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Effective Distribution of Roles and Responsibilities in Global Software Development Teams

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ABSTRACT

Context. Industry is moving from co-located form of development to a distributed development in order to achieve different benefits such as cost reduction, access to skillful labor and around the clock working etc. This transfer requires industry to face different challenges such as communication, coordination and monitoring problems. Risk of project failure can be increased, if industry does not address these problems. This thesis is about providing the solutions of these problems in term of effective roles and responsibilities that may have positive impact on GSD team.
Objectives. In this study we have developed framework for suggesting roles and responsibilities for GSD team. This framework consists of problems and casual dependencies between them which are related to team's ineffectiveness, then suggestions in terms of roles and responsibilities have been presented in order to have an effective team in GSD. This framework, further, has been validated in industry through a survey that determines which are the effective roles and responsibilities in GSD.
Methods. We have two research methods in this study 1) systematic literature review and 2) survey. Complete protocol for planning, conducting and reporting the review as well as survey has been described in their respective sections in this thesis. A systematic review is used to develop the framework whereas survey is used for framework validation. We have done static validation of framework.
Results. Through SLR, we have identified 30 problems, 33 chains of problems. We have identified 4 different roles and 40 different responsibilities to address these chains of problems. During the validation of the framework, we have validated the links between suggested roles and responsibilities and chains of problems. Addition to this, through survey, we have identified 20 suggestions that represents strong positive impact on chains of problems in GSD in relation to team's effectiveness.
Conclusions. We conclude that implementation of effective roles and responsibilities in GSD team to avoid different problems require considerable attention from researchers and practitioners which can guarantee team's effectiveness. Implementation of proper roles and responsibilities has been mentioned as one of the successful strategies for increasing team's effectiveness in the literature, but which particular roles and responsibilities should be implemented still need to be addressed. We also conclude that there must be basic responsibilities associated with any particular role. Moreover, we conclude that there is a need for further development and empirical validation of different frameworks for suggesting roles and responsibilities in full scale industry trials.

Keywords: Global Software Development Team, Team‟s Effectiveness, Roles and Responsibilities, Framework, Global Software Development Challenges.

ACKNOWLEDGMENT

This thesis was not possible without moral and official support of Darja Šmite, our supervisor and her few following comments.

Happy	Good work students, major improvements
Wonder	Is this what you are trying to say?
Angry	This is nonsense
Blank	Am I misinterpreting this?
Suggesting	Guys, It‟s you, who has to do it.
Confused	How?
Disappointed	Do your homework, Please

To special people in my life and their few comments

Saleem Naz, Mother	I am praying for you, have you taken your lunch?
Omer Saleem, Brother	When will you finish your thesis and get a job?
Saba, Samia and Maryum, Sisters	Don‟t worry, You will do it.
Maleeha Pal and Jia Hashmi, Special Friends	I am always with you.
Sushma Joseph, Thesis Partner	I am sure; no one can bear you.
Saleem Ahmed, Father	I will not send you more money this time.
God	You must stay patience in every situation.

Azeem Ahmad

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Sushma Joseph Kolla

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1 INTRODUCTION

Software Industry has been shifted from traditional co-located form of development to a form where teams are distributed geographically and collaborates with each others. Distributed software development (DSD) is becoming a common practice in today"s industry. Software development teams, in DSD, are not physically co-located and therefore cannot see or speak in person on a regular basis [1]. Team members are being distributed from adjacent buildings to being distributed over different continents in DSD [1]. Global Software Development (GSD) is a special case of DSD where teams are distributed across national boundaries [1]. It includes outsourcing as well as distributed teams within the same organization that are disbursed in different countries [1].

Software Industry is facing challenges in GSD that can minimize the problems of distributed development while still achieving the benefits. There are different solutions to address different problems that are raised during GSD and this study provides a solution to different problems in GSD in term of effective roles and responsibilities. The implementation of effective roles and responsibilities can assist project managers to address different problems of GSD that can guarantee the project success. This study also identifies the dependencies between problems of GSD. The framework for suggesting roles and responsibilities has been presented in this study which has been validated (static validation) in industry through survey.

1.1 Background

GSD has many assumed benefits such as specialized talent hunting, expansion through acquisition, development cost reduction, attaining time to market, wide customer range which have expedite the need of GSD teams [2].

Together with these assumed benefits, GSD teams face a lot of challenges such as cross-site communication, work distribution, as well as coordination and control issue [3]. Communication, coordination, collaboration and monitoring have been marked as major challenges faced by the GSD teams [4]. These challenges, in distributed work, tend to result in longer completion times of distributed work item as compared to similar co-located ones [5].

Team building, when team members are geographically distributed, can be more difficult and may induce language and cultural barriers that hamper effective communication [3]. The barriers such as geographical, temporal and cultural poses challenges related to project diversity and complexity when increasing the scope of organizational operations and opening up for a broader skills and product knowledge base [6][7]. These diversities and complexities in project, due to different barriers, are hard to manage as mentioned in [8], that no proven method for successful GSD has been formulated yet, and it requires a better understanding of the process dimension of GSD. There are number of other difficulties, research has highlighted in GSD, such as understanding the requirements, establishing and managing GSD teams, effective coordination between/within GSD teams, differences between process maturity level and appropriate selection of development tools [9].

The processes of communication, coordination and collaboration are at the heart of, and key enablers of software development process. The approach for successful GSD requires better communication, coordination and control. Thissen et al. in [10], provided rich information about communication tools that allow teams to work together in order to produce software products in spite of differences in location and time zone difference. Serce et al. in [11] suggested that communication patterns in GSD may be related to communication mode, task type, experience level of leader and culture within teams. Layman in [1] identified four success factors such as 1) defined customer authority for effective decision making and clear requirement statements 2)

having team member of one team physically located with other team 3) immediate response to asynchronous queries 4) providing the team with continuous access to process and product information. These factors can lead to good communication within distributed teams.

Begel et al. in [12] conducted a survey, in order to determine the success of tasks, which reveals that most common objects of coordination are schedule and features rather than code or interfaces. The survey also reveals that personal contacts work better to achieve high interactions between teams to go more smoothly. Taweel et al. in [13] emphasized the importance of two main issues that are 1) lack of managed synchronous and asynchronous collaboration mechanism and 2) lack of regular coordination between team members. A set of efficient practices for global virtual team management, for good coordination, has been provided in [14] which included a definition of skills and abilities needed to work in these teams, availability of collaborative work environments and shared knowledge management practices.

Researchers in [8][9][12][15] emphasized to have clear roles and responsibilities within teams in order to achieve successful GSD. Lings et al. in [8] provided different strategies for successful GSD and „maintaining a list of roles and responsibilities" is one of the strategies. The framework called NextMove has been presented in [16] which assist project managers in answering two important questions: 1) what should be done next and 2) who should do it. Begel et al. in [12] concluded that it is important to consider the different roles, people play on their teams when coordinating with each other.

It is important to define clear roles and responsibilities, within teams, in order to review the current distributed development scenarios [17]. Communication and coordination problems can be avoided by distributing proper roles and responsibilities where each team member is sure about his particular roles and responsibilities [4].

1.2 Problem Domain

Researchers in [17][18][19][20][21] have studied globally distributed teams, in a particular context, in order to cope with the challenges raised during GSD. Many case studies have been conducted in order to solve particular problems within teams for better GSD. Researchers in [8][22][23] concluded that great clarity in roles and responsibilities provides successful distributed development. Selecting a particular person for a particular role provides more flexible scheduling that worked well for global collaboration [24]. Understanding and maintaining particular roles also help to have better communication with other sites in GSD [25].

Through implementation of proper roles and responsibilities, different problems can be addressed in GSD. At the same time, this research also covers the role of the team leader, project managers, developers and how effective they were e.g. in monitoring the work [4][26]. Apart from providing the suggestions as „having roles and responsibilities" to avoid problems in GSD, there is a gap that requires an attention to studying, understanding and suggesting particular roles and responsibilities corresponding to the particular globally distributed team structures and evaluating their effectiveness or ineffectiveness [19].

1.3 Aims and Objectives

The aim of this thesis work is to develop a new framework that suggests effective roles and responsibilities for GSD teams. This framework depends on the problems and the dependences between them which are related to GSD team"s ineffectiveness. These problems together with their dependencies shall be mitigated through the implementation of different roles and responsibilities.

Our work, here, aims at providing a framework for structuring roles and responsibilities, either by hiring new staff or modifying current staff responsibilities, in order to create effective teams for GSD. Addition to this, we will validate these roles

and responsibilities in industry through survey. Figure 1-1 explains the structure of this thesis.

The objectives of this study are as follows:

- *Identifying problems in GSD which determine teams' ineffectiveness.*
- *Identifying casual dependencies between problems in GSD that determine team's ineffectiveness.*
- *Building a framework for suggesting effective roles and responsibilities in GSD teams with respect to identified dependencies between problems.*
- *Static validation (through a survey) of the framework in industry.*

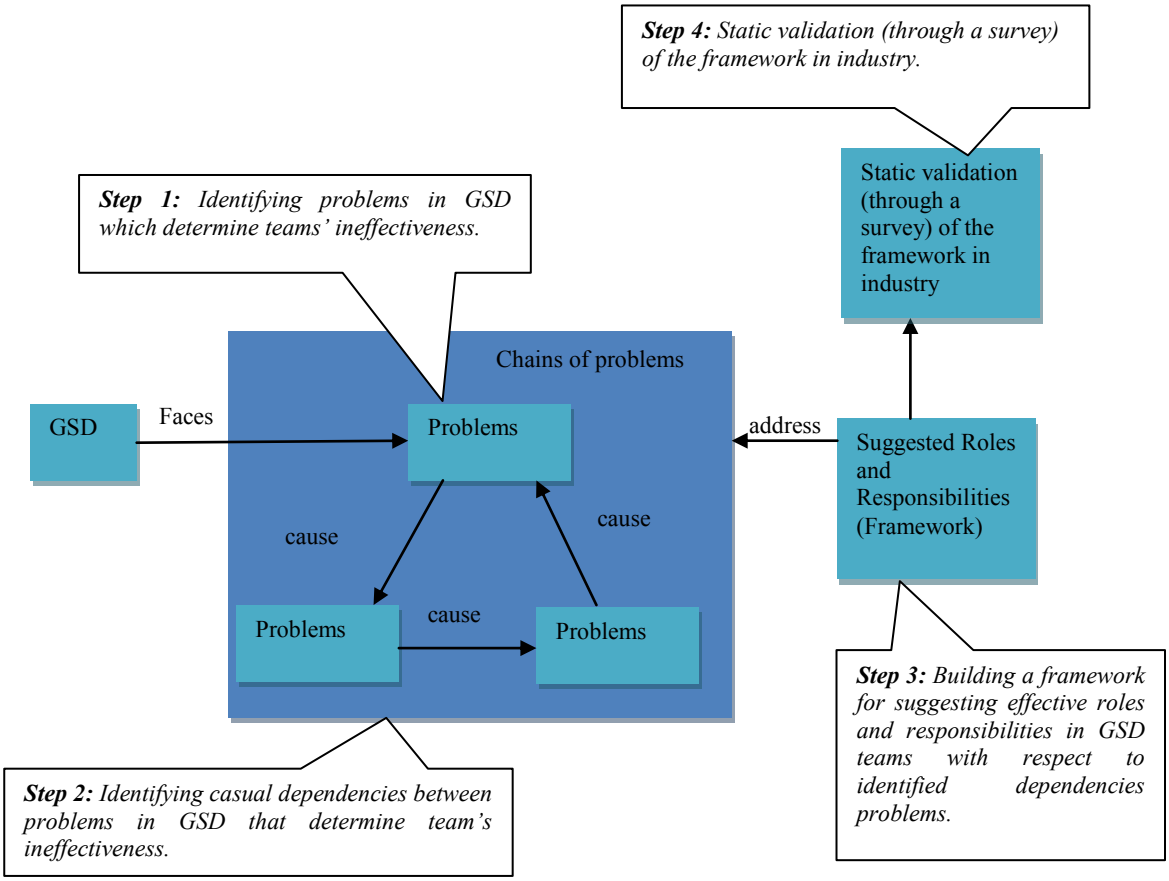


Figure 1-1. Aims and Objectives

1.4 Research Questions

Research question is the statement that depicts the reason of conducting a research [27]. Three research questions have been proposed in this thesis, which are as follows:

RQ1. What are the problems and casual dependencies between them that influence the effectiveness of GSD team?

RQ2. How can these casual dependencies between problems be addressed through implementation of the roles and responsibilities in GSD teams?

RQ3. How useful the implementation of roles and responsibilities, found through RQ2, are in industry?

1.5 Thesis structure

Figure 1-2 represents the thesis structure. This thesis consist 7 chapters describing introduction, research methodology, results and references.

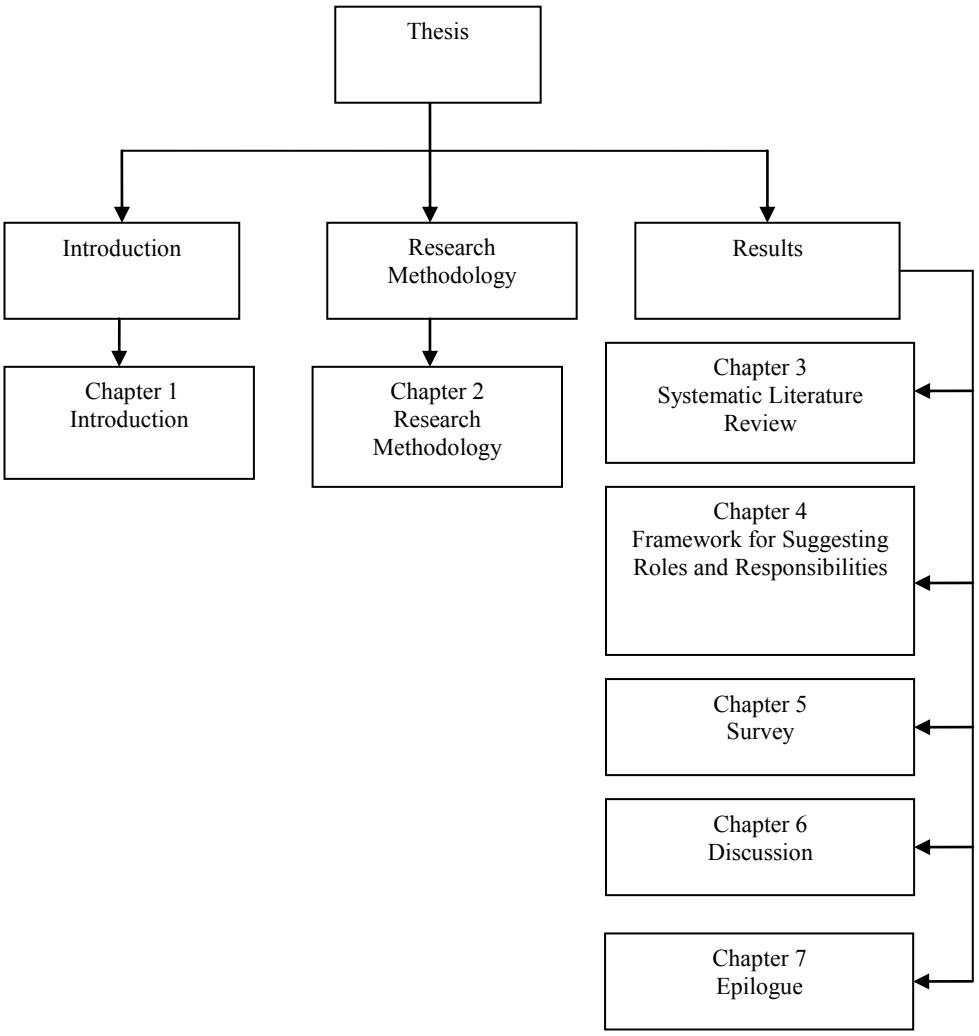


Figure 1-2. Thesis Structure

1.6 Key Terms and their Explanation

There are few important terms that have been used in this research. We consider it necessary to explain them before we provide the results.

Global Software Development Team

The GSD team, in this study, is about different groups of co-workers, separated from each other by physical distance over the national border and may encounter the time zone difference. „Over the national border" means teams locating on different countries which make it different from other definition of DSD teams such as, being separated within national border.

Team Effectiveness/Ineffectiveness

Team effectiveness/ineffectiveness has been measured through "Big 5 in Team Work" which has been proposed in [28]. Salas et al in [28] discussed "Big 5 in team work" consists of team leadership, mutual performance monitoring, backup behaviour,

adaptability and team orientation. Identified problem and the dependencies between them have been linked with the above dimension of big 5 in team work. These dimensions have been explained further in detail in section 3.3.2.2.

Problem

Problems in GSD leave a negative impact on the project. It also describes the characteristics of the environment of project that have an impact on the project [29]. It can also be of different types such as remote site"s characteristics (e.g. the process maturity or the staff experience at the site), relationships between sites (e.g., the cultural difference or if two sites has previous working experience between them), task characteristics (e.g., the complexity of a task), or overall project"s characteristics (e.g., the time pressure or the type of project) [29]. The example of these problems can be lack of knowledge management, lack of maturity in the team or lack of face-to-face meetings which in turn cause other problems such as communication problem, increase project failure risk and interaction barrier respectively.

Rules

Rules are the way to document casual dependencies between problems. Rules formalize how the problem may have an impact on another problem [29]. It can be done in two ways: 1) certain combinations of influencing problems can increase the possibility and severity of the problem, 2) other combinations can decrease it [29]. In our study, we have used second way for documenting the causal dependencies. For example, high degree of dependency of task, lack of communication structure and conflicts can increase coordination problems. Three Boolean operators has been used during the definition of rules such as „and (&&)", or (||) and „not (!)".

Role

Role in this thesis refers to the person"s designation in the team. It is obvious that particular designation leads to particular behaviour of person. This behaviour is called responsibility. The example of role can be a project manager or liaison engineer.

Responsibility

It is defined in online dictionary [30] as "a particular burden of obligation upon one who is responsible". A particular burden of obligation, in this thesis, is considered as a practice, activity or action of a responsible person (role), which he/she conducts to achieve a particular purpose.

Dependency

It is defined in online dictionary [30] as "In this type of relations, an element e1 depends on an element e2, if the existence of e1 relies on the existence of e2, or if changes in e2 have to be reflected in e1" [31].

2 RESEARCH METHODOLOGY

In this chapter the design of this research is described. The research methodology used, for answering the research questions in our study is discussed in following sections and a motivation has been provided for selecting particular research methods.

2.1 Research Design

This research has been conducted in two different phases 1) state of art (systematic literature review) and 2) state of practice (survey). The results are obtained to answer the research questions mentioned in section 1.4. Initially a systematic literature review (SLR) is applied through the guidelines of Kitchenham [32] to gather the data relevant for our study from existing literature. The purpose of the SLR is to qualitatively explore the effectiveness/ineffectiveness of GSD teams, problems that are related to team‟s effect effectiveness and than suggesting roles and responsibilities for GSD teams. The results in relation to the research questions RQ1, RQ2 and RQ3 are presented in this study. We analyzed the collected qualitative data using thematic analysis and the results obtained are produced in the form of framework.

This framework consolidates various research results (suggestions of roles and responsibilities, problems and dependencies among them, and effectiveness of team) which have been developed based on the problem statement elicited from state of art (SLR) and then this framework is successfully validated through state of practice (in industry). This framework consists of 3 modules such as suggestions (roles and responsibilities), chains of problem (dependencies among problems) and team‟s effectiveness.

For state of practice, a survey is conducted to validate the proposed framework such as by asking questions whether they have these identified roles and responsibilities addressed in academia for improving team effectiveness in GSD. Participants were asked to validate the links between chains of problems and suggestions of roles and responsibilities. This survey addresses RQ3. Descriptive Statistics is used for describing survey results. The research design of the study is shown in below Figure 2-1.

2.2 Research Methods

Research is a study that goes beyond the influences of personal ideas and experience of an individual [27]. There are three different types of methods that can be used in the research i.e. quantitative, qualitative and mixed research. Both qualitative and quantitative methods are used in this research in order to address our research questions.

2.2.1 Systematic Literature Review

SLR is described in [32] as “identifying, evaluating and interpreting all available research relevant to a particular research question, or topic area, or phenomenon of interest”. SLR is a secondary study and literature selected (individual studies) is known as primary studies [32]. Literature review is conducted in order to summarize the existing evidences, to propose a framework or background and to identify any gaps in existing research [32]. Tertiary review can be another possible selection but based on our initial literature survey, we did not get any SLR on our research topic that led us avoid tertiary review studies. The main purpose of this research required a well methodology to “identify, analyze and interpret all available evidence related to our research questions in a way that is unbiased and (to a degree) repeatable [33]”. Thus, SLR was selected as one of the method for conducting our research. SLR is a structured and repeatable methodology that helps in reducing researcher‟s biases.

