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Overcoming Challenges of Requirements Elicitation in Offshore Software Development Projects

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ABSTRACT

Context. Global Software Development (GSD) is the plan of action in which software development is performed under temporal, political, organizational and cultural boundaries. Offshore outsourced software development is the part of GSD, which refers to the transfer of certain software development activities to an external organization in another country. The primary factors driving offshore outsourced software development are low cost, access to a large pool of skilled laborers, increased productivity, high quality, market access and short development cycle. Requirements engineering (RE) and especially requirements elicitation is highly affected by the geographical distribution and multitude of stakeholders.

Objectives. The goal of conducting this study is to explore the challenges and solutions associated with requirements elicitation phase during offshore software projects, both in research literature and in industrial practice. Moreover, this study examines that which of the challenges and practices reported in literature can be seen in industrial practice. This helped in finding out the similarities and differences between the state of art and state of practice.

Methods. Data collection process has been done through systematic literature review (SLR) and web survey. SLR has been conducted using guidelines of Kitchenham and Charters. During SLR, The studies have been identified from the most reliable and authentic databases such as Compendex, Inspec (Engineering village) and Scopus. In the 2nd phase, survey has been conducted with 391 practitioners from various organizations involved in GSD projects. In the 3rd phase, qualitative comparative analysis has been applied as an analysis method.

Results. In total 10 challenges and 45 solutions have been identified from SLR and survey. Through SLR, 8 challenges and 22 solutions have been identified. While through industrial survey, 2 additional challenges and 23 additional solutions have been identified. By analyzing the frequency of challenges, the most compelling challenges are communication, control and socio-cultural issues.

Conclusions. The comparison between theory and practice explored the most compelling challenges and their associated solutions. It is concluded that socio-cultural awareness and proper communication between client and supplier organization's personnel is paramount for successful requirements elicitation. The scarcity of research literature in this area suggests that more work needs to be done to explore some strategies to mitigate the impact of additional 2 challenges revealed through survey.

Keywords: Requirements elicitation, Global software development, offshore outsourced software development, Mitigation strategies, Empirical study, Systematic literature review, Survey

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Zia ur Rehman Yosuf

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1 INTRODUCTION

Global software development (GSD) and offshore outsourced software development are becoming common in the software engineering industry [P1]. GSD is the coordinated work of software development teams which are widely dispersed geographically crossing many national and cultural boundaries [1] [2]. Offshore outsourced software development is the part of GSD [3], which refers to the transfer of a certain software development activities to an external organization in another country [4] [P2]. The primary forces driving offshore outsourced software developments are low cost, access to a large pool of skilled laborers, increased productivity, high quality, market access and a short development cycle [5] [6] [7]. However in spite of these benefits, offshore projects bring some challenges like communication, coordination, and control. This is due to the fact offshore teams work across geographic, temporal, cultural, and organizational boundaries [1] [8] [9] [10].
Requirements engineering (RE) and especially requirements elicitation are highly affected by geographical distribution [P3] [P4] and a multitude of stakeholders [P1]. For instance, face-to-face communication for requirements elicitation from geographically distributed stakeholders is not always possible due to distance or time zone differences [P5]. Previous experiences imply that the factors contributing to the failure of offshore outsourced software development are mainly related to requirements [11]. Research has shown that correcting software defects can require nearly 200 times more effort if the correction is carried out in the maintenance phase instead of requirements elicitation and specification phase of a software lifecycle [12]. Therefore in order to achieve the anticipated results, to control and mitigate huge costs and extra efforts, there is an obvious need to explore the challenges of requirements elicitation in GSD and associated strategies to mitigate the impact of those challenges.
There are empirical studies in the area of requirements elicitation in global context. However to the best of author's knowledge, no comprehensive correlation of various categories of challenges and mitigation strategies for requirements elicitation, from research literature and industrial practice has been made yet. In this study, various problems and their mitigation practices have been identified, correlating the results of Systematic literature reviews (SLR) and industrial surveys. Contrasting the challenges and their solutions or mitigation practices of requirements elicitation enlisted in research literature and industrial practice may help.
The comparison of evidence from various studies is essential to draw a conclusion about empirical support as a phenomenon [13]. This will help requirements engineers to pay more consideration to the major challenges during eliciting requirements from stakeholders during offshore outsourced software development projects. Additionally it will provide new directions for researchers to explore the reasons and mitigation strategies for most prevalent challenges encountered both in literature and industrial practice.

1.1 Aims and objectives

The aim of this research study is to investigate the problems and relevant strategies to mitigate their impact during requirements elicitation phase in offshore software projects.

The primary aims of the research will be made through the following objectives:

- To identify the problems that GSD teams encounter in the requirements elicitation phase in the available research literature
- To identify solutions to the problems of requirement elicitation in GSD in the research literature
- To identify the problems that GSD teams encounter in the requirements elicitation phase in software organizations
- To identify solutions to those problems of requirement elicitation in GSD in

software organizations
- To identify similarities and differences between the evidences found in research literature and industrial practice.
- To understand the problems in requirements elicitation those are most frequently reported in the literature and by the practitioners and provide proper solutions to them.

1.2 Research questions

To achieve the aim of this research, the following research questions are posed:

RQ1: Which challenges are reported in the research literature regarding global requirement elicitation?

RQ2: What are the proposed solutions to the reported challenges in the literature?

RQ3: What challenges are faced during the requirement elicitation in GSD projects in software organizations?

RQ4: What practices are applied in software industry to address the identified challenges?

RQ5: What are the similarities and differences between challenges and practices reported in research literature and industrial practice?

RQ6: What are the most prevalent challenges based on their frequency in research literature and industrial practice?

1.3 Expected outcomes

The research outcome of this thesis is a report that includes:

- List of challenges in requirement elicitation, through literature review and industrial survey
- List of practices to alleviate the identified challenges
- List of similarities and differences of challenges and practices reported in research literature and industrial survey, which will highlight the gaps in the current research
- List of prioritized challenges based on their frequencies in research literature and industrial survey
- Suggestions for future research

1.4 Thesis Outline

The reminder of the thesis is structured as follows:

Chapter 0 Introduction: provides an insight to the targeted research area and motivation behind this study. It also describes the main aim & objectives of this thesis and expected outcomes.

Chapter 2 Background: elaborates the research background and related work of this study.

Chapter 3 Research Methodology: This chapter delineates the methods employed for conducting this research along with its motivation.

Chapter 4 Research Conduct: elaborates the procedure of Systematic Literature Review (SLR) and industrial survey.

Chapter 5 Results: presents the results of both SLR and industrial survey.

Chapter 6 Discussion: provides the comparison of SLR and Survey results. Further, validity threats to this study are described to ensure the trustworthiness of this study.

Chapter 7 Epilogue: Summarized the research outcomes, mapping of research questions and possible clues for future work.

2 BACKGROUND

2.1 Global Software Development (GSD)

2.1.1 HISTORY

The concept of developing software in distributed settings was initiated even before the term GSD was coined. In 1960's large computer vendors e.g. IBM initiated developing software in globally distributed settings [14]. Later in 1970's another form of distributed software development called contract programming was introduced in which certain parts of development were transferred to a third party [15]. PC revolution in 1990's embarked the globalization of software which inspired smaller organization to get involved in the field of software development [14] [16]. In the last few decades, a consistent and inevitable trend toward the globalization of software-intensive businesses has been observed. Therefore national markets are transforming into global markets and creating new forms of cooperation that approach across national boundaries [17]. Consequently nowadays more software projects are running in globally distributed settings and GSD is becoming a norm in software industry [18] [19] [20] [21] [22].

2.1.2 Benefits and Challenges

There are various motives and business driving factors for the growing trend of GSD [23] [24]. These include access to a large pool of skilled labor [14] [25] [26] [27] [28] [29] [30], improved time to market by utilizing round the clock development [21] [23] [25] [31] [32] [33], proximity to the customers and market [31] [25] [33] [29] [34] [35] [36], cost reduction via transferring software development to low wages countries [21] [23] [27] [25] [32] [33] [37] [38] [26] [36] [25] [39], cross-site modularization of development work [25] [32], to exhibit a global image [25] [31] and opportunity for innovation and shared best practices [38] [25].

According to Herbsleb et al. [20] GSD projects usually take 2.5 times more than co-located projects. The reason is that GSD encounters several challenges which are caused by the temporal, geographical and socio-cultural distance amongst team members [14] [25] [40] [9] [41] [42]. Temporal distance reduces the opportunity for real-time collaboration; since working hours at remote locations do not overlap, the response time increases. Geographic distance reduces the communication frequency particularly when team members experience problems with media. While socio-cultural distance involves organizational or national culture's difference, politics, language and work ethics' can lead to differences causing miscommunication [9]. According to some researchers poor 3 Cs - Coordination, Communication and Collaboration are the major challenges of GSD projects [19] [20] [32] [39] [43] [44] [45] [46].

2.1.3 GSD Collaboration Forms

Different forms of collaboration modes exist in distributed software development scenario. A general representation of these collaboration forms [47] in GSD is illustrated in Table 2.1

Table 2.1: Various Collaboration Modes

Different Organization	Onshore outsourcing	**Offshore outsourcing**
Same Organization	Onshore insourcing	Offshore insourcing
	Same Country	Different Country

2.1.4 Offshore Software Outsourcing

Offshore software outsourcing is a modern business strategy of transferring software development work to another organization located in foreign countries [48]. It is a contract-based relationship between client and vendor organization where a company (client) contracts out all or part of its software development works to another company (vendor) in another country, who provides agreed services on agreed wages [49]. According to [7], seven out of ten software projects usually fails due to various kinds of challenges in offshore outsourced software development.

2.2 Global Requirements Engineering (GRE)

2.2.1 GRE and its Challenges

Requirements Engineering (RE) is very crucial activity for the success of any software development project [P6] [50], which is concerned with the exploration and specification of stakeholders' needs and constraints to the system to serve as a basis for all other activities of system development [51] [52]. RE is difficult, however it is even more challenging in GSD [P7] [53], because stakeholders' geographical distribution introduces major challenges in RE. Geographical distance plays a significant role in exacerbating the problems of human, organizational and political nature. These generic major challenges are inadequate communication, knowledge management, cultural diversity and time differences [54]. According to Herbsleb [19], hampered communication, knowledge integration, differing domain vocabularies, process mismatches, incompatible environments, and cultural differences are major challenges in global requirements engineering.

2.2.2 Requirements Elicitation

Requirements elicitation is the first phase in the RE process [55]. It is one of the most significant and very critical phase in software development process [56] [P8]. During elicitation process, developers and requirements engineers work with customers and end-users to find out the problems to be solved, the required performance and constraints on the

system [57]. If requirements elicitation is poorly conducted; the outcome will be software requirements specification (SRS) full of ambiguous, conflicting, overlapping, missing, incomplete, infeasible, inconsistence, unrealistic and unverifiable requirements [57] [58]. It has been observed that if defects in requirements elicitation phase are not resolved, it could consume enormous time, extra efforts and money at later phases of development cycle [P3].

2.2.3 Requirements Elicitation in Offshore Outsourced Software Development Projects

Software engineering is shifting from the traditional co-located settings of development to an offshore outsourced software development scenario where diverse stakeholder teams define the software requirements in global settings [54].

Requirements elicitation is very important phase in software development process because requirements collected from this phase will signify whether the developed system will work properly or not [59]. Moreover, software project's failure or success is mainly dependent on the quality of requirements because it is the base for the system to be established. Accurate requirements elicitation considerably enhances the quality of requirements and consequently quality of the system. Therefore there is significant need to understand and apply elicitation techniques properly for a successful software development projects [60].

Although collaboration technologies have been improved well, still offshore outsourced software development teams are facing considerable challenges in elicitation of requirements [P4]. Both practitioners and researchers have acknowledged that requirements elicitation phase is the most affected phase in global settings [60], because it is basically a communication intensive process between stakeholders and requirements specialist [61]. Offshore outsourced software development spawns challenges in requirements elicitation process [62]. The geographical dispersion of stakeholders, temporal distance between different sites and cultural diversity of stakeholders exacerbates the communication problems for requirements elicitation [54] [63]. For the reason that, time zone differences set hurdles for synchronous communication and geographical distance also make it more difficult to arrange face-to-face meetings [19]. Therefore offshore teams usually use asynchronous communication channels e.g. emails to cope up with this problem but exchange of such an extensive amount of emails is very hard to keep track of [P5].

2.3 Related Work

Most of the research studies discuss problems of GSD or RE in general. Some studies point out the problems of requirements elicitation in GSD settings or propose some solution to some specific problem. For instance, studies conducted by Aranda et al. [P9] [P10] [P11] [P12] [P13] [P14] [P15] [P16] [P17] and Bendjenna et al. [P8] proposed a strategy for choosing suitable tool and technique for requirements elicitation in GSD settings. For this purpose they have developed learning style model (LSM) by utilizing cognitive informatics psychology to classify stakeholders according to a set of behavioral characteristics about the various ways in which they receive and process information during requirements elicitation. A similar experiment conducted by Lloyd et al. [P18], assesses the effectiveness of groupware software tools and elicitation techniques for distributed requirements elicitation.
Menten et al. [P3] focus the problems related to communication during requirements elicitation. They have proposed a method for requirements elicitation by using audio recording and wiki technologies to allow multiple stakeholders for requirements elicitation in globally distributed software development settings.
Todd and Huang [P19] discussed the problem of scale up during collaborative requirements elicitation process that encompasses hundreds and thousands of distributed stakeholders. They have used an approach of data-mining and machine learning to automatically determine topics from the stakeholders' needs, using recommender systems to consign stakeholders into suitable discussion groups.

Prause et al. [P20] have explored the problems related to management and communication of requirements in multi-national projects. They have proposed web-based computer-aided requirements elicitation procedure that reduces the number of face-to-face meetings needed for requirements gathering in GSD projects. Similarly Lohman et al. [P1] also explore the challenge of communication for requirements elicitation due to geographical distribution and multitude of stakeholders. They propose the web-based solution, where all stakeholders are permitted to declare their requirements or edit the existing ones. It provides regular wiki features e.g. allowing to track, review and rollback changes or a facility to discuss requirements. Riechert and Berger [P21] also elaborate the issue of requirements elicitation from a spatially distributed large stakeholder groups. To deal with this challenge, they have proposed the use of semantic databased Wikis, which has the facility to improve the agreement between stakeholders; by enhancing continuous formation of a shared vocabulary of domain knowledge. In another study [P22] Laurent and Huang also discuss requirements elicitation in large-scale open source distributed projects from large numbers of stakeholders. To deal with this challenge of scaling up, they proposed a forum based requirements gathering procedure where large numbers of stakeholders from geographically dispersed locations in diverse time-zones collaboratively participate in the feature gathering process to explore their needs, discuss relevant issues, demand new features and produce suitable requirements. In such forum, stakeholders connect in discussions by participating in a shared discussion thread. They find their suitable discussion threads by themselves. Each of the forums provides both browse and search facilities, mainly intended to assist stakeholders in finding their relevant discussion thread.

Herrera et al. [P23] [P24] [P25], highlighted the challenges of scaling up during large and complex projects where requirements' knowledge is scattered across thousands of geographically dispersed stakeholders. To cope with this issue of scale up, they have developed a method, which consists of data mining, discussion forums and recommender system. Initially a web-based tool has employed to gather distributed stakeholders' needs and their generic comments. Then, data mining, recommender system and unsupervised clustering techniques are applied for the analysis of stakeholders' needs, to determine major and crosscutting issues, and an associated set of highly focused discussion forums are created dynamically. For timely placement of stakeholders into corresponding forums, an initial user authentication profile is created to capture the stakeholders' interests. This profile makes initial forum recommendations on the basis of each stakeholder's provided needs, and then creates further collaborative recommendations in accordance with the interests of identical stakeholders. Finally, in every discussion forum a groupware setting helps these distributed stakeholders working in collaboration each to convert their needs into sets of precisely expressed requirements.

Aranda et al. [P2] explores the factors that might be the source of communication problems for requirements elicitation during offshore software development projects. They have identified four factors i.e. time difference between sites, language difference, cultural difference and stakeholders' cognitive aspects. Cognitive aspects are the ways in which people react according to their inborn features.

To avoid or mitigate the impact of the above mentioned four factors, in another studies; Aranda et al. [P26] [P27] have proposed three strategies. These strategies are learning about cultural diversity, selection of suitable technology and use of ontology as a communication facilitator. Ontology helps to share a common vocabulary for domain components, and also to build a common understanding of the problem during elicitation process. Moreover their [P27] experiment revealed that if the time overlap among offshore sites is low, it's better to use asynchronous groupware tools and to avoid elicitation methods based on synchronous interaction (like brainstorming). Furthermore when the stakeholders' mother language is not the same and the degree of understanding of a common language is intermediate or less, it's better to use asynchronous tools, in order to give people the opportunity to read and write with more care.

Sabahat et al. [P6] have conducted a comprehensive survey of challenges and various approaches of global requirements elicitation. They have proposed an iterative framework

for elicitation (IRE). Their results show that such iteration in RE process is more effective in satisfying more number of customers in fulfilling their requirements.

Damian et al. [P28] [P4] have compared two modes of communication and identified which mode need to be deploy to achieve effective communication during distributed requirements elicitation i.e. whether face-to-face (F2F) communication or synchronous text-based computer-mediated communication (CMC). Their research shows that stakeholders considerably anticipated having increased chance to participate and more openly discuss conflicting matters with each other during synchronous text-based communication (e.g. chat and IM) for elicitations as compared to face-to-face interaction. Moreover, synchronous text-based communication is suitable to attain common grounds among conversational stakeholders unknown to each other [P28]. Face-to-face interaction provides more chance to familiarize with each other, and gives an enhanced aptitude for the expression of complex ideas and to grasp others' opinions. However, text-based communication is more effective than face-to-face communication on the capability of open discussion for conflicting matters. Therefore either communication medium could be used depending on some particular aspects of satisfaction with performance [P4].

ol s and Ali [P5] have investigated the challenge of facilitating the collaborative exchange of ideas, information and needs during distributed requirements elicitation process. For that purpose they have presented a collaborative tool i.e. Spatial Hypertext Wiki which offer a spatial virtual board for distributed stakeholders to share, brainstorm and discuss the knowledge concerned with RE. The wiki pages works as a virtual board where distributed stakeholders can add, shift or group notes about their needs. Moreover it helps the novel ideas for requirements and the transfer of tacit knowledge to the requirements definitions.

Study conducted by Damian [P7] reports the challenges drawn from industrial empirical studies, of stakeholders' interaction in global requirements engineering (GRE). According to her, the main challenges for GRE are knowledge acquisition and sharing, aligning RE processes and tools, and the third factor, which is affected by the two challenges previously mentioned, is communication and coordination in GSD teams.

Duarte et al. [P29] conducted an action research and identified that lack of user involvement or motivation in requirements elicitation has a negative impact on GSD projects. They have proposed social visualization techniques to motivate stakeholders and enhance their awareness about requirements. Use of requirements visualization tools like graphical use case models; business process diagrams and requirements definition through scenarios helps in stimulating stakeholders' involvement. oc ial visualization gives information about the presence, activities and other data of a remote team member's social involvement in a community. This type of social visualization increases awareness of activities in a social environment and stimulates other users to participate in online communities for requirements elicitation.

Ramzan et al. [P30] have put emphasis on value-based requirements elicitation (VBRE) in GSD settings. They consider that it's difficult to make financially responsible decisions using value-neutral methods in requirements elicitation because it treats every stakeholder equally, though different stakeholders have different opinions and expectations. The problem takes place when stakeholders are not valued. They have proposed a model consists of 5 steps for requirements elicitation from valued stakeholders in GSD environment.

Comprehensive study of requirements elicitation's issues in GSD environment revealed the fact that elicitation is incredibly significant phase of the software development life cycle since this phase has a direct effect on success of a project. There are several studies that discussed the only challenges or issues relating to requirements elicitation and some of them also provide situational recommendations or mitigation practices. However, no study has been conducted to correlate all reported challenges against solutions or mitigation strategies. It is therefore, imperative to understand the state of art and state of practice in relation to requirements elicitation in offshore outsourced software development projects to mitigate impact of challenges that are undermining the success of these projects.

2.4 Motivation

Traditional software engineering practices do not address most of the challenges faced by RE teams working in offshore outsourced software projects [64]. Previous research studies either highlight specific challenges of requirements elicitation in GSD settings or propose solutions e.g. a method to choose suitable tools or techniques for requirements elicitation in GSD settings. However, to the best of my knowledge, no systematic review effort has been made yet in this area. From available literature, no comprehensive correlation has been drawn between challenges and their solutions in a global scenario. The aim of this study is to correlate specific problems against their corresponding solutions, in order to highlight the differences of literature and industrial practice. Analysis of the results leads to the determination of the most prevalent challenges of requirements elicitation in offshore outsourced software development projects.

