 3. Lack of effective requirement management

5. LIMITATIONS OF CURRENT WORK

How correct are our results in selection process? One possible threat to internal validity is that the reason and causes for factor might not be explained in some papers. The authors of these studies were not supposed to report the original reasons why these success factors were used during the selection of vendors. It is also possible that in some studies there may have been a tendency for particular kinds of other barriers and challenges to be reported. Many of the contributing studies were self-reported experience reports, case studies and empirical studies which may be subject to attribution, reporting or publication bias. The methodologies were not clearly defined in some papers and most of the methodologies through which we identified our factors were mostly self-reported experience reports, SLR or literature reviews. Only 3 authors have used experimental methodology. During the selection of primary studies and data extraction we have performed the inter-rater reliability tests in order to reduce the researcher's bias. However, it was not possible to check each and every paper by the secondary reviewer. For checking the correctness or verifying the critical factor these identified factors should be validated through questionnaire survey from software industry. Through survey it will be also possible for us to identify some new factors which can contribute to the knowledge of software engineering.

6. CONCLUSION AND FUTURE WORK

A list of challenges is identified through SLR and some of them are marked as more critical. These challenges were analyzed in different sub continents, i.e. Asia, Europe, America, Australia and mix countries. The challenges are analyzed in three different company sizes, i.e. small, medium and large. Using different research methodologies, we discussed these factors in detail. In future, we will identify practices and solutions to limit the effect of the challenges and through questioner survey these practices will be validated. Moreover, we will develop, Requirement Implementation Model (RIM) which will address success factors and challenges and solutions for these factors will be given. Case studies will be conducted to validate this model. The concept of this model is already published in one of our paper in detail [34]. Our current work is one of the important step of the model.

Appendix (List of papers)

1. W. J. Lloyd, M. B. Rosson, and J. D. Arthur, "Effectiveness of elicitation techniques in distributed requirements engineering," presented at Requirements Engineering, 2002. Proceedings. IEEE Joint International Conference on, 2002.
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