Main steps in SLR according to [32] are as follow:

- **Planning the Review:** Defining the basic review procedures before conducting the review
- **Conducting the Review:** After agreement of protocol, review is started in the proper way.
- **Reporting the Review:** The final step of SLR for documenting and reporting the results.

The detailed process of planning, conducting and reporting the review are presented in Chapter 3.

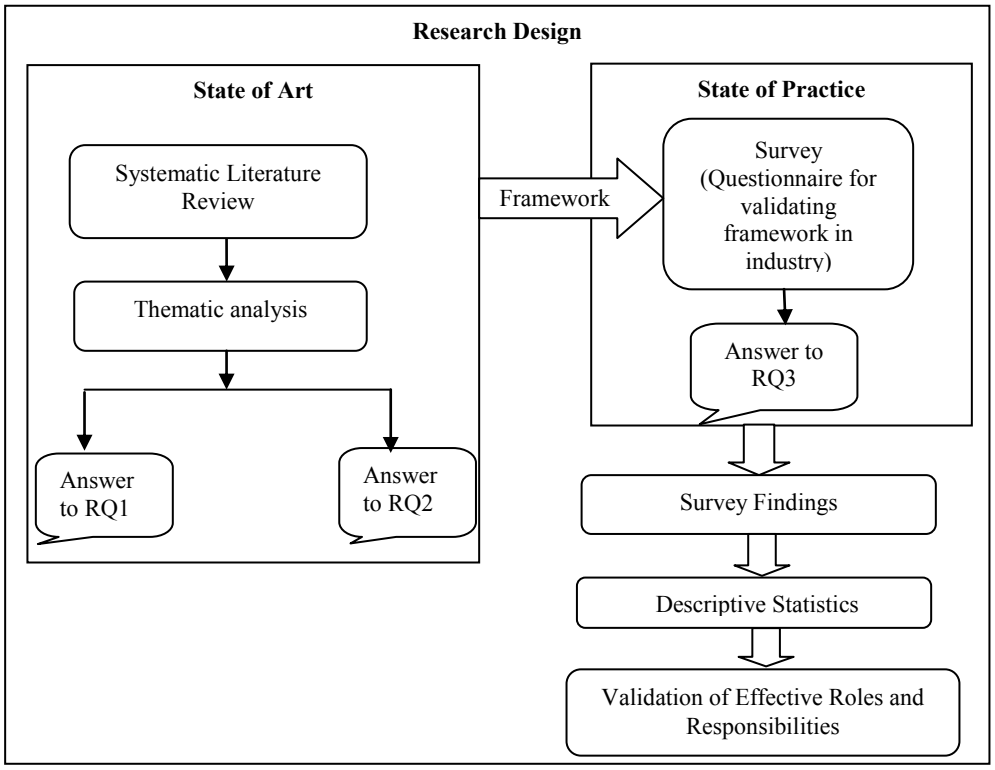


Figure 2-1. Research Design

2.2.2 Survey

A survey is a form of empirical study for providing a quantitative or numeric description on some fraction of the population or the sample through the data collection process by asking questions to the people [34][35]. A survey can be conducted either through interviews or questionnaire [36][37]. We are conducting survey through questionnaires. The designed questions are based on the findings of framework.

For conducting survey, we used both combinations of closed-ended and open-ended questions. We designed close-ended questions in the beginning of the survey, so that the participants can have some background on the issues. Close-ended questions take less time and less expensive survey method. By asking closed-ended questions, we can validate our findings. Open-ended questions allow practitioners to include more information and understandings of the subject. It helped us to obtain information regarding additional roles and responsibilities which are missing in literature. The detailed processes of conducting a survey are presented in survey chapter 5.

2.2.3 Data Analysis Methods

Research synthesis is a collective term for a family of methods, in order to summarize, integrate, combine, and compare the findings of different studies on a specific topic or research question [38]. A method is needed for analysing the data [38][39][40][41][42]. Qualitative data is non numeric data with diverse types of values or a descriptive data that can‟t be measured or counted [42][43]. We used two data analysis methods i.e. thematic analysis and descriptive statistics analysis. Thematic analysis is used for analysing data for our research questions. We used descriptive statistics analysis method for our survey.

2.2.3.1 Thematic analysis

Thematic analysis is one of the foundational methods for qualitative analysis. It is treated as first qualitative method of analysis, as it provides core skills for conducting different forms of qualitative analysis [44]. Holloway and Todres [45] identified „thematizing meanings‟ as one of the generic skills across qualitative analysis. Boyatzis characterizes thematic analysis not as a specific method, but as a tool to use across different methods [46]. Ryan and Bernard [47] also considered thematic coding as a process performed within „major‟ analytic traditions (for example in grounded theory), rather than a specific approach in its own way.

For analysis the collected data we need to use one data analysis methods. We used thematic analysis for identifying, analyzing and reporting the patterns /themes within the data. In relation to our data, we want to provide more detailed and refined group of themes, that relates with our research questions. Thematic analysis is more suitable for doing this type of analysis. The data which is important to our research questions are captured as themes, which represent patterned response or meaning/patterned within the data set. Themes or patterns in our analysis are identified using inductive or bottom-up approach. In inductive approach, identified themes are strongly linked to the data themselves. Inductive analysis is a process of coding the data without any analytic preconceptions or fitting into a preexisting coding frame [48] for evolving research questions.

There are many other methods available for data synthesis. Some of them are narrative synthesis, meta study, grounded theory etc. Narrative synthesis is used to give summary of the findings of primary studies [49]. It is applied to perform reviews of quantitative and/or qualitative research; our motive is not give a summary of findings so narrative synthesis is not suitable for analyzing our data. When coming to meta study, it is used for analyzing theories, methods and finding in qualitative research, further synthesizing into a new way [50]. We don‟t want to analyze any theory or methods that already exist because we want to develop a framework based on our findings not on existing theories or methods. Grounded theory is used to construct a body of knowledge based on understandings like what is happening or happened by analysing raw data from real ground rather than relying on existing notions or “off the shelf” theories [51]. We are not developing from grounds because we have plan in our mind what data to be analysed. When we have categories or process of development in mind, grounded theory is not suitable for analysis and more over it is more suitable for analysing interviews or surveys.

The detailed explanation of thematic analysis is discussed in section 3.2.7.

2.2.3.2 Descriptive Statistics

Descriptive statistics are used for describing the basic features of the data in a study [52]. It provides summaries of the samples and measurements. It is used simply for describing what‟s going on with the data [52]. In Qualitative Comparative analysis either one entity or some portion of data, such as a statement or an idea, are selected and compared with other entities to determine their common and distinct characteristics [53]. We are not comparing any similarities or difference between state

of art and state of practice. We are validating our findings from SLR in industry for confirmation and testing as well as produced a descriptive statistics on our survey data. The detailed explanation of descriptive statistics is discussed in section 5.4.

3 SYSTEMATIC LITERATURE REVIEW

A SLR is about identifying, evaluating and interpreting all available research that is relevant to a particular research question, or topic area, or phenomenon of interest [32]. This SLR helps us to understand the state-of-art practices for factors that effect GSD together with the available roles and responsibilities. There are three phases of SLR which are as follows [33]:

- Planning the review
- Conducting the review
- Reporting the review

The first phase (planning the review) consists of explaining the need of performing the review together with development of a review protocol. The review protocol is about guidelines in order to search for a complete SLR process [33]. The second phase (conducting the review) has following steps [33]:

- Identification of research
- Selection of primary studies
- Study quality assessment
- Data extraction and monitoring
- Data synthesis

The last and final phase (reporting the review) is about reporting the results of SLR in form of research report or thesis.

3.1 Planning the Review

Planning the review is about a review protocol, and consists of following steps.

3.1.1 Identify the need of systematic literature review

The purpose of this SLR is to gather and summarize the available literature related to roles and responsibilities of GSD teams, based on different influencing factors. It also includes identifying factors common for each problem. Furthermore, this SLR provides grounds to develop a framework, for suggesting roles and responsibilities, based on different influencing factors and problems.

3.1.2 Review protocol development

This section describes the detailed plan for conducting SLR and provides a process/method to select primary studies which can, further, reduce biasness [33].

3.1.2.1 Search strategy

The search strategy includes search terms and selected databases. We maintained systematic review search log, which includes total number of studies found in databases, total number of selected studies after applying inclusion and exclusion criteria. The following steps are considered in order to develop the search string.

1) Important search terms are identified from our research questions.
2) Alternate words and synonyms, used in research questions, have been identified in order to minimize the effect of difference in terminologies (Table 3-1).
3) Our listed search terms are combined with Boolean operators to form a search string (Table 3-1).

4) Boolean “OR” is used in order to join an alternatives and synonyms.
5) Boolean “AND” is used in order to join major terms
6) Expert advice from librarians on how to search effectively.
7) Scan different papers for the controlled terms that could be related to the study

3.1.2.2 Search Keywords

Table 3-1 represents the search terms used to identify primary studies. These search terms consist of two groups. First group represents general term such as distributed software development or global software development because this project particularly aims to address GSD. The second group represents „what actually we are looking for?“ it is related to formation of team, its structure, roles and responsibilities in a globally distributed development. By looking into different relevant papers, we have decided to avoid the terms such as „teams or team‘s“ in our search terms. We used the term „team“ e.g. team design, team composition. The last row in Table 3-1 represents the final search string.

Table 3-1. Search Terms

Groups	Search terms
Group 1	1.1 Distributed development 1.2 Global development 1.3 Distributed software development 1.4 Global software development 1.5 Virtual software development
Group 2	2.1 Team structure 2.2 Team roles 2.3 Team formation 2.4 Team responsibilities 2.5 Team Design 2.6 Team Composition
Final Search String	(("Distributed development" OR "Global development" OR "Distributed software development" OR "Global software development" OR "Virtual software development") AND ("Team Structure" OR "Team roles" OR "Team formation" OR "Team responsibilities" OR "Team Design" OR "Team Composition"))

3.1.2.3 Data Sources

Search engines available for software engineering are not sufficient for supporting SLR [54]. For this reason, researchers of software engineering are bound to perform search that are more response dependant. Brereton et al. [27] identified seven relevant sources related to software engineers that are appropriate for conducting SLR in software engineering such as:

- IEEE Explore
- ACM Digital library
- Google scholar (scholar.google.com)
- Citeseer library (citeseer.ist.psu.edu)
- Inspec (www.iee.org/Publish/INSPEC/)
- SceinceDirect (www.sciencedirect.com)
- EI Compendex (www.engineeringvillage2.org/Controller/Servlet/AthensService).

The data sources used for SLR are presented in Table 3-2. Two of the databases mentioned by Brereton et al. have not been selected such as Google scholar and Citeseer library because of their credibility. Kitchenham et al. [33] prefer Springer Link for journal search. We have also included this database for our SLR. As mentioned in [55], it is always difficult to find grey literature. however we acknowledge that inclusion of such literature would have contributed in increasing internal validity.

Table 3-2. Data Sources

Sr. #	Database name
1.	IEEE explore
2.	ACM Digital Library
3.	Engineering Village
4.	Science Direct (Elsevier)
5.	Springer Link

3.1.2.4 Study Selection Criteria

3.1.2.4.1 Inclusion and Exclusion Criteria

The study inclusion and exclusion criteria lead to identifying those primary studies that provide direct evidence about the research questions [33]. The resulted primary studies will be numerous, if we only search with search string, so we used inclusion and exclusion criteria in order to assess their actual relevance of papers. The inclusion and exclusion criteria are based on research questions. We conducted several meetings to define the review protocol (basic inclusion and exclusion criteria, quality assessment criteria and data extraction strategy) in order to have a similar understanding of the review protocol. The purpose of these meetings was to avoid publication biases and disagreements in opinion as everyone will have a similar understating of the review protocol. The selection criteria, decided during the protocol definition, reduce the publication bias [33].

Table 3-3 presents inclusion and exclusion criteria that have been arranged specifically. It helped us to get relevant and valid articles. We are treating inclusion criteria as basic and detailed criteria. In table 3-3 points from 1 to 6 are treated as basic inclusion criteria and 7-11 are treated as detailed inclusion criteria. Basic inclusion criteria (1-6) was required to implement on each study but detailed inclusion criteria (7-11) can be implemented based on study nature. We selected publication year from 2000 as GSD is mentioned a 21st century field in [56][57].

Table 3-3. Inclusion and Exclusion Criteria

Inclusion Criteria
1. The publication year of article is from 2000 to 2011
2. The article is in English language.
3. The article is available in full text.
4. The article is peer reviewed.
5. The article can be a qualitative or quantitative research.
6. The article relates to GSD.
7. The article will be included if it compares or evaluates performance of teams in globally distributed software development.
8. The article will be included if it compares or evaluates any communication, coordination and monitoring strategy/structure/tools/model/pattern for globally distributed teams.
9. The article will be included if it compares or evaluates framework for measuring effectiveness of teams in globally distributed software development.
10. The article will be included if it describes the structure/formation/design of a distributed team.
11. The article will be included, if it discusses roles and responsibilities of team in globally distributed software development.

Exclusion Criteria
1. Article that do not fulfill inclusion criteria.

3.1.2.5 Study Selection Procedure

We followed the following steps for selection of primary studies.

- Title of the article
- Abstract of the article
- Conclusion of the article
- Full text of article

3.1.2.6 Quality Assessment Criteria

Through quality assessment, we can assess the papers for primary studies that present convincing evidence by avoiding irrelevant papers that do not address our research questions. We performed quality assessment criteria individually and the results have been cross checked. The quality criteria have been used as a checklist during quality assessment of primary studies. We are not measuring the quality in terms of weight infect we will use „Yes" or „No". In order to avoid the publication bias, the quality assessment criteria has been designed during planning of review protocol. Publication bias refers to the problem that positive results are more likely to be published than negative results [33]. This positive and negative concept sometimes depends on the viewpoint of the researcher [33]. The common understating of the protocol will reduce the probability of publication bias and difference in selection of study.

Table 3-4. Quality Assessment Criteria

Quality Assessment Criteria
1. Is the reader able to understand the aims of the research?
2. Is the context of study clearly stated, that includes population being studied (e.g. academic vs. industrial) and the task to be performed by population (e.g. small scale vs. large scale)
3. Do the conclusion relate to the aim and purpose of research defined?
4. Are validity threats related to research reported?
5. Whether team"s composition is discussed clearly?
6. Has results of team"s composition, in term of its effectiveness or ineffectiveness been reported?
7. If there are roles and responsibilities involved, are they defined clearly?
8. If the framework/pattern to solve any challenges (communication, coordination) of globally distributed software development is proposed, is it validated in academia or industry?

3.1.2.7 Data Extraction Strategy

Data extraction form is used to accurately record the information; researchers obtain from primary studies [33]. It must be designed to collect all the information in order to address research questions [33]. As discussed in [33], Data extraction form has piloted on a sample of primary studies to make sure that it works, before conducting a full scale systematic review. This activity also helped us to assess issues such as completeness, clarity and quality of data extraction form. This activity has been done together as it is recommended that each researcher should take part in a pilot study [33]. The continuous support from our supervisor and her expert judgment removed any doubt regarding the quality of data extraction form. After the piloted study is completed, we applied data extraction form on 8 studies together. Then data extraction form has been applied on rest of the studies individually and results were cross

checked. We also performed test-retest process where one of us performed a second data extraction from on selection of primary studies to check data extraction consistency. Disagreement had been resolved by consensus among authors of this thesis. Data extraction form presented below contains some standard information (number 1-8) and some specific information regarding the study.

1) Title
2) Authors and Affiliations
3) Publication year
4) Source
5) No. of pages
6) Research Methodology of study
7) Document Type
8) Conference/Journal info.
9) Whether research is conducted in industry or academia
10) How many development sites included: 2, 3 … n sites?
11) How many teams included: 1, 2 …n teams?
12) What roles and responsibilities of teams are discussed?
13) What are the influencing factors that cause problems for communication and coordination practices in GSD?
14) What practices in team formation have been reported?
15) Team nature (coding/testing): whether it is coding team or testing team?
16) Description of framework/model/pattern, if there is any.
17) On what grounds framework/model/pattern is constructed?
18) What are the limitations of framework/model/pattern?
19) How is the framework/model/pattern validated in academia/industry?

3.1.2.8 Synthesis of Findings

Data synthesis includes a process which combines small different pieces of data to form a coherent whole unit [58]. The collected data has been sorted out and summarized with respect to thematic and descriptive synthesize [32].

3.1.3 Validation of Review Protocol

Review protocol is very important element of SLR and required validation [33]. Conducting a pilot search is proposed in order to identify primary studies by using search string as per defined in review protocol [33]. Supervisor of this thesis has verified the review protocol. Addition to this, search strings and used resources (databases) were also verified and validated with the help of BTH librarians.

3.1.3.1 Pilot Study

The purpose of pilot study in SLR is to develop and assure consistent understanding and mutual agreement on review process and procedure between two authors [32]. This pilot study must be done before embarking on the complete extent of SLR [32]. It helped us to avoid potential bias and to mitigate the risk of following an inconsistent process and concepts by authors. We have developed inclusion/exclusion criteria, quality assessment criteria and data extraction form based on our consensus. This protocol is developed with mutual agreement and understanding of authors of this study together with supervisor. The mutual agreement during the protocol development reduces the chances of having disagreements when piloting the study. There were few discussion took place between authors during piloting the study, and the purpose was to stay synchronized regarding the protocol.

3.2 Conducting the Literature Review

Once the protocol has been agreed, the next phase is to perform the review process according to protocol. Conducting the review has following stages.

3.2.1 Identification of research

As per review protocol, articles have been retrieved from five major electronic databases. A trial search is performed in each database with same search string. We observed minor differences in each database with respect to search string"s syntax formulation. We refined keywords by observing trial search. After refining keywords again we performed search in each database then an initial set of studies are obtained. Figure 3-1 shows the search strategy, which helps us to find relevant articles related to our research questions

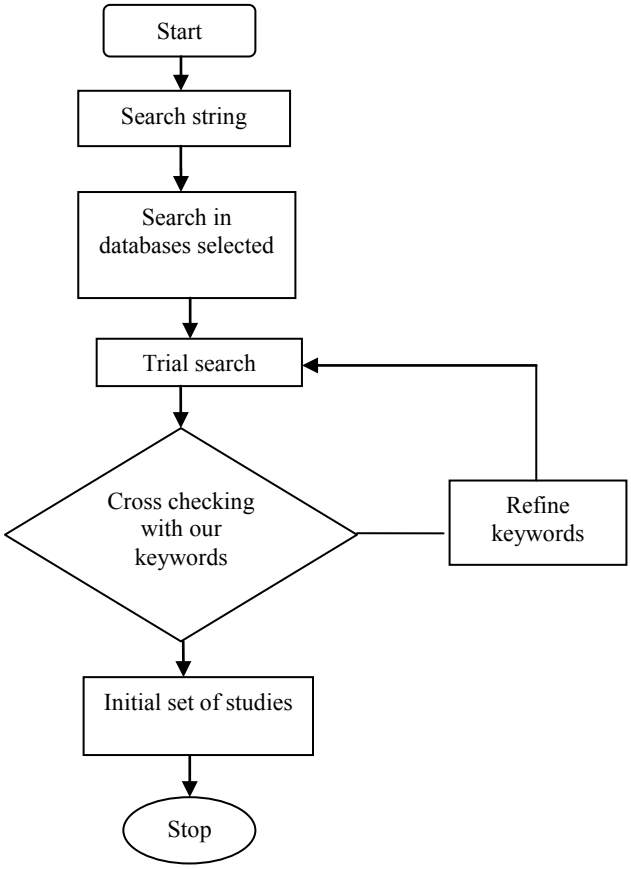


Figure 3-1. Search Strategy

3.2.2 Selection of primary studies

Brereton et al. [59] identified seven electronic resources of relevance to software engineering, out of which we selected four databases namely IEEE, ACM, Science direct and Engineering village (EI) for our SLR. Kitchenham et al. [33] prefer Springer Link for journal search. We have also included this database for our SLR. We performed a manual search for all the proceedings of conference on Global Software Engineering "**International Conference on Global Software Engineering (ICGSE)**". This is performed because there is a chance of missing important articles when performing search in databases. Initially we got 1319 studies from five databases. We got 141 studies from IEEE, 495 from ACM digital library, 274 from

Engineering village which includes both Compendex and Inspec. We got 399 from Science direct and 10 from Springer link.

All these initial set of 1319 studies, selected by both authors, are brought into Endnote to remove the duplicates where 29 studies are discarded as duplicated. After removing duplicates, basic inclusion criteria (i.e. title, abstract and conclusion) are applied on 1290 studies. We discarded 778 studies using basic inclusion and exclusion criteria. We left with 512 studies.

One of these 512, both authors implemented detail inclusion criteria separately. Author 1 selected 80 studies and author 2 selected 75 studies. Again both the authors went to full text separately, author 1 selected 20 and author 2 selected 23.