In the context of this study, the correlation of elicitation challenges and their corresponding solutions would help practitioners to acknowledge the most prevalent challenges during eliciting requirements from stakeholders during offshore outsourced software development projects.

Industrial practitioners reported additional challenges during the survey process; this enables future work to be conducted by researchers, in order to find solutions to the corresponding challenges.

3 RESEARCH METHODOLOGY

This chapter provides the research design and research methods to answer the posed research questions. Moreover the motivation has been provided for selecting particular research methods.

3.1 Research Design

This research has been conducted in three steps i.e. investigation of state of art, state of practice and analysis of findings. Initially a SLR has been conducted through the guidelines of Kitchenham and Charters [65] to gather the data relevant for this study from existing research literature. The purpose of this step is to qualitatively explore the challenges and its solutions or mitigation practices regarding requirements elicitation in offshore outsourced software development projects. The gathered data has been analyzed qualitatively and the results provided the answers to RQ1 and RQ2.

In the second step of the research, an industrial survey has been conducted in order to explore the challenges and their solutions in relation to requirements elicitation in offshore development projects in software companies. The data gathered from the survey has been analyzed to get the answer for RQ3 and RQ4. Descriptive Statistics [66] has been used for describing survey results.

In the third step, after collecting the data from SLR and survey, they are compared against each other through comparative analysis method [67] [68]. This answers RQ5 and RQ6.

These three steps of research methodology are summarized in **Figure 3.1**.

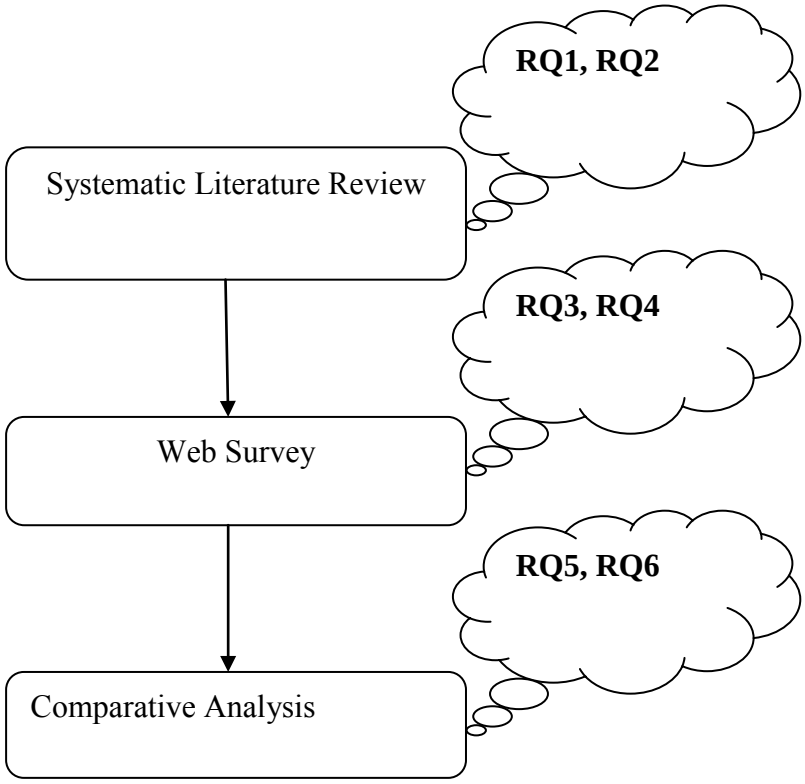

Figure 3.1 Overview of Research Methodology

3.2 Research Methods

Creswell [69] defines research as a study that goes beyond the influences of personal ideas and experiences of an individual. There are three types of methods for conducting a research i.e. qualitative, quantitative and mixed methodology. However in order to address the above mentioned research questions and to get the expected outcomes, mixed method approach (both qualitative and quantitative) has been used because the combination of qualitative and quantitative research approach produce consistent results [70].

3.2.1 Systematic Literature Review (SLR)

The qualitative research step comprises of systematic literature review (SLR). According to Kitchenham and Charters [65] "*systematic literature review is a means of evaluating and interpreting all available research relevant to a particular research question, topic area, or phenomenon of interest*". LR helps researchers to delineate the explicit and rigorous criteria to identify, critically assess and synthesize all available research literature [71]. Moreover, SLR helps in conducting a verifiable and accurate procedural review of research evidences and incorporates the scientific work in an unbiased way [65] [72] [73]. Therefore SLR has been selected to review the available literature.
There are three phases of SLR as defined by Kitchenham and Charters [65]:

- Planning the Review (Developing and Evaluating review protocol)
- Conducting the Review (Selection of primary studies, data extraction and data synthesis)
- Reporting the Review (SLR results are presented in this phase)

3.2.2 Empirical Research

There are various research methods available for conducting empirical research e.g. case studies, surveys and experiments [74]. The case studies are conducted to investigate the contextual realities i.e. to examine why and how the things happen [75]. On the other hand, experiments are usually performed to control over the situation and to manipulate the behavior directly, systematically and precisely [74]. Therefore because of its controlled nature; experiments are also not very suitable for this study. Consequently it has been decided to conduct empirical research with the help of survey as it has the potential to collect much more data from many practitioners working at various roles in various organizations. Moreover survey helps in understanding the views of a larger population which consequently helps in generalizing the results [74].

Quantitative research provides statistics through the use of large-scale survey research, using methods such as questionnaires [76]. The web survey has been conducted to include wider and larger range of audience around the world. Because, if the participants of the survey (sample) are diverse enough, that results of analyses may represent the population, and hence the findings can be generalized [69]. The prime advantage of survey is "its capability to generalize about an entire population by making deductions based on data derived from a small portion of that population" [77]. Moreover, survey aims to explore a certain situation and describe the significant factors associated with that situation [78]. Besides, for this study, conducting a survey is more suitable because it facilitates to add insight of diverse practitioners in various software industries. This survey corresponds to research questions RQ3 and RQ4.

3.2.3 Data Analysis

Research synthesis is a way to summarize, integrate, and compare the results of different studies on a specific topic or research question [13]. Qualitative data is non-numeric data with diverse types of values in descriptive form that can't be counted or measured [79] [80]. It is based on expressing and observing something in a detail rather than depicting numerical

inferences [80]. Qualitative data analysis (QDA) is used to transform such sorts of immeasurable data into logical results [81].
In this phase, the collected data from SLR and survey has been analyzed. For this purpose, narrative analysis and descriptive statistics has been used. Narrative synthesis is used for analyzing the data collected from SLR while descriptive statistics analysis has been used for analyzing the data collected from survey.

3.2.3.1 Narrative Synthesis

Narrative synthesis has been used to analyze the findings of SLR. Narrative synthesis is a method of descriptions and ordering of primary evidence with interpretation combined with specific techniques that facilitate to increase transparency and reliability [13]. In addition, it is a well refined way of combining and summarizing of results from multiple studies with the help of words and text with the aim of producing a new knowledge [82]. It can be applied to reviews of qualitative as well as quantitative research [13]. Thus the data gathered from SLR has been presented using narrative synthesis in the following steps:

- Descriptions of all challenges and their corresponding solutions have been identified and extracted from 30 primary studies.
- Descriptions of all challenges have been synthesized in 8 categories since most studies have described the same issue in different ways.
- Descriptions of all solutions have also been synthesized in 22 categories.
- Every challenges and solution has been assigned a name and unique ID i.e. C1 to C8 for 8 categories of challenges and S1 to S22 for 22 categories of solutions.

3.2.3.2 Descriptive Statistics

Descriptive statistics is an approach for organizing and summarizing sample data to express their significance of characteristics [83]. Descriptive statistics are used for quantitatively describing the main attributes of the data in a study. Moreover, it provides summaries of the samples and measures [66]. Descriptive statistics also helps in summarizing and classifying the gathered data in clear and comprehensible way [74].
Descriptive statistics in this thesis has been used for providing summaries of the samples size and measures of the survey. Samples refer to respondents of the survey. Different respondents have selected different challenges and corresponding solutions. Statistics in terms of frequency (number of responses) and overall percentage for all challenges and solutions has been illustrated in the tabular form in section 5.2

3.2.3.3 Comparative Analysis

Comparison process is an essential part of any research. Systematic and logical comparative methods help to understand similarities and differences between the entities in a study. Moreover it helps to build a conceptual model of prospective relationship among these entities [67] [84]. Comparative analysis has been conducted by first extracting the challenges and solutions of requirements elicitation in offshore outsourced software development projects from both SLR and industrial survey. The challenges and solutions of requirements elicitation gathered from literature have been compared with the ones gathered from industrial practitioners via web survey.

4 RESEARCH CONDUCT

4.1 Systematic Literature Review

According to Kitchenham and Charters [65] "*systematic literature review is a means of evaluating and interpreting all available research relevant to a particular research question, topic area, or phenomenon of interest*".
In order to find the answer for research question RQ1 and RQ2, systematic literature review (SLR) has been performed according to guidelines proposed by Kitchenham and Charters [65]. The purpose of the SLR for this study is to identify and analyze all published research evidence to fulfill the aim and objectives of the study. In this thesis, only those study materials are included which have been published from 1st January 2000 to 1st April 2013. The main reason behind defining this criterion is that there is not relevant material available related to this study prior to 2000. According to Friedman [85], GSE (Global Software Engineering) was not recognized as an effect of globalization's trend prior to 21st century. Moreover, systematic review conducted by Smite el al. [16] says that, studies conducted after year 2000 are more relevant than studies published before 21st century because effect of globalization on GSE is recognized as 21st century trend. Therefore only those studies have been included which are published after year 2000.
The design and execution of SLR consists of the following three phases.

- Planning the review (Developing and evaluating review protocol)
- Conducting the review (Selection of primary studies, data extraction and data synthesis)
- Reporting the review (SLR results are documented and presented in this phase)

4.1.1 Planning the Review

The planning phase mainly concerns with the steps for performing literature review in a systematic way and the development of review protocol. In this phase, the need for the SLR is justified and the review protocol (research questions, search strategy and selection criteria) is developed.

4.1.1.1 Purpose of the Systematic Review

Main purpose of this systematic review is to gather and summarize the available research literature for empirical evidences of challenges and solutions regarding global requirement elicitation.
The output of SLR has been used as input for helping to formulate the questions of survey, which is elaborated in Section 5.1.2

4.1.1.2 Defining Research Questions

The following research questions will be answered by the systematic literature review.

1. What challenges are reported in the research literature regarding global requirement elicitation?
2. What are the solutions to the reported challenges in the literature?

4.1.1.3 Developing a Review Protocol

A review protocol helps to define a procedure to carry out a specific systematic review. Moreover, it also minimize the researcher bias [65].
This section defines the detailed procedures for conducting systematic literature review. It also gives a method to choose primary studies to decrease biasness.

4.1.1.3.1 Search Strategy

First of all the research scope has been defined i.e. the requirements elicitation phase during GSD. This helped in setting the research questions and identifying the main keywords. The preliminary keywords are searched in authentic databases i.e. Scopus, Inspec and Compendex. On the base of search hits, scope of the study, research questions; the preliminary keywords have been redesigned and searches have been performed once again. The following steps are followed to develop the search strings.

- Major search terms are extracted from the research questions
- Synonyms or alternatives of search terms have been identified
- Boolean operator "OR" has been used to combine interventions i.e. synonyms
- Boolean operator "AND" has been used to combine population and interventions
- Librarian has been asked for efficient and effective search tips

4.1.1.3.2 Search Keywords

Based on the RQ1 and RQ2 the two sets of keywords have been formulated. Because the two inevitable points to be consider in every potential study are requirements elicitation and GSD domain. To avoid the risk of missing any important paper, the words challenge or solution have been excluded from the keywords because different authors have used different terms for challenges and solutions. By that way wider range of papers has been collected. Following are the set of keywords that are identified in conducting SLR. Asterisk (*) in set B is used to match zero or more non-space characters during search.

A: {requirements elicitation, requirements acquisition, requirements acquiring, requirements gathering, requirements extraction, requirements capture}

B: {global software engineering, global software development, distributed software engineering, distributed software development, collaborative software development, collaborative software engineering, multi-site software development, cross-site software development, global software team*, distributed development, distributed team*, dispersed team*, virtual team, offshore*, outsource*}

4.1.1.3.3 Search Strings

Search strings are developed by combining different keywords using AND operator and synonyms of each keywords using OR operator. Following are the summarized search strings developed from the keywords defined above:

{A1 OR A2 OR A3 OR A4 OR A5 OR A6} AND {B1 OR B2 OR B3 … OR Bn}
i.e.
(requirements AND (elicitation OR acquisition OR acquiring OR gathering OR extraction OR capture)) AND ((offshor* AND (software OR development OR outsource*)) OR ((global OR distributed OR dispersed OR virtual) AND team*) OR ((global* OR distributed OR collaborative OR "multi-site" OR geographic*) AND ("software development" OR "software engineering")))

4.1.1.3.4 Data Sources

The electronic databases that are selected to perform the search for primary studies are:

- Engineering Village (Inspec & Compendex)
- Scopus

Scopus has been chosen because it is considered to be the largest database of abstracts and citations [65] while Engineering Village (EV) platform has been selected to execute and evaluate search string because it has the capability to access publications from several other sources through one single interface. EV is the leading web-based powerful platform that combines database searching of all literature databases via single interface [86]. Sometimes the full text of every article is not always available in EV databases therefore it provides links to SFX@Blekinge. For retrieving a full-text of articles and journals, publishers' sites

have been used i.e., IEEE Xplore, ACM Digital library, Springer Link, Scopus, Science Direct, Wiley Inter Science and ISI Web of Science.

4.1.1.4 Study Selection Criteria

The study selection criterion is used for justifying the selected search strategy that is suitable for the research questions [87]. The study selection criteria consist of inclusion and exclusion criteria. It will determine the research papers suitable for the research scope. The research papers have been selected on the basis of title, abstract, keywords, introduction and conclusion that utmost matches with the research questions.

4.1.1.4.1 Inclusion criteria

Inclusion of articles has been done using a tollgate approach [88]. This method consists of four stages as described in the Table 4.1

Table 4.1: Inclusion Criteria

	Stage	Selection Criteria
1	Overall selection	✓ Publication date January 2000 to April 2013 ✓ Published in English ✓ Published in conference/ journal/ workshop proceedings ✓ Full text ✓ Non-duplicate
2	By title and Abstract	✓ Contain search words ✓ Has empirical background ✓ Must focus on requirements elicitation ✓ Study relates to GSD domain
3	Introduction and conclusion	✓ Empirical background ✓ Identify any challenge and or propose any solution or practice to mitigate the identified challenge of requirements elicitation
4	Full text level	✓ Study contain empirical research work ✓ Mainly focus on any challenge of requirements elicitation and or any practice to mitigate them

4.1.1.4.2 Exclusion criteria

The research articles have been excluded that do not fulfill the inclusion criteria mentioned above and:

- Editorial notes and comments
- Articles that did not offer any qualitative or quantitative data evidence
- Anecdotal studies

4.1.1.5 Data Quality Assessment Criteria

After passing through the selection criteria, the included primary studies have been assessed against a quality criteria defined as a checklist. Its purpose is to make sure that appropriate papers have been selected for primary studies and these studied are aligned with the overall goal of this thesis. Data quality assessment criteria are illustrated in Table 4.2

Table 4.2: Quality Assessment Criteria

#	**Quality Assessment Checklist**	Yes/No/Partial
1	Is aim of the study clearly explained?	
2	Does the research study clearly specify the research methodology?	
3	Are the results of study properly mentioned?	

4.1.1.6 Data Extraction Strategy

MS Excel sheet has been used as a data extraction form to extract data from primary studies. Besides MS word file has been used to record the details of identified challenges and solutions. Data extraction form contains some general information and some specific information regarding this study. See Appendix 9.1for complete data extraction form.

4.1.1.7 Data Synthesis Strategy

Data has been synthesized by collecting and summarizing the results of primary studies related to the research questions. The summary of the search articles with respect to the primary areas are described in Table 4.3

Table 4.3: Summary of finally selected articles

Key Area	Authors	Year	Reference
Challenges to requirements elicitation in GSD projects	Author 1 Author 2 …. Author n	2000 – 2013 …. ….	R1 R2 …. Rn
Solutions or practices to mitigate challenges to requirements elicitation in GSD projects	Author 1 Author 2 …. Author n	2000 – 2013 …. ….	R1 R2 …. Rn

4.1.2 Conducting the Review

This phase contains selection of primary studies, evaluation assessment of their quality based on different review protocol criteria such as data extraction and data synthesis.

4.1.2.1 Identification of Research

Preliminary search strategy has been developed in consultation with supervisor and BTH[1] librarian. Initially search has been made using various combinations of search terms derived from the research question. Key words have been identified to find the articles related to the topic. Afterward a list of synonyms and alternatives has been identified by consultation with two PhD candidates at BTH. Refined search strings have been developed using Boolean operator AND and OR. Later on, review protocol has been evaluated by BTH librarian.
To minimize the risk of publication bias, the following measures have been taken:

- ✓ Relevant conferences has been scanned
- ✓ Relevant authors have been contacted for any unpublished article
- ✓ Manual search has been performed online

Zotero[2] has been used as a reference management tool. It is open-source reference management software that collects, saves, manages, and cites bibliographic information.

4.1.2.2 Selection of Primary Studies

Tollgate approach [88] has been used in selection of relevant research studies. This approach consists of four phases as described in **Error! Reference source not found.** in section 4.1.1.4.1. The same search string has been used for each database.
Initially 546 papers have been collected from Scopus and 1962 papers from Engineering village which include both Inspec and Compendex i.e. 1411 papers from Compendex, 551 papers from Inspec. The details of number of research papers extracted from each database are illustrated in Table 4.4.

[1] http://www.bth.se/eng/library/
[2] https://www.zotero.org/

Table 4.4: Research papers from various databases

Sr. #	Database	Search String	Total articles found
1	Engineering Village (Compendex & Inspec)	(requirements AND (elicitation OR acquisition OR acquiring OR gathering OR extraction OR capture)) AND ((offshor* AND (software OR development OR outsource*)) OR ((global OR distributed OR dispersed OR virtual) AND team*) OR ((global* OR distributed OR collaborative OR "multi-site" OR geographic*) AND ("software development" OR "software engineering")))	1962 (Compendex: 1411 Inspec: 551)
2	Scopus	(requirements AND (elicitation OR acquisition OR acquiring OR gathering OR extraction OR capture)) AND ((offshor* AND (software OR development OR outsource*)) OR ((global OR distributed OR dispersed OR virtual) AND team*) OR ((global* OR distributed OR collaborative OR "multi-site" OR geographic*) AND ("software development" OR "software engineering")))	546
	Total		2508

4.1.2.3 Papers Selected from Primary Studies

The process of final papers selection has been based on tollgate approach [88] which consists of four stages already defined in Table 4.1 in section 4.1.1.4.1.

Initially 2508 papers have been collected. The criterion mentioned in stage 1 in Table 4.1 has been applied on 2508 articles. Therefore the studies written in language other than English or unavailable in full text or duplicate papers has been removed. By that way, 755 articles have been identified as eligible to be passed out to the second stage for further filtration.

By applying the criteria mentioned in stage 2 in Table 4.1 on those 755 articles, 48 articles have been identified as eligible to be passed out to the third stage for further filtration.

By applying the criteria mentioned in stage 3 in Table 4.1 on those 48 articles, 30 articles have been identified as eligible to be passed out to the final stage for further filtration.

By applying the criteria mentioned in stage 4 in Table 4.1 all articles have been passed out of the final stage, so all those 30 articles have been selected as a primary studies for this thesis. The list of finally selected primary studies is provided in Appendix 9.2.

The Figure 4.1 shows the graphical representation of these four inclusion/exclusion rounds.