Finally we end up with 16 primary studies using full text and quality criteria by discarding 121 studies through electronic databases. The agreement between the authors is calculated using Kappa coefficient given in section 3.2.3. For ICGSE we performed manual search based on our research questions. We identified 32 studies manually. Similar to electronic database, we applied basic inclusion, detailed inclusion criteria and full text for selecting studies. We selected 9 articles from ICGSE. We found 4 articles as duplicates. Finally we end up with 5 articles from ICGSE. Now from databases and manual search we have 21 articles as primary studies.

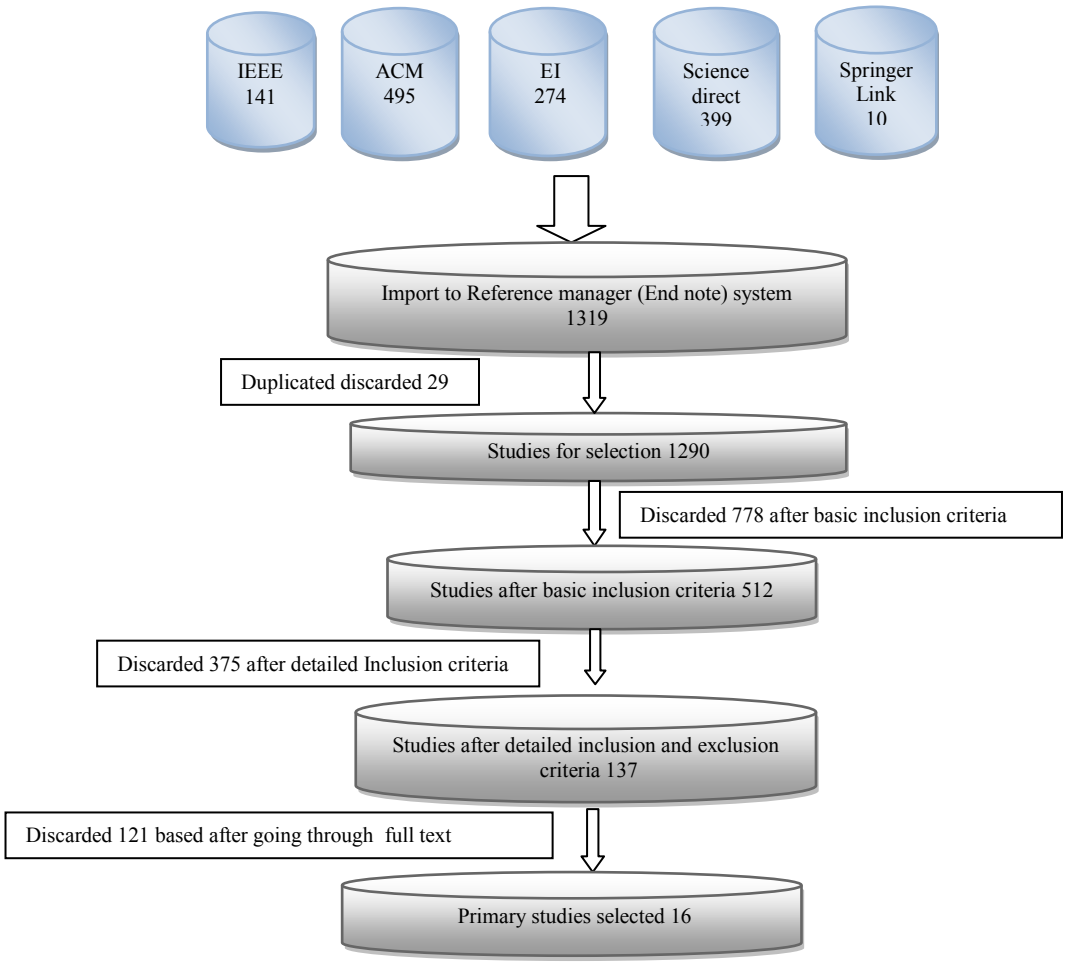


Figure 3-2. Summary of Articles found and it"s Filtering.

3.2.3 Calculation of Kappa Coefficient

"Kappa coefficient (κ) is used as the de facto standard for measuring the intercoder agreement between two authors in tagging tasks." [60] We applied Kappa

coefficient [61] for assessing the degree of agreement between authors to select primary studies based on inclusion and exclusion criteria and our kappa coefficient is equal chance of agreement. κ is calculated as [60][61]:

$$\kappa = \frac{P(A) - P(E)}{1 - P(E)}$$

Where P (A): probability of observed agreement among authors.

P (E): probability of expected agreement.

κ value ranges from-1 to 1 with following interpretations:

κ = 1: perfect agreement

κ = 0: agreement is equal to chance

κ = -1: perfect disagreement.

For total N number of studies, P (A) and P (E) are computed as follows:

$$P(A) = (\text{No. of studies authors say YES} + \text{No. of studies both authos say NO})/N$$

$$P(E) = (\text{No. of studies author1 say YES}/N)*(\text{No. of studies author2 say YES}/N) + (\text{No. of studies author1 say NO}/N)*(\text{No. of studies author2 say NO}/N)$$

The Kappa statistic was calculated for selected studies based on detailed inclusion criteria, full text separately. Results are shown in Table 3-5.

Table 3-5. Calculated Kappa Coefficient

Studies Based on	Author 1	Author 2	Calculated Kappa Value		
			P(A)	P(B)	κ
Detailed inclusion Criteria	80	75	1.131	1.139	0.01
Full Text	20	23	1.069	0.37	0.124

3.2.4 Selected Articles

Total number of identified primary studies for our systematic literature review, are 21 articles (16 from database search and 5 from manual search) as per shown in table 3-6. The final list of articles included in our study from electronic and manual search is shown in Table 3-7.

Table 3-6. Articles Selected from Databases and Manual Search

Search	No: of Article	Primary studies
Databases	16	[S1] [S2] [S4] [S6] [S8] [S9] [S10] [S11] [S12] [S14] [S15] [S16] [S17] [S19] [S20] [S21]
Manual Search	5	[S3] [S5] [S7] [S13] [S18]
Total	21	

Table 3-7. List of Articles Included for Primary Studies

Study #	Title
S1	B.E. Munkvold and I. Zigurs, "Process and technology challenges inswift-starting virtual teams," *Information & Management*, vol. 44, Apr. 2007, pp. 287-299.
S2	A. Begel, N. Nagappan, C. Poile, and L. Layman, "Coordination in large-scale software teams," *Proceedings of the 2009 ICSE Workshop on Cooperative and Human Aspects on Software Engineering*, Washington, DC, USA: IEEE Computer Society, 2009, pp. 1–7.
S3	A. Taweel, B. Delaney, T. Arvanitis, and Lei Zhao, "Communication, Knowledge and Co-ordination Management in Globally Distributed Software Development: Informed by a scientific Software Engineering Case Study," *Global Software Engineering, 2009. ICGSE 2009. Fourth IEEE International Conference on*, 2009, pp. 370-375.
S4	G.O. Wiredu, "A framework for the analysis of coordination in global software development," *Proceedings of the 2006 international workshop on Global software development for the practitioner*, New York, NY, USA: ACM, 2006, pp. 38–44.
S5	Suling Zhang, Marilyn Tremaine, Jerry Fjermestad, Allen Milewski, and Patrick O'Sullivan,

	"Delegation in Virtual Team: the Moderating Effects of Team Maturity and Team Distance," *Global Software Engineering, 2006. ICGSE '06. International Conference on*, 2006, pp. 62-68.
S6	D.K. Mak and P.B. Kruchten, "NextMove: A framework for distributed task coordination," *2007 Australian Software Engineering Conference, ASWEC 2007 - Taming Complexity through Research and Practice, April 10, 2007 - April 13, 2007*, Melbourne, Australia: Inst. of Elec. and Elec. Eng. Computer Society, 2007, pp. 399-408.
S7	Helena Holmstrom, Eoin O Conchuir, Par J Agerfalk, and Brian Fitzgerald, "Global Software Development Challenges: A Case Study on Temporal, Geographical and Socio-Cultural Distance," *Global Software Engineering, 2006. ICGSE '06. International Conference on*, 2006, pp. 3-11.
S8	J.C. Tang, C. Zhao, X. Cao, and K. Inkpen, "Your time zone or mine?: a study of globally time zone-shifted collaboration," *Proceedings of the ACM 2011 conference on Computer supported cooperative work*, New York, NY, USA: ACM, 2011, pp. 235–244.
S9	V. Casey, "Leveraging or Exploiting Cultural Difference?," *Global Software Engineering, 2009. ICGSE 2009. Fourth IEEE International Conference on*, 2009, pp. 8-17.
S10	M. Cataldo and J.D. Herbsleb, "Communication networks in geographically distributed software development," *Proceedings of the 2008 ACM conference on Computer supported cooperative work*, New York, NY, USA: ACM, 2008, pp. 579–588.
S11	F. Serce, R. Brazile, K. Swigger, G. Dafoulas, F. Alpaslan, and V. Lopez, "Interaction patterns among global software development learning teams," *Collaborative Technologies and Systems, 2009. CTS '09. International Symposium on*, 2009, pp. 123-130.
S12	J.D. Herbsleb, A. Mockus, T.A. Finholt, and R.E. Grinter, "Distance, dependencies, and delay in a global collaboration," *Proceedings of the 2000 ACM conference on Computer supported cooperative work*, New York, NY, USA: ACM, 2000, pp. 319–328.
S13	F. Serce, F. Alpaslan, K. Swigger, R. Brazile, G. Dafoulas, V. Lopez, and R. Schumacker, "Exploring Collaboration Patterns among Global Software Development Teams," *Global Software Engineering, 2009. ICGSE 2009. Fourth IEEE International Conference on*, 2009, pp. 61-70.
S14	M.R. Thissen, J.M. Page, M.C. Bharathi, and T.L. Austin, "Communication tools for distributed software development teams," *Proceedings of the 2007 ACM SIGMIS CPR conference on Computer personnel research: The global information technology workforce*, New York, NY, USA: ACM, 2007, pp. 28–35.
S15	F.C. Sere, K. Swigger, F.N. Alpaslan, R. Brazile, G. Dafoulas, and V. Lopez, "Online collaboration: Collaborative behavior patterns and factors affecting globally distributed team performance," *Computers in Human Behavior*, vol. 27, 2011, pp. 490-503.
S16	R. Czekster, P. Fernandes, A. Sales, and T. Webber, "Analytical Modeling of Software Development Teams in Globally Distributed Projects," *Global Software Engineering (ICGSE), 2010 5th IEEE International Conference on*, 2010, pp. 287-296.
S17	J.A. Espinosa and E. Carmel, "The impact of time separation on coordination in global software teams: A conceptual foundation," *Software Process Improvement and Practice*, vol. 8, 2003, pp. 249-266.
S18	B. Lings, B. Lundell, P. Agerfalk, and B. Fitzgerald, "A reference model for successful Distributed Development of Software Systems," *Global Software Engineering, 2007. ICGSE 2007. Second IEEE International Conference on*, 2007, pp. 130-139.
S19	H. Pichler, "Be successful, take a hostage or "outsourcing the outsourcing Manager"," *Global Software Engineering, 2007. ICGSE 2007. Second IEEE International Conference on*, 2007, pp. 156-161.
S20	T.A.B. Pereira, V.S. dos Santos, B.L. Ribeiro, and G. Elias, "A recommendation framework for allocating global software teams in software product line projects," *Proceedings of the 2nd International Workshop on Recommendation Systems for Software Engineering*, New York, NY, USA: ACM, 2010, pp. 36–40.
S21	K. Swigger, F. Nur Aplaslan, V. Lopez, R. Brazile, G. Dafoulas, and F.C.Serce, "Structural factors that affect global software development learning team performance," *Proceedings of the special interest group on management information system's 47th annual conference on Computer personnel research*, New York, NY, USA: ACM, 2009, pp. 187–196.

3.2.5 Study quality assessment

Each study has been assessed through quality criteria provided in Table 3-4 individually. Results have been cross matched later. The conflict in opinion or data has been removed through a consensus. Our supervisor is a renowned researcher in global software engineering and her opinion had made a real difference. Quality assessment criteria for study selection are addressed in Table 4, where some criteria have been extracted from [55]. Quality criteria (1-4) in Table 3-4 have been applied on each study. Other criteria (5-8) are based on study nature for example, whether it is describing a framework or evaluating team effectiveness.

3.2.6 Data extraction

In this phase, data extraction forms were designed and piloted after the finalization of review protocol and the purpose of these forms was to document and gather the extracted data from the primary studies. This assisted reader in extracting the relevant data from the primary study and reduced the chances of any biased behaviour. All the extracted data was dually cross-checked in order to minimize the chances of missing any important information.

3.2.7 Data Analysis

We performed thematic analysis in six phases namely familiarizing our self with our data, generating initial codes, initial thematic mapping, developing thematic mapping, final thematic mapping and producing the report [44]. In first phase we familiarized with data by immersing ourselves through searching and reading for meanings and patterns of the data. We read thoroughly the entire data for getting ideas and identifying possible patterns before we began to code. Initially we collected list of ideas about what data consists of and what is interesting about that data.

We identified two possible patterns such as problems and roles and responsibilities. We extracted the text from primary studies which seemed interesting to us (you can find textual description from table 3-8 in the column "text extract from primary studies"). In second phase, after getting idea on the collected data, we identified the codes for each list in the data. We performed manual coding to identify particular feature of the data set. We coded individual extracts of data. This coding process is essential for organizing the data into meaningful groups.

Table 3-8 presents the textual description, identified code, identified rule and the rule description. Table A in Appendix A presents complete list of identified problems (codes) and identified rules.

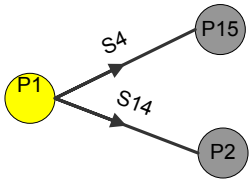
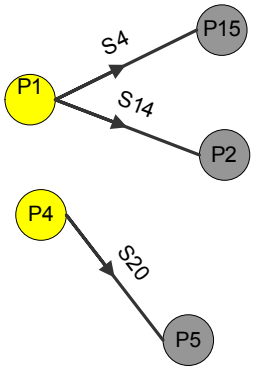
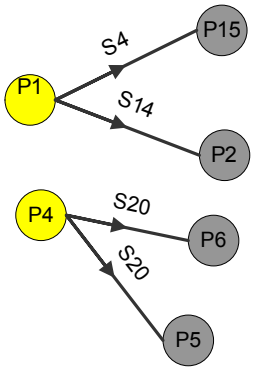
Table 3-8. Data Extraction Example

Text Extracted from Primary Studies	Problems Coded	Identified Rule	Rule Description
We often experience minor language problems, especially when vocabulary is limited to technical subjects…even going out at night with them [non-native English speakers], conversation can revert back to technical subjects because of their limited vocabulary". Language and vocabulary itself is not the main problem but rather the interpretation of what is said. Language problems as the primary reason for – if not conflict – but misunderstandings.	-Language difference -misunderstanding	Language difference → + misunderstanding	Language difference increases misunderstanding among teams
"Teams did not succeed in developing trust, but instead struggled with polarization among subgroups at each location. Teams regarded the lack of an initial face-to-face meeting as a major cause for lack of development of trust" .	-Lack of face-to-face meeting -Lack of trust	Lack of face-to-face meeting→ +lack of trust	Lack of face to face meeting increase lack of trust

In third phase (initial thematic mapping) after all the data is coded and collated, we have long list of codes that are identified across data set. Here after analyzing the codes, different codes are combined to form an overarching theme. In initial thematic mapping, codes which are related to problems are placed under a theme named as "chains of problems" (Table 3-12) and also codes related to roles or responsibilities are coded under the theme „roles and responsibilities" (Table B in Appendix A). One of our research questions is to find the ineffectiveness of teams in GSD based on these identified problems. So, from one of our research questions we captured „team ineffectiveness" as a theme which is linked to the identified problems in terms of team ineffectiveness.

The interoperated themes are clearly linked back to our research question, but each in distinct way. In this phase, we also identified chains of problems that influence each other. Chains of problems are based on rules. Table 3-9 describe steps for conducting chain of problems using rules. The chains of problems (Figure 3-3) have been formed by including different rules one by one. We added a new rule in the previous rule in each step and developed the graph (chain of problems). This graph consists of nodes (problems) which can have predecessor, successor or both. This chain of problems has been explained in detail in section 4.1.1.

Table 3-9. Steps to Form a Graph for Chains of Problems

Steps	Rule	Chains of Problems
Step 1 (Rule1)	!(knowledge management) → + interaction barrier, + communication problem	
Step 2 (Rule1 + Rule2)	(high degree of dependency of task → + communication overhead	
Step 3 (Rule1 + Rule2 + Rule3)	(high degree of dependency of task → + project failure risk	

In fourth phase (developing of thematic mapping) after coding the appropriate codes to the themes, we started developing the mapping between the themes. We

inducted the themes „roles and responsibilities" and „team effectiveness" with chains of problems. The theme roles and responsibilities are linked with the nodes of the graph .This link is supported from systematic review and the theme team effectiveness is linked with nodes having no successor. Because the chain of problems starts with one problem and ends with node which has no successor. So team effectiveness is linked to nodes with no successor and this link is supported by team effectiveness from "Big five" of teamwork [28].

In fifth phase of thematic analysis, a final thematic mapping is provided in the form of frame work. This frame work consists of three modules as shown in Figure 3-3.

Figure 3-3. Framework Structure

The first module based on suggestions, which has been extracted from SLR, in term of roles and responsibilities and presented in section 4.2. These suggestions are related with chains of problems. These suggestions are particularly made in order to solve the chain of problems. Table B in Appendix A represents the textual data from primary studies which have been used to extract suggested roles and responsibilities. Table B in Appendix also presented the mapping between extracted roles and responsibilities and identified problem, presented in Table 3-9. Second module of the framework is chain of problems. These chains of problems are related to team ineffectiveness, which is third module in framework. This final thematic mapping appears in tabular form such as Table 3-12.

Final step of thematic analysis is about writing of the report with sufficient evidence of the themes within the data.

3.3 Reporting the Review

3.3.1 Quantitative Results

In quantitative analysis, the results of number of primary studies selected, publication year, and research methodology are represented as statistical data in a numerical form.

3.3.1.1 Primary Studies Selection

IEEE Xplore, ACM Digital Library, Engineering Village, Science direct, Springer Link, and ICGSE were searched by the authors to select primary studies. We selected 3 studies from IEEE, 7 studies from ACM, 4 from Engineering village, 2 studies from science direct and 5 studies from ICGSE. We included Springer link even we did not find any primary study from this database. We followed the review protocol addressed in our study. Figure 3-4 represents the databases together with number of studies found

in it.

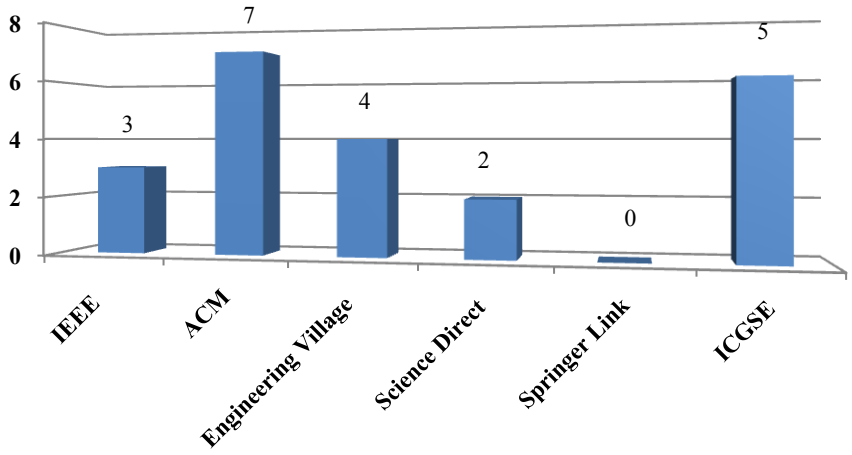


Figure 3-4. Primary Studies with Respect to Databases

3.3.1.2 Publication Year

A total of 21 papers, published till the time of search i.e. March 2011, are found relevant to the research field are represented in figure. All these studies addressing communication, coordination, collaboration issues in globally distributed projects. It has clear evidence that not much research was done in global software development before 21st century [62]. If we see the Figure 3-5, in 2000, very less research is conducted in this field and again from 2004 there is a gradual increase in research i.e. 90% of published papers are between 2006-2011. Note that the statistics for 2011 incomplete since the search was conducted in March 2011.

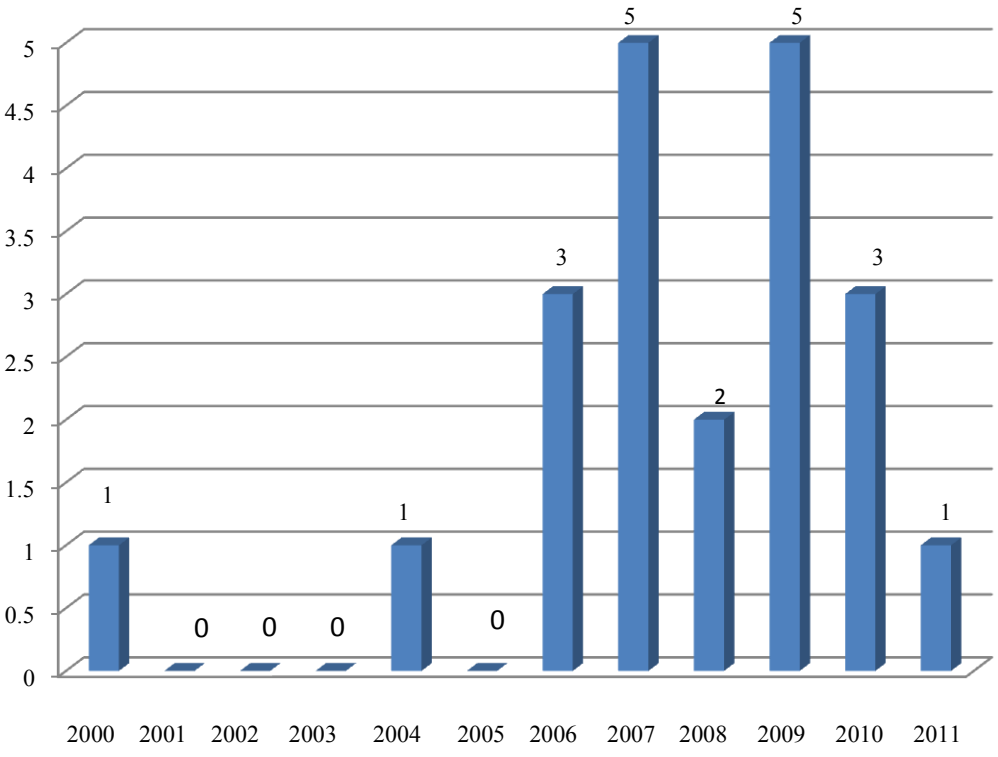


Figure 3-5. Primary Studies with Respect to Publication Year

3.3.1.3 Research Methodology

A summary of research methods employed in selected primary studies are shown in Figure 3-6. We classified research methodologies of primary studies based on qualitative, quantitative and mixed methods. Out of 21 selected primary studies, 49% of studies proposed models for distributed teams based on various resources availability, team‟s expertise and support levels, in order to have good communication, coordination and collaboration. Some models also addresses team member‟s experiences and more complex tasks in distributed project development. 28% of the studies used case study as their main research method, 9% of studies employed interviews as research method and 14% studies used experiment. Some studies used laboratory and industrial experiments for conducting their research, only 5% of the studied used surveys as their research methodology in our primary studies.

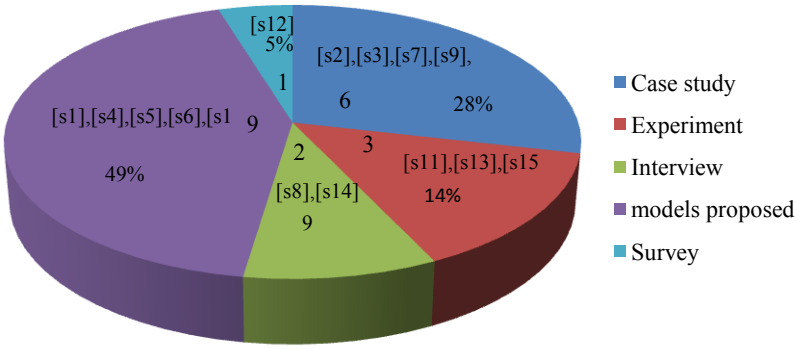


Figure 3-6. Primary Studies with Respect to Research Methods

3.3.1.4 Quality of Primary Studies

Results of quality assessment are presented in Table 3-10. Here Y represents yes and it satisfies mentioned quality criteria and N represents that it does not satisfying given criteria.

Table 3-10. Results of Quality Assessment Criteria

Study ID	Quality criteria assessment								
	QC1	QC2	QC3	QC4	QC5	QC6	QC7	QC8	Score
S1	Y	Y	Y	N	Y	Y	N	Y	6
S2	Y	Y	Y	N	Y	Y	N	N	5
S3	Y	Y	Y	N	Y	Y	Y	N	6
S4	Y	N	Y	Y	N	N	Y	N	4
S5	Y	N	Y	N	Y	Y	Y	N	5
S6	Y	N	Y	N	N	N	N	N	2
S7	Y	Y	Y	N	N	N	Y	N	4
S8	Y	Y	Y	N	N	N	Y	N	4
S9	Y	Y	Y	N	N	N	Y	N	4
S10	Y	Y	Y	Y	N	N	Y	N	5
S11	Y	Y	Y	Y	Y	Y	N	N	6
S12	Y	Y	Y	N	N	N	N	N	3
S13	Y	Y	Y	N	Y	Y	N	N	5
S14	Y	Y	Y	N	N	N	Y	N	4
S15	Y	Y	Y	N	Y	Y	Y	N	6
S16	Y	N	Y	N	Y	Y	Y	N	5
S17	Y	Y	N	Y	Y	Y	Y	Y	7
S18	Y	Y	Y	N	N	N	N	N	3
S19	Y	Y	Y	N	N	N	Y	N	4

S20	Y	Y	N	N	N	N	N	N	2
S21	Y	Y	Y	Y	Y	Y	N	N	6

Mapping of studies to their respective quality groups is shown in Table 3-11 below.

Table 3-11. Mapping of Studies Quality Groups

Quality group	Studies
High Quality	S1, S2, S3, S5, S10, S11, S13, S15, S16, S17, S21,
Average Quality	S4, S7, S8, S9, S12, S14, S18, S19
Low Quality	S6, S20

If a particular study has quality assessment with 5 or more Y (yes) then it is considered as study with high quality. A study that satisfies criteria for more than 5 Y‟s grouped as high quality. A study which satisfies criteria between 2 and 4 Y‟s (yes) are grouped under average quality and studies with less than or equal to 2 Y‟s (yes) are grouped into low quality. Studies S6, S20 are included even thought they are low quality because these fulfils our basic inclusion criteria. It was suggested in NHMRC [63] that, the inclusion of low quality studies neither adjusts nor removes the bias of studies.

3.3.2 Qualitative Results

Through qualitative analysis, we have identified different problems and dependencies among them that can be related to GSD in term of team‟s ineffectiveness. We have also identified different roles and responsibilities that can mitigate these problems. Following sections describe problems, dependencies between them and suggested roles and responsibilities as part of the qualitative result of SLR.

3.3.2.1 Problems and Casual Dependencies among them

Together with the assumed benefits of GSD, project managers are facing different problems that are related to team‟s ineffectiveness which further can increase the risk of project failure. During the analysis of SLR, we have not only identified the problems but we have also observed that there is a casual relationship between problems. In our study one problem (P1) leads to some other problem (P2), but itself this problem (P1) caused by another different problem (P3). For example, misunderstanding in GSD teams, which has been appeared 7 times in our primary studies, leads to communication problem (Table A in Appendix A) but misunderstanding itself causes by many other problems such as lack of face to face meeting or less collaboration (Table A in Appendix A). This example led us identify different casual dependencies between problems.

Table A in Appendix A presents the textual description extracted from primary studies, together with identified problems, its coding, study reference number and Rules (way to document casual dependencies). The method for identifying casual dependencies and problems has been presented in section 3.2.7.

This section describes the problems, and the casual dependencies between them. The identified problems together with the number of times, it appeared in primary studies, has been presented in Figure 3-7. As seen in Figure 3-7, „misunderstanding“ has been mentioned 7 times in our primary studies with communication infrastructure appearing 6 times. The problems are labelled with P1, P2 etc. and presented in Table 3-12.

3.3.2.1.1 Misunderstanding

Due to different level or gaps of communication between different disciplines, misunderstandings are caused. Misunderstandings reduce frequent interactive communication and longer collaboration [S7]. In society when individuals from masculine and feminine work together at the organizational level the difference in focus can lead to misunderstandings. The negative impact on the productivity of the virtual teams is created by misunderstanding which was due to lack of clear information on each one's culture difference though it was easy to understand how and why actions and issues were misinterpreted [S9].

3.3.2.1.2 Communication Infrastructure

Communication deals with the flow of information among teams and across sites, involving key roles that participate in this information flow [64]. Individual in a core perform critical communication role as well as they are top contributor in GSD [64]. Thissen et al. in [S14] describes communication tools. This study also summarizes the tools for distance communication and informational exchange. Thissen et al. in [S10] concludes that teams should be allowed to choose their own communication tool from a variety of option.

Researchers in [S2] [S3] described communication as a major part as well as hurdle of/in GSD. There are two types of communication: asynchronous and synchronous. There is a close relationship between time separation and synchronous/asynchronous which has been explained in [S17]. The article describe asynchronous as: “teams instil better practices in their non-overlapping work times to compensate for the lack of common work hour” and synchronous as “teams plan for the existing synchronous overlap time and/or enlarge the windows of synchronous (overlapping) times”.

Many researchers have studied professional software development teams empirically in order to gain greater understanding of how software development processes, tools, and people impact coordination [S2]. Tools those are best suitable for software developers may not be appropriate for program managers [S2]. It is very important to select an appropriate tool for coordination in GSD. Through proper tool selection, teams can coordinate their tasks, and increases project transparency by providing timely and relevant information [S6].

Table 3-12. Problems in GSD

Problems	#
Lack of knowledge management	P1
Interaction barrier	P2
Communication problem	P3
High degree of dependency of task	P4
Communication overhead	P5
Project failure risk	P6
Communication infrastructure	P7
Quality of collaboration	P8
Conflict	P9
Difficulty to handle interdependencies	P10
Lack of trust	P11
Less collaboration	P12
Misunderstanding	P13
Lack of face-to-face meeting	P14
Coordination problems	P15
Lack of early decision making or management	P16
Lack of frequent communication	P17
Development rework	P18
Lack of mature team	P19
Lack of clear procedures and processes	P20
Lack of modular approach	P21
Lack of site visit	P22

Language difference	P23
Time zone difference	P24
Delay in response	P25
Cultural difference	P26
Collaboration problems	P27
Delay in resolving of work issue	P28
Lack of cultural training	P29
Delay in project	P30

3.3.2.1.3 Lack of Trust

Lack of initial face to face meetings is the main reason for lack of development of trust [S18]. It is hard to develop trust between participators who doesn't know each other. Trust is something which can be gained by doing things right. Once trust is lost in the early stage among the team members, it will be really hard to regain it [S1].

3.3.2.1.4 Lack of Face-to-Face Meeting

Lack of face-to-face meeting at initial level or during the project execution has been marked a major factor. Requests raised by the person from another team are often not clear, which further requires an additional communication for clarification that cause delay in whole process [S6, S11, S17]. This clarification may be nearly instantaneous when team members are working face-to-face [S17]. Keeping track of face-to-face meeting and encouraging it increase trust and productivity of team [S11, S17].

3.3.2.1.5 Project Failure Risk

Risk is not problem it is recognition of problems before it occur in the project. Distribution of project knowledge, communication, and coordination of project is difficult in global software development [S6]. Risk in project can be lowered through mature team and having clear processes and processes [S18]

3.3.2.1.6 High Degree of Dependency of Task

The central part of coordination is process interdependencies [S4]. Many authors have approached interdependence from a different perspective, but its fundamental representation of a mutual relationship between two entities in an organising effort still holds true [S4]. It is a continuous variable, and it is recommend understanding its degrees and variations in degrees over the course of a distributed activity must be taken into account in analysis [S4]. Interdependencies are managed by four attributes what (management actions), how (methods), where (locations of actions), when (times of actions), and under what circumstance (contexts) [S4].

3.3.2.1.7 Communication Overhead

When there is a high interdependency among modules of the projects, automatically the need for communication between the work groups increases. Discrete functional parts are partitioned in order to reduce dependencies across the sites, which in turn reduce communication overhead [S18]. And also by reducing the technical interdependencies among modules, communication overhead can be reduced between teams [S10, S14].

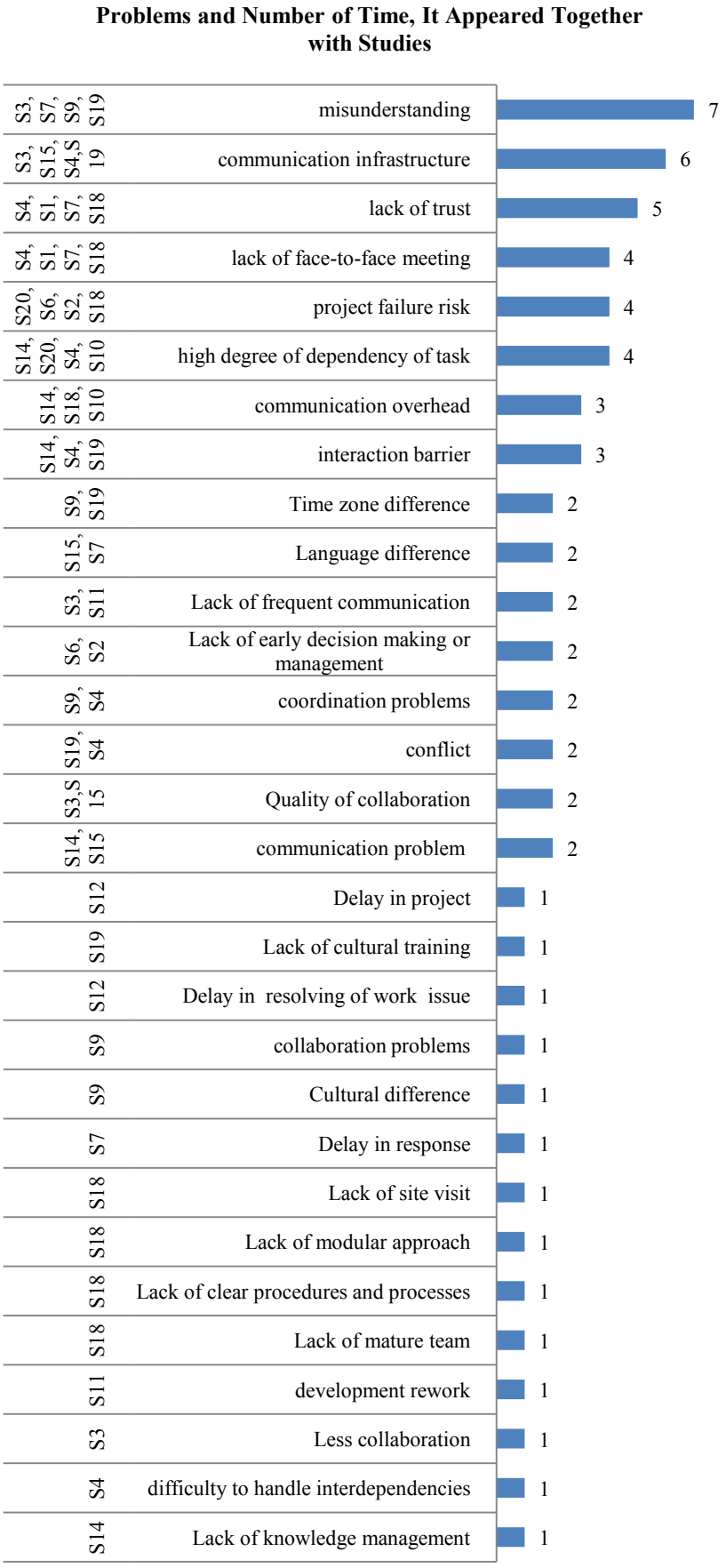


Figure 3-7. Problems Identified together with its Count

3.3.2.1.8 Interaction Barrier

Interactions between teams are considered as one of the dominant process in software development. Interaction barrier occurs due to lack of knowledge management and lack of communication [S4, S14]. Interactions between teams can be increased through face to face meetings in order to have rich flow of information [S4]. Due to time zone difference it is difficult to interact in global development [S19]. Interactions between the groups can be increased by using asynchronous tools. Through this asynchronous communication behaviour team performance increases [S17].

3.3.2.1.9 Different Time zones

The measure of dislocation in time experienced by two actors wishing to interact is called temporal difference [S7]. Temporal difference is not only defined by the difference in time between two sites, but it also includes the time shifting work patterns which can further reduce the opportunities for real time collaboration and increase the delay in response because of working hours of locations do not overlap [S7]. This time zone difference together with time shifting work pattern can either increase or decrease temporal distance. The synchronization of working hour overlap is very important between sites in order to achieve good communication and coordination between them. The time zone difference is not just about overlapping the working hour; it includes many other factors which are mentioned in Table 3-13.

Table 3-13. Types of Time Difference (bases on [S17])

- Time zone difference
- Workday differences (i.e. start and ending times of workday)
- Weekend differences (i.e. weekend days vary)
- Holiday Differences (i.e. religious and national holidays vary)
- Lunch and other break hours (i.e. American break for lunch is earlier than many other cultures)

These types of time difference can appear to be the minor things but it really makes a big difference in order to get development teams synchronized. Weekend is on different days in different countries of the world. The weekend days in Arab countries are Friday and Saturday whereas many countries have Saturday and Sunday as a weekend. Each country has different religious and national holidays and same in the case of lunch and break hours. These are the few factors that need to be kept in mind in order to get teams synchronized and avail real time collaboration and interaction windows.

3.3.2.1.10 Language Difference

Language is one of the major factors which impact both the type and amount of communication between different countries [65]. Speaking of different languages create misunderstandings, conflicts and confusion between team members.

3.3.2.1.11 Lack of Frequent Communication

The inability of team members not having frequent communication and coordinate leads to delay, ambiguity in understandings between team members, ill-defined requirements and the repetition of development effort are the main problems [S3].

3.3.2.1.12 Lack of Earlier Project Decision Making / management

The importance of early management of coordination, communication and knowledge management is very critical for GSD projects [S3]. In order to avoid conflicts and increase response, it is essential that a consistent, autonomous, PM strategies is developed and followed early in the project [S3]. GSD requires production schedule to be synchronized and task coordinated, which creates dependencies not just among task but also people [S3]. These things should be done before the project start actually in order to avoid any hurdle which can stop execution of a project [S3].

3.3.2.1.13 Coordination Problems

In organisation research, coordination is a well know concept and one of the key challenge in GSD. Coordination between teams becomes difficult with increase in project size and complexity. Many researchers consider coordination problem in terms "management of task interdependencies, managing information uncertainties and equivocalties, interpersonal and interunit conflict management, design and utility of technology and technology representations" [S4]. It is difficult to understand to coordination problems in any domain without knowing the phenomena for being coordinated.

3.3.2.1.14 Conflict

Conflict is integral problem in coordination which requires its resolution immediately [S4]. GSD teams subsequently engender conflicts with corollaries on interdependent relations [S4] . Conflict resolution, if not handled properly, can lead to failure of project as well as the team would not be able to work again on any project.

3.3.2.1.15 Quality of Collaboration

In globally distributed teams quality of collaboration is related to the modes of communication, task type, and levels of leadership [S15]. Task type is a factor which can affect the type of communication behaviours that occur within a team. Some task types requires collaboration at being of the project and some requires at the end of the project, these type of task features affect the amount and kind of collaboration between team members. A synchronous and asynchronous communication mode offers different capabilities for facilitating collaboration between teams [S15].

3.3.2.1.16 Communication problems

Effective communication is one of the biggest challenges in global software development. Difference language adds another level of complexity for communication [S19]. Due to the lack of communication between distributed teams, team knowledge does not develop as rich [S3]. Communication is negatively impacted due to geographical, temporal, linguistic and cultural distance. Culture is considered as communication and communication is separated into main three elements words, material things and behaviour [S3].

3.3.2.1.17 Delay in Project

Delays in resolving work issues automatically slow development of project considerably. Due to interdependencies between the cross sites increasing, there is delay in project [S12]. Delay can be avoided using richer communication tools like audio or video in need of urgency.

3.3.2.1.18 Lack of Culture Training

Training in cultural issues is useful [S18]. Cultural training at initial level increase trust among group members and encourage members to coordinate with each other.

3.3.2.1.19 Delay in Resolving of Work Issue

Delay is considered as time taken to resolve an issue [S12]. Delay in resolving work issues occur due to distance and interdependencies between the sites [S12]. Distance reduces communication and collaboration between sites. When there is no proper communication automatically it leads to delay in solving the issues of work [S12].

3.3.2.1.20 Collaboration Problems

Collaboration between teams is mainly affected due to cultural difference [S9]. Due to temporal distance which occurs due time zone difference also, reduce collaboration with team members in other sites [S12]. Variety of collaboration tools like instant messaging, chat, video call etc. are provided for improving cross site collaboration [S1].

3.3.2.1.21 Culture difference

The measurement of understanding of one person towards other actor"s values and normative practices is called socio-culture distance [S7]. The term socio-cultural or cultural difference means the same. GSD involves different people from different parts of the world which creates substantial amount of problems. Culture affects people, their behavior and it has a large impact on people that lead them to behave in a certain way to specific situations. There are many studies (for example,[S3, S11, S13]) describing culture as a major problem in GSD that can play a vital role in delay in time to market, and even in the failure of a project. Casey in [65] discussed a case study conducted in three sites including Malaysia, Ireland and Israel. He mentioned the culture as "socially derived, taken for granted assumptions about how to act and think". Furthermore, "culture remains blow in every day consciousness and only becomes obvious when it is contrasted with different culture norms" [65].