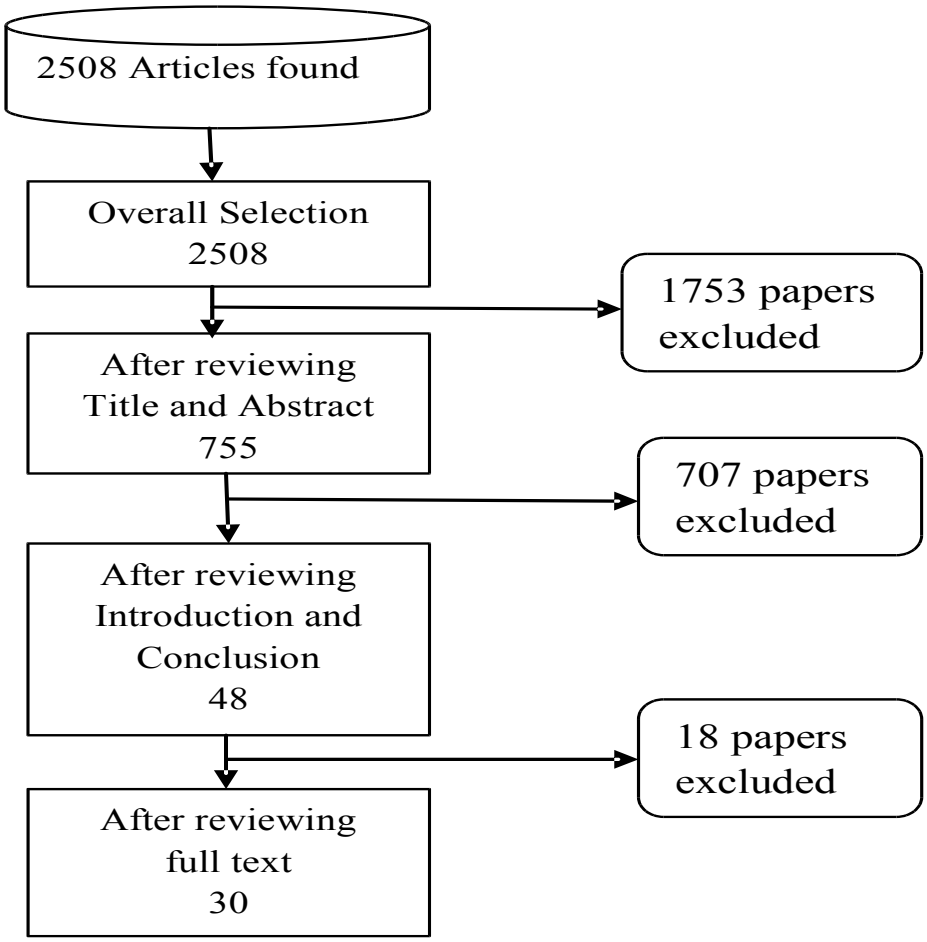

Figure 4.1 Primary Studies' Selection

4.1.2.4 Study Quality Assessment

The purpose of the study quality assessment is to minimize the chances of bias in terms of suitability of papers selection in this study [65]. Quality assessment check list has been created and selected primary studies have been rated on three scales i.e. Yes, Partially and No.
Table 4.5 shows the quality assessment result of the selected primary studies.

Table 4.5: Quality Assessment Criteria Results

#	**Quality Assessment Checklist**	No. of Articles		
		Yes	**Partially**	**No**
1	Is aim of the study clearly explained?	28	2	0
2	Does the study clearly state the research methodology?	24	4	2
3	Are the results of study properly mentioned?	28	1	1

4.1.2.5 Data Extraction

Data extraction form helps the researchers to record the information gathered from primary study. Moreover it also helps to minimize the chances of bias [65]. Data extraction form mentioned in Table 4.3 (section 4.1.1.6) has been used to record the required information from the primary studies.

4.1.2.6 Data Synthesis

Data synthesis is an important phase of SLR which involves organizing and summarizing the findings of primary studies [65]. In order to answer the research question, the raw data gathered from data extraction form has been categorized and analyzed. The data has been tabulated to present the requirements elicitation challenges and their associated solutions or practices to mitigate them to form the basis of designing a survey. Data synthesis form

mentioned in Table 4.3 (section 4.1.1.7) has been used to document the challenges and solutions from the primary studies.

This chapter delineated the plan and design of this research i.e. the way this study has been conducted. Therefore reporting of SLR results is illustrated in next chapter in section 5.1.

4.2 Survey

The aim of this section is to illustrate the design of the survey along with questions. Survey provides a "*quantitative or numeric description of trends, attitudes, or opinions of population by studying a sample of that population*" [69]. A comprehensive online survey has been conducted in order to validate the results of SLR and to explore the state of practice that have been adopted by practitioners regarding requirements elicitation in offshore outsourced software development projects. This survey corresponds to research questions RQ3 and RQ4.

4.2.1 Rationale for Survey

Web survey has been conducted to explore the extent to which industry practitioners are experiencing requirements elicitation's challenges and associated solutions, in comparison with what stated in research literature. To conduct this type of research, web survey is more appropriate option as compared to other research methods like experiments and case studies. The dismissal of these alternatives is previously discussed in section 3.2.2.
Web survey is suitable in collecting data from different parts of world from wide range of industrial practitioners since it is not constrained by temporal or geographical distance. In addition, it is feasible method to conduct with respect to time and budget since physical presence of the author is not required for conducting web survey.
Survey Questionnaire can be found in Appendix 9.7.

4.2.2 Objectives of Survey

The main aim for conducting survey is to investigate industrial practices in relation to requirements elicitation's challenges and associated solutions in offshore outsourced software development projects. For this study, experience of industry practitioners working in offshore outsourced software development projects has helped. Some space has been left for further comments so that respondents feel free to express their additional views. The following objectives have been framed for this survey:

- To gain general demographics information of offshore outsourced software development team
- To explore the challenges faced by the practitioners during requirements elicitation phase in offshore outsourced software development projects
- To explore the practices applied in software industry to address those identified challenges

4.2.3 Ensuring that appropriate resources are available

It has been ensured that appropriate resources are available prior to conduct of the survey. Foremost resources required for this survey are, contextual data and population i.e. practitioners working in offshore outsourced software development projects. The contextual data comprise the challenges and corresponding solutions mitigation strategies which have been explored through the results of SLR. The practitioners working in GSD projects especially in offshore outsourced software development projects have been targeted prior to the design of survey. The sources used to contact these practitioners are discussed in section 4.2.6.

4.2.4 Questionnaire Design

Mainly, there are two common ways for data collection in surveys i.e. interviews and questionnaire. The disadvantage of interviews is cost and time. Therefore, web-based questionnaire has been used as a data collection instrument because it allows wide collection of responses across the globe in a short time period at very low expense [89]. The questionnaire for survey has been designed carefully after reviewing the relevant literature thoroughly. SLR has made the basis of questionnaire's design for conducting this survey. Closed ended questions have been used with checkboxes to test the findings from SLR. Online survey software tool, Survey Gizmo[3] has been used for data collection from the respondents. Web survey has been chosen because the respondents are located around the world and it is more convenient and cost effective to collect data from them via online platform. The reason for choosing Survey Gizmo is that it's very easy to use and cost effective for students. Moreover, it provides more logic and questions' formatting features as compared to its counterparts e.g. it has a facility for Facebook and Twitter integration and it provides almost all the enterprise features to students at low cost [90]. The questions in the survey have been divided in to two pages, one being demographic questions and other being contextual. The following demographic information has been collected:

- Role of the respondent
- Experience of respondent in software engineering
- Number of employees in respondent's organization
- Location of the main site
- Activities performed by the main site
- Number of offshore sites
- Location of the top 3 offshore sites
- Number of people involved in the project
- Types of software products developed
- Type of software development model used

The second page has 9 contextual questions. The purpose of this section is to explore the extent to which industry practitioners are experiencing requirements elicitation's challenges and associated solutions. In addition, it also helped to indicate similarities and disparities between research literature and industry practitioners' experience. The following information has been collected via contextual questions:

- Out of those 8 categories of challenges (found in SLR), how many of them have been faced by the respondent
- Solution / Strategy used to cope up with each of those 8 categories of challenges

Besides, at the end of every question, one extra checkbox "other" has been used to allow the respondent to write some other answer if they have faced some extra problem or if they follow some other practices for the identified challenges in their companies. Questionnaire can be found in Appendix.

4.2.5 Survey Piloting

Questionnaire has been carefully designed on the basis of data collected from SLR. To test the questionnaire, 3 students of MSc Software Engineering of BTH[4] have been requested to fill the survey and give feedback. Moreover, 2 practitioners from software companies have also been requested to fill in the survey. One practitioner is verification engineer in Ericsson Stockholm. He has 8 years of experience as an agile practitioner in software development projects. Other practitioner is a project manager at Sony mobile corporations in Sweden. He has 7 years of experience in requirements coordination and project management in telecom

[3] http://www.surveygizmo.com/
[4] http://www.bth.se/eng

industry. This process has been done in 3 iterations. Based on their feedback and suggestions, after 3 iterations, the questionnaire has been modified to make it convenient for respondents. Afterward the questionnaire has been sent to the supervisor for review and verification. Based on her feedback modifications have been made. The supervisor continuously provided her comments and feedback on the questionnaire design until it has been ready for online distribution. Survey piloting is illustrated in Figure 4.2.

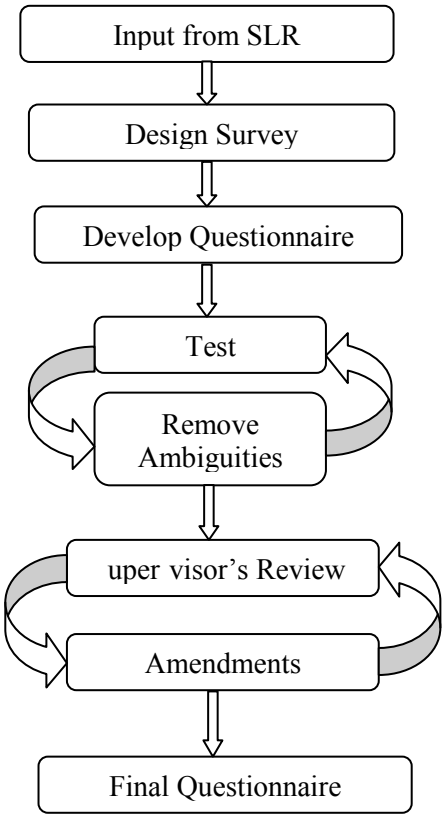

Figure 4.2 Survey Piloting

4.2.6 Survey Execution

After finalizing the survey, the questionnaire has been sent to the potential respondents by email and also via professional networks i.e. LinkedIn and Xing[5]. The respondents have been selected based on their current or prior experience in GSD. Moreover, various companies have been searched that are involved in GSD and especially in offshore outsourced software development. Then each company has been requested to participate in filling survey questionnaire. To find the relevant software companies in Sweden, an online database allabolag.se[6] has been used. Participants have been humbly requested to distribute the survey to their colleagues and other relevant contacts. The survey has also been distributed on Facebook groups and Yahoo group of offshore software development.

[5] https://www.xing.com/
[6] http://www.allabolag.se/

4.2.7 Sampling of Survey Population

Choosing a set of respondents as a subset from the whole population under study is known as sampling. There are two types of sampling i.e. probability sampling and non-probability sampling. In probability sampling, researcher chooses a subset of the entire population [91]. Convenience sampling, which is non-probability sampling technique, has been used for conducting this survey because of time and resource constraints and also for the reason that the target population is quite specific. However, the population has been limited only to the practitioners who have past or present experience with GSD projects. Furthermore the population also comprised of volunteers from industry that have been contacted through email provided on their company's websites.

This chapter provided the overall procedure of research employed in this thesis. The results of survey are reported in next chapter in section 5.2.

5 RESULTS

5.1 Reporting the Results of SLR

This section presents the results of SLR based on the 30 primary studies which are given in Appendix 9.2. The results are presented in two sections i.e. quantitative and qualitative. In quantitative analysis, the results are represented as statistical data in a numerical form. While through qualitative analysis, the narrative description of reported challenges and relevant solutions of requirements elicitation in offshore outsourced software development projects have been presented.

5.1.1 Quantitative Results

Quantitative analyses statistically elaborate the results of SLR on the basis of various characteristics. The results of SLR are presented according to the sources, year of publication, research method and research context.

5.1.1.1 Selected Primary Studies

This section presents the information about the selected primary studies. Each research paper has been described with information like authors' name, publication year, publication name, and study type.

5.1.1.2 Primary Studies' Sources

Initially two index engines i.e. Engineering village (Inspect & Compendex) and Scopus has been used for search because these two index engines contains most authentic literature databases. Both c opus and Engineering village provided redirection link to the publisher's sites e.g. IEEE Xplore, ACM Digital Library, Springer link, Science Direct via SFX@Blekinge.
Among 30 primary studies, 18 studies have been found in IEEE, 9 from Springer Link, 1 study from ACM and 2 studies from Google Scholar. It is clear from the Figure 5.1 that majority of the papers are found in IEEE. The main reason is that most of the international conferences on global software engineering (ICGSE), requirements engineering and cognitive informatics have been conducted and published by IEEE.

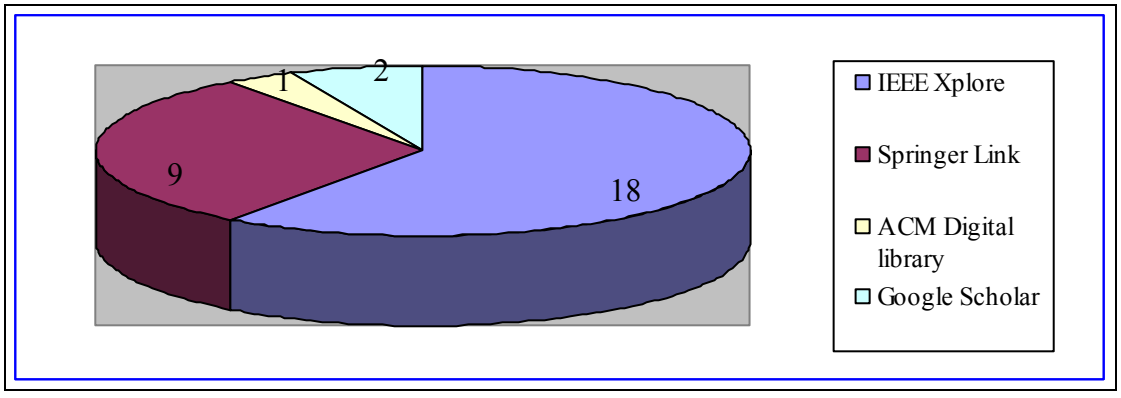

Figure 5.1 Primary Studies with respect to Databases

5.1.1.3 Publication Year

For this research, papers have been searched from year 2000 till 2013. The reason is that GSD arise as a prevalent trend in 21st century [85] for that reason going behind 2000 was not

so fruitful. A total of 30 papers, have been published till the time of search i.e. 1st April 2013, have been found apt to the research field are represented in the Figure 5.2

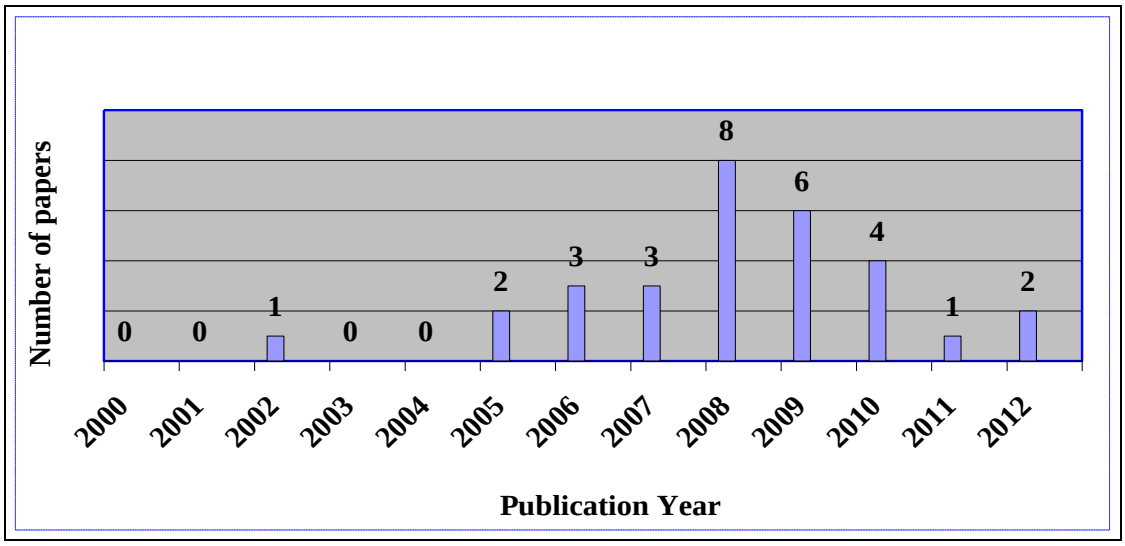

Figure 5.2 Primary Studies with respect to Publication Year

Figure 5.3 shows that except 1, all other research papers are published from 2005 onwards. One of the main reasons is that all conferences on global software engineering (ICGSE)[7] have been held after the year 2005.

5.1.1.4 Research Method

Empirical evidence is categorized on the basis of Research methods [74], i.e. Experiment, Survey, Case studies, Focus groups, Action Research etc. Figure 5.3 shows the categorization of the research papers on the basis of research method.

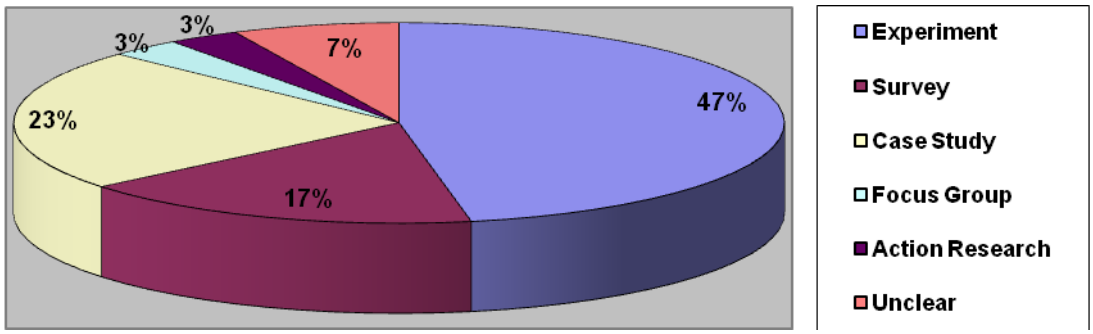

Figure 5.3 Primary Studies with respect to Research Methods

Out of 30 primary studies, majority of the studies (47%) employed experiment to fulfill their research objectives, 17% studies conducted survey, 23% studies performed case studies, 3% study employed focus groups approach and 3% study executed an action research method while the research method of 2 studies (i.e. 7%) was unclear. Over all statistics reveals that majority of the studies used empirical research methods to perform their research. This further enhances the credibility of results.

[7] http://www.icgse.org/

5.1.1.5 Context

Table 5.1 presents the contextual information of each primary study in terms of research method, research background, subject of investigation and project size. Regarding research method, 5 papers have proposed some model to cope up with some issue but did not explicitly mention the research method though the rest of 25 (83%) studies clearly mention the research method employed in their studies. As a whole there are 27 (90%) research papers reported in industrial context. Mostly the subjects of investigation are industry practitioners as there are 23 (77%) studies on practitioners. This shows that most of the literature has industrial validation which further enhances the reliability of this study.

Table 5.1 Research Context of Primary Studies

Research Work Context		**No. of Publications**
Research Method	Experiment	14
	Survey	5
	Model Proposed	5
	Case Study	3
	Interview	1
	Focus Groups	1
	Action Research	1
Research Background	Industry	27
	Academia	3
Subject of Investigation	Practitioners	23
	Students	6
	Mixed	1
Project Size	Large	12
	Medium	4
	Small	1
	Unclear	13

5.1.2 Qualitative Results

Qualitative analysis of SLR elaborates various challenges of requirements elicitation and their relevant solution or practices to mitigate them, reported in primary studies.

5.1.2.1 Reported Challenges of requirements elicitation

Initially 44 descriptions of various challenges of requirements elicitation from those 30 primary studies have been extracted. However many of them are actually the same challenges with different narratives. Therefore author categorized all those 44 descriptions of challenges in 8 categories (C1 – C8) as:

- C1: Tools
- C2: Linguistic barriers
- C3: Communication
- C4: Control & Promote
- C5: Scaling-up
- C6: Coordination
- C7: Socio-cultural
- C8: Prioritizing stakeholders

Challenges related to tools and technology used for requirements elicitation were given the name C1 (Tools). Challenges due to differences in language or dialects have been given the name C2 (Linguistic barriers). Challenges due to lack of face-to-face interaction or due to selection of inappropriate medium, mode or technique for elicitation have been given the name C3 (Communication). Challenges related to managing the process, goals, standards or

facilitating the stakeholders' participation have been given the name C4 (Control & Promote). Challenges due to requirements gathering from a large number of distributed stakeholders have been given the name C5 (Scaling-up). Challenges due to integration of tasks, team members or stakeholders have been given the name C6 (Coordination). Challenges due to national or organizational cultural differences have been given the name C7 (Socio-cultural). And Challenge due to prioritizing stakeholders for requirements elicitation has been given the name C8 (Prioritizing stakeholders).
These 8 categories of challenges have been mentioned in various primary studies in different ways.