3.3.2.1.22 Delay in Response

Delay of responses causes problems and frustration for individuals working in the different projects. There is chance of losing track of overall work process due to delay in response [S7].

3.3.2.1.23 Lack of Site Visit

The manger visit to another site creates mutual trust among members and higher authority which lead to maturity of team [S18]. The fear of being left back increases if manger does not visit to sites which can turn into less productive team.

3.3.2.1.24 Lack of Modularization Approach

The adoption of this mechanism makes development independently with few interactions [S3]. All GSD projects have strict requirements and are large enough to modularise and amenable to splitting into appropriate units of work (not too large or small) [S18]. Modularization approach reduces feature dependency across sites, reducing the need of communication, such as twice in a week [S18]. These units (work of packaged) reduces the need for coordination either not too small or not to large enough to frustrate [S18]. "Ownership" of largely independent work packets is handed over to a remote site, rather than breaking packages down further [S18].

3.3.2.1.25 Lack of clear procedure and process

Distribution risk can be lowered for project by ensuring 1) mature team and 2) clear procedure and processes [S18]. Clear process and procedure increase transparency within organization which can improve team productivity.

3.3.2.1.26 Lack of Mature Team

Zhang et al. in [S10] have investigated delegation practices for global software teams. This study has discussed the reason behind the less effectiveness of the software team and recommending project managers to avoid conflicting roles within teams for better effectiveness. There are many factors that influence the outcomes of teams such as follower maturity, group development [65], and team reality [65]. Of these factors, individual and team maturity may be the most common and critical general factor for team success.

Zhang et al. in [S10] measured three dimensions of team maturity such as: team technical competency, team motivation and virtual team skills (ability to work in distributed environment).

3.3.2.1.27 Development Rework

Locating a skilled person for the task, which has strength required for developing the specific task, will reduce the chance for development rework [S6]. Addition to this communication problem can lead misunderstanding which further increases the chance of development rework [S11]. A well synchronized team reduces the probability of development rework.

3.3.2.1.28 Less Collaboration

Less collaboration increases misunderstanding between teams that further lead to increase in project failure risk [S3]. Proper use of collaboration tool makes team comfortable in collaborating with each other that has a positive impact on GSD teams [S18]. Longer collaboration keep GSD team synchronized and increase trust among them.

3.3.2.1.29 Difficult to Handle Interdependencies

Higher degree of dependency between tasks requires additional overhead of communication and coordination [S3]. Technology representation are mutually interrelates with interdependencies [S3]. Personal visits, frequent emails between teams reduce difficulty to handle interdependencies [S18].

3.3.2.1.30 Lack of Knowledge Management

Knowledge management in GSD is equally important as communication, coordination and control. It helps attain the potential benefits of collaboration [S3]. It has been recommended for having all project members in the weekly coordination meeting in order to maintain the shared team knowledge across the project members [S3]. If there is the lack of the availability of the shared team knowledge means that team members working on dependent components could not take, in some cases, simple decisions to progress the development unless they receive a response from other teams, or the project manager [S3]. Sharing knowledge is a contributing behaviour which can assist teams to get higher performance [65]. Key issue for higher collaboration in GSD is effective knowledge networking in sites. The teams in other locations have little or no knowledge about specific domain of project [S19].

Table 3-14 describes the rules for casual dependencies. These rules have been extracted from Table A in Appendix A. These rules represent the initial level dependencies where section 3.3.2.2 describes higher level dependencies. These rules are very important and further form different chains of problems. We will call these higher level causal dependencies in this study as chains of problems. We have suggested roles and responsibilities for these different chains of problems. These chains of problems have been related with GSD team‟s ineffectiveness.

Table 3-14. Casual Dependencies Between Problems (Rules)

Study #	Rule
S14	!(knowledge management) → + interaction barrier, + communication problem
S14	high degree of dependency of task → + communication overhead
S20	(high degree of dependency of task → + project failure risk
S3,S15	!(communication infrastructure) → - Quality of collaboration
S4	!(communication infrastructure) → +conflict, +difficulty to handle interdependencies, + ack of trust
S3	!(communication infrastructure) && (Less collaboration) → + misunderstanding
S4	!(face-to-face meeting) → + Interaction barrier
S1, S7	!(Face-to-face meeting) → + lack of trust
S7	!(Face-to-face meeting) → + misunderstanding
S4	(high degree of dependency of task) && !(communication infrastructure) && (lack of trusts) && (misunderstanding) → +coordination problems
S6, S2	!(Early decision making or management) → + project failure risk
S3	!(frequent communication) → + misunderstanding
S11	!(frequent communication) → + development rework
S18	!(mature team) && !(clear procedure and process) → + project failure risk
S18	!(modular approach) → +communication overhead
S10	High degree of dependency of task → + communication overhead
S18	!(site visit) || !(face-to-face meeting) → + lack of trust
S7	Language difference→ +misunderstanding
S15	Language difference→ +communication problems
S7, S8	Time zone difference→ + delay of response
S9	Cultural difference → + collaboration problems, + coordination problems, +misunderstanding
S12	Delay in resolving of work → + delay in project
S19	!(communication infrastructure) & (time zone difference) → + interaction barrier
S19	!(Cultural training) → + misunderstanding, + conflicts

3.3.2.2 Chains of Problems that Indicates GSD Team's Ineffectiveness

This section describes the higher level of casual dependencies where problem can cause or can be caused by another problem. We call it chaining. We have developed several chains of problems to form a graph that have been related with the team‟s ineffectiveness. These chains of problems have been derived from primary studies. Figure 3-8 represents the chains of problems identified from primary studies. The way, we have developed the chains of problems has been described in section 3.2.7.

Problems have been linked with team effectiveness through "Big 5 in Team Work" which has been proposed in [28]. Section 3.2.7 describes how this link has been supported. Salas et al in [28] discussed "Big 5 in team work" consisting of team leadership, mutual performance monitoring, backup behaviour, adaptability and team orientation.

- **Team Leadership:** "Ability for directing and coordinating other team members‟ activities, assess team performance, assign tasks, develop team knowledge and skills, motivate team members, plan and organize, and establish a positive atmosphere" [28].
- **Mutual Performance Monitoring:** "ability to develop common understandings of the team environment and apply appropriate task strategies to accurately monitor teammate performance" [28].
- **Backup Behaviour**: "ability to anticipate other team members‟ needs through accurate knowledge about their responsibilities. Includes the ability to shift workload among members to achieve balance during high periods of workload or pressure" [28].

- **Adaptability**: “ability to adjust strategies based on information gathered from the environment through the use of backup behaviour and reallocation of intra-team resources” [28].
- **Team Orientation**: “propensity to take others‟ behaviour into account during group interaction and belief in importance of team goal over individual members‟ goals” [28].

Nodes having yellow colours are those problems that have no predecessor, for example these problems cause other problems. We call it a root problem. The nodes with gray colour are the caused problems that have been raised due to other problems and have many predecessors but have not successor. We call it as leaf problem. We have linked leaf problems with dimension of „big five in teamwork‟. For example problem such as P6, P25, P2, P3, P15, P8, P10, P9, P18, P27, P30 and P5 are leaf problems and have been linked with different dimension of „big 5 in team work‟ in order to identify team ineffectiveness. For example, consider leaf problem „project failure risk‟ (P6) which causes due to „high degree of dependency of tasks‟ (P4). This problem (P6) is linked with team leadership dimension of big five of teamwork which is improper directing or coordinating other team members So, we mapped this problem P6 with team leadership of big five.

Problems such as P1, P4, P16, P19, P20, P24, P22, P7, P14, P12, P17, P23, P29, P26, P28 and P21 are root problems that cause other problems. Through Figure 3-8, we can easily figure out different chains of problems and look at casual dependencies between them which have been linked directly to the team‟s effectiveness.

For example P1->P3 is one chain as shown in Figure 3-8 which has been extracted from the rule „! (Knowledge management) → + communication problem‟, and than related to „team leadership‟. The detailed process of developing these chains has been presented in section 3.2.7. We have identified 33 different chains of problems as shown in Table 4-1. These chains have been developed with close cooperation of both author of this study. There was a threat to miss a link between problems but this threat has been mitigated by following a step by step strategy as mention in section 3.2.7 and in Table 3-9. We have observed that the relationship between problems and team effectiveness is N: 1, there are many problems that can be linked with single dimension of team effectiveness

Roles and responsibilities have been suggested for these chains of problems in Section 4.

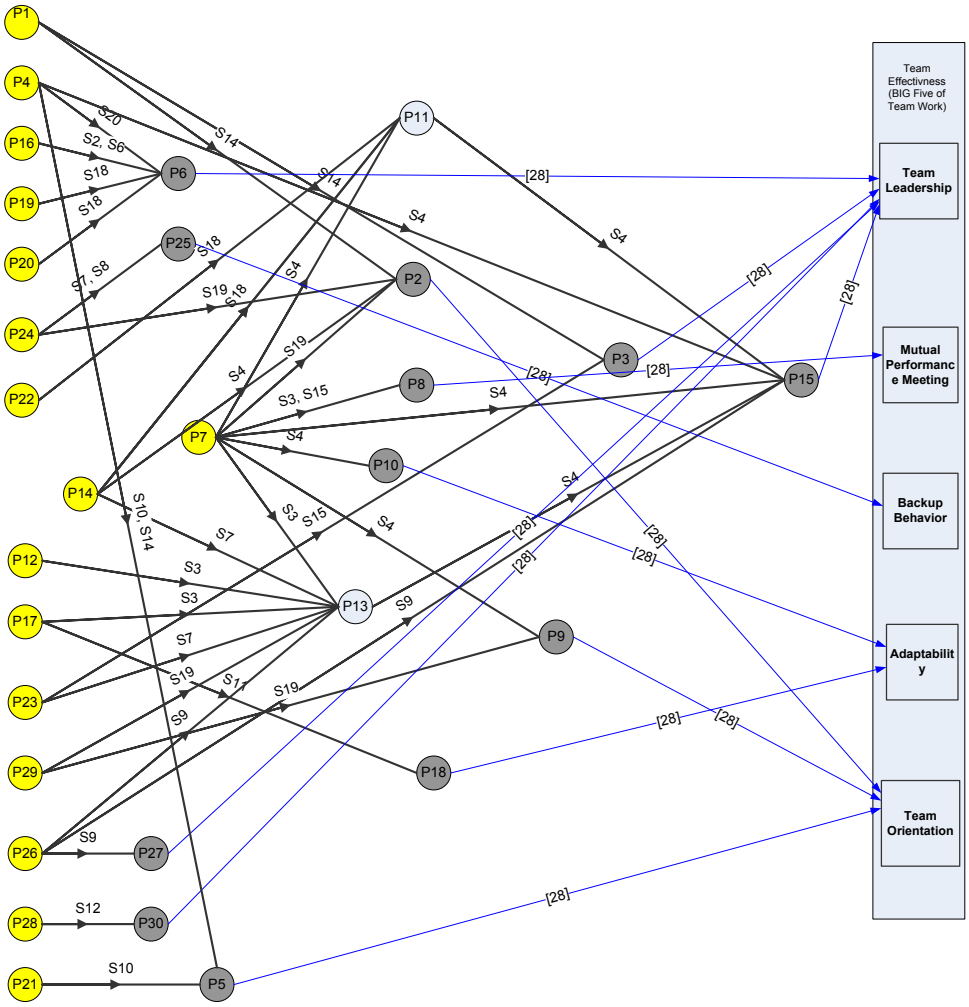


Figure 3-8. Problems Chains and their Relation with Team‟s Ineffectiveness

4 FRAMEWORK FOR SUGGESTING ROLES AND RESPONSIBILITIES

The framework has been based on chains of problems that indicate GSD team‟s ineffectiveness together with suggestions of roles and responsibilities. This framework can be used by the project manager, a team leader or any of the team members of GSD team. It defines the chains of problems that can assist project manager/team members in order to identify the source of particular problem and than they can also look for suggested roles and responsibilities from the framework in order to avoid that particular problem or chains of problems. We have developed chains of problems (section 3.3.2.2) and this section suggest roles and responsibilities for chains of problems. This framework is statically validated in industry in order to validate the links of suggestions to chains of problems and find our effective roles and responsibilities.

4.1 Suggestions Related to Roles and Responsibilities

Roles and responsibilities have been provided as suggestion for chains of problems that indicates GSD team‟s ineffectiveness. We have extracted 4 roles and 40 responsibilities from our primary studies and these limited numbers of roles lead us to consider roles and responsibilities separately. There are particular roles that have different responsibilities but we have extracted many responsibilities that are not bound with any particular roles. A represents roles as Role1, Role2, etc and responsibilities as R1, R2 and R3 etc. The method for coding roles and responsibilities has been provided in section 3.2.7.

As described earlier that roles and responsibilities are mapped with the chains of problems, Figure 4-1 presents clear visualization of these chains of problems together with respective roles and responsibilities. All the nodes, in Figure 4-1, are linked with corresponding suggestion (roles and responsibilities) on its left side of root node. We observed that roles are related to problems, not chains. There are cases where role is only suggested for a particular problem rather than chain of problems. For example if we look at chain P1->P3 (row number 1) in Table 4-1, we noticed that Role 1 is suggested for P1 and there is no role suggested in literature regarding P3. This is a reason to write problem number together with role for better understanding.

As shown in Table 4-1, this study is suggesting roles and responsibilities separately which are independent of each other. These responsibilities can be practiced by team leader or any member of the team.

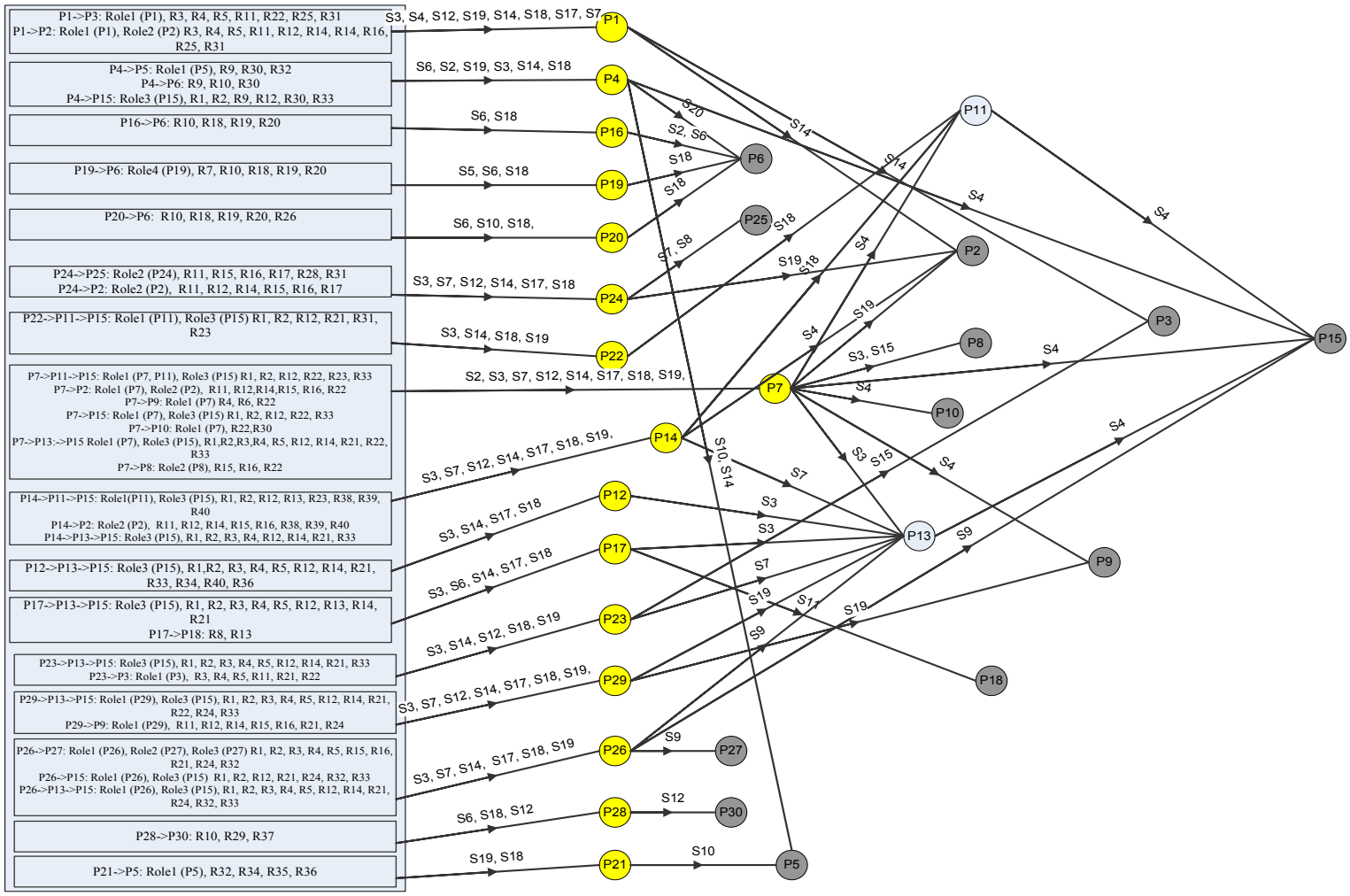


Figure 4-1. Suggested Roles and Responsibilities together with Chains of Problems

This Figure 4-1 has been mapped to Table 4-1. Table 4-1 describes the chains of problems and suggested roles and responsibilities with respect to individual problem of chains. For example the problem chain P1->P3 can be solved through the implementations of Role 1 and Responsibilities such as R3, R4, R5, R11, R22, R25 and R31.

Table 4-1. Framework (Tabular Form)

Sr. #	Suggestions			Chain of problems	Team Effectiveness
	Roles	Problems	Responsibilities		
1	Role 1 (P1)	P1	R3, R4, R5, R11, R25, R31	P1->P3	Team leadership
		P3	R3, R4, R5, R11, R22		
2	Role 1 (P1) Role 2 (P2)	P1	R3, R4, R5, R11, R25, R31	P1 ->P2	Team orientation
		P2	R11, R12, R14, R15, R16		
3	Role 1 (P5)	P4	R9, R30	P4->P5	Team leadership
		P5	R32,		
4	-	P4	R9, R30	P4->P6	Team orientation
		P6	R10		
5	Role 3 (P15)	P4	R9, R30	P4->P15	Team leadership
		P15	R1, R2 , R12, R33		
6	-	P16	R18, R19, R20	P16->P6	Team leadership
		P6	R10		
7	ROLE4 (P19)	P19	R7, R18, R19, R20,	P19->P6	Team leadership
		P6	R10		
8	-	P20	R18, R19, R20, R26	P20->P6	Team leadership
		P6	R10		
9	Role 2 (P24)	P24	R11, R15, R16, R17	P24->P25	Backup behavior
		P25	R11, R28, R31		
10	Role 2 (P2)	P24	R11, R15, R16, R17	P24->P2	Team orientation
		P2	R11, R12, R14, R15, R16		
11	Role1 (P11) Role3 (P15)	P22	R21, R31	P22->P11->P15	Team leadership
		P11	R23		
		P15	R1, R2, R12, R33		
12	Role1 (P11) Role3 (P15)	P14	R38, R39, R40	P14->P11-> P15	Team leadership
		P11	R23		
		P15	R1, R2, R12, R13		
13	Role 2 (P2)	P14	R38, R39, R40	P14->P2	Team orientation
		P2	R11, R12, R14, R15, R16		
14	Role3 (P15)	P14	R38, R39, R40	P14->P13-> P15	Team leadership
		P13	R3, R4, R14, R21		
		P15	R33, R12, R1, R2		
15	Role 3 (P15)	P12	R1, R2, R34, R35, R36	P12->P13->P15	Team leadership
		P13	R3, R4, R5, R14, R21		
		P15	R1, R2, R12, R33		
16	Role 3 (P15)	P17	R13	P17->P13->P15	Team leadership
		P13	R3, R4, R5, R14, R21		
		P15	R1, R2, R12, R33		
17	Role 3 (P15)	P23	R21	P23->P13->P15	Team leadership
		P13	R3, R4, R5, R14, R21		
		P15	R1, R2, R12, R33		
18	Role 1 (P3)	P23	R21	P23->P3	Team leadership
		P3	R3, R4, R5, R11, R22		
19	Role 3 (P15) Role 1(P29)	P29	R21, R24	P29->P13->P15	Team leadership
		P13	R3, R4, R5, R14, R22		
		P15	R33, R12, R1, R2		
20	Role 1 (P29)	P29	R21, R24	P29->P9	Team orientation
		P2	R11, R12, R14, R15, R16		
		P26	R21, R24, R32		
		P27	R1, R2, R3, R4, R5, R15, R16		
22	Role1 (P26) Role3 (P15)	P26	R21, R24, R32	P26->P15	Team leadership
		P15	R1, R2, R12, R33		
23	Role 1 P26) Role3 (P15)	P26	R21, R24, R32	P26->P13->P15	Team leadership
		P13	R3, R4, R5, R14, R21		

		P15	R1, R2, R12, R33		
24	-	P28	R37	P28->P30	Team leadership
		P30	R10, R29,		
25	Role 1 (P5)	P21	R34, R35, R36	P21->P5	Team orientation
		P5	R32		
26	-	P17	R13	P17->P18	Adaptability
		P18	R8		
27	Role1 (P7,P11) Role 3 (P15)	P7	R22	P7->P11->P15	Team leadership
		P11	R23		
		P15	R1, R2, R12, R33		
28	Role 1 (P7) Role 2 (P2)	P7	R22	P7->P2	Team orientation
		P2	R11, R12, R14, R15, R16		
29	Role1 (P7) Role 3 (P15)	P7	R22	P7->P15	Team leadership
		P15	R1, R2, R12, R33		
30	Role 1 (P7)	P7	R22	P7->P10	Adaptability
		P10	R30		
31	Role 2 (P8)	P7	R22	P7->P8	Mutual performance meeting
		P8	R15, R16		
32	Role1 (P7) Role 3 (P15)	P7	R22	P7->P13->P15	Team leadership
		P13	R3, R4, R5 R14, R21		
		P15	R1, R2, R12, R33		
33	Role1 (P7)	P7	R22	P7->P9	Team Orientation
		P9	R4, R6		

The next section describes the validation part of this framework. The link of suggested roles and responsibilities has been validated in industry.

4.2 Role Based Analysis

During the SLR, we have identified 4 roles, 40 responsibilities and validated it in 7 different organizations through survey. For this reason, we have provided role based analysis in Table 4-2 in order to show the clear picture. Table 4-2 represents the responsibilities and associated roles. We can see that there are many responsibilities that do not have any associated role. This limitation restricts the detailed role based analysis in this thesis.

Table 4-2. Role Based Analysis

Responsibilities	**Role1**	**Role2**	**Role3**	**Role4**	**No Role**
R1			X		
R2			X		
R3					X
R4					X
R5					X
R6					X
R7				X	
R8					X
R9					X
R10					X
R11					X
R12					X
R13					X
R14					X
R15		X			
R16					X
R17					X
R18					X
R19					X

R20					X
R21					X
R22	X				
R23	X				
R24	X				
R25	X				
R26					X
R27					X
R28					X
R29					X
R30					X
R31					X
R32	X				
R33			X		
R34					X
R35					X
R36					X
R37					X
R38					X
R39					X
R40					X

5 SURVEY

A survey is a form of empirical study for providing a quantitative or numeric description on some fraction of the population or the sample through the data collection process by asking questions to the people [66][35]. A survey can be conducted either through interviews or questionnaire. We conducted survey through online questionnaire in order to strengthen our research. The main reason for conducting survey is to validate our findings in industry. The detailed process for performing survey is described in the following sections.

5.1 Designing on-line surveys

Before implementing the survey we have to design the survey. Our designed survey consists of two steps sampling and questionnaire design [67]. Sampling is a process of selecting participants to fill the questionnaire [67]. Questionnaire design consists of set of questions for the samples (participants) to answer the questions. Samples and Questionnaire design are explained clearly in the following sections.

5.1.1 Sampling

There are two ways to obtain samples; one way is systematic approach and other is non-systematic approach [68][69]. In systematic approach the list of entire population is available and samples are drawn from that list based on the statistics, so that every member have equal chance of being selected and non-systematic sampling is used for small-scale survey [67]. We used non-systematic approach for conducting this survey because this survey is on small scale and it is also difficult to get contacts from many companies and listing all the members and selecting people from that list. We used personalized sampling method for performing non-systematic sampling process. We invited 28 participants personally to answer the questionnaires. The concerned persons are experienced in GSD projects and are from different companies with different designations. The details of companies and role of participants in our survey are shown in the Table 5-1. Table 5-2 presents the total number of participants with respect to designation.

Table 5-1. Survey Participants with Respect to Companies

Sr.#	Companies	Role of participated Persons
1.	Infosys	Systems Engineer, Project Manager
2.	Cordys	Software Engineer, Project Manager
3.	Versant Technologies Pvt. Ltd.	Developers, Team lead
4.	Polaris Software Lab Limited	Systems Engineer
5.	Patni Computer Systems	Software Engineer ,Team lead
6.	Maveric Systems Limited	System Engineer
7.	C-DAC Research & Developement	Project Engineer

Table 5-2. Number of Survey Participants with Respect to Designation

Role of participated Persons	No: of participants
Systems Engineers	10
Software Engineers	6
Developers	5
Team leads	2
Project Managers	5

5.1.2 Questionnaire design

We mainly used closed ended questions with checkboxes because we want to test our findings. We designed 33 questions with the help of the literature findings. In these questions we suggested roles and responsibilities for each problem chain. Participants were asked to select those suggestions that they think will have a positive impact on the chains of problems. We also asked participants to write extra roles and responsibilities, if they follow extra practices for these problems in their companies. So, that it can help us to extend our findings from literature. At the end of the survey we asked participants to fill additional feedback to know the applicability of our suggestions form their view point.

5.2 Implementing on-line surveys

Implementation means; the task of bringing the questionnaire on the web page by selecting appropriate development environment and implementation step in the survey process is affected based on the decision to perform a survey on-line [67]. There are two ways to develop the survey either through self development or commercial tools. We are using Googledocs, commercially available tool, for entering the questionnaire into the tool and it generates the necessary web page and scripts. It also assisted us to trace the responses from the participants so that if they won"t respond we can resend invitation to the mail.

5.3 Executing on-line surveys

We invited all 28 participants through mails and asked them to fill the survey form. The feature for automatic tracking of participants for monitoring and controlling significantly increased overall response rates. Figure 5-1 shows the number of respondents per day for our survey. It can be seen from the figure that many respondents answered the survey within a short time after the invitation is sent. We send a reminder to the participants at the end of second day to increase the response rate, which helped significantly.

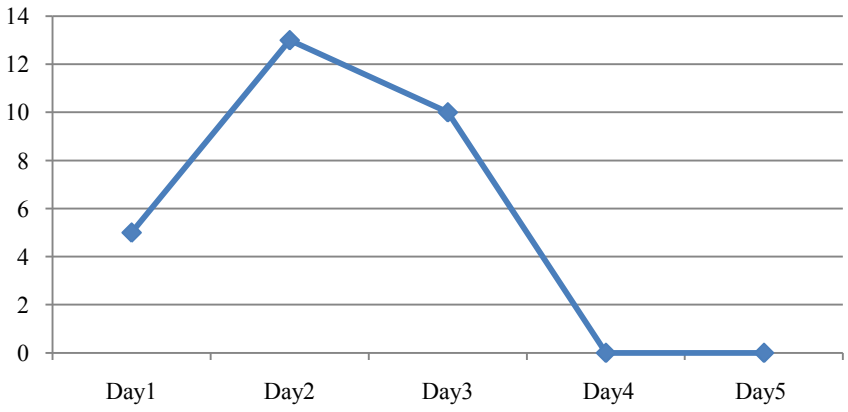


Figure 5-1. Number of Respondents (Y-axis) per day (X-axis)

5.4 Data Analysis

The survey response rate is 100% because all of the 28 participants had completed the survey. Their responses were included and analyzed for the purposes of validation of our findings. Descriptive statistics is used for describing what is or what the data shows [52]. Descriptive statistics in this thesis used for providing summaries of the samples and the measures of our survey. Samples refers to participants .Participants of

the survey were asked to select suggestions that can have positive impact on chains of problems. Data indicated that each role and responsibility, which we suggested for a particular chain, is useful and not a single suggestion is refused by the survey participants. Different participant selected different suggestions for particular chain of problems. In other way, each suggestion has been selected during the survey by participants. Now the matter of concern is that how many times, a particular suggestion is selected by the participants with respect to a particular chain of problems. This is why we have categorized our suggestions into two categories which have 1) strong positive impact and 2) weak positive impact. Suggestions that have been selected are measured with percentages (i.e. with highest percentage and lowest percentage). The percentage describes; which suggestion has been selected how many times by the participants (occurrence of responses). It is calculated automatically by Googledocs. Suggestions that have highest percentage come under the category of „strong positive impact" and the suggestions that have a lowest percentage comes under the category of „weak positive impact". Table 5-3 shows strong and weak positive impacts of suggestions for each chain of problems.

5.5 Survey Results

Survey results have been presented in this section. We have validated each link between suggestions and chains of problems in industry. Table 5-3 presents the results of suggestions with respect to each chain of problems in term of its percentage for example problem chain (C1) has suggestions such as roles1, R3, R4, R5 and R11 with 19%, 33%, 59%, 15% and 41% respectively.

Furthermore, these percentages, as described in section 5.4, led us to develop Table 5-4 which categorized the suggestions as having strong and weak positive impact on chains of problems. For example, In the Table 5-3, „distribute required knowledge among sites through meetings" (R4) has a highest value of percentage (59%) which represents that it has strong positive impact on C1 (P1->P3) whereas responsibilities such as „practice longer collaboration" (R5) and „responsibility to have frequent communication between the onsite and the offshore team" (R22) has lowest percentage (15%) which represents weak positive impact on problem chain (C1). Suggestion with weak positive impact can be due to context dependency of companies. Context dependency means practitioners in this survey selected suggestions according to their own company context. Table 5-4 represents all those suggestions that have strong or weak positive impact on chains of problems.

Participants were also asked to provide additional information regarding suggestions which can help us extend the findings from literature. Participants did not provide any additional suggestions which can have positive impact on chain of problems other than what we suggested to them in survey. This may lead us to conclude that participants were bound under company policy not to reveal the company processes or any other information regarding the practices; they are performing for better GSD.

Table 5-3. Applicability of Roles and Responsibilities (in percentage) with respect to each chain of problems

	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	C14	C15	C16	C17	C18	C19	C20	C21	C22	C23	C24	C25	C26	C27	C28	C29	C30	C31	C32	C33
Role 1	19	11	39									15						17	15	12	15	22	30		7		22	15	16			11	25
Role 2		11								19	11		19								19							15			23		
Role 3					50							31		19	11	15	27		11			11	11				22		44	52		22	
Role 4								52													4												
R1					42						30	50		27	33	30	12		15		7	19	22				26		20				
R2					19						7	12		12	19	11	27		7		7	7	19				11		20				
R3	33	33												31	44	48	19	38	30		15		22								44	
R4	59	48												38	33	33	38	25	37	32	15		19								15	46
R5	15	41												23	37	19	23	29	19		19		7								11	
R6																				12												54
R7								44																								
R8																										65						
R9			61	65	38																											
R10				54		21	19	56	23															63								
R11	41	26								23	33		23					42										35				
R12		26			8						19	4	19	15	19	33	19		11			19	19				33	42	28			
R13																15										62						
R14		19											42	38	30	48	54		22				26					31			52	
R15		22								73			31								30							23			42		
R16		19								31			31								19							31			50		
R17										54	57																					
R18						4	4	2	4																								

						6	2	4	2																									
R19						75	69	44	38																									
R20						50	50	48	65																									
R21														27	15	15	35	50	52	60	52	52	44									44	
R22	15																	38									56	66	68	60	73	56	54
R23											41	50															52						
R24																			52	64	52	63	56										
R25	37	15																															
R26									50																								
R27											41																						
R28										42						37																	
R29																								54									
R30			36	38	42																								52				
R31	22	22								27																							
R32			50																		37	33	33		30								
R33					62						37	19		8	26		27		22			37	37				30		28				
R34															11										48								
R35															15										70								
R36															22										44								
R37																								38									
R38												50	46	19																			
R39												31	27	27																			
R40												19	38	38																			
other			4	4		4	4					4								4	4								4		4	4	

Table 5-4. Effectiveness of the Roles and Responsibilities

Chain of Problems	Suggestions		
	Strong Positive Impact	**Weak Positive Impact**	**Positive Impact**
C1	R4	R5, R22	Role1, R3, R11, R25, R31,
C2	R4	Role1, Roles2	R3, R5, R11, R12, R14, R15, R16, R25, R31,
C3	R9	R30	Role1,R32
C4	R9	R30	R10
C5	R33	R12	Role3, R1, R2, R9, R30
C6	R19	R10	R10, R18,R19, R20
C7	R19	R10	R10, R18, R19, R20,
C8	R10	R18	Role4, R7, R10, R18, R19, R20
C9	R20	R10	R18, R19, R26
C10	R15	Role2	R11, R16, R17, R28, R31
C11	R17	Role2	R1, R2, R11, R12, R23, R27, R33
C12	R1, R23, R38	R12	Role1, Role3, R2, R33, R39, R40
C13	R38	Role2, R12	R22, R14, R15, R16, R39, R40
C14	R4,R40	R33	Role3, R1,R2, R3, R5, R12, R14, R21, R38, R39
C15	R3,	R34, Role3	R1, R2, R4, R5, R12, R14, R21, R33, R35, R36
C16	R3, R14	R2	Role3, R1, R4, R5, R12, R13, R21, R28
C17	R14	R2	Role3, R1, R3, R4, R5, R12, R21, R33
C18	R21	Role 1	R3, R4, R5, R11, R22
C19	R21, R24	R2	Role1, Role3, R1, R3, R4, R5, R12, R14, R33
C20	R24	Role1, R6	R4, R21,
C21	R21, R24	Role4	Role1, Role2, R1, R2, R3, R4, R5, R15, R16, R32
C22	R24	R2	Role1, Role3, R1, R12, R21, R32, R33
C23	R24	R3	Role1, Role3, R1, R2, R4, R5, R12, R14, R21, R32, R33
C24	R10	R37	R29
C25	R35	Role1	R32, R34, R36
C26	R8	R13	-
C27	R22	R2	Role1,Role3, R1, R12, R23, R33
C28	R22	Role1, Role2	R11, R12, R14, R15, R16
C29	R22	Role1	Role3, R1, R2, R12, R33
C30	R22	Role3, R30	-
C31	R22	Role2	R15, R16
C32	R22	Role1, R5	Role3, R3, R4, R14, R21
C33	R22, R6	Role1	R4

Addition to this, we asked our participants to rate the usefulness and cost-effectiveness of our suggestions. The respondents were asked to use a qualitative scale: all, many, few and none. The feedback results are shown in Figure 5-2.

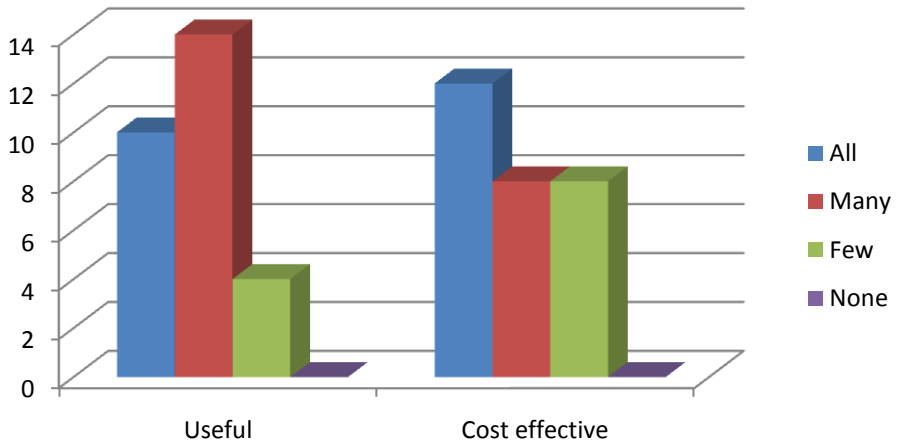


Figure 5-2: Feedback of Survey

9 participants marked all suggestions as useful whereas not a single participant respondent that none of suggestions are useful. As far as cost effectiveness is concerned, 11 participants marked all suggestions as cost effective in their opinion and not a single participant respondent that none of the suggestion is cost effective. We did not calculate the cost of suggestion through formula; we simply asked them to give their opinion.

6 DISCUSSION

During the results analysis of SLR, we have observed that there are studies [25][22] which provide suggestions such as „having roles and responsibilities" to avoid different problems in GSD, but there are really few studies [22][70] that exactly tell what particular roles and responsibilities should be implemented in order to avoid different problems in GSD. Results of SLR have identified that there is a gap that requires an attention for studying, understanding and suggesting particular roles and responsibilities corresponding to the globally distributed team structures and evaluating their effectiveness or ineffectiveness.

During the SLR, we identified different problems that affect GSD team"s effectiveness. We observed that these are not independent problems but it may lead or be caused by some other problems. We identified 33 chains of problems and noticed that there is a strong chaining (casual relationship) among these problems. We identified another gap here that requires an attention for studying and understanding, proper and strong chaining among problems. This action raises a research question: **Can GSD problems be minimized by properly studying or understanding the casual relationship among different problems?** There are studies [71][72][73][74][75][76], referenced in different sections of this thesis, that describe different problems in GSD together with its affect on performance of team, but no one has concluded that understanding the casual relationship among problems and providing a solution for it, can have a positive impact on GSD teams. The dependencies among problems can be identified to its maximum level. We have identified dependencies at initial level (Table 3-14) and next level (Figure 3-8). But the research can be extended to find the final level dependencies, if there is any existed, among problems that can assist project managers to trace down the cause of particular problem back to its source problem. This can be addressed through the research question such as **what dependency levels exist among different problems in GSD?**

We observed a strong relationship between chains of problems and roles and responsibilities. We concluded that if proper role and responsibilities are implemented in a proper way, than GSD problems can be minimized or perhaps, avoided. This analysis has been supported in studies such as [22][25][70]. We identified 40 responsibilities and 4 roles that have positive impact on different chains of problems. This is a major contribution of this thesis because no previously published studies have provided a consolidated view on effective roles and responsibilities for GSD.

Generally, there are always one or more responsibilities associated with a particular role, but during the analysis of SLR results, we have noticed that we have roles which do not have particular responsibilities and the same way, we have responsibilities that are not associated with any particular role. This was a reason to separate responsibilities from the roles in our thesis. This action raises a question: **what basic responsibilities can be assigned to different roles in GSD to achieve team's effectiveness?**

After separating the responsibilities from roles, we linked different roles and responsibilities (suggestions) with the chains of problems. This link was further validated in industry through survey. This step is the backbone of this thesis where roles and responsibilities have been suggested to chains of problems in order to have an effective GSD team.

During the analysis of SLR and survey results, we have noticed that roles and responsibilities are depended on context such as geographical, temporal, cultural and organizational. Each company may have different context and the problems can be different which further can be addressed through different roles and responsibilities. This analysis requires an attention from practitioners towards the external factors that

can affect GSD team‟s effectiveness. The question, we raise here is, **what are the internal or external factors that can triggers different GSD problems?** It is also worth mentioning here the cost of implementing the suggestions. Cost of each suggestion was not primary goal in this research but it requires an extensive research to determine the cost of each suggestion and figure out ROI. What we observe that some suggestions can be costly while the others are not. The decision to implement it remains with the project managers or high authorities to decide what is important for them and what is not.

We are not successful in capturing the exact roles because of different terminologies in role‟s designation in industry such as some companies can have scrum manager or technical lead as a different name but same responsibilities. We have also considered it as a validity threat in our survey and have been mentioned in section 7.1.

GSD is mentioned a 21st century field in [56][57] and since that time, we do not have literature, used for this SLR, that describe particular roles and responsibilities for GSD and the same thing has been observed during the analysis of survey, when participants were asked to provide additional roles and responsibilities which they are practicing in their company. Only one person, in questions Q3, Q4, Q6, Q7, Q12, Q20, Q21, Q30, Q32 and Q33, selected „other‟ as an option but not even a single participant provided any additional role or responsibility. This action led us assume that this is a company policy to not reveal such confidential information and then will researcher never be able to capture state-of-practices? And if this assumption is wrong, than the alternate methodology for capturing exact roles and responsibilities, for this thesis, could be interviews rather than SLR.

The results from survey and SLR can not only assist project manager or team members to have role and responsibility to address different problems but also, it can provide an overview of suggestions together with the frequency of their applicability in industry (Table 5-3).

7 EPILOGUE

7.1 Validity Threats

In this section, the threats of validity concerning the research methodology of this thesis are discussed. In this thesis we have conducted a systematic literature review to find the problems and casual dependencies between them that influence the effectiveness of GSD teams. There are four different types of validity threats [37].