Figure 5.**4** shows how many of primary studies have discussed each challenge. The vertical bars represent those 8 challenges while horizontal bars show the number of primary studies for each of these 8 challenges.

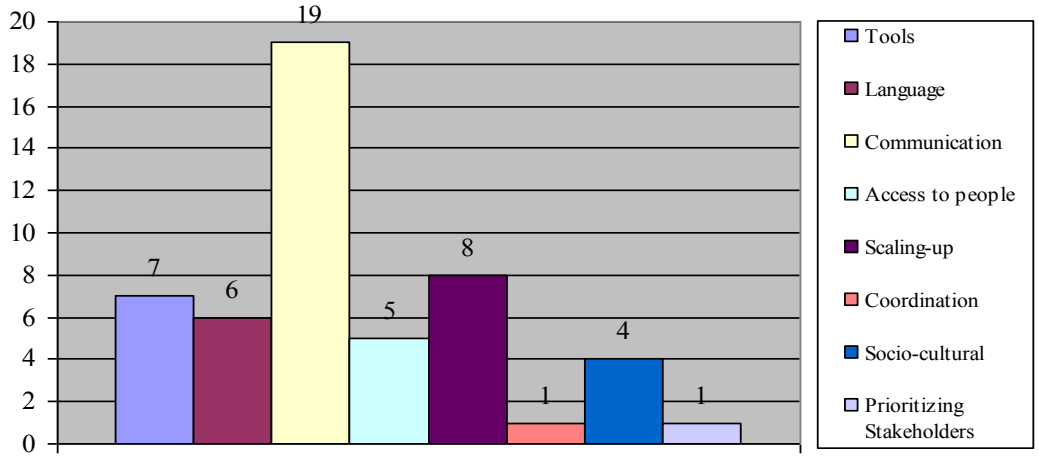

Figure 5.4 Number of Primary Studies for each Challenge

Table 5.2 illustrates the details of these 8 categories of challenges with various descriptions as stated in research literature.

Table 5.2: Reported challenges of requirements elicitation in research literature

Challenges	**Challenges' descriptions in primary studies**
C1: tools	1: less rich communication media for remote elicitation [P18] 2: ambiguous information because of less rich communication medium [P3] 3: how to choose the most suitable tools considering stakeholders' preferences during global requirements elicitation? [P9] 4: how to select the most suitable groupware tools according to the learning styles of the members of virtual team? [P10] 5: how to choose the most suitable technology for group of stakeholders considering information concerning stakeholders' cognitive characteristics? [P11] 6: how to choose an appropriate groupware tools / technology for elicitation in virtual teams? [P12] [P27]
C2: linguistic barriers	1: stakeholders' linguistic diversity [P8] 2: misunderstanding arise because some words have more than one meaning, or different words refer to the same concept [P2] [P13] 3: the requirements team cannot understand the language of client team [P6] 4: distributed stakeholders had different languages [P13]

	5: when stakeholders are not from the same country, and even if they share the same mother language, misunderstandings may arise about words' meanings [P26] 6: language barriers increase the risk of misinterpretation [P3] 7: language barriers increase the risk of dissemination of false information [P3]
C3: communication	1: comfort feeling of two or more stakeholders with an elicitation technique was at variance [P8] 2: stakeholders don't feel comfortable expressing their ideas and describing facts when methodology / elicitation technique is not closer to the way they perceive and reason about the world [P13] [P14] [P15] 3: how to select a suitable elicitation technique according to stakeholders' cognitive / learning styles? [P16] [P9] [P10] [P11] [P12] 4: which communication mode to deploy to achieve effective communication during distributed requirements elicitation i.e. whether face-to-face (F2F) communication or synchronous text-based computer-mediated communication (CMC) [P28] [P4] 5: less / poor communication across developer and customer sites leads to missing requirements [P6] 6: inefficient communication medium for requirements elicitation [P6] 7: lack of face-to-face interaction makes the loss of communication richness problem [P26] 8: difficulty in arranging face-to-face communication because of spatial distribution and multitude of stakeholders [P1] 9: face-to-face communication for requirements elicitation cannot be possible because of distance and time zone differences [P5] 10: inefficient or ineffective communication between stakeholders in order to elicit requirements [P3] 11: lack of face-to-face interaction [P27] 12: lack of informal or face-to-face communication for elicitation [P17] 13: lack of informal communication [P7]
C4: Control & promote	1: how to manage access control in a dynamically evolving, collaborative and inclusive requirements elicitation process [P19] 2: lack of user involvement/motivation in requirements elicitation [P29] 3: how to improve stakeholders' participation in requirements elicitation process [P17] 4: non-active involvement of stakeholders [P20] 5: how to facilitate the collaborative exchange of ideas, information and needs [P5]
C5: scaling-up	1: how to support collaborative requirements elicitation process that involve hundreds or even thousands of distributed stakeholders [P19] 2: eliciting stakeholders' needs and desires for large and complex projects in which requirements knowledge is distributed across thousands of global stakeholders [P23] 3: eliciting requirements from a large number of globally distributed stakeholders [P1] 4: In large and complex software projects; in-person requirements meetings are not feasible on a regular basis because the knowledge needed to elicit requirements is dispersed across many thousands of stakeholders [P24] 5: communication overhead during distributed requirements elicitation process of large projects [P20] 6: requirements elicitation from a spatially distributed large stakeholder groups [P21] 7: gathering requirements in large-scale open source distributed

	projects from large numbers of stakeholders [P22] 8: traditional elicitation practices do not scale well when applied to larger projects, where knowledge is distributed across numerous geographically dispersed stakeholders [P25]
C6: coordination	how to bring relevant stakeholders together into highly focused, topic-centric discussion groups [P25]
C7: Socio-cultural	1: cultural issues e.g. work habits, behaviors, different working hours, lunch breaks, weekends or holidays times [P2] [P13] [P27] 2: cultural difference e.g. attitude towards hierarchy (the "power distance" that relates to perceived relationships between supervisors and subordinates) [P7] 3: organizational cultural differences: e.g. stakeholders in remote organizations often follow different methodologies for eliciting and managing requirements and they lack authoritative leadership in RE process [P7]
C8: prioritizing stakeholders	It's difficult to make financially responsible decisions using value-neutral methods in requirements elicitation because it treats every stakeholder equally though different stakeholders have different opinions and expectations [P30]

5.1.2.2 Solutions / Practices to identified Challenges reported in SLR

After scanning primary studies, 22 solutions have been identified in primary studies for the above-mentioned 8 challenges. Each solution has been assigned an ID i.e. from S1 to S22. Mapping of solutions against reported challenges in SLR is illustrated in Table 5.3 in the next section 5.1.2.3.

S1. **Real time virtual meetings via MOOsburg**: It is a place-based collaborative environment for distributed work, to facilitate file sharing, informal unarranged meetings, email and asynchronous discussions [P18].
S2. **Group email distribution**: Open issues or questions could be clarified by group email distribution list [P18].
S3. **Video or teleconferencing meetings**: Small distributed teams have found weekly meetings supported by video- or teleconferencing successful for requirements gathering and validation activities [P7].
S4. **Using audio and wiki technology**: This method uses interviews for the requirements elicitation using a software tool to capture the audio information of the interviews and notes of the requirements gathered. The audio information and the requirements are connected to facilitate the traceability of the rationale and discussions in later stages. Stakeholders are able to comment on the wiki pages or to create a glossary in the wiki. By that way, all stakeholders have sound information at hand. The use of this method avoids that the notes taken by the interview to become biased by the interviewer. Hence the problem of misinterpretation and the dissemination of false information on requirements are therefore reduced [P3].
S5. **Choosing suitable Communication mode**: If the time overlap among offshore sites is low, so it's better to use asynchronous groupware tools and to avoid elicitation methods based on synchronous interaction (like brainstorming). Moreover when the stakeholders' mother language is not the same, and the degree of understanding of a common language is intermediate or less, it's better to use asynchronous tools, in order to give people the opportunity to read and write with more care [P2] [P13] [P27].
S6: **Learning Style Model (LSM)**: Choosing an appropriate groupware tool and elicitation technique according to stakeholders' preferences (cognitive styles) on the base of Felder il verman's Learning ty le Model (L M) [P8] [P17] [P14] [P15] [P16] [P12] [P9] [P10] [P11].
S7: **Iterative framework for elicitation** (**IRE**): elicitation and analysis phase of RE are performed iteratively to extract requirements from the clients until an acceptable result of the

process has been achieved. During analysis and negotiation phase, when any incomplete or ambiguous requirements are identified, requirements engineer have to go back iteratively to elicitation phase to renegotiate the requirements with the client or can review the data gathered from client via different elicitation methods. Requirements engineer may use interviews and prototypes as main elicitation technique while scenarios and questionnaires can be used to collect requirements and customer's specification whenever he/she needs to go back to the elicitation phase due to incomplete requirements. He/she can use the data from these back up elicitation techniques clearance of requirements or can renegotiate the customer for some specific ambiguous requirements. Research illustrates that such iteration in the RE process satisfies more number of customers in achieving their requirements [P6].

S8: Using Ontology as communication facilitators: Ontology helps to share a common vocabulary for domain components, and also to build a common understanding of the problem. It is very helpful in global requirements elicitation because lots of requirements are gathered from numerous distributed stakeholders. Besides it helps to simplify the knowledge structure and allow a comprehensible specification of the concepts, notations and the terms used to represent them [P2] [P13] [P27] [P26].

S9: **SoftWiki**: Using the wiki concept, all stakeholders are permitted to declare their requirements or edit the existing ones. The user interface gives features for intuitive requirements and their easy linking to other predefined requirements. It provides regular wiki features e.g. allowing to track, review and rollback changes or a facility to discuss requirements [P1].

S10: **ShyWiki**: The Spatial Hypertext aspects of the wiki offer a spatial virtual board for distributed stakeholders to share, brainstorm and discuss the knowledge concerned with RE. The wiki pages works as a virtual board where distributed stakeholders can add, shift or group notes about their needs. Moreover it helps the novel ideas for requirements and the transfer of tacit knowledge to the requirements definitions [P5].

S11: **Synchronous text-based Computer-mediated Communication (CMC) Vs F2F:** Stakeholders considerably anticipated having increased chance to participate and more openly discuss conflicting matters with each other during synchronous text-based communication (e.g. chat and IM) for elicitations as compared to face-to-face interaction. Moreover, synchronous text-based communication is suitable to attain common grounds among conversational stakeholders unknown to each other [P28]. Face-to-face interaction provides more chance to familiarize with each other, and gives an enhanced aptitude for the expression of complex ideas and to grasp others' opinions. However, text-based communication is more effective than face-to-face communication, due to the capability of open discussion for conflicting matters. Therefore either communication medium could be used depending on some particular aspects of satisfaction with performance [P4].

S12: **Data mining, forums and Recommender System**: Initially, a web-based tool is employed to gather distributed stakeholders' needs and their generic comments. Then, data mining, recommender system and unsupervised clustering techniques are applied for the analysis of stakeholders' needs, to determine major and crosscutting issues, and an associated set of highly focused discussion forums is created dynamically. For timely placement of stakeholders into forums, an initial user authentication profile is created to capture the stakeholders' interests. This profile makes initial forum recommendations on the basis of each stakeholder's provided needs, and then creates further collaborative recommendations in accordance with the interests of identical stakeholders. Finally, in every discussion forum, groupware setting helps these distributed stakeholders working in collaboration each to convert their needs into sets of precisely expressed requirements [P19] [P23] [P24].

S13: **Volere requirements schema**: Volere procedure guarantee that all essential aspects of requirements are steady to an agreed schema, cautiously attended and that the approach applied have verified its worth in practical work. Volere template differentiates between global constraints that affect the project, functional and non-functional requirements. Moreover, the classification of Volere template needs to provide justification for every requirement and the assessment of client satisfaction [P20].

S14: **Online collaboration and use of social visualization techniques** to motivate stakeholders and enhance their awareness about requirements. Use of requirements visualization tools like graphical use case models; business process diagrams and requirements definition through scenarios helps in stimulating stakeholders' involvement. Social visualization gives information about the presence, activities and other data of a remote team member's social involvement in a community. This type of social visualization increases awareness of activities in a social environment, stimulating other users to participate in online communities for requirements elicitation [P29].

S15: **Forum-based requirements gathering processes by vendor based open source software projects**: In this process, large numbers of stakeholders from geographically dispersed locations in diverse time-zones collaboratively participate in the feature gathering process to explore their needs, discuss relevant issues, demand new features and produce apt requirements. In such forum, stakeholders connect in discussions by participating in a shared discussion thread. They find their suitable discussion threads by themselves. Each of the forums provides both browse and search facilities, mainly intended to assist stakeholders in finding their relevant discussion thread [P22].

S16: **Semantic data Wikis**: Semantic databased Wikis has the facility to improve the agreement between stakeholders by enhancing continuous formation of a shared vocabulary of domain knowledge. Semantic databased Wikis helps to define a more meaningful and formal structure. This kind of technique is mandatory for more practical knowledge management approach in RE and permits consistency checks through reasoning abilities. Besides, making links between requirements and occurrences of other standard Semantic Web vocabularies becomes possible [P21].

S17: **Organizer & Promoter of Collaborative Ideas** (OPCI): It uses clustering to automatically group the stakeholders' ideas into interrelated units, which make a preliminary set of discussion forums. Then it keeps stakeholders into their related forums and uses a recommender system to recommend further forums that could be significant to them. Recommender technologies can be used to keep stakeholders informed of relevant discussions during the requirements elicitation process. The OPCI approach form a more comprehensive setting which organizes the ideas of more stakeholders by proposing several points of view, interests, disagreements and tradeoffs as soon as possible in the software engineering lifecycle. Therefore it increases the possibility of extracting a complete and accurate set of requirements [P25].

S18 – S21: **Learning about Cultural diversity:** For requirements engineers it's worth to be aware of the normal behavior of offshore cultures as well as conscious of their own behavior, particularly for actions that could be unpleasant or misinterpreted in other cultures. To mitigate such sorts of challenges there are three solutions as follows:

i. **S18**: Literature reviews, seminars and courses [P2] [P13].

ii. **S19**: **Cultural mediation**: Mediators or bridgeheads have the experience of visiting the offshore sites therefore they have better perception of norms customs and normal behavior about foreign culture. For that reason they could be referents for communication with team members at the offshore sites [P2] [P13].

iii. **S20**: **Establish cultural liaisons**. Cultural liaison (project manager, analyst etc) bridges the cultural gap across offshore sites. These liaisons could play a vital role in trust and relationship building as well as in requirements elicitation and validation while dealing with tacit knowledge regarding cultural aspects of remote sites [P7].

iv. **S21**: **Virtual mentoring**: based on simulation and 3D virtual human actors and it can become an interesting way for motivating stakeholders in foreign language training and cultural familiarization [P2] [P13] [P26] [P27].

S22: **Five steps value based requirements elicitation framework**: 1. Assign value to stakeholders by applying Analytical Hierarchy Process (AHP). 2. Extract valued requirements from valued stakeholders. 3. Requirement engineer and system analyst will

refine those requirements according to project needs and will make a questionnaire according to project scope, which fulfills effectively the needs of all stakeholders. 4. Get stakeholders' feedback. 5. Review all the requirements and identify that how many stakeholders have chosen the similar option against certain requirement. If equal value exists for two options of one requirement, favor the option with the highest stakeholders' value above the other [P30].

5.1.2.3 Mapping of reported solutions against reported challenges

One major contribution of this study is the mapping of challenges and their corresponding solutions reported in research literature. The Table 5.3 provides the solutions or mitigation practice to all those 8 categories of identified challenges.

Table 5.3 Reported Solutions in Literature for each Challenge

Reported Solutions	Challenge addressed
S1, S2, S3	C1: Tools
S4, S5	C2: Linguistic barriers
S3, S4, S5, S6, S7, S8, S9, S11	C3: Communication
S3, S6, S10, S12, S13, S14	C4: Control & promote
S12, S9, S15, S16	C5: Scaling-up
S17	C6: Coordination
S18, S19, S20, S21	C7: Socio-cultural
S22	C8: Prioritizing Stakeholders

5.2 Reporting the Survey Results

Total 417 responses have been received of the survey. However all responses have been checked for validity as recommended by Wohlin [74]. Consequently, partially filled responses or responses with invalid demographic information have been deleted. As a result, 26 responses had to be deleted, and so the total number of complete responses became 391. Sections below describe, various information gathered from questionnaire.

5.2.1 Geographical locations of Respondents

Most of the responses have been collected from Europe, South Asia, South-east Asia and North America while only few responses came from Africa and Australia. Total 391 valid responses have been received from various parts of the world. Most number of responses has been received from India, Sweden and Poland i.e. 91, 57 and 26 respectively. The detail of the geographical locations of all these 391 responses is illustrated in Appendix 9.3.

5.2.2 Current Role of respondent in the project

The designations that the respondents held in the projects also varied in terms of their roles, which shows diverse group of respondents. This diversity enabled the collection of different views and perceptions of challenges and relevant strategies. Among 392 respondents, top three most reported roles are Developer/Programmer, Tester and Project Manager which has been mention 119, 59 and 59 times respectively. In this survey, respondents had the choice to choose one or more roles. The frequency and percentage of current roles of those 391 respondents is provided in Appendix 9.4.

5.2.3 Years of experience in software engineering

Asking about experience in software engineering helped to know that how reliable are the answers of those respondents. Experience of the majority of the respondents is either 6-10 years (46.3%) or 1-5 years (43.7%). Only 2 respondents have less than 1 year of experience

hence most of the survey respondents have well experience in the field of software engineering and they are aware of state of practice in software industry.

The detail of the overall experience of respondents is summarized in Figure 5.5.

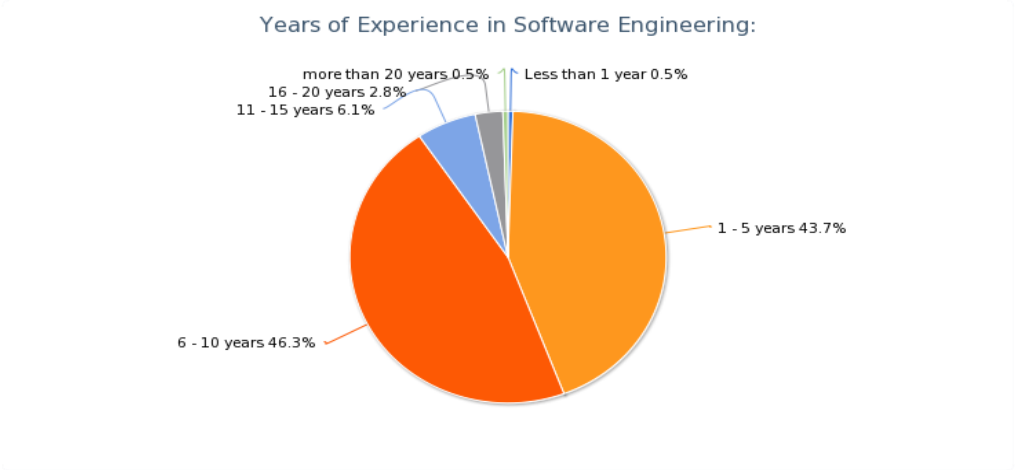

Figure 5.5 Respondents' Experience in of tware Engineering

Frequency of each respondent's experience and its percentage is illustrated in Table 5.4.

Table 5.4 Respondents' Experience in Software Engineering

Respondent's Experience	Count	Percent
Less than 1 year	2	0.51%
1 - 5 years	171	43.73%
6 - 10 years	181	46.29%
11 - 15 years	24	6.13%
16 - 20 years	11	2.81%
more than 20 years	2	0.51%

5.2.4 Number of employees in respondent's organization

Respondents vary in size of organization they work. Size of their organizations varies from small to very large. Only 14% respondents belongs from newly established small scale organizations having less than 100 employees while most of the respondents' organizations have employees ranging from 101 to 1000 which comprise almost 72% of the whole responses. It has been come to notice that vendor organizations in developing countries have less number of employees as compared to client organizations. Detail of the number of employees in respondent's organization is shown in Figure 5.6.