7.1.1 Internal Validity

Internal validity means a casual relationship between the treatment and outcome [37]. Publication bias is an internal threat in the systematic literature review. Publication bias is seen as one of the internal threat in our thesis. In order to mitigate this threat, the authors of this thesis conducted several meetings to define the review protocol (inclusion and exclusion criteria, quality assessment criteria and data extraction strategy) in order to have a similar understanding of the review protocol. The purpose of these meetings was to avoid publication biases and disagreements in opinion as everyone will have a similar understating of the review protocol. The selection criteria, decided during the protocol definition, reduce the publication bias [33]. Further in order to check the agreement level between the authors kappa coefficient is calculated. The calculated kappa coefficient for detailed inclusion is 0.01 and full text is 0.1249 (Table 3-5). According to [58], if the kappa coefficient lies between 0 and less than one, than the agreement between authors is "equal to chance" which means that both authors have the same levels of understandings. Selecting only few primary studies by rejecting large number of papers might be one of the internal threats. To mitigate this threat the authors of this thesis read full text of all the papers individually and then discussed with each other about the papers to be included. And also a manual search is performed in "**International Conference on Global Software Engineering (ICGSE)**" so the chance of missing important articles can be reduced.

The threat to instrumentation was reduced as the data extraction forms are designed after reading the literature and also by consulting the supervisor, the forms were updated. We applied data extraction form on 8 studies together. Then data extraction form has been applied on rest of the studies individually and results were cross checked. Disagreement had been resolved by consensus among authors of this thesis.

7.1.2 External Validity

External validity is concerned with generalizations [37]. In this thesis, the external validity is related to generalizations of the survey results.

We conducted survey with limited participants from different geographical locations such as from Asia and America. The idea was to validate the results with global software development companies with different backgrounds, cultures and organizational structures. So, this can likely to support the generalization of the results. However, we conducted survey with 28 participants in seven different organizations, which may be the sufficient population for high degree of generalizations.

7.1.3 Construct Validity

Construct validity is concerned with the relationship between theory and observation [37]. In our thesis this validity threat can be relevant for our design of systematic literature review. Our search string may not be able to reveal all research data presented in the literature. The search terms are decided with expert advice from librarians. Our supervisor also checked our search strings initially and also after the

refinement of search string. So this minimizes the threat to the validity of our systematic review.

Another threat is coding of textual description during the data analysis. There is a chance of coding wrong terms and misinterpreting the textual description. To avoid this both the authors discussed carefully. There can also be similar threats when linking chains of problems with team ineffectiveness. To avoid this both authors studied articles of team effectiveness.

. In survey there is threat of context dependency i.e. in our study the role Technical Supplier Manager can be considered as Scrum Manager by participant according to their context. So, to mitigate this threat, we explained the terms such as chain of problems, roles and responsibilities in our survey form on introduction page.

7.1.4 Conclusion Validity

Conclusion validity threat is concerned with the relationship between the treatment and outcome [37]. In our thesis, the conclusion validity threat is identified when extracting casual dependencies. When we are extracting the textual description for finding casual dependencies there is a chance of missing information. Both the authors went through the text very carefully in order to avoid missing the useful information. We extracted text which is seen to be more important.

7.2 Conclusion

Global software development may have many assumed benefits but the problems it faces, are very real. There can be many solutions to address these problems but this study has provided the solution to these problems in term of effective roles and responsibilities. This section provided mapping between results and relevant research questions in order to present and verify its completeness.

RQ1. What are the problems and casual dependencies between them that influence the effectiveness of GSD team?

Section 3.3.2.1 describes the problems that have been identified through SLR. Figure 3-7 in section 3.3.2.1 also described the number of times each problem appeared in primary studies. We have identified 30 problems. The problem „misunderstanding" has been appeared seven times in our primary studies. This was the major problem that has been addressed in our primary studies. After identifying the problems, we also have identified casual dependencies between problems and presented in section 3.3.2.2. Table A in Appendix A describes how we identified the problems and the casual dependencies through the use of rules. We identified 33 casual dependencies between problems and presented in Figure 3-8. It is not possible to capture all the GSD problems and their casual dependencies in one study as these problems are dependent on different contexts such as geographical, temporal, cultural and organizational.

RQ2. How can these casual dependencies between problems be addressed through implementation of the roles and responsibilities in GSD teams?

We have developed a framework that contains the results from RQ1 and answer RQ2. This framework is about suggesting roles and responsibilities with respect to chains of problems. Section 4.1 describes the suggesting roles and responsibilities together with the link to chains of problems. We have identified 4 different roles and 40 different responsibilities that can be implemented to address different chains of problems. The framework has been presented in Figure 4-1 and Table 4-1. Table B in Appendix A presents the useful information that assisted us to identify the roles and responsibilities from primary studies. We observed that many similar responsibilities can be applied in order to address different problems. It has been observed that implementing a proper role and responsibility can avoid many problems.

RQ3. How useful the implementation of roles and responsibilities, found through RQ2, are in industry?

Survey results have been provided in section 5.2. Survey has validated each link which was developed through SLR between suggested roles and responsibilities and chains of problems. Addition to this, we have realized that few roles and responsibilities have been selected widely by the participant that indicates the importance of the particular role and responsibility with respect to particular chains of problems. The results have concluded which responsibility has a strong and weak positive impact on a chain of problems. Table 5-2 in section 5 represents the responsibilities together with its impact on chains of problems.

7.3 Future Work

We have identified the gap that there must be a research in industry regarding effective roles and responsibilities that may have positive impact on different problems in GSD. The work in this thesis can be extended to develop a classification scheme of global software projects based on different context such as temporal, geographical and cultural. This classification scheme can generalize the nature of GSD projects. After developing a classification scheme, we can generalize the roles and responsibilities with respect to particular classification. There is little research in providing a solution to different problems in GSD in terms of effective roles and responsibilities that requires an attention of research and practice to explore it in different directions.

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APPENDIX A

Table A. Identified Problems together with Casual Dependencies between them.

Sr #	Textual Description from primary source	Problems identified	Problems coded	Study #	Rule
1	"Exchange of knowledge among these remotely located software development teams must overcome new barriers in order to provide interactions and communication comparable to the original co-located operations."	Exchange of knowledge	Lack of knowledge management	S14	!(knowledge management) → + interaction barrier, + communication problem
		Interaction barrier	Interaction barrier		
		Communication barrier	communication problem		
2	"Dependences among modules have a direct impact on the level of communication required by teams responsible for implementing them".	Dependencies among modules	High degree of dependency of task	S14	(high degree of dependency of task → + communication overhead
		Communication overhead	Communication overhead		
3	"Software development is carried out simultaneously by multiple team members and then combined into a single product. There is a high degree of interdependence in the tasks that is critical to the project"s success"	high degree of interdependence in the task	High degree of dependency of task	S20	(high degree of dependency of task → + project failure risk
		critical to project success	project failure risk		
4	"The study reveals that quality of collaboration in globally distributed teams is related to the mode of communication".	Mode of communication	Communication infrastructure	S3, S15	!(communication infrastructure) → - Quality of collaboration
		Quality of collaboration	Quality of collaboration		
5	"However, as I have reiterated in this paper, understanding how technology representations mutually interrelate with interdependencies, conflicts and uncertainties and equivocalities, and how they are managed are more important than merely understanding technology representations. It is fundamentally wrong to isolate technology representations because the representations can assume the roles	Technology representation	Communication infrastructure	S4	!(communication infrastructure) → +conflict, +difficulty to handle interdependencies, + lack of trust
		Interdependencies	difficult to handle interdependencies		

	of any of the organizing dimensions – people, processes and information."	Conflicts	Conflicts		
		Uncertainties	Lack of trust		
6	"However, we noted that misunderstandings reduce with longer collaboration and more frequent and interactive communication."	frequent and interactive communication	communication infrastructure	S3	!(communication infrastructure) && (Less collaboration) → + misunderstanding
		Reduces longer collaboration	Less collaboration		
		misunderstanding	misunderstanding		
7	"In software development, interactions between people, for example, are considered as one of the dominant processes. These interactions may be conducted face-to-face, thus enabling the flow of "rich information" between interacting parties"	face-to-face meeting	Lack of face-to-face meeting	S4	!(face-to-face meeting) → + Interaction barrier
		interaction barrier	Interaction barrier		
8	"In meeting face-to-face, the aim is to get to know each other and to create social networks that can generate trust, respect and commitment and in the long term facilitate development work across various geographical sites."	face-to-face meeting	Lack of Face-to-face meeting	S7	!(Face-to-face meeting) → + lack of trust
		lack of trust	Lack of trust		
9	"Teams did not succeed in developing trust, but instead struggled with polarization among subgroups at each location. Teams regarded the lack of an initial face-to-face meeting as a major cause for lack of development of trust"	lack of an initial face-to-face meeting	lack of face-to-face meeting		lack of face-to-face meeting → lack of trust
		lack of development of trust	lack of trust	S1	
10	"Our study reveals face-to-face interaction as prioritized in critical phases such as front-end and back-end of projects. For example, the integration phase is considered crucial as there can be unexpected behavior, and also implementation of key features often requires people to be co-located. However, while face-to-face	face-to-face meeting	Lack of face-to-face meeting	S7	!(Face-to-face meeting) → + misunderstanding

	interaction is considered crucial in these phases."				
		unexpected behavior	misunderstanding		
11	"In sum, the processes that have simplified coordination as "managing interdependencies" have, at the same time, led to the gradual oversight of the other factors such as uncertainties and equivocalities, technology representations and conflict as integral problems of coordination."	managing interdependencies	high degree of dependency of task	S4	(high degree of dependency of task) && !(communication infrastructure) && (lack of trusts) && (misunderstanding) → +coordination problems
		technology representations	communication infrastructure		
		uncertainties	Lack of trust		
		equivocalities	Misunderstanding		
		problems of coordination	Coordination problems		
12	"The importance of early management of communication, coordination and project knowledge is critical for global software development projects."	early management of communication, coordination and project knowledge	Lack of early decision making or management	S2	!(Early decision making or management) → + project failure risk
		critical for global software development projects."	Project failure risks	S6	
13	"Due to the lack of communication to clarify misunderstandings between the scientific and development teams, this process was a particular challenge that resulted often in ill-defined requirements."	lack of communication	Lack of frequent communication	S3	!(frequent communication) → + misunderstanding
		misunderstandings	misunderstandings		
14	"Because of the lack of communication, in most cases developers relied on local domain users or scientists to try to refine the requirements to speed up development	lack of communication	Lack of frequent communication	S11	!(frequent communication) → + development rework

	to meet deadlines. However, when the complete distributed scientific team has reached an agreement on these requirements, in some cases, the developers had to re-develop part of the system to meet the new agreed requirements."	re-develop part	development rework		
		delay in response	delay in response		
16	"Risk of distribution has been lowered for each project by ensuring that the following are already in place: 1) a mature team, 2) clear procedures and processes."	mature team	Lack of mature team	S18	!(mature team) && !(clear procedure and process) → + project failure risk
		clear procedures and processes	Lack of clear procedures and processes		
		risk of distribution	project failure risk		
17	"Partitioning for discrete functional parts reduces feature dependency across sites, reducing the need for communication".	discrete functional parts	modular approach	S18	(modular approach) → - communication overhead
		reducing the need for communication	Communication overhead	S18	
18	"By reducing the technical interdependencies among modules, thereby reduce the need for communication among work groups."	interdependencies among modules	High degree of dependency of task	S10	High degree of dependency of task → + communication overhead
		reduce the need for communication	communication overhead		
19	"Travel is restrained by cost, but trust tends to decrease in the absence of face to face meetings so it is supported if a manager requests it".	Travel	site visit	S18	!(site visit) || !(face-to-face meeting) → + lack of trust
		absence of face-to-face meeting	Lack of face-to-face meeting		
		trust ends to decrease	lack of trust		

20	"We often experience minor language problems, especially when vocabulary is limited to technical subjects…even going out at night with them [non-native English speakers], conversation can revert back to technical subjects because of their limited vocabulary". "Language problems as the primary reason for – if not conflict – but misunderstandings".	language problems, limited vocabulary	Language difference	S7	Language difference→ +misunderstanding
		misunderstanding	misunderstanding		
21	"language skills may have impacted both the type and amount of communication,	language skills	Language difference	S15	Language difference→ +communication problems
		type and amount of communication	Communication overhead		
22	"delay of responses is seen as problematic and frustrating for individuals working in the different projects in different time zones".	individuals working in the different projects in different time zones	Time zone difference	S7 S8	Time zone difference→ + delay of response
		delay of responses	delay of responses		
		ability, followed by individual characteristics, particularly experience	Team performance		
23	"Collaborations had proved problematic as a result of cultural distance. -The operation of virtual teams requires a level of cooperation and coordination that cannot ignore the impact cultural distance plays and the barriers and misunderstandings it can create".	cultural distance	Cultural difference	S9	Cultural difference → + collaboration problems, + coordination problems, +misunderstanding
		Collaborations had proved problematic	collaboration problems		
		coordination that cannot ignore the impact cultural distance	coordination problems		

		misunderstandings	misunderstandings		
24	"The most frequent consequence of cross-site problems was delay in the resolution of work issues. By delay, we mean the additional time it takes to resolve an issue when more than one site is involved".	delay in the resolution of work issues	Delay in resolving of work	S12	Delay in resolving of work → + delay in project
25	"The biggest challenge in global development is effective communication. With the distribution of the team over different time zones, it is nearly impossible to get all players together".	effective communication	communication infrastructure	S19	!(communication infrastructure) && (time zone difference) → + interaction barrier
		With the distribution of the team over different time zones	time zone difference		
		Impossible get all players together.	Interaction barrier		
26	"Having to communicate in a foreign language adds another level of complexity. Learning to correctly express issues and problems in a foreign language takes a long time, but is crucial to successful project execution".	communicate in a foreign language	Language difference	S19	Language difference → + delay in project
		crucial to successful project execution.	delay in project		
27	"Working with a different company in a different country requires understanding how they work, and to the reasons for working the way they do. Without being at least "culturally conscious" it is very easy to misunderstand or bluntly insult the other team".	Without being at least "culturally conscious"	Cultural training	S19	!(Cultural training) → + misunderstanding, + conflicts
		it is very easy to misunderstand or bluntly insult the other team.	Misunderstanding and conflicts		

Table B. Identification of roles and responsibilities with respect to each problems

Textual Description	Problem	Problem number as coded in section	Role	Role Labeled	Responsibility	Responsibility Labeled
"The management team decided to form new focused teams and schedule additional weekly meetings for these teams between the sites within the time difference overlap and further utilize the collaboration tools. These meetings included respective team members and often the project manager" [S3].	-Coordination Problem -Collaboration problem -Less collaboration	P27, P15, P12	A technical lead or coordinator	Role3	-Schedule weekly meetings with another site within time difference overlap	R1
					-proper use of collaboration tools	R2
"These meetings served, to a certain degree, as an equivalent to face-to-face meetings. The notion for having all project members in the weekly coordination meeting is to maintain the shared team knowledge across the project members. A distributed document management system was deployed based on Wiki systems to enable document management and asynchronous collaboration with tools that allow stored exchange of ideas and casual discussions to serve effectively as a project forum. However, we noted that such misunderstandings reduce with longer collaboration and more frequent and interactive communication" [S3].	-Lack of knowledge management -communication problems -collaboration problems -misunderstanding	P1, P3, P27, P13	NA		-Weekly coordination meeting with each sites	R3
					-Distribute required knowledge among sites through meetings	R4
					-practice longer collaboration	R5
"on the one hand, the tool representation must be understood in terms of how it facilitates people‟s efforts in a software development activity (external orientation of technology representations); and, on the other hand, the sign representation must be understood in terms of how it shapes people‟s psychological attributes such as attitudes, feelings, perceptions, motives and frames of reference. The latter is important for understanding the antecedents of conflict, the potential roles of" [S4].	conflicts	P9	NA		-Selection of proper technology and its understanding	R6
					-Required knowledge should be shared among sites	R4
"When the virtual team members are satisfied with the team leader, the team leader will be more able to influence the members to work towards team goals and therefore to improve team performance" [S5].	Lack of mature team	P19	Team Leader	Role4	-Influence team members to work toward team goals	R7

"Locate the most skilled person for the task: in theory, a person whose strengths match those that are required by the task will perform the task most efficiently" [S6].	rework of development	P18	NA		-During structuring of team, find out the person whose skills best matches with the project nature or task nature	R8
"in a large project, the team will work more efficiently if tasks are distributed among the team members instead of overburdening the minority of members who excel in many fields" [S6].	high degree of dependency of task	P4	NA		-Balanced workload among all team members.	R9
"for tasks that require a high degree of familiarity with the related artefacts, it is better to locate a team member who has previous experience with the artefact than to force another member to spend time familiarizing himself or herself with the artefact before performing the task" [S6,]	-delay in project -project failure risk	P30, P6	NA		-Locate a person who has a previous experience in the task.	R10
"Workers have difficulty finding the right people across sites. The extreme volatility of communication networks suggests that this will be a continuing problem, especially at remote sites, where there is relatively little sparse interaction, and correspondingly few opportunities to learn who does what, and who has what expertise, and to be aware of where they are now. We are currently deploying a tool called Experience Browser which provides a visualization of the CM system, designed to make it easy to discover who has experience working on which parts of the code, and to get contact information for that person" [S12].	-interaction barrier -communication problem -lack of knowledge management	P2, P3, P1	NA		-Maintain webpage of people regarding their designation and work of each site.	R11
"Allow team members to select communication tool from the variety of option" [S14, S18].	-communication problem -coordination problem	P2, P15	NA		-Allow team members to select communication tool according to their comfort	R12

"Insist on frequent communication among all members including some synchronous interaction such as telephone, chat and web conferencing" [S14].	-Lack of frequent communication	P17	NA		-Practice frequent communication	R13
"The e-mail chain begins when one actor initiates a message, the receiver does not understand it fully and asks for clarification, the sender attempts to clarify, the receiver misinterprets again, and so on. Meanwhile, an entire week has gone by. Therefore, experienced individuals stop this chain early „by picking up the phone" and clarifying the message through a richer communication medium." [S17]	-misunderstanding -interaction barrier	P13, P2			-Resolve misunderstanding or conflict through phone call, voice chat or video conferencing	R14
"Some software organizations also create liaison roles to help team members interact across sites In one of our previous studies involving a software team with members in the United Kingdom, Germany and India, we found that a number of Indian software engineers were trained in the UK and German sites for a few months to familiarize themselves with team members and the work context in those sites and then worked as liaison engineers. Once trained, these liaison engineers would go back to India and would serve as points of contact for the UK and German developers. Liaison engineers would often adjust their work schedules to increase their window of work-time overlap with their British and German counterparts." [S7, S17, S18]	-Interaction barrier -time zone difference -collaboration problem -quality of collaboration	P2, P24, P27, P8	Liaison engineer	Role2	-Help to adjust work schedule with respect to other team	R15
					-Figuring out more online collaboration window with another team	R16
"Less-experienced team members need to be made aware of time-separation issues. They are not used to thinking about their counterparts being gone for the day while they work. They are not used to computing the direction of the time difference. Thus, various awareness tactics are important. (e.g. the distant team member reminds her counterpart that the scheduled meeting is set for 2 PM local time, and	-Time zone difference	P24			-Keep team members updated regarding the time zone difference of another team	R17
					-Maintain webpage of each team about availability and personal information	R11

members remind their distant teammates about shift to „daylight savings time", which is at different times in different countries). A simple tactic is to post hours and time differences on the common web site." [S17]						
"At the start of any project agree and communicate project goals and targets, and ensure that commitments are genuinely understood. Define which teams are involved, and what will be done in each location. Further, agree and document binding inter-organisational processes and stabilising processes." [S18]	-lack of mature team -lack of early decision making -lack of clear roles and responsibility	P19, P16, P20	NA		-Early communication of projects goals and targets	R18
					-Maintain transparency of each site: which site is consists of which members and responsible for what	R19
					-Manage documents within sites	R20
"Managers, particularly from the main site, are encouraged to visit other sites where they have responsibilities. On-site cultural training is undertaken. For example, managers will be made aware that in some cultures it is polite to agree with managers, but that this does not necessarily mean understanding or ability to deliver. Language can be the hardest problem in meetings. Language training is undertaken to reduce future communication problems." [S18]	-Misunderstanding -lack of culture training -language difference -culture difference -Lack of site visit	P13, P29, P26, P23, P22	NA		-Early culture and language training	R21
The TSM is clearly responsible for all communication between the onsite and the offshore team. The onsite team has a communication partner for each issue. [S19]	-Communication infrastructure -communication problem	P7, P3	technical supplier manager	Role1	-Responsibility to have frequent communication between the onsite and the offshore team"	R22
Since the TSM is from the same company as the offshore team, there is a trust relationship between the TSM and the offshore team ("He/She is one of us" feeling). [S19]	-Lack of trust	P11	Technical supplier manager	Role1	-Can build a relationship with the onsite team, which can reduce the fear of the onsite people	R23

The TSM is the one who needs to understand both cultures and be aware of the differences in order to mediate between the different teams in the event of misunderstandings due to the different cultural backgrounds of the different locations. This also means that the TSM needs to be trained and aware of the cultural differences [S19].	-lack of culture training - culture difference	P29, P26	Technical supplier manager	Role1	-Understands both cultures and understand the differences in order to mediate between the different teams when misunderstandings happens due to the different cultural backgrounds of the different locations	R24
One of the challenges in building up a new team at an offshore location is that the specific domain know how might not be available on the local market. Creating and executing a plan for domain know how build up at the offshore location is the responsibility of the TSM [S19]	Lack of knowledge management	P1	Technical supplier manager	Role1	- Creating and executing a plan for specific domain	R25
Great clarity is maintained over roles and responsibilities, and also expectations. To aid in this, all decisions of meetings (including especially teleconferences) are documented clearly in minutes within a shared repository. [S18, S10]	Lack of clear roles and responsibility	P20	NA		-Great clarity is maintained over roles and responsibilities, and also expectations.	R26
					-maintain shared repository	R27
Common strategies include the development of a project home page, which includes team member details and important planning information such as national holidays. Also summaries project progress as well as planning and team-specific information. Record decisions and make them easily accessible. Ensure timely feedback to communications about progress, including deliverables. [S18]	Delay in response,	P25			-maintain updated home page of each sites	R11
					-Ensure timely feedback to communications about progress, including deliverables	R28
Management meetings are held every week or two, and technical meetings every week – or more frequently during design reviews. There will also be 1:1 contact daily with team members. [S18]	Delay in project	P30			-conduct regular meeting for project tracking	R29
Within teams, personal visits and email are the most popular ways to fix blocked dependencies [S2]	-high degree of dependencies -difficulty to handle interdependencies	P4, P10, P22			-personal visits and regular email	R30

Design artifacts and other documents are also maintained in a central, shared repository. This reduces delays in response because of visibility of current status [S3]	-Lack of knowledge management - delay in response	P1, P25			-maintain shared repository and strong documentation	R31
TSM is someone who has experience in Project Management, has exceptional communication skills, is still on top of the used technology and is culturally competent. [S19]	-Communication overhead -cultural difference	P5, P26	Technical supplier manager	Role1	-experience in project management, communication skills and should understand culture of other team	R32
A technical lead was assigned to each site that would be responsible to coordinate process, development and schedule activities". [S3]	coordination problems	P15	technical leader	Role3	-coordinate process, development and schedule activities	R33
A system architecture mirrors the structure of the organisation which built it so for software development work ensure that the architecture of the system is consistent with the distributed structure of the team. This may significantly impact on architectural decisions, but will reduce the need for intensive collaboration and allow optimum utilisation of local skills. For other life-cycle phases plan natural divisions of work in relatively small bundles. Partitioning for discrete functional parts reduces feature dependency across sites, reducing the need for communication (once or twice a week typically). Units of work are packaged to reduce the need for coordination, not too small yet not large enough to frustrate. Work is focused on certain phases in the distribution life-cycle, e.g. QA-type testing. However, the site will have been engaged in the project as early as possible [S18]	-Lack of modular approach -Less collaboration	P21, P12			-Functional partitioning reduces feature dependency across sites,	R34
					-Distributing the life-cycle phases to focus on certain phase of work.	R35
					Need for intensive collaboration is reduced by allowing optimum utilisation of local skills	R36
The most frequent consequence of cross-site problems was delay in the resolution of work issues. By delay, we mean the additional time it takes to resolve an issue when more than one site is involved. Finally, the finding about non-help during heavy workload and delay may argue for tools supporting richer interaction, i.e., high quality audio and	Delay in work resolving issues	P28			-Using richer interaction, i.e., high quality audio and video for effective conveying the nuances of expression more accurately in the need of urgency.	R37

video, that may be more effective in conveying the nuances of expression and emotion that allow more accurate determination of urgency.[S12]						
The key feature is that the cost (not necessarily monetary) to bring dispersed team members together is a significant inhibiter to spontaneous face-to-face meetings. In software development, interactions between people, for example, is considered as one of the dominant processes. Consider collocating developers, not only managers. There may be a one-off project initiation session, where understandings are forged and strategic thinking can take place. There may also be regular (e.g. quarterly) synchronisation and review meetings, but front-loading travel is considered most effective. Members from a team are brought together early if a new partner site is involved. Other than this, certain phases are recognised as ideal: project initiation and completion; design phase; integration phases; training. In planning collocations, the long-term advantages of trips in both [S18]	Lack of face to face	P14			-Encourage temporary collocation in the early development phases.	R38
					-Collocate developers and managers	R39
					-Travel to other site so that trust can be reduced by having face to face interactions.	R40

APPENDIX B

Survey Question and Answers

1. In Global Software Development, communication problems occur due to knowledge management between teams. Which of the following roles and responsibilities have positive impact on this chain of problems?

- Technical Supplier Manager
- Weekly coordination meeting with each site
- Distribute required knowledge among sites through meetings
- Practice longer collaboration
- Maintain web page of people regarding their designation and work of each site
- Creating and executing a plan for domain know how build up at offshore location
- Maintain shared repository and strong documentation
- Responsible for all communication between the onsite and off shore team. The onsite team has a communication partner for each issue other
- other

2. In Global Software Development, interaction barrier occur due to knowledge management between teams. Which of the following roles and responsibilities have a positive impact on this chain of problems?

- Technical Supplier Manager
- Liaison Engineer
- Weekly coordination meeting with each site
- Distribute required knowledge among sites through meetings
- Practice longer collaboration
- Maintain web page of people regarding their designation and work of each site
- Creating and executing a plan for domain know how build up at offshore location
- Maintain shared repository and strong documentation
- Allow team members to select communication tool according to their comfort
- Resolve misunderstanding or conflict through phone call, voice chat or video conferencing
- Help to adjust work schedule with respect to other team
- Figuring out more online collaboration window with other team other
- other

3. In Global Software Development, communication overhead occurs due to high degree of dependency of task between teams. Which of the following roles and responsibilities have a positive impact on this chain of problems?

- Technical Supplier Manager
- Balanced workload among all team members
- Personal visits and regular email
- Experience in project management, communication skills and should understand culture of other team
- Other

4. In Global Software Development, there is a project failure risk due to high degree of dependency of task between teams. Which of the following roles and responsibilities have a positive impact on this chain of problems?

- Balanced workload among all team members.
- Personal visits and regular email
- Locate a person who has a previous experience in the task
- Other

5. In Global Software Development, coordination problems occur due to high degree of dependency of task between teams. Which of the following roles and responsibilities have a positive impact on this chain of problems?

- Technical lead or coordinator
- Balanced workload among all team members
- Personal visits and regular email
- Coordinate process, development and schedule activities
- Allow team members to select communication tool according to their comfort
- Schedule weekly meetings with another site within time difference overlap
- Proper use of collaboration tools
- Other

6. In Global Software Development, there are project failure risks due to lack of early decision making or management of project. Which of the following roles and responsibilities have a positive impact on this chain of problems?

- Early communication of projects goals and targets
- Maintain transparency of each site: which site is consists of which members and responsible for what
- Manage documents within sites
- Locate a person who has a previous experience in the task
- Other

7. In Global software development, there are project failure risks due to lack of mature team in projects. Which of the following roles and responsibilities have a positive impact on this chain of problems?

- Team leader
- Early communication of projects goals and targets
- Maintain transparency of each site: which site is consists of which members and responsible for what
- Manage documents within sites
- Locate a person who has a previous experience in the task
- Influence team members to work toward team goals
- Other

8. In Global Software Development there are project failure risks due to lack of clear procedure and processes. Which of the following roles and responsibilities have a positive impact on this chain of problems?

- Early communication of projects goals and targets
- Maintain transparency of each site: which site is consists of which members and responsible for what
- Manage documents within sites locate a person who has a previous experience in the task
- Locate a person who has a previous experience in the task
- Great clarity is maintained over roles and responsibilities, and also expectations
- Others

9. In Global Software Development, delay of responses occurs due to time zone difference between sites. Which of the following roles and responsibilities have a positive impact on this chain of problems?

- Liaison engineer
- Keep team members updated regarding the time zone difference of another team
- Maintain webpage of people regarding their designation and work of each site
- Help to adjust work schedule with respect to other team
- Figuring out more online collaboration window with another team
- Ensure timely feedback to communication about progress, including deliverables
- Maintain shared repository and strong documentation
- other

10. In Global Software Development, interaction barrier occurs due to time zone difference between sites. Which of the following roles and responsibilities have a positive impact on this chain of problems?

- Liaison Engineer
- Keep team members updated regarding the time zone difference of another team
- Maintain webpage of people regarding their designation and work of each site.
- Help to adjust work schedule with respect to other team
- Figuring out more online collaboration window with another team
- Allow team members to select communication tool according to their comfort
- Resolve misunderstanding or conflict through phone call, voice chat or video conferencing
- other

11. In Global Software Development, coordination problem occurs due to lack of trust among sites and further lack of trust is caused due to lack of site visits. Which of the following roles and responsibilities have a positive impact on this chain of problems?

- Technical Supplier Manager
- A technical lead or coordinator
- Early culture and language training
- Maintain shared repository and strong documentation
- Coordinate process, development and schedule activities
- Build a relationship with the onsite team, which can reduce the fear of the onsite people
- Allow team members to select communication tool according to their comfort
- Schedule weekly meetings with another site within time difference overlap
- Proper use of collaboration tools
- Other

12. In Global Software Development, coordination problem occurs due to lack of trust among sites and lack of trust occurs due to lack of face to face meetings. Which of the following roles and responsibilities have a positive impact on this chain of problems?

Technical Supplier Manager

- A technical lead or coordinator
- Encourage temporary collocation in the early development phases
- Collocate developers and managers
- Travel to other site so that trust can be reduced by having face to face interactions
- Build a relationship with the onsite team, which can reduce the fear of the onsite people
- Coordinate process, development and schedule activities
- Schedule weekly meetings with another site within time difference overlap
- Proper use of collaboration tools
- Allow team members to select communication tool according to their comfort
- other

13. In Global Software Development, interaction barrier occurs due to lack of face to face meetings between teams. Which of the following roles and responsibilities have a positive impact on this chain of problems?

- Liaison Engineer
- Encourage temporary collocation in the early development phases
- Collocate developers and managers
- Travel to other site so that trust can be reduced by having face to face interactions
- Maintain webpage of people regarding their designation and work of each site.
- Allow team members to select communication tool according to their comfort
- Resolve misunderstanding or conflict through phone call, voice chat or video conferencing
- Help to adjust work schedule with respect to other team
- Figuring out more online collaboration window with another team
- other

14. In Global Software Development, coordination problems occurs due to misunderstanding and misunderstanding occurs due to lack of face to face meetings between teams. Which of the following roles and responsibilities have a positive impact on this chain of problems?

- A technical lead or coordinator
- Encourage temporary collocation in the early development phases

- Collocate developers and managers
- Travel to other site so that trust can be reduced by having face to face interactions
- Early culture and language training
- Resolve misunderstanding or conflict through phone call, voice chat or video conferencing
- Weekly coordination meeting with each sites
- Distribute required knowledge among sites through meetings
- Practice longer collaboration
- Coordinate process, development and schedule activities
- Allow team members to select communication tool according to their comfort
- Schedule weekly meetings with another site within time difference overlap
- Proper use of collaboration tools
- other

15. In Global Software Development, coordination problems occurs due to misunderstanding and misunderstanding occurs due to less collaboration. Which of the following roles and responsibilities have a positive impact on this chain of problems?

- A technical lead or coordinator
- Early culture and language training
- Resolve misunderstanding or conflict through phone call, voice chat or video conferencing
- Weekly coordination meeting with each sites
- Distribute required knowledge among sites through meetings
- Practice longer collaboration
- Coordinate process, development and schedule activities
- Allow team members to select communication tool according to their comfort
- Schedule weekly meetings with another site within time difference overlap
- Proper use of collaboration tools
- Functional partitioning reduces feature dependency across sites,
- Distributing the life-cycle phases to focus on certain phase of work.
- Need for intensive collaboration is reduced by allowing optimum utilisation of local skills
- other

16. In Global Software Development, coordination problems occurs due to misunderstanding and misunderstanding occurs due to lack of frequent communication. Which of the following roles and responsibilities have a positive impact on this chain of problems?

- A technical lead or coordinator
- Early culture and language training
- Resolve misunderstanding or conflict through phone call, voice chat or video conferencing
- Weekly coordination meeting with each sites
- Distribute required knowledge among sites through meetings
- Practice longer collaboration
- Coordinate process, development and schedule activities
- Allow team members to select communication tool according to their comfort
- Schedule weekly meetings with another site within time difference overlap
- Proper use of collaboration tools
- Practice frequent communication
- other

17. In Global Software Development. due to language difference in team members causes misunderstanding which in turn, affects coordination between teams. Which of the following roles and responsibilities have a positive impact on this chain of problems?

- A technical lead or coordinator
- Early culture and language training
- Resolve misunderstanding or conflict through phone call, voice chat or video conferencing
- Weekly coordination meeting with each sites
- Distribute required knowledge among sites through meetings
- Practice longer collaboration
- Coordinate process, development and schedule activities
- Allow team members to select communication tool according to their comfort
- Schedule weekly meetings with another site within time difference overlap
- Proper use of collaboration tools

- Other

18. In Global Software Development, communication problems occur due to language difference. Which of the following roles and responsibilities have a positive impact on this chain of problems?
    - Technical Supplier Manager
    - Early culture and language training
    - Maintain webpage of people regarding their designation and work of each site.
    - Weekly coordination meeting with each sites
    - Distribute required knowledge among sites through meetings
    - Practice longer collaboration
    - Responsible for all communication between the onsite and the offshore team. The onsite team has a communication partner for each issue
    - Other

19. In Global Software Development, coordination problems occur due to misunderstanding and misunderstanding occurs due to lack of culture training. Which of the following roles and responsibilities have a positive impact on this chain of problems?
    - Technical Supplier Manager
    - A technical lead or coordinator
    - Understands both cultures and understand the differences in order to mediate between the different teams when misunderstandings happens due to the different cultural backgrounds of the different locations
    - Early culture and language training
    - Resolve misunderstanding or conflict through phone call, voice chat or video conferencing
    - Weekly coordination meeting with each sites
    - Distribute required knowledge among sites through meetings
    - Practice longer collaboration
    - Coordinate process, development and schedule activities
    - Schedule weekly meetings with another site within time difference overlap
    - Proper use of collaboration tools
    - Allow team members to select communication tool according to their comfort
    - other

20. In Global Software Development, conflicts occur due to lack of culture training. Which of the following roles and responsibilities have a positive impact on this chain of problems?
    - Technical Supplier Manager
    - Understands both cultures and understand the differences in order to mediate between the different teams when misunderstandings happens due to the different cultural backgrounds of the different locations
    - Early culture and language training
    - Distribute required knowledge among sites through meetings
    - Selection of proper technology and its understanding

21. In Global Software Development, collaboration occur due to lack of cultural difference. Which of the following roles and responsibilities have a positive impact on this chain of problems?
    - A technical lead or coordinator
    - Liaison Engineer
    - Technical Supplier Manager
    - Early culture and language training
    - Understands both cultures and understand the differences in order to mediate between the different teams when misunderstandings happens due to the different cultural backgrounds of the different locations
    - Experience in project management, communication skills and should understand culture of other team
    - Help to adjust work schedule with respect to other team
    - Figuring out more online collaboration window with another team
    - Weekly coordination meeting with each sites
    - Distribute required knowledge among sites through meetings
    - Practice longer collaboration
    - Schedule weekly meetings with another site within time difference overlap

- Proper use of collaboration tools
- Other

22. In Global Software Development, coordination problem occur due to cultural difference. Which of the following roles and responsibilities have a positive impact on this chain of problems?
- A technical lead or coordinator
- Technical Supplier Manager
- Early culture and language training
- Understands both cultures and understand the differences in order to mediate between the different teams when misunderstandings happens due to the different cultural backgrounds of the different locations
- Experience in project management, communication skills and should understand culture of other team
- Coordinate process, development and schedule activities
- Allow team members to select communication tool according to their comfort
- Schedule weekly meetings with another site within time difference overlap
- Proper use of collaboration tools
- other

23. In Global Software Development, coordination problem occur due to misunderstanding and misunderstanding occurs due to cultural difference between sites. Which of the following roles and responsibilities have a positive impact on this chain of problems?
- A technical lead or coordinator
- Technical Supplier Manager
- Early culture and language training
- Understands both cultures and understand the differences in order to mediate between the different teams when misunderstandings happens due to the different cultural backgrounds of the different locations
- Experience in project management, communication skills and should understand culture of other team
- Coordinate process, development and schedule activities
- Allow team members to select communication tool according to their comfort
- Schedule weekly meetings with another site within time difference overlap
- Proper use of collaboration tools
- Resolve misunderstanding or conflict through phone call, voice chat or video conferencing
- Weekly coordination meeting with each sites
- Distribute required knowledge among sites through meetings
- Practice longer collaboration
- Other

24. In Global Software Development, there can be delay in project due to delay in resolving work issues. Which of the following roles and responsibilities have a positive impact on this chain of problems?
- Using richer interaction, i.e., high quality audio and video for effective conveying the nuances of expression more accurately in the need of urgency.
- Locate a person who has a previous experience in the task
- Conduct regular meeting for project tracking
- Other

25. In the Global Software Development, communication overhead occurs due to lack of modular approach. Which of the following roles and responsibilities have a positive impact on this chain of problems?
- Technical Supplier Manager
- Functional partitioning reduces feature dependency across sites
- Distributing the life-cycle phase to focus on certain phase of work
- Need for intensive collaboration is reduced by allowing optimum utilization of local skills
- Experience in project management, communication skills and should understand culture of other team
- Other

26. In Global software Development, development rework occurs due to lack of frequent communication. Which of the following roles and responsibilities have appositive impact on this chain of problems?

- Practice Frequent Communication
- During structuring of tem, find out the person whose skills best matches with the project nature or task nature
- Other

27. In Global Software Development, coordination problems occur due to lack of trust among teams and lack of trust occurs due to lack of communication infrastructure. Which of the following roles and responsibilities have a positive impact on this chain of problems?

- Technical Supplier Manager
- A technical lead or coordinator
- Responsible for all communication between the onsite and the offshore team. The onsite team has a communication partner for each issue.
- Can build a relationship with the onsite team, which can reduce the fear of the onsite people.
- Coordinate process, development and schedule activities.
- Allow team members to select communication tool according to their comfort
- Schedule weekly meetings with another site within time difference overlap
- Proper use of collaboration tools
- Other

28. In Global software Development, interaction barrier occurs due to lack of communication infrastructure between team. Which of the following roles and responsibilities have a positive impact on this chain of problems?

- Technical supplier manager
- Liaison engineer
- Responsible for all communication between the onsite and the off shore team. The onsite team has a communication has a communication partner for each issue
- Maintain webpage of people regarding their designation and work of each site
- Allow team members to select communication tool according to their comfort
- Resolve misunderstanding or conflict through phone call, voice chat or video conferencing
- Help to adjust work schedule with respect to other team
- Figuring out more online collaboration window with another team
- Other

29. In Global Software Development, coordination problems occurs due to lack of communication infrastructure between team. Which of the following roles and responsibilities have a positive impact on this chain of problems?

- Technical supplier manager
- A technical lead or coordinator
- Responsible for all communication between the onsite and the offshore team. The onsite team has a communication partner for each issue
- Coordinate process, development and schedule activities
- Allow team members to select communication tool according to their comfort
- Schedule weekly meetings with another site within time difference overlap
- Proper use of collaboration tools
- Other

30. In Global Software Development, there is difficulty in handling interdependencies occur due to lack of communication infrastructure between team. Which of the following roles and responsibilities have a positive impact on this chain of problems?

- A technical lead or coordinator
- Responsible for all communication between the onsite and the offshore team. The onsite team has a communication partner for each issue
- Personal visits and regular email
- Other

31. In Global Software Development, lack of communication infrastructure affects the quality of collaboration between team. Which of the following roles and responsibilities have a positive impact on this chain of problems?

- Liaison engineer
- Responsible for all communication between the onsite and the offshore team. The onsite team has a communication partner for each issue
- Help to adjust work schedule with respect to other team
- Figuring out more online collaboration window with another team
- Other

32. In Global Software Development, coordination problems occur due to misunderstanding and misunderstanding occurs due to lack of communication infrastructure between sites. Which of the following roles and responsibilities have a positive impact on this chain of problems?

- A technical lead or coordinator
- Technical supplier manager
- Responsible for all communication between the onsite and the offshore team. The onsite team has a communication partner for each issue
- Early culture and language training
- Resolve misunderstanding or conflict through phone call, voice chat or video conferencing
- Weekly coordination meeting with each sites
- Distribute required knowledge among sites through meetings
- Practice longer collaboration
- Other

33. In Global Software Development, conflicts occur due to lack of communication infrastructure. Which of the following roles and responsibilities have a positive impact on this chain of problems?

- Technical Supplier Manager
- Responsible for all communication between onsite and the offshore team. The onsite team has a communication partner for each issue
- Selection of proper technology and its understandings
- Distribute required knowledge among sites through meetings
- Other