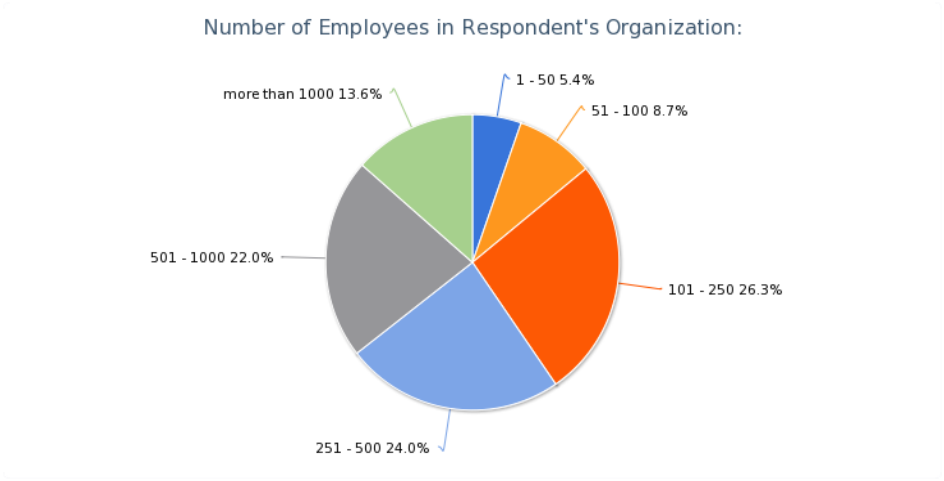

Figure 5.6 Number of Employees in Respondent's Organization

Frequency of each organization's size and its percentage is given in the Table 5.5.

Table 5.5 Size of Respondent's Organization

Number of employees	Count	Percent
1 - 50	21	5.37%
51 - 100	34	8.69%
101 - 250	103	26.34%
251 - 500	94	24.04%
501 - 1000	86	21.99%
more than 1000	53	13.55%

5.2.5 Location of the Main Site

Respondents have mentioned the location of their main site in 54 countries around the world. Among all, the top three most reported main site's locations are India, w eden and USA, which have been mentioned by 56, 50 and 48 respondents respectively. It has been come to notice that most of the client firms are located in developed countries like Sweden, USA etc. The details of the locations of main sites are provided in Appendix 9.5.

5.2.6 Activities performed by the main site

Respondents have mentioned 17 activities performed by their main site. The frequency and percentage of each activity is shown in Table 5.6 .

Table 5.6 Activities performed by Main Site

Activity	Count	Percent
Planning	253	12.36%
Training	84	4.10%
Design	204	9.97%
Documentation	152	7.43%
Requirements Analysis	265	12.95%
Requirements elicitation	254	12.41%
Development / Programming	238	11.63%
Deployment / Installation	207	10.11%
Testing	216	10.56 %
Maintenance / Support	152	7.42%
Other	21	1.02%

Moreover it has been come to notice that respondents from vendor organizations most frequently reported development activity while respondents from client firms most frequently reported planning activity.
Among 391 respondents, 21 have mentioned some other activity, which was not in the list. The detail of those other activities is given in Table 5.7.

Table 5.7 Other Activities Performed by Main Site

Other Activity	Count
Marketing	15
Sales	03
Distribution	01
Product Management	01
Business Development	01
Education	01
Meeting with Offshore Customer	01

5.2.7 Number of Offshore sites

Respondents have mentioned their offshore sites ranging from 1 to 17 but majority of them have mention 3 to 10 offshore sites. Moreover it has been came to notice that large organizations have usually more than 2 offshore sites while small scale organizations have less than 3 offshore sites. The percentage of each count is illustrated in Figure 5.7. Horizontal line shows the number of offshore sites while vertical bar shows the percentage of each count.

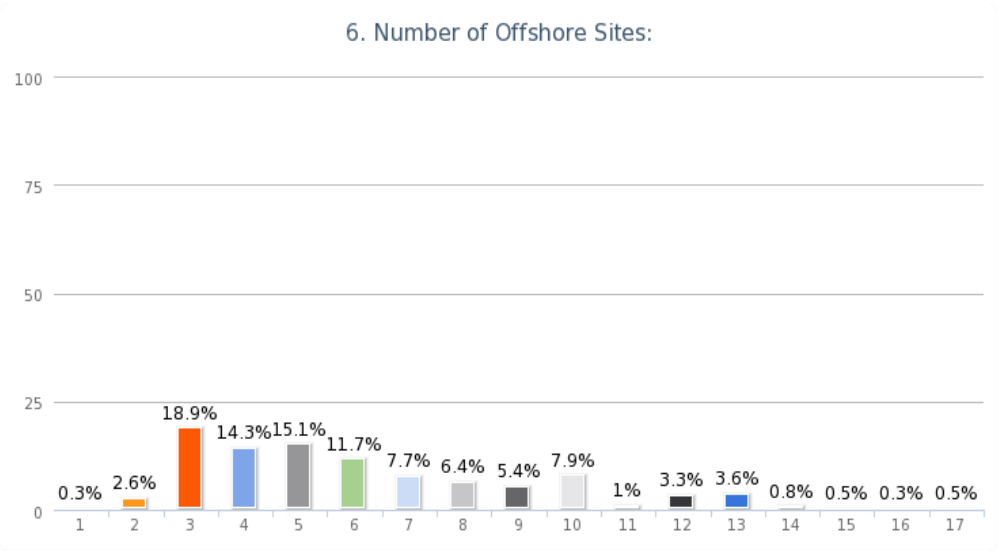

Figure 5.7 Percentage of Number of Offshore Sites

Detail of each count of number of offshore sites is illustrated in Table 5.8.

Table 5.8 Number of Offshore Sites

Number of Offshore Sites	Count	Number of Offshore Sites	Count
1	01	10	31
2	09	11	04
3	74	12	13
4	56	13	14
5	59	14	03
6	46	15	02
7	30	16	01
8	25	17	02
9	21	**Total**	**391**

5.2.8 Location of the top three offshore sites

Respondents have mentioned their top 3 offshore sites in 74 different countries around the world. Among all, most reported countries for offshore sites are USA, India and UK which have been collectively mentioned 130, 96 and 84 times respectively. Moreover it has been come to notice that most of the large scale client organization of developed countries of North America e.g. USA are sending their development tasks to offshore locations like India, Vietnam, Philippines etc. Likewise, the majority of the clientele in Western Europe are sending their development tasks to Central and Eastern Europe e.g. Hungary, Poland, Romania, Bulgaria etc. The statistics for each site and percentages are illustrated in Appendix 9.6.

5.2.9 Number of People involved in the project

As the team size increases, the interaction amongst members increases proportionally. Most of the respondents have mentioned their projects' size ranging from 51-100 people (41.43%) or 1-50 (40.4%) that comprise almost 82% of the whole responses, which indicates that the majority of respondents hail from small to medium size team. Results are shown in the Figure 5.8.

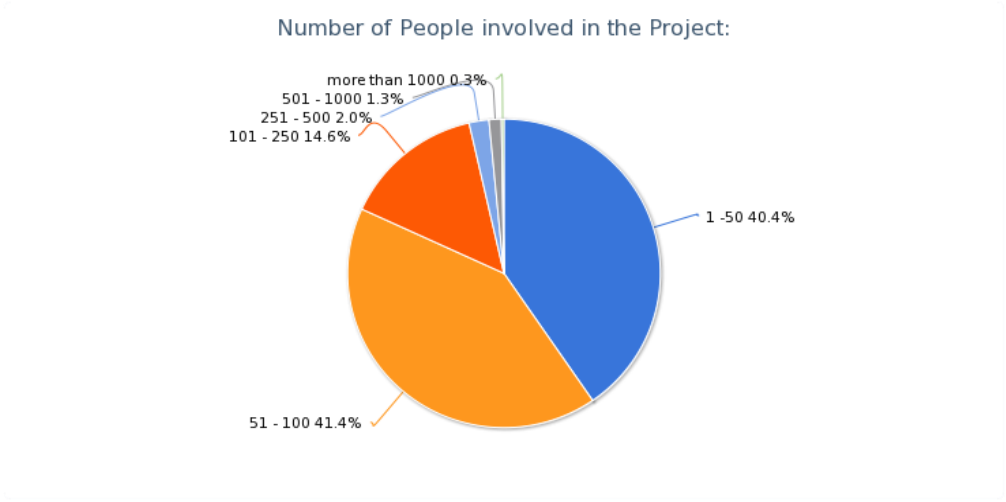

Figure 5.8 Size of the Project

Frequency of each organization's size and its percentage is given in the Table 5.9

Table 5.9 Size of the Project

Number of people involved	Count	Percent
1 -50	158	40.40%
51 - 100	162	41.43%
101 - 250	57	14.58%
251 - 500	8	2.04%
501 - 1000	5	1.27%
more than 1000	1	0.25%

5.2.10 Types of Software Products developed

The respondents of the survey had been involved in different kinds of projects. Top 3 software products mentioned by respondents are Web development, E-commerce and embedded system which has been reported 230, 222 and 130 times respectively. Details of their project's domains are given in Table 5.10.

Table 5.10 Types of Software product developed

Software Product	Count	Percent	Software Product	Count	Percent
Telecommunication	125	6.73%	Embedded system	130	7%
Web development	230	12.39%	Hardware control	71	3.82%
Health care	74	3.99%	Process control software	73	3.93%
Finance	90	4.85%	Artificial Intelligence	25	1.34%
E-commerce	222	11.96%	Simulators	39	2.10%
Information management	161	8.67%	System Software	76	4.09%
Automotive	38	2.05%	Middleware	32	1.72%
Real time / control system	55	2.96%	Adware	3	0.16%
Engineering software	60	3.23%	Support / Utilities	85	4.58%
Networking / Communication	59	3.18%	Other	208	11.20%

Among 391 respondents, 208 have mentioned some other software products, which are not in the list. The detail of those 208 responses is given in Table 5.11.

Table 5.11 Other types of Software Products reported by practitioners

Other Software Products	Count	Other Software Products	Count
Enterprise Resource Planning (ERP) software	47	Data warehousing software	02
Cloud Computing Portals	37	Travel Domains - Flights	02
Supply Chain Management applications	37	Hotel Management software	02
Business Intelligence (BI) tools	30	Geological modeling software	02
Aviation	09	Core Banking	01
Desktop Publishing Software	08	Enterprise Systems	01
Content Management System (CMS) software	07	Domain name registration	01
Games Software	07	Electronics software	01
e-learning / Educational software	07	Media Production software	01
Web scraping software	06	Production Testing software	01
Mobile Apps	06	SEO (Search Engine Optimization) tools	01
Tourism portals	04	Software for Forestry & Agricultural Research	01
Database Management Systems	03	Software for Oil & Gas Geology	01

5.2.11 Software Development Model used in those Projects

Majority of the respondents have reported that they are using agile methods during those projects, which is more than 73 % of the total responses. Around 19% of respondents have mentioned iterative and incremental model. However, very few respondents have specified some model other than these two. The detail of frequency and percentage of each model is illustrated in Figure 5.9 and Table 5.12.

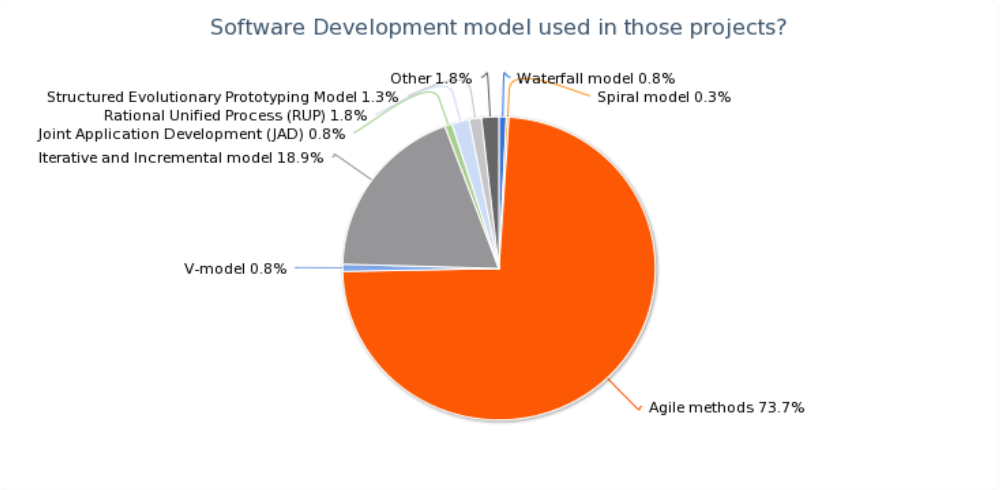

Figure 5.9 Software Development Model used

Frequency and percentage of each development model used by practitioners is given in Table 5.12.

Table 5.12 Software Development Model used

Development Model	Count	Percentage
Waterfall model	3	0.76%
Spiral model	1	0.25%
Agile methods	288	73.65%
V-model	3	0.76%
Code and Fix model	0	0.0%
Iterative and Incremental model	74	18.92%
Rapid Application Development (RAD)	0	0.0%
Joint Application Development (JAD)	3	0.76%
Rational Unified Process (RUP)	7	1.79%
Structured Evolutionary Prototyping Model	5	1.27%
Other	7	1.79%

Among 391 respondents, 7 did not specify any one of the above mentioned software models or did not mention any specific model. The detail of those 7 responses is given in Table 5.13.

Table 5.13 Other types of Software Development Model used

Development Model	Count
Depends on the customer	02
Depends on the Project	01
More than one model	01
Hybrid model	01
Hybrid of Waterfall & Agile	01
Hybrid of Scrum & Waterfall	01

5.2.12 Challenges encountered by practitioners during requirements elicitation

Asking about challenges and relevant strategies helped to get an overview of the state of practice in software industries. Various challenges in relation to requirements elicitation

have been identified via survey. The frequency and percentage of each reported challenge is given in Table 5.14.

Table 5.14 Challenges reported by Practitioners

ID	Identified Challenges	Count	Percentage
C1	Improper Tool / Technology	122	31.20%
C2	Linguistic barriers	96	24.55%
C3	Communication	326	83.37%
C4	Control & promote	254	64.96%
C5	Scaling-up	76	19.43%
C6	Coordination	92	23.52%
C7	Socio-Cultural issues	280	71.61%
C8	Prioritizing stakeholders	4	1.02%
	Other	177	45.26%

Among 391 respondents, 177 have mentioned some other challenges that could affect requirements elicitation process in one way or another. Among those 177 responses, 28 valid descriptions of challenges along with their frequency are described in Table 5.15.

Table 5.15 Additional Challenges reported by Practitioners

#	Additional challenges reported by practitioners	Count
1	In vendor organization, developers or testers didn't had chance to communicate directly with clients or business sponsor, consequently in some cases they made assumptions about requirements	17
2	Client or Business sponsor's priorities clashed with the priorities of supplier organization's personnel	16
3	Different perceptions of software quality among various groups of stakeholders	11
4	Low compliance of CMMI in vendor firms also hinders elicitation process	08
5	Lack of protection for business secrets (intellectual property rights) in developing countries also hampers the elicitation process	09
6	Lack of repository to reuse the requirements across several projects	07
7	Identification of all potential stakeholders and sources of requirements	07
8	Client and project sponsor had conflicting views about some requirements	07
9	Staff turnover / signoff at offshore site	07
10	Changing requirements of the customer for superior products and services in short time frames	06
11	Lack of common understanding of requirements among distributed-stakeholders	05
12	Offshore Supplier had lack of client's business knowledge	05
13	Political issues in some countries e.g. trade union strikes, shut downs, power cuts etc also affects requirements gathering from offshore client	04
14	Some stakeholders were unclear of the system's scope	04
15	Difficulty in fulfilling end-user expectations	04
16	Even though stakeholders communicated in the same language but their accent or dialect was hard to understand	04
17	Lack of trust among client or business sponsor and supplier firm	04
18	Sometimes requirements gathered at the beginning of the projects are quite different with those existing at the end of the project	03
19	Sometimes it becomes difficult for project managers and business	03

	sponsors to get an accurate sense of project progress and status	
20	Lack of knowledge about country specific laws and regulations	02
21	Standard deviation of project estimates sometimes vary wildly	02
22	om etimes it's unclear how to gather product requirements globally from external and internal customers and how to form plans and change requests from those requirements	02
23	Some Stakeholder's priorities clashed with the priorities of developers	02
24	Budget constraints i.e. extra charges of language translators and limited time to translate every conversation with every stakeholder	02
25	Managing the expectations of stakeholders that what can and what cannot be done in distributed setting	01
26	Stakeholders' lack of knowledge of the available environment in which the system needs to be operating	01
27	Long feedback loops	01
28	Poor documentation skills	01

Since many challenges belongs to the same category of challenges with different aspects. Therefore challenges have been grouped into 6 categories i.e. linguistic barriers, communication, coordination, control, trust and general category. Since the categories of challenges related to linguistic barriers, communication, coordination and control has already been explored via L R therefore it's been assigned the same ID as in section 5.1.2.1 i.e. C2, C3, C6 and C4 respectively. Besides, challenges of trust and general category have been assigned C9 and C10 respectively. Categorized challenges are illustrated in Table 5.16.

Table 5.16 Categories of Additional Challenges Reported by Practitioners

ID	**Challenges' descriptions in Survey**
C2: Linguistic barriers	1: Even though stakeholders communicated in the same language but their accent or dialect was hard to understand
C3: Communication	1: In vendor organization, developers or testers didn't had chance to communicate directly with clients or business sponsor, consequently in some cases they made assumptions about requirements 2: Different perceptions of software quality among various groups of stakeholders 3: Client and project sponsor had conflicting views about some requirements 4: some stakeholders did not had clear idea of the system's scope 5: Difficulty in fulfilling end-user expectations 6: om e t akeholder's priorities clashed with the priorities of developers 7: Stakeholders' lack of knowledge of the available environment in which the system needs to be operating 8: Long feedback loops
C6: Coordination	1: Client or Business sponsor's priorities clashed with the priorities of supplier organization's personnel 2: Low compliance of CMMI in vendor firms also hinders elicitation 3: Staff turnover / signoff at offshore site 4: changing requirements of the customer for superior products and services in short time frames 5: Lack of common understanding of requirements among distributed-stakeholders 6: Offshore Supplier had lack of client's business knowledge 7: Managing the expectations of stakeholders that what can and what cannot be done in distributed setting 8: Poor documentation skills

C4: Control & promote	1: Lack of repository to reuse the requirements across several projects 2: Identification of all potential stakeholders and sources of requirements 3: Sometimes requirements gathered at the beginning of the projects are quite different with those existing at the end of the project 4: Sometimes it becomes difficult for project managers and business sponsors to get an accurate sense of project progress and status 5: Standard deviation of project estimates sometimes vary wildly 6: om etimes it's unclear how to gather product requirements globally from external and internal customers and how to form plans and change requests from those requirements 7: Lack of knowledge about country specific laws and regulations
C9: Trust	1: Lack of protection for business secrets (intellectual property rights) in developing countries also hampers the elicitation process 2: Lack of trust among client or business sponsor and supplier firm
C10: General	1: Political issues in some countries e.g. trade union strikes, shut downs, power cuts etc also affects requirements gathering from remote client 2: Budget constraints i.e. extra charges of language translators and limited time to translate every conversation with every stakeholder

5.2.13 Solutions for the identified challenge

Participants have also been asked to provide additional information regarding relevant strategies to mitigate the identified challenges. Participants did not provide any suggestions for the additional two problems (which are mentioned as C9 and C10 in Table 5.16), which can have positive impact on problems other than what is suggested to them in survey. This may lead to conclude that participants are bound under company policy not to disclose the company processes, strategies or any other information regarding those practices.
Of the 22 solutions accounted for in literature, industry practitioners have identified an additional 23 solutions for the 8 challenges presented. Various descriptions of solutions reported by survey respondents are categorized in 8 categories i.e. tool, linguistic, communication, control, scale, coordination, culture and prioritizing. In subsequent tables, abbreviations for these 8 categories of solutions have been used as sur_tool, sur_ling, sur_com, sur_ctrl, sur_scal, sur_cord, sur_cult and sur_prtz respectively. The detail of solutions from survey for each challenge (C1 – C8) is shown in subsequent sections.

5.2.13.1 Solutions for C1

Among 391 respondents of survey, 255 have mentioned some solution to cope up with the challenges related to tools / technology (C1). Industrial practitioners have confirmed these solutions (S1, S2, and S3) in the survey. The details are given in Table 5.17.

Table 5.17 Solutions to overcome C1

ID	Solutions to overcome C1	Count	Percent
S1	Real time virtual meetings using some tools	108	24.83%
S2	Group email distribution list	142	32.64%
S3	Videoconferencing or Teleconferencing	162	37.24%
	Other	23	5.29%

Among 255 responses, 23 have mentioned some additional solutions to overcome C1 which are not mentioned in SLR. Among those 23responses, 14 valid responses are summarized in the Table 5.18.

Table 5.18 Additional solutions to overcome C1

ID	Additional Solutions to overcome C1	Count
sur_tool	Use of BaseCamp, Redmine, Zyncro, MS SharePoint, MS LYNC etc	13
	Common groupware tools across all sites	01

All 14 responses in Table 5.18 are grouped under single category i.e. sur_tool because all these responses refers to some web-based project management tool.

5.2.13.2 Solutions for C2

Among 391 respondents, 198 have mentioned some solution to cope up with the challenge of linguistic barriers (C2). The details are summarized in Table 5.19.

Table 5.19 Solutions to overcome C2

ID	Solutions to overcome C2	Count	Percent
S4	Using audio recording of interview and linking it with Wiki technology	24	6.14%
S5	Choosing suitable communication mode (synchronous or asynchronous)	143	36.57%
	Other	60	15.35%

Among 198 responses, 60 have mentioned some other solution to overcome C2. Among those 60, valid responses are summarized in the Table 5.20.

Table 5.20 Other solutions to overcome C2

ID	Additional Solutions to overcome C2	Count	
sur_ling1	Human translators (Scribe)	16	30
	Utilizing multi-lingual staff members	13	
	role of intermediar, e.g. technical leader participate in strategic meetings and translate the information to the concerned team members	01	
sur_ling2	Formalized written communication	09	
sur_ling3	Using prototype tool SR-Elicitor or storyboarding	02	
sur_ling4	video recording of important requirements gathering meetings	01	

All 30 responses in Table 5.20 are grouped under single category i.e. sur_ling1 because all these responses refers to utilize scribe i.e. some team member for language translation.

5.2.13.3 Solutions for C3

Among 391 respondents, 381 have mentioned some solution to cope up with the challenge of communication (C3). The details are summarized in Table 5.21.

Table 5.21 Solutions to overcome C3

ID	Solutions to overcome C3	Count	Percent
S6	Choosing an appropriate groupware tool and elicitation technique according to stakeholders' preferences (cognitive styles) on the base of Felder Silverman's Learning Style Model (LSM)	170	12.04%
S5	Use of synchronous interaction e.g. brainstorming if the time overlap is large while use of asynchronous groupware tools when the time overlap is low	278	19.69%
S7	Iteration in Interviews and prototyping	126	8.92%
S4	Using audio recording of interview and linking it with Wiki technology	23	1.63%
S8	Using ontology (to share a common vocabulary) as	76	5.38%

	communication facilitators		
S9	Web-based tool supported by Wiki features	57	4.04%
S3	Video or teleconferencing meetings	279	19.76%
S11	Synchronous text-based computer-mediated communication (e.g. chat, IM)	149	10.55%
	Other	254	17.99%

Among these 381 responses, 254 have mentioned some other solutions to overcome C3. Among those 254, valid responses are categorized and summarized in the Table 5.22.

Table 5.22 Additional strategies to overcome C3

ID	Additional Strategies to overcome C3	Count	
sur_com1	IBM Jazz technology platform e.g. Rational requirements composer	31	37
	Web application platform e.g. Microsoft SharePoint	06	
sur_com2	CoREA (Collaborative Requirements Elicitation and Analysis)	20	117
	web-based project management software: PjojectPier, PjojectHQ, Redmine or BaseCamp, KForge etc.	18	
	(ADREAM) Agent-assisted Distributed Requirements Elicitation and Management	14	
	EGRET (Eclipse based Global Requirements Tool)	16	
	Remote desktop sharing tools	15	
	Advanced Multimedia Organizer for Requirements Elicitation (AMORE)	12	
	DOORS tool for collaboration & elicitation	12	
	FacTrace tool for online requirements gathering	12	
	ARENA (Anytime, Anyplace REquirements Negotiation Aids) tool	02	
	eRequirements: web-based tool	02	
	use of "Jira" tool because it offers Open-Social dashboard	06	
sur_com3	Web-based Focus Groups for requirements gathering	08	
sur_com4	Telephone calls or Skype meetings	05	
sur_com5	Virtual Private Network (VPN)	03	

All 37 responses in Table 5.22 are grouped under single category i.e. sur_com1 because all these responses refers to some web application collaborative platform. While all 117 responses are grouped under single category i.e. sur_com2 because all these responses refers to some web-based tool for requirements elicitation in distributed settings.

5.2.13.4 Solutions for C4

Among 391 respondents, 356 have mentioned some solution to cope up with the challenge of control & promote (C4). The details are summarized in Table 5.23.

Table 5.23 Solutions to overcome C4

ID	Solution to overcome C4	Count	Percent
S12	Web-based tool with data mining and unsupervised clustering using of recommender systems to place stakeholders into appropriate discussion groups	60	7.36%
S6	Choosing an appropriate groupware tool and elicitation technique according to stakeholders' preferences (cognitive styles) on the base of Felder Silverman's Learning Style Model (LSM)	89	10.92%

S13	Volere process to ensure that all important aspects of requirements are consistent to an agreed schema, carefully addressed and that the methods applied have proven their value in practical work	43	5.28%
S14	Participation in online communities and use of requirements visualization tools like graphical use case definition; requirements definition through scenarios and storyboards for requirements validation; business process diagrams, use case models	214	26.26%
S3	Videoconferencing or teleconferencing	219	26.87%
S10	Spatial Hypertext Wiki	15	1.84%
	Other	175	21.47%

Among these 356 responses, 175 have mentioned some sort of web service to overcome C4. Among those 175, 127 valid responses are summarized in the Table 5.24.

Table 5.24 Additional solutions to overcome C4

ID	Additional Solutions to overcome C4	Count
sur_ctrl	Web-feeds or Blogs	31
	Discussion lists	19
	Online Forums	19
	Google Groups	26
	Mailing lists	14
	Online social networks / social web	15
	Online calendars e.g. Google Calendar	07

All 127 responses in Table 5.24 are grouped under single category i.e. sur_ctrl because all these responses refers to some web applications for information sharing in distributed environment.

5.2.13.5 Solutions for C5

Among 391 respondents, 175 have mentioned some solution to cope up with the challenge of scaling-up (C5). The details are summarized in Table 5.25.

Table 5.25 Solutions to overcome C5

ID	Solution to overcome C5	Count	Percent
S9	Web-based tool supported by Wiki features	62	26.50%
S16	Semantic data-based Wikis	25	10.68%
S12	Web-based elicitation tool using data mining, groupware environment and recommender system	44	18.80%
S15	Forum-based requirements gathering processes	69	29.49%
	Other	34	14.53%

Among these 175 responses, 34 have mentioned some other solutions to overcome C5. Among those 34, valid responses are summarized in the Table 5.26.

Table 5.26 Additional solutions to overcome C5

ID	Additional Solutions to overcome C5	Count	
sur_scal1	Confluence; a web-based corporate wiki	08	17
	Polarion software tool	09	
sur_scal2	Microsoft Sharepoint	02	
sur_scal3	web-based social networks and collaboration filtering	01	

All 17 responses in Table 5.26 are grouped under single category i.e. sur_scall because all these responses refers to some collaborative software for gathering and management of requirements in large scale distributed projects.

5.2.13.6 Solutions for C6

Among 391 respondents, 177 have mentioned some solution to cope up with the challenge of bringing relevant stakeholders together into highly focused topic-centric discussion groups (C6). The details are summarized in Table 5.27.

Table 5.27 Solutions to overcome C6

ID	solution to overcome C6	Count	Percent
S17	Organizer & Promoter of Collaborative Ideas (OPCI)	84	21.48%
	Other	98	25.06%
	Total responses	177	45.27%

Among these 177 responses, 98 have mentioned some other solutions to overcome C6. Among those 98, valid responses are summarized in the Table 5.28.

Table 5.28 Additional solutions to overcome C6

ID	Additional Solutions to overcome C6	Count	
sur_ctrl	Online discussion forums	43	69
	Google Groups	10	
	Online Communities and social networks	11	
	Mailings lists or Discussion lists	05	
sur_cord	Strong BC (Business Cases)	01	

All 69 responses in Table 5.28 are grouped under single category i.e. sur_ctrl because all these responses refers to some web applications for information sharing in distributed environment.

5.2.13.7 Solutions for C7

Among 391 respondents, 348 have mentioned some solution to cope up with the challenge of socio-cultural issues (C7). The details are summarized in Table 5.29.

Table 5.29 Solutions to overcome C7

ID	Solutions to overcome C7	Count	Percent
S18	Learning about cultural diversity through literature reviews, seminars, courses, etc.	266	47.59%
S19	Cultural mediation	74	13.24%
S20	Cultural liaisons	56	10.01%
S21	Virtual mentoring: based on simulation and virtual actors	19	3.40%
	Other	149	26.65%

Among these 348 responses, 149 have mentioned some other solutions to overcome C7. Among those 149, valid responses are summarized in the Table 5.30.

Table 5.30 Additional solutions to overcome C7

ID	Additional Solutions to overcome C7	Count	
sur_cult1	FriendFeed real-time feed aggregator	21	46
	Zyncro; a corporate social intranet	18	
	Yammer corporate social network	07	
sur_ctrl	Online forums	15	41
	Online communities	07	
	Online Discussion lists	04	
	Creating a portal that has the information about cultural context	12	
	Web feeds	03	

sur_cult2	Creating a role of intermediar, e.g. technical leader participate in strategic meetings and propagate the information to the team members	02
sur_cult3	Exchange of greeting mails to offshore team members on their cultural events or festivals (e.g. Christmas, Easter, New year)	03
sur_cult4	Taking help of cultural anthropologist	02
sur_cult5	if possible, arrange visits to offshore sites	09
sur_cult6	early socialization in kick-off meeting	10

All 46 responses in Table 5.30 are grouped under single category i.e. sur_cult1 because all these responses refers to some enterprise social software. Moreover all 41 responses in 2nd column are grouped under single category i.e. sur_ctrl because all these responses refers to some web application for information sharing in collaborative environment.

5.2.13.8 Solutions for C8

Among 391 respondents, only 33 have mentioned some solution to cope up with the challenge of prioritizing various stakeholders for requirements elicitation (C8). The details are summarized in Table 5.31.

Table 5.31 Solutions to overcome C8

ID	Solution to overcome C8	Count	Percent
S22	Five steps value based requirements elicitation framework	13	3.32%
	Other	20	5.11%
	Total Responses	33	8.44%

Among these 33 responses, 20 have mentioned some other solution to overcome C8. Among those 20, valid responses are summarized in Table 5.32

Table 5.32 Additional solutions to overcome C8

ID	Additional Solutions to overcome C8	Count
sur_ptz1	Prioritized by board / steering committee	05
sur_ptz2	Power/Interest Grid Analysis of Stakeholders	02

Majority of the respondents (92%) did not encounter any problem regarding C8. Only 7 respondents mention some additional solution to overcome C8. Five respondents mentioned that the board or steering committee prioritizes stakeholders; because they have sound knowledge of value-based requirements engineering and they take goals and interests of stakeholders into account.

6 DISCUSSION

This chapter describes the lessons learnt and validity threats relevant to this study.

6.1 Comparative Analysis

The purpose of performing qualitative comparative analysis (QCA) is to explore the gap between research literature and industrial practice and to figure out the most prevalent categories of challenges. Moreover, QCA helps in comparing various attributes through human analytical insight rather than relying on computer assisted applications [84]. As in this study, one of the aims is to assess what has and has not been addressed in research literature in comparison with industrial practices in relation to requirements elicitation's challenges and their mitigation strategies in offshore outsourced software development projects. For that reason, comparative analysis has been found to be suitable to achieve this aim.

In comparative analysis, firstly the challenges and practices gathered from both SLR and industrial survey were listed down. The challenges and practices reported in literature have been compared with the ones gathered from industrial practitioners. Therefore comparative analysis helped in identifying the gap between research literature and industrial practice.

6.1.1 Similarities and Differences between literature and industrial practice

Majority of the challenges and practices reported by the industry practitioners are same with what have already been found in SLR. However, there are some challenges and practices, which have been exposed in industrial survey, but are not identified by the research literature.

After completing and reporting SLR and survey, differences between literature and practice have been found. Challenges and solutions reported in literature have also been identified in practices. However besides existing challenges and solutions reported in literature, many additional challenges and solutions have been identified in industrial survey.

6.1.1.1 Reported Challenges

Total 10 challenges have been found through SLR and survey. Among these 10 challenges reported by research literature and industrial practitioners, 8 challenges are reported in both SLR and survey while remaining 2 challenges have been found only through industrial survey. Figure 6.1 presents a comparison of the number of challenges found in SLR and industrial survey.

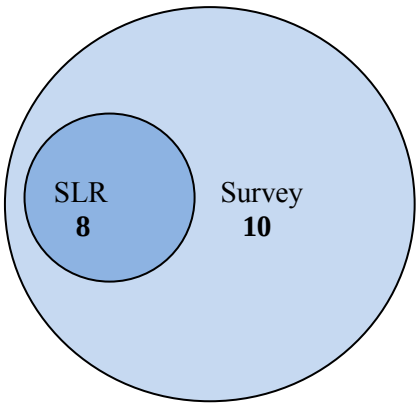

Figure 6.1 Number of Challenges reported in SLR and Survey

Each of those 8 common challenges has been reported different number of times in research papers and also by the industry practitioners. For instance C2 i.e. linguistic barriers has been discussed in 6 research studies which is 11.76% of the primary studies while this challenges

(C2) has been reported by 96 respondents through survey which is 7.7% of the total responses. The comparison of frequency of these 8 common challenges from SLR and survey has been presented in Table 6.1.

Table 6.1 comparison of frequency of common challenges in SLR and Survey

ID	Name of the Challenge	Reported in SLR		Reported in Survey	
		Count	Percentage	Count	Percentage
C1	Improper tools / technology	7	13.72%	122	31.20%
C2	Linguistic barriers	6	11.76%	96	24.55%
C3	Communication	19	37.24%	326	83.37%
C4	Control & promote	5	9.80%	254	64.96%
C5	Scaling-up	8	15.69%	76	19.43%
C6	Coordination	1	1.96%	92	23.52%
C7	Socio-cultural issues	4	7.84%	280	71.61%
C8	Prioritizing stakeholders	1	1.96%	4	1.02%
C9	Trust	-	-	13	3.32%
C10	General	-	-	08	2.04%

C6 and C8 appear to be the two least reported challenges both by research literature and industrial practitioners. For instance, regarding C6, one respondent commented that "*There is no problem of getting the right stakeholders in a place if we can motivate it, we don´t need strategies for this issue. We just need really strong and good BC (Business Cases) that shows the most important value of what need to be done*." im ilarly regarding C8, most of the respondents commented that "*it's not an issue or problem for them since every stakeholder's view counts*."

Besides these 8 common challenges in the SLR, practitioners identified 4 additional descriptions of challenges in the web survey. Those 4 descriptions have been grouped in additional 2 categories i.e. C9 (Trust) and C10 (General).

6.1.1.2 Reported Solutions

Besides 22 solutions reported by literature, 23 additional solutions have been identified by the industry practitioners. In total 45 solutions have been found through SLR and survey. Amongst the 45 solutions reported, 22 solutions are reported in both SLR and survey whilst the remaining 23 solutions have only been found through the industrial survey. Figure 6.2 illustrates a comparison of the number of solutions found in SLR and industrial survey.

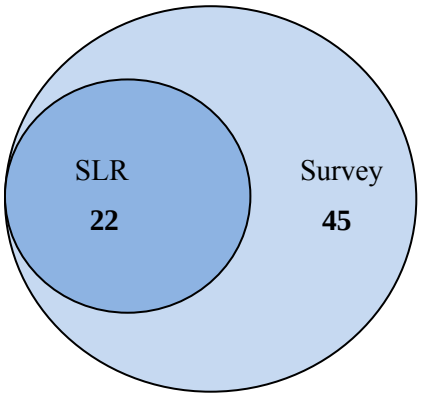

Figure 6.2 Number of solutions reported in SLR and Survey

Solutions for each of the 8 common challenges between SLR and survey is compared and tabulated below one by one.

To overcome the challenge of improper tools / technology (C1), there are 3 solutions reported in research literature i.e. S1, S2 and S3 in three different research articles which is

3.33% of the total primary studies. The comparison of frequency of solutions for C1 from SLR and survey is presented in Table 6.2.

Table 6.2 comparison of frequency of solutions for C1 in SLR and Survey

ID	Name of the Solution	Reported in SLR		Reported in Survey	
		Count	Percentage	Count	Percentage
S1	Real time virtual meetings using some tools	1	3.33%	108	27.62%
S2	Group email distribution list	1	3.33%	142	36.31%
S3	Videoconferencing or Teleconferencing	1	3.33%	162	41.43%
sur_tool	Web-based project management tools	-	-	14	3.58%

Additional solution sur_tool explored via survey has been presented in Table 5.18 of section 5.2.13.1.

According to the above statistics in **Error! Reference source not found.**, the most frequently reported solutions for C1 are S2 and S3. Therefore if time overlap between offshore sites is large, it is better to conduct video or teleconferencing otherwise group email distribution is better option because synchronous interaction is not necessary in this case.

The comparison of frequency of solutions for C2 i.e. linguistic barriers, from SLR and survey is presented in Table 6.3.

Table 6.3 comparison of frequency of solutions for C2 in SLR and Survey

ID	Name of the Solution	Reported in SLR		Reported in Survey	
		Count	Percentage	Count	Percentage
S4	Using audio recording of interview and linking it with Wiki technology	1	3.33%	24	6.13%
S5	Choosing suitable communication mode (synchronous or asynchronous)	3	10%	143	36.57%
sur_ling1	Utilizing scribe for translation	-	-	30	7.67%
sur_ling2	Formalized written communication	-	-	09	2.30%
sur_ling3	Using prototype tool SR-Elicitor or storyboarding	-	-	02	0.51%
sur_ling4	Video recording of requirements gathering meetings	-	-	01	0.25%

Additional 4 solutions sur_ling1, sur_ling2, sur_ling3 and sur_ling4 have been presented in Table 5.20 section 5.2.13.2.

According to the above statistics in **Error! Reference source not found.**, the most frequently reported solution for C2 is S5. Therefore when the stakeholders' mother language is not same, it is better to use asynchronous mode of communication because it gives people the opportunity to read and express their needs with more care.

The comparison of frequency of solutions for C3 i.e. improper communication, from SLR and survey is presented in Table 6.4.

Table 6.4 comparison of frequency of solutions for C3 in SLR and Survey

ID	Name of the Solution	SLR		Survey	
		Count	%age	Count	%age
S6	Choosing an appropriate groupware tool and elicitation technique according to stakeholders' preferences (cognitive styles) on the base of Felder Silverman's Learning Style Model (LSM)	9	30%	170	43.47%
S5	Use of synchronous interaction e.g. brainstorming if the time overlap is large while use of asynchronous groupware tools when the time overlap is low	3	10%	278	71.09%
S7	Iteration in Interviews and prototyping	1	3.33%	126	32.22%
S4	Using audio recording of interview and linking it with Wiki technology	1	3.33%	23	5.88%
S8	Using ontology (to share a common vocabulary) as communication facilitators	4	13.33 %	76	19.43%
S9	Web-based tool supported by Wiki features	1	3.33%	57	14.57%
S3	Video or teleconferencing meetings	1	3.33%	279	71.35%
S11	Synchronous text-based computer-mediated communication (e.g. chat, IM)	2	6.67%	149	38.10%
sur_com1	Web application collaborative platform	-	-	37	9.46%
sur_com2	Web-based tool for requirements elicitation in distributed settings	-	-	117	29.92%
sur_com3	Web-based Focus Groups for requirements gathering	-	-	08	2.04%
sur_com4	Telephone calls or Skype meetings	-	-	05	1.27%
sur_com5	Virtual Private Network (VPN)	-	-	03	0.76%

Additional 5 solutions sur_com1, sur_com2, sur_com3 and sur_com4 have been presented in Table 5.22 of section 5.2.13.3

According to the above statistics in **Error! Reference source not found.**, the most frequently reported solutions for C3 are S3, S5, S6, S11 and sur_com2. o it's better to use synchronous interaction e.g. video or teleconferencing if time overlap between remote sites is large while utilize asynchronous groupware communication tools when the time overlap is low. Moreover it is worth to choose the right groupware tool and elicitation method according to the stakeholder's preferences according to Felder Silverman's Learning Style Model.

Besides the most frequently reported solutions, some respondents specified the reason of using sur_com1 (web application collaborative platforms) e.g. "Rational requirements composer" that "*it provides both textual and visual techniques to elicit and elaborate requirements*".
Regarding sur_com2 respondents indicated that "*the use of CoREA method* (Collaborative Requirements Elicitation and Analysis) *enables us to systematically elicit requirements, specifically in distributed environment and facilitates quantitative decision support for analysis and selection of relevant requirements*." im ilarly regarding EGRET (Eclipse based

Global Requirements Tool), other respondents stated "*it is helpful for offshore projects since it support the requirements communication across distributed teams*."

The comparison of frequency of solutions for C4 i.e. control & promote, from SLR and survey is presented in Table 6.5

Table 6.5 comparison of frequency of solutions for C4 in SLR and Survey

ID	Name of the Solution	SLR		Survey	
		Count	%age	Count	%age
S12	Web-based tool with data mining and unsupervised clustering using of recommender systems to place stakeholders into appropriate discussion groups	3	10%	60	15.34 %
S6	Choosing an appropriate groupware tool and elicitation technique according to stakeholders' preferences (cognitive styles) on the base of Felder Silverman's Learning Style Model (LSM)	9	30%	89	22.76 %
S13	Volere process to ensure that all important aspects of requirements are consistent to an agreed schema, carefully addressed and that the methods applied have proven their value in practical work	1	3.33%	43	10.99 %
S14	Participation in online communities and use of requirements visualization tools like graphical use case definition; requirements definition through scenarios and storyboards for requirements validation; business process diagrams, use case models	1	3.33%	214	54.73 %
S3	Videoconferencing or teleconferencing	1	3.33%	219	56.01 %
S10	Spatial Hypertext Wiki	1	3.33%	15	3.83%
sur_ctrl	web applications for information sharing in distributed environment	-	-	127	32.48 %

Additional set of solution sur_ctrl explored via survey has been elaborated in Table 5.24 of section 5.2.13.4.

According to the above statistics in **Error! Reference source not found.**, the most frequently reported solutions for C4 are S3, S14 and sur_ctrl. Besides participation in online communities, use of requirements visualization tools and video or teleconferencing; more than 32% respondents figured out the new strategy i.e. use of various web applications for information sharing in distributed environment.

The comparison of frequency of solutions for C5 i.e. scaling-up, from SLR and survey is presented in Table 6.6.

Table 6.6 comparison of frequency of solutions for C5 in SLR and Survey

ID	Name of the Solution	SLR		Survey	
		Count	%age	Count	%age
S9	Web-based tool supported by Wiki features	1	3.33%	62	15.85%
S16	Semantic data-based Wikis	1	3.33%	25	6.39%
S12	Web-based elicitation tool using data mining, groupware environment and	3	10%	44	11.25%

	recommender system				
S15	Forum-based requirements gathering processes	1	3.33%	69	17.64%
sur_scal1	collaborative software for gathering and management of requirements in large scale distributed projects	-	-	17	4.34%
sur_scal2	Microsoft SharePoint	-	-	02	0.51%
sur_scal3	web-based social networks and collaboration filtering	-	-	01	0.25%

Additional 3 solutions sur_scal1, sur_scal2 and sur_scal3 have been presented in Table 5.26 of section 5.2.13.5.
Regarding additional solution i.e. sur_scal1, respondents revealed that "*Confluence (a web-based corporate wiki) is a better choice for gathering requirements from a large number of distributed stakeholders*." im ilarly other respondents mentioned that "*use of Polarion software for requirements gathering was effective for agile methods*."

According to the above statistics in **Error! Reference source not found.**, the most frequently reported solutions for C5 are S9 and S15. Therefore to cope up with the issues of requirements gathering from a large number of stakeholders, it could be worth to use shared forums and tools supported by wiki features.

The comparison of frequency of solutions for C6 i.e. bringing relevant stakeholders together, from SLR and survey is presented in Table 6.7.

Table 6.7 comparison of frequency of solutions for C6 in SLR and Survey

ID	Name of the Solution	SLR		Survey	
		Count	%age	Count	%age
S17	Organizer & Promoter of Collaborative Ideas (OPCI)	1	3.33%	84	21.48%
sur_ctrl	web applications for information sharing in distributed environment	-	-	69	17.64%
sur_cord	Strong BC (Business Cases)	-	-	01	0.25%

69 respondents have mentioned various kinds of web-based applications to bring relevant stakeholders into focused topic centric discussion groups. Additional 2 solutions sur_ctrl and sur_cord explored via survey have been presented in Table 5.28 of section 5.2.13.6.

According to the above statistics in **Error! Reference source not found.**, the most frequently reported solutions for C6 are S17 and sur_ctrl. S17 i.e. OPCI uses forums and recommender system approach which has been discussed in section 5.1.2.2 in detail.

The comparison of frequency of solutions for C7 i.e. socio-cultural issues, from SLR and survey is presented in Table 6.8.

Table 6.8 comparison of frequency of solutions for C7 in SLR and Survey

ID	Name of the Solution	SLR		Survey	
		Count	%age	Count	%age
S18	Learning about cultural diversity through literature reviews, seminars, courses, etc.	2	6.67%	266	68.03%
S19	Cultural mediation	2	6.67%	74	18.92%
S20	Cultural liaisons	1	3.33%	56	14.32%
S21	Virtual mentoring: based on simulation and virtual actors	4	13.33 %	19	4.85%
sur_cult1	Enterprise social software	-	-	46	11.76%
sur_ctrl	Web applications for information sharing in distributed environment	-	-	41	10.48%

sur_cult2	Creating a role of intermediar, e.g. technical leader participate in strategic meetings and propagate the information to the team members	-	-	02	0.51%
sur_cult3	Exchange of greeting mails to offshore team members on their cultural events or festivals (e.g. Christmas, Easter, New year)	-	-	03	0.76%
sur_cult4	Taking help of cultural anthropologist	-	-	02	0.51%
sur_cult5	If possible, arrange visits to offshore sites	-	-	09	2.30%
sur_cult6	Early socialization in kick-off meeting	-	-	10	2.55%

Additional 7 solutions i.e. sur_cult1, sur_ctrl, sur_cult2, sur_cult3, sur_cult4, sur_cul5 and sur_cult6 have been presented in Table 5.30 of section 5.2.13.7.

According to the above statistics in **Error! Reference source not found.**, the most frequently reported solutions for C7 are S18, S19 and S20. Therefore to cop up with socio-cultural issues, team members should focus on literature reviews, seminars and courses about national and organizational cultural differences. Moreover cultural mediation and cultural could bridge the cultural gaps across offshore sides, which are discussed in detail in section 5.1.2.2.

Besides the most frequently reported solutions, 46 respondents have mentioned the use of some sort of enterprise social software for propagation of organizational culture across offshore sites. Some respondents mention the use FriendFeed (real-time feed aggregator), they revealed that "*it consolidates the updates from various social media and helps in virtual socialization of distributed team*." imilarly some respondents stated the use of Zyncro; a corporate social intranet. In their view, "*Zyncro helps in exchange of socio-cultural context and propagation of organizational cultural knowledge among distributed teams*."

The comparison of frequency of solutions for C8 i.e. prioritizing stakeholders, from SLR and survey is presented in Table 6.9.

Table 6.9 comparison of frequency of solutions for C8 in SLR and Survey

ID	Name of the Solution	SLR		Survey	
		Count	%age	Count	%age
S22	Five steps value based requirements elicitation framework	1	3.33%	13	3.32%
sur_prtz1	Prioritized by board / steering committee	-	-	05	1.27%
sur_prtz2	Power/Interest Grid Analysis of Stakeholders	-	-	02	0.51%

Most of the survey respondents don't consider C8 as a problem therefore only few responded about its solution i.e. S22 which is discussed in section 5.1.2.2.
Five respondents mentioned that the board or steering committee usually makes decision in this regard. Two respondents indicated that they've used Power/Interest Analysis Grid of Stakeholders for this purpose.

6.1.2 Combined Mapping of Challenges to Solutions

There are situations where a challenge from socio-cultural issues could be addressed by a mitigation strategy of control and a challenge from linguistic barrier could be addressed by a mitigation strategy of communication. To address this kind of situation, a mapping has been

done where challenges are mapped to the corresponding mitigation strategies both from SLR and survey. **Table 6.10** illustrates the mapping of challenges to corresponding mitigation strategy. This mapping is based on both literature findings and practitioners' responses.

Table 6.10 Overall Mapping of Challenges to Solutions

Challenge ID	Corresponding Solutions
C1: tools	S1, S2, S3, sur_tool
C2: linguistic barriers	S4, S5, sur_ling1, sur_ling2, sur_ling3, sur_ling4
C3: communication	S3, S4, S5, S6, S7, S8, S9, S11, sur_com1, sur_com2, sur_com3, sur_com4, sur_com5
C4: Control & promote	S3, S6, S10, S12, S13, S14, sur_ctrl
C5: scaling-up	S12, S9, S15, S16, sur_scal1, sur_scal2, sur_scal3
C6: coordination	S17, sur_ctrl, sur_cord
C7: Socio-cultural	S18, S19, S20, S21, sur_ctrl, sur_cult1, sur_cult2, sur_cult3, sur_cult4, sur_cult5, sur_cult6
C8: prioritizing stakeholders	S22, sur_prtz1, sur_prtz2

In total 23 additional solutions have been identified by the practitioners but 7 of them are frequently reported by practitioners. By looking at the frequency of solutions in **Error! Reference source not found.** to **Error! Reference source not found.**, the most reported solutions are sur_tool, sur_ling1, sur_com1, sur_com2, sur_ctrl, sur_scal1 and sur_cult. It has been noted that, unlike SLR, most practitioners have reported some kind of web-based tools or web applications to cope up with challenges.

Besides, it has been observed that different solutions are proposed for the same problem; both in research literature and industrial practice. It might be due to the differences between different organizations' cultures. In other words, mitigation strategies to cope up with these challenges might be dependent on the situational needs of the organization or project. It is suggested to create and maintain an online repository, which contains and maintains reported problems and various mitigation strategies encountered by practitioners regarding requirements gathering in offshore outsourced software development projects. This online repository should be an open-source database updated by GSD practitioners.

6.2 Most Prevalent Challenges

An interesting observation has been drawn while comparing the results of SLR with the survey. Unlike scaling-up of large number of stakeholders which is a prevalent in SLR but it has been mentioned by only 6% of survey respondents. But contrary to this, another interesting observation has been made in relation to C4 (Control & Promote) which is reported only in 9.8 % of research literature but it has been reported by 20% of survey respondents. Similarly, C8 (Socio-cultural issues) has not been so much valued in SLR i.e. it has been mentioned in only 7.84% of research literature but it has been reported by 22% of survey respondents.

According to the statistics obtained from SLR and survey results, the percentage of frequency of each category of challenge is compiled in Table 6.11 to figure out the most prevalent categories of challenges.

Table 6.11 Most Prevalent Challenges

ID	Name of the Challenge	SLR	Survey	Average
C1	Improper tools / technology	13.72%	9.59%	11.65
C2	Linguistic barriers	11.76%	7.55%	9.65

C3	Communication	37.24%	25.64%	**31.44**
C4	Control & promote	9.80%	20.00%	**14.90**
C5	Scaling-up	15.69%	6.00%	10.84
C6	Coordination	1.96%	7.23%	4.59
C7	Socio-cultural issues	7.84%	22.04%	**14.94**
C8	Prioritizing stakeholders	1.96%	0.31%	1.13
C9	Trust	-	1.02%	1.02
C10	General	-	0.62%	0.62

By examining the average of the frequency of each challenge, it is obvious that most prevalent categories of challenges are C3, C4 and C7 i.e. communication, control & promote and socio-cultural issues.

6.3 Validity Threats

Validity of any research is concerned with the relationship between conclusions and reality [92]. No matter how well the research has conducted, there is always possibility of some factors which might have influence the reliability and accuracy of the results. There are mainly four kinds of threats to the validity of any research study. Those are internal, external, construct and conclusion validity threats [74]. These four types of validity threats related to this research study are discussed below along with their mitigation strategies.

6.3.1 Internal Validity

The purpose of internal validity is to ensure that the data collected for the study enables us to draw a valid conclusion [74]. Internal validity threats mostly deals with the matters related to design and its execution so as to prevent systematic errors [65] [69].
The aim of SLR is to gather as much research literature as possible, related to the area of research topic. Hence, search strings have been framed according to the guidelines proposed by Kitchenham and Charters [65] and queried it in relevant digital libraries. Moreover, manual search has also been conducted by screening all articles one by one published in ICGSE (international conference on global software engineering) so the chance of missing important articles could be reduced.

Publication bias in SLR is also one of the threats related to internal validity which refers to "the problem that positive results are more likely to be published than negative results" [65]. To overcome this threat a systematic literature review protocol has been properly defined, approved from supervisor, search strings have been verified from senior librarian. In this manner, review protocol has been strictly followed in a systematic way.

Another threat might have been the hesitation of survey respondents for not to disclose the required information in the survey. For mitigating this threat, the respondent and his/her organization's name were excluded from the questionnaire. Furthermore, the respondents have been assured of their anonymity of the information they provided in the survey.
Moreover, respondents are usually less likely to participate when they think that the research is not so beneficial. For that reason, respondents have been informed about the objectives and worth outcomes of the survey.

6.3.2 External Validity

External validity threat is concerned with generalization of the findings of the study outside the scope of the study [74]. In other words it is about asking how well the results can be applied to general population.
External validity threat related to SLR is that publications prior to year 2000 have not been considered. So there could have been a possibility of missing some publications before 2000. Running the search string to explore the frequency of articles published prior to year 2000

has mitigated this threat, but there is no important paper published prior to 2000 exactly relevant to this study.

Respondents of the survey are from every continent. The idea has been to gather responses from relevant industrial practitioners from various parts of the world to support the generalization of the results. Approaching the desired respondents in various parts of the world is a difficult task therefore an online questionnaire has been developed and distributed on various online GSD groups and professional networks like LinkedIn and Xing, to reach more target respondents in less time. However some respondents did not fill the survey completely, which could have affected the reliability and accuracy of the final results. To overcome this threat, partially filled responses have been excluded.

6.3.3 Construct Validity

Construct validity assess the use of accurate definition and measures associated with the variables. In other words, it concerns with the relationship between theory and observation [74]. In this study, the important threat to construct validity can be related to the design of SLR. There could have been a chance of missing important publications from the specific databases due to some inappropriate search strings. In order to mitigate this threat, senior librarians at BTH have been consulted for expert advice, since they are skilled enough when it comes to dealing with the search strings for specific search engines. They refined the search string for effective and accurate results.

There could have been an extra question in questionnaire to ask the survey respondent about the solution for the additional challenges that they have faced. Furthermore there could have been possibility that some terms in the reviewed literature do not refer to the same construct as reviewer might interpret, even if they use the same term. Consequently the reviewer might misinterpret the term used in the reviewed literature. To mitigate this threat, the context has been kept in mind for every review to make sure that the term in reviewed literature has the same construct as the reviewer's interpretation.
In survey there could have been confusion regarding use of few terms e.g. OPCI[8] and "five steps value-based requirements elicitation framework". To overcome this threat, the explanation of these terms has been given in the footnote of the questionnaire.

6.3.4 Conclusion Validity

Conclusion validity concerns with accuracy of conclusion based on gathered data [69], In other words, it makes sure that the collected data is sufficient for the rest of the research work for leading to an accurate and reliable conclusion [74].
I assumed that all respondents of the survey are involved in offshore outsourced software projects but there is possibility that some of them are involved in GSD projects but not exactly in offshore outsourcing, which could undermine the validity. The potential threat regarding SLR concerns with the selection of accurate research publications and data extraction. The reliability of selecting accurate research publications for review of SLR has been increased by strictly following the review protocol. Moreover, to mitigate the threat of missing challenges and solutions related to requirements elicitation in offshore software project from primary studies, a comprehensive study selection criteria and data extraction form has been constructed and strictly followed during the SLR.

Another threat related to conclusion validity is misinterpretation of questions in survey. There might have been a chance that respondents misunderstand or misinterpret the survey questions and give improper answers, which might have affected the study results.

To minimize this threat, three students of MSc Software Engineering, that have taken GSE course[9] and two professionals, having experience of offshore software projects, have been

[8] Organizer and Promoter of Collaborative Ideas

requested to fill in the survey and give back feedback on it. On the basis of their feedback, some modifications have been made on the structure of survey questionnaire, to make them easy to understand. Finally, questionnaire has been sent to the supervisor for further enhancements and modifications have been made according to her suggestions.

[9] http://edu.bth.se/utbildning/utb_kurstillfalle.asp?KtTermin=20142&KtAnmKod=COM1691&lang=en&parentPtKod=PAAES13h

7 EPILOGUE

This section summarizes all works performed in this thesis by revisiting each of research question and its answer. In addition possible future works is also presented.

7.1 Conclusion

Several challenges are associated with requirements elicitation. However, an increasing number of publications, in last five years, indicate a growing interest in this area. This study explores the area of requirements elicitation in offshore outsourced software development projects from both of state of art and state of practice in order to understand which challenges are hampering requirements elicitation in these projects, as well as what mitigation strategies can conciliate their impact. Three sequential phases have been carried out to methodically achieve the aim of this study. Relevant data have been collected through SLR and industrial survey. Qualitative comparative analysis has been applied as an analysis method. As a result 10 challenges and 45 solutions have been identified. By analyzing the frequency of challenges, the most compelling challenges are C3, C4 and C7 i.e. communication, control & promote and socio-cultural issues. To alleviate the challenges of requirements elicitation in offshore outsourced software development projects, there is a need of socio-cultural awareness and enhanced communication between client & supplier organization's personnel and other stakeholders.

7.2 Research Questions Revisited

7.2.1 Research Question 1

RQ1: What challenges are reported in the research literature regarding global requirement elicitation?

Challenges from research literature are methodologically explored through systematic literature review procedures suggested by Kitchenham and Charters [65]. Finally a total of 8 challenges (C1 – C8) have been declared. The results are discussed in detail in Section 5.1.2.1

7.2.2 Research Question 2

RQ2: What are the proposed solutions to the reported challenges in the literature?

Solutions to the identified challenges have also been explored from research literature through systematic literature review procedures developed by Kitchenham and Charters [65]. Finally a total of 22 solutions (S1 – S22) have been declared. The results are discussed in detail in Section 5.1.2.2.

7.2.3 Research Question 3

RQ3: What challenges are faced during the requirement elicitation in offshore outsourced software development projects in software organizations?

Challenges have been investigated through industrial survey from organizations. Consequently 2 additional challenges (C9 and C10) have been explored from industrial practitioners. The results are discussed in detail in Section 5.2.12.

7.2.4 Research Question 4

RQ4: What practices are applied in software industry to address the identified challenges?

Industrial practices have also been explored through web survey from various respondents in various organizations. As a result 23 additional practices have been discovered from industrial practitioners. The detail of these 23 practices is presented in Section 5.2.13.
Moreover, the mapping of challenges to overall solutions (both from SLR and Survey) is delineated in section 6.1.2

7.2.5 Research Question 5

RQ5: What are the similarities and differences between challenges and practices reported in research literature and industrial practice?

The findings from SLR and industrial survey have been analyzed with a help of qualitative comparatively analysis. It has been observed that that majority of the challenges and solutions identified by the survey participants are already reported in SLR. Consequently 8 challenges have been found similar between research literature and industrial practice. However there are two most additional categories of challenges which are reported by industry practitioners, but have not been reported by SLR i.e. trust and general category regarding political issues and budget constraints. Similarly 22 solutions have been found similar between literature and industrial practice while 23 solutions have been found different through industrial survey. Complete details of similarities and differences are illustrated through various tables in Section 6.1.1.

7.2.6 Research Question 6

RQ6: What are the most prevalent challenges based on their frequency in research literature and industrial practice?

By examining the frequency of all challenges; both in SLR and survey, the most prevalent categories of challenges have been figured out are C3, C4 and C7 i.e. communication, control & promote and socio-cultural issues. The results are illustrated in section 6.2.

7.3 Future Work

The exploration of challenges of requirements elicitation in distributed scenario has revealed further directions of the research journey to discover more treasure from other aspects.

Considering the results of this study, especially the 2 additional challenges revealed through the industrial survey, a suitable set of strategies or framework could be developed to overcome the impact of those additional challenges. In addition the reasons and impact of identified most prevalent challenges should be investigated in more detail so that the practitioners could pay extra attention to those aspects, which exacerbate these challenges. Besides, the mapping of challenges or solutions could be done with respect to various collected demographical information. Moreover same research could be conducted for requirements negotiation since it came to notice that elicitation and negotiation have strong relation with each other.

From SLR, it has been found that limited numbers of empirical studies exist in literature. Therefore, more studies are needed to investigate the state of practice, from both client and vendor's perspectives. In addition, the identified challenges could be investigated separately in terms of project size, type of products developed or distribution of responsibilities across offshore sites which could mean savings in terms of time and cost.

8 REFERENCES

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9 APPENDIX

9.1 Data Extraction form

Table 9.1 Data Extraction Form

Category	**Description**
Title of Article	
Name of Authors	
Year of Publication	
Type	☐Journal article ☐Conference proceeding ☐ Book section
Database Source	
Study Method	☐Case Study ☐Experiment ☐Survey ☐Interviews ☐Others
Research Background	☐Industry ☐Academia
Project size	Small, Medium, Large, Unclear
Identified Challenges	GSD challenges about requirements elicitation
Identified Solutions	Solutions or mitigation strategies to the reported challenges
Application Domain	

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9.3 Geographical Locations of Survey Respondents

Table 9.2 Geographical locations of survey respondents

Geographical location of Respondents	**Count**	**Geographical location of Respondents**	**Count**
Argentina	12	Kenya	02
Australia	03	Latvia	04
Austria	02	Lithuania	01
Belarus	01	Malaysia	12
Brazil	07	Mexico	08
Bulgaria	07	Netherlands	01
Canada	08	Pakistan	10
China	01	Philippines	11
Cyprus	03	Poland	26
Denmark	04	Romania	14
Finland	02	Russia	06
France	02	Slovakia	12
Germany	05	South Africa	01
Greece	01	Spain	01
Hong Kong	01	Sweden	57
Hungary	14	Turkey	09
India	91	Ukraine	11
Indonesia	04	United Kingdom	04
Iran	05	United States	16
Italy	04	Vietnam	06
Japan	02	**Total**	**391**

9.4 Current Role of the Survey Respondents

Table 9.3 Current Role of the survey respondents

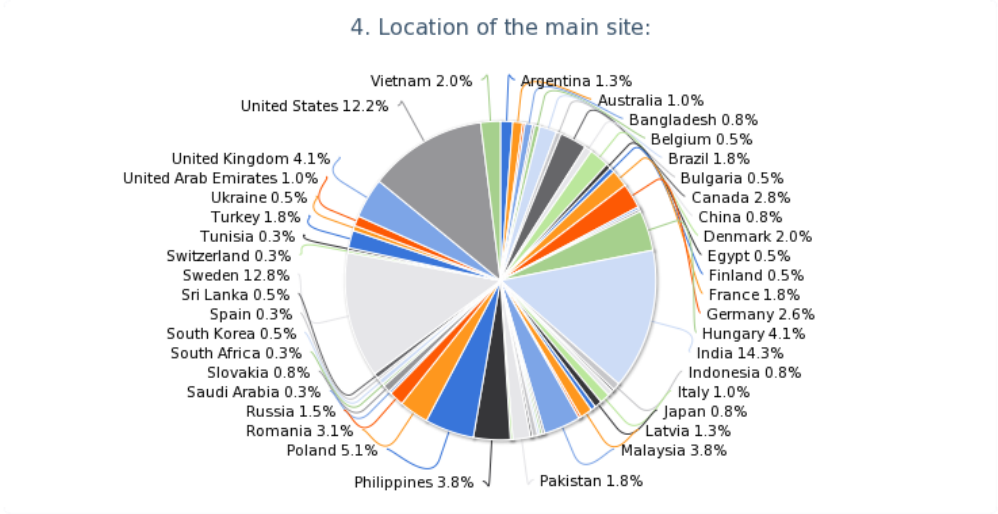
Role of the Respondent	Count	Percent
Product Owner	9	1.44%
Product Manager	11	1.76%
Program Manager	14	2.24%
Software Engineer	51	8.16%
Managing Director	8	1.28%
Database Administrator	8	1.28%
Project Manager	59	9.44%
Iteration Manager	3	0.48%
Software Architect	33	5.28%
Team lead	52	8.32%
Technical lead	31	4.96%
Developer / Programmer	119	19.04%
Product Engineer	0	0%
Design Engineer	3	0.48%
System Designer	2	0.32%
System Administrator	11	1.76%
System Analyst	13	2.08%
Business Analyst	30	4.80%
Quality Assurance Manager	33	5.28%
Tester	59	9.44%
Consultant	26	4.16%
Other	50	8%

Among 391 respondents, 50 have mentioned some other role which was not mentioned in the list. The detail of those 50 responses is given in table Table 9.4.

Table 9.4 Other roles mentioned by survey respondents

Other Roles	Count	Other Roles	Count
Software Quality Assurance Engineer	25	Director of Business development	03
Offshore Coordinator	07	Software Configuration Manager	01
Technical Writer	04	Scrum Master	01
Research Fellow	02	Financial Analyst	01
Strategic Manager	01	Marketing Manager	01
System Manager	01	Presales Manager	01
Test Lead	01	I.T. Auditor	01

9.5 Location of the Main Site



Among these 54 countries, majority of the main sites have been reported in India, Sweden, USA, Poland, Hungary, UK, Malaysia, Philippine, Romania and Canada. These top 10 countries are shown in the Figure 9.1. The vertical bar shows the reported number of main sites in each country.

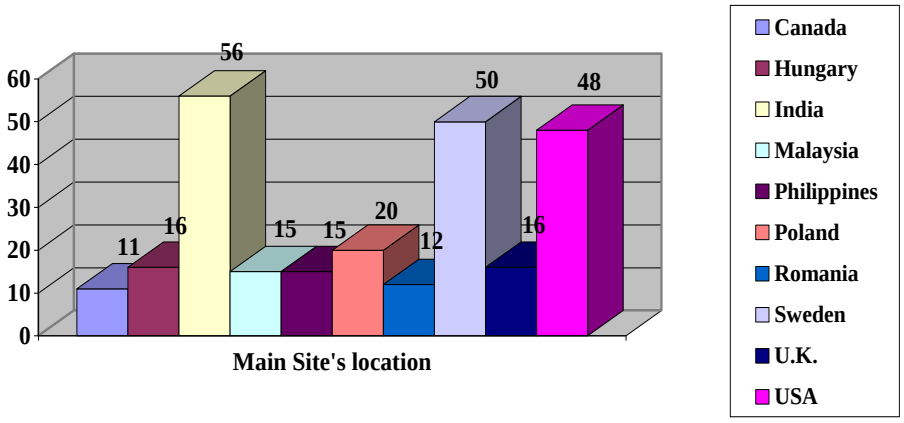


Figure 9.1 Top 10 locations of main sites

Frequency of the locations of all reported main sites is given in Table 9.5.

Table 9.5 Frequency of locations of main sites reported in survey

Location of main site	Count	Percent	Location of main site	Count	Percent
Argentina	5	1.27%	Malaysia	15	3.8%
Australia	4	1.02%	Malta	1	0.25%
Bahrain	1	0.25%	Mexico	1	0.25%
Bangladesh	3	0.76%	Morocco	1	0.25%
Belarus	1	0.25%	Netherlands	2	0.51%
Belgium	2	0.51%	Norway	1	0.25%
Brazil	7	1.79%	Pakistan	7	1.79%
Bulgaria	2	0.51%	Peru	1	0.25%
Canada	11	2.81%	Philippines	15	3.83%
China	3	0.76%	Poland	20	5.11%
Denmark	8	2.04%	Romania	12	3.06%
Egypt	2	0.51%	Russia	6	1.53%
Finland	2	0.51%	Saudi Arabia	1	0.25%
France	7	1.79%	Slovakia	3	0.76%
Germany	10	2.55%	South Africa	1	0.25%
Greece	1	0.25%	South Korea	2	0.51%
Hong Kong	1	0.25%	Spain	1	0.25%
Hungary	16	4.09%	Sri Lanka	2	0.51%
India	56	14.32%	Sweden	50	12.78%
Indonesia	3	0.76%	Switzerland	1	0.25%
Iran	1	0.25%	Tunisia	1	0.25%
Ireland	2	0.51%	Turkey	7	1.79%
Italy	4	1.02%	Ukraine	2	0.51%
Japan	3	0.76%	United Arab Emirates	4	1.02%
Kenya	2	0.51%	United Kingdom	16	4.09%
Latvia	5	1.27%	United States	48	12.27%
Lithuania	1	0.25%	Vietnam	8	2.04%

9.6 Location of the top 3 offshore sites

Table 9.6 Location of top 3 offshore sites

Offshore location	Site-1	Site-2	Site-3	Percent
Afghanistan	0	0	2	0.17%
Albania	0	1	0	0.08%
Argentina	7	9	7	1.95%
Australia	19	14	21	4.60%
Austria	0	1	4	0.42%
Azerbaijan	0	1	0	0.08%
Bahrain	0	1	0	0.08%
Belarus	2	0	1	0.25%
Belgium	4	3	0	0.59%
Bolivia	0	1	0	0.08%
Brazil	2	1	4	0.59%
Bulgaria	0	5	5	0.85%
Canada	5	27	10	3.57%
China	8	11	6	2.12%
Costa Rica	0	0	1	0.08%
Cyprus	3	0	1	0.34%
Czech Republic	1	2	6	0.76%
Denmark	3	5	8	1.36%
Egypt	1	0	0	0.08%
Estonia	0	3	4	0.59%
Finland	4	0	2	0.51%
France	7	8	8	1.95%
Germany	16	20	18	4.60%
Hong Kong	5	2	5	1.02%
Hungary	7	16	17	3.41%
India	61	20	15	8,18%
Indonesia	2	2	4	0.68%
Ireland	6	11	18	2.98%
Israel	0	0	1	0.08%
Italy	2	0	2	0.37%
Japan	2	5	0	0.59%
Kenya	0	2	0	0.17%
Latvia	1	2	3	0.51%
Libya	1	0	0	0.08%
Liechtenstein	0	1	0	0.08%
Lithuania	0	0	2	0.17%
Luxembourg	0	1	0	0.08%
Macedonia	2	1	0	0.25%
Malaysia	7	12	10	2.46%
Malta	0	1	0	0.08%
Mexico	9	7	7	1.95%
Moldova	1	0	0	0.08%
Morocco	1	0	0	0.08%
Netherlands	2	2	4	0.68%
New Zealand	0	0	1	0.08%
Nigeria	1	1	0	0.17%

Norway	3	2	3	0.68%
Pakistan	6	3	5	1.19%
Philippines	12	19	7	3.23%
Poland	10	29	32	6.03%
Portugal	4	2	3	0.76%
Qatar	1	1	3	0.42%
Romania	14	14	20	4.08%
Russia	13	9	8	2.55%
Saudi Arabia	2	0	1	0.25%
Serbia	2	0	1	0.25%
Singapore	5	4	8	1.44%
Slovakia	0	3	3	0.51%
South Africa	1	1	2	0.34%
South Korea	0	2	0	0.17%
Spain	1	3	4	0.68%
Sri Lanka	0	1	0	0.08%
Sweden	3	3	7	1.10%
Switzerland	5	6	1	1.02%
Tanzania	0	0	1	0.08%
Thailand	0	0	1	0.08%
Tunisia	1	1	1	0.25%
Turkey	3	3	1	0.59%
Ukraine	7	4	6	1.44%
United Arab Emirates	3	13	11	2.30%
United Kingdom	28	30	26	7.14%
United States	70	30	30	11.05%
Venezuela	0	0	1	0.08%
Vietnam	4	7	7	1.53%

Among these 74 countries, some countries have been frequently mentioned by the respondents. These top 10 most reported countries are USA, India, UK, Poland, Germany, Romania, Canada, Hungary, Philippine and Malaysia. Number of reported offshore sites in these ten countries are 130, 96, 84, 71, 54, 48, 42, 40, 38 and 29 respectively. These statistics are illustrated via bar graph in .

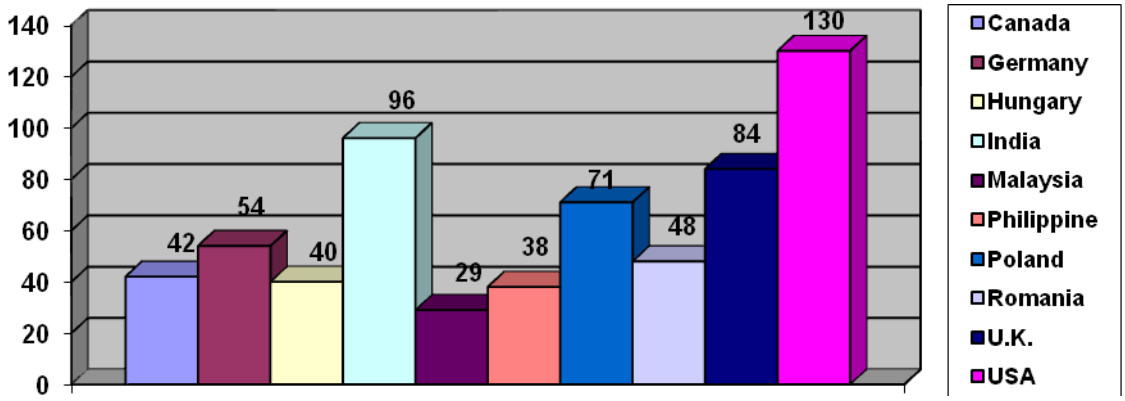


Figure 9.2 Number of top 3 offshore locations (top 10 countries)

9.7 Questionnaire for Survey

Dear practitioner!

We are contacting you to participate in this survey (which takes maximum **20 minutes**) due to your invaluable knowledge and experience in offshore-outsourced software projects.

The main goal of the survey is to investigate problems of requirements elicitation process as well as their solutions in offshore outsourced software development projects.

We sincerely appreciate your experience and expert opinion. In return, we will **openly** share the results of our analyses with you, which is a comprehensive summary of problems and solutions in the area from the viewpoints of researchers and practitioners.

The survey is open for you until 2013-10-01 and your input will be analyzed **collectively** and the results will be presented **anonymously**.

Here is the link to the survey: http://edu.surveygizmo.com/s3/1298692/requirements-elicitation-in-offshore-outsourced-software-projects

Please do not hesitate to contact me if you need any additional information.

Contact : Zia ur Rehman, zure06@student.bth.se

1. What is your current role in the project?

☐ Product Owner	☐ Product Manager	☐ Program Manager
☐ Software Engineer	☐ Managing Director	☐ Database Administrator
☐ Project Manager	☐ Iteration Manager	☐ Software Architect
☐ Team lead	☐ Technical lead	☐ Developer / Programmer
☐ Product Engineer	☐ Design Engineer	☐ System Administrator
☐ System Analyst	☐ System Designer	☐ Quality Assurance Manager
☐ Tester	☐ Consultant	☐ Other (Please specify)

2. Years of experience in software engineering?

○ less than 1 year	○ 1 to 5 years
○ 6 to 10 years	○ 11 to 15 years
○ 16 to 20 years	○ more than 20 years

3. How many employees does your organization have?

○ 1 - 50	○ 51 - 100	○ 101 - 250
○ 251 - 500	○ 501 - 1000	○ more than 1000

4. In which country is the main site located?

Select Country

5. Which activities are performed by the main site? (You may choose more than one option)

☐ Planning	☐ Training	☐ Requirements Analysis
☐ Requirements elicitation	☐ Design	☐ Development / Programming
☐ Deployment / Installation	☐ Testing	☐ Documentation

☐ Maintenance / Support ☐ Other (Please Specify)

6. Number of offshore sites that you work together:

Enter number

7. Please specify the location of the top three offshore site that you collaborate with:

Country1 Country2 Country3

8. How many people in total have been involved in this project?

○ 1 - 50 ○ 51 - 100 ○ 101 - 250

○ 251 - 500 ○ 501 - 1000 ○ more than 1000

9. What type of software product are you developing?

☐ Telecommunication ☐ Web development ☐ Automotive
☐ Real time/ control software ☐ Finance ☐ Embedded system
☐ e-commerce software ☐ System Software ☐ Engineering software
☐ Middleware ☐ Support Utilities ☐ Artificial Intelligence
☐ Networking ☐ Hardware control ☐ Process control software
☐ Scientific software ☐ Adware ☐ Information management
☐ Other (Please Specify)

10. Which software development model do you use?

○ Waterfall ○ Spiral model ○ Agile method

○ V-model ○ code and fix ○ Iterative & incremental

○ Rapid prototyping ○ Evolutionary prototyping

○ Rapid Application Development ○ Rational Unified Process

○ Joint Application Development ○ Other (Please Specify)

Domain specific (Contextual) Questions:

1. Which of the following problems have you encountered?
   - ☐ Improper tool / technology for communication with remote stakeholders
   - ☐ Communication with remote stakeholders e.g. difficulty in selecting a suitable elicitation technique
   - ☐ ta keholder's language differences
   - ☐ Eliciting requirements from a large number of distributed stakeholders
   - ☐ Difficulty in access to people e.g. access control, collaborative exchange of ideas or lack of stakeholder's motivation
   - ☐ Cultural issues e.g. timing, holidays, different working hours, work habits and behaviors
   - ☐ Bringing relevant stakeholders together into highly focused topic-centric discussion groups
   - ☐ Value assignment to various stakeholders on the basis of their role, time of availability, mean of communication, cultural differences etc
   - ☐ Any other (please specify if it's not in the above list)

2. Which of the following strategies have you used to overcome the problem related to tools/ technology?
   - ☐ Real time virtual meetings using some tools e.g. MOOsburg
   - ☐ Group email distribution list
   - ☐ Videoconferencing or Teleconferencing
   - ☐ Other (please specify if it's not in the above list)

3. Which of the following strategies have you used to overcome the problem of stakeholder's linguistic barriers?
   - ☐ Using audio recording of interview and linking it with Wiki technology
   - ☐ Choosing suitable communication mode (synchronous or asynchronous)
   - ☐ Other (please specify if it's not in the above list)

4. How did you cope with the problem related to communication with remote stakeholders? (e.g. choosing suitable elicitation technique or communication mode)
   - ☐ Choosing an appropriate groupware tool and elicitation technique according to stakeholders' preferences (cognitive styles) on the base of Felder i lverman's Learning Style Model (LSM)
   - ☐ Use of synchronous interaction e.g. brainstorming if the time overlap is large while use of asynchronous groupware tools when the time overlap is low
   - ☐ Iteration in Interviews and prototyping
   - ☐ Using audio recording of interview and linking it with Wiki technology
   - ☐ Using ontology (to share a common vocabulary) as communication facilitators
   - ☐ Web-based tool supported by Wiki features
   - ☐ Video or teleconferencing meetings
   - ☐ Synchronous text-based computer-mediated communication (e.g. chat, IM)
   - ☐ Other (please specify if it's other than above)

5. Which of the following strategies have you used to overcome the problems related to access to people? (e.g. lack of stakeholder's motivation or access control)

☐ Web-based tool with data mining and unsupervised clustering using of recommender systems to place stakeholders into appropriate discussion groups

☐ Choosing an appropriate groupware tool and elicitation technique according to stakeholders' preferences (cognitive styles) on the base of Felder i lverman's Learning Style Model (LSM)

☐ Volere process to ensure that all important aspects of requirements are consistent to an agreed schema, carefully addressed and that the methods applied have proven their value in practical work.

☐ Participation in online communities and use of requirements visualization tools like graphical use case definition; requirements definition through scenarios and storyboards for requirements validation; business process diagrams, use case models

☐ Videoconferencing or teleconferencing

☐ Spatial Hypertext Wiki

☐ Other (please specify if it's not in the above list)

6. Which of the following strategies have you used for requirements elicitation if the number of distributed stakeholders was very large?

☐ Web-based tool supported by Wiki features

☐ Semantic data-based Wikis

☐ Web-based elicitation tool using data mining, groupware environment and recommender system

☐ Forum-based requirements gathering processes

☐ Other (please specify if it's not in the above list)

7. Which strategies have you used to overcome the problem of bringing relevant stakeholders together into highly focused topic-centric discussion groups?

☐ Organizer & Promoter of Collaborative Ideas (OPCI) [i]

☐ Other (please specify if it's other than above)

8. Which strategies have you used to overcome the problem of socio-cultural issues?

☐ Learning about cultural diversity through literature reviews, seminars, courses, etc.

☐ Cultural mediation

☐ Cultural liaisons

☐ Virtual mentoring: based on simulation and virtual actors

☐ Other (please specify if it's not in the above list)

9. As different stakeholders have different opinions and expectations; which strategy did you use to prioritize various stakeholders for requirements elicitation?

☐ Five steps value based requirements elicitation framework[ii]

☐ Other (please specify if it's other than above)

[i] It utilizes clustering to automatically group the stakeholders' ideas into cohesive units which form an initial set of discussion forums. It then places stakeholders into their corresponding forums and utilizes a recommender system to suggest additional forums that might be of interest to them.

[ii] 1. Assign valued to stakeholders by applying Analytical Hierarchy Process (AHP). 2. Elicit valued requirements from valued stakeholders. 3. Requirement engineer and system analyst will purify those requirements according to project needs and will make an experienced questionnaire (having options against every requirement) 4. Get stakeholders' feedback. 5. Check all the requirements and figure out that how many stakeholders have selected a same option against certain requirement. If same value occurs for two options of one requirement, prefer the option whose stakeholder value is more than the other one.