PMCMG: Project Management Challenges Model for Global Software Development

BY

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Dedicated To

My parents

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I would like to thank Allah (SWT) for giving me the strength, patience and ability to accomplish my thesis work. Peace and blessing of Allah be upon his last messenger Prophet Mohammed (Sallallahu-Alaihe-Wasallam), who guided us to the correct path.

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ABSTRACT (ENGLISH)

Name : Mohammed Rehan Riaz

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In the last 10 years, many firms in the world have started adopting Global Software Development (GSD) to reduce their software development cost. Global Software Development (GSD) is the process where a company (client) gives all or part of its software development activities to another company (vendor), who provides services in return for financial compensation. GSD helps companies to leverage the benefits of multi-site development with respect to time, cost and access to skillful resource. Recent study shows that about 50% of the companies that tried global software development have failed to realize the expected outcomes. One of the major concerns is that most of the clients endorse global contracts with their vendors before testing their project management readiness for the global software development activities.

Hence, the objective of this thesis research is to address the project management problem and develop a comprehensive Project Management

Challenges Model for Global Software Development (PMCMG). PMCMG aims to evaluate strength and weaknesses in terms of designing, implementing, improving and measuring appropriate strategies to manage global software development operations of an organization. We followed a two-phase approach in making our research a comprehensive study. In the first phase we determined the challenges via a Systematic Literature Review (SLR) using customized search strings derived from our research question. We then complemented our findings with a Questionnaire survey answered by experts present in the software industry. Results from the case study show, PMCMG will provide software practitioners the ability to understand the pros and cons of current project management practices and address those areas which require remedial action.

Mohammed Rehan Riaz

ABSTRACT (ARABIC)

ملخص الرسالة

الاسم الكامل: محمد ريحان رياض

عنوان الرسالة: نموذج لتحديات إدارة مشاريع تطوير برامج الحاسوب عالميا (GSD)

التخصص: المعلومات وعلوم حاسوب

تاريخ الدرجة العلمية: ديسمبر 2013

في العقد الأخير من الفترة الماضيه، هناك كثير من الشركات حول العالم بدأت تتبنّى مفهوم تطوير نُظم الحاسوب عالمياً (GSD) وذلك لتقليل تكلفة تطوير تلك النُظم. مفهوم تطوير نُظم الحاسوب عالميا (GSD) يعرف بأنه علملية تعاقد شركة ما (عميل) مع شركة أخرى (بائع) لعمل تطوير لجزء أو كلٍ من أنظمتها الحاسوبية. هذا المفهوم يتيح لنا الفائدة من تطوير البرامج في أماكن متعدده حول العالم لفوائد عديدة أهمها الحصول على أكثر ساعات عمل من خلال فارق التوقيت بين المدن، وتقليل تكاليف تطوير النظم من خلال إيجاد مطورين بأقل تكاليف، وكذلك التعاقد مع مصادر ومطورين أكثر خبرة مما هو متوفر لدينا. إن الأبحاث التي أُجريت حديثاً بيّنت بأن نصف الشركات التي تبنّت مفوم تطوير برامج الحاسوب عالميا (GSD) فشلت لتحقق النتائج المتوقعه. ولقد كانت أحد القضايا الهامه هي أن العميل قد يؤيد عمل عقود مع البائع قبل أن يفحص مدى تجهيزات إدارة مشروع التطوير لديهم للبدء في تطوير نظم عالمياً.

ومن أجل ذلك، فإن الغرض من هذه الرسالة هو إبراز مشكلة إدارة المشاريع وتطوير نموذج شامل يتضمن التحديات التي تواجه إدارة المشاريع لتطوير نظم الحاسوب عالمياً، تم إطلاق إسم لهذا النموذج بـ (PMCMG). ذلك النموذج يهدف إلى تقييم نقاط القوة والضعف في تصميم وتنفيذ وتطوير وكذلك قياس التخطيط المناسب لإدارة نشاط تطوير نظم الحاسوب عالمياً لشركة محدده. لقد إتبعنا في بحثنا هذا طريقتين ذو مرحلتين متاليتين لجعل بحثنا هذا يفيدنا بدراسة شاملة. في الخطوة الأولى قمنا بتحديد التحديات من خلال منهجية مراجعة الأبحاث السابقة Systematic Literature Review (SLR) بإستخدام كلمات بحث محددة ومشتقة من سؤال البحث الذي قمنا بتحديده. بعد ذلك أكملنا نتائجنا بعمل إستبيانات تم الإجابة عنها من قبل خبراء في المجال العملي لتطوير نظم الحاسوب. النتائج من هذه الدراسة أظهرت بأن النموذج المُعَد (PMCMG) يستيطيع أن يزود الخبراء في مجال الأعمال بالقدرة على فهم الإيجابيات والسلبيات لإدارة مشروع معين وإبراز أهم التحديات التي تحتاج إلى لفت الإنتباه والتعامل معها لإيجاد الحلول المناسبه لها.

CHAPTER 1

INTRODUCTION

1.1 GENERAL

Global Software Development (GSD) is a modern software engineering paradigm. Global Software Development (GSD) is the process where a company (client) contracts all or part of its software development activities to another company (vendor), who provides services in return for a financial compensation. Over the past 10 years, many organizations across the globe have started adopting GSD in order to reduce their software development cost. GSD helps companies to leverage the benefits of multi-site development with respect to time, cost and access to skillful resource. Software development outsourcing has been rising steadily and an 18-fold increase in the outsourcing of IT-enabled business processes is estimated[1]. Small and medium sized organizations can use outsourcing to address their issues of limited resources and lack of technical expertise. This creates a business opportunity for the Vendor organizations and hence they are struggling to contest internationally

in attracting software development projects. Previous research suggests that 50 % of the companies that have tried global software development (outsourcing) have failed to realize the projected outcomes which has resulted in poor global relationships, misunderstanding the projects' requirements, high costs and poor services [2, 3]. One of the major concerns is that most of the clients endorse global contracts with their vendors before testing their project management readiness for the global software development activities[2, 4].

1.2 PROBLEM STATEMENT

Despite the significance of this problem, little research has been carried out to improve organizations project management readiness for global software development. Understanding issues relating to organizations global project management readiness will help to ensure successful outcome of projects and to maintain long lasting relationships between clients and vendors at different geographical locations. Due to the increasing trend of GSD we are hence interested to discover and solve the project management challenges in GSD projects. Hence, the objective of this thesis research is to address this problem and develop a comprehensive Project Management Challenges Model for Global Software Development (PMCMG). This model can serve as a documentation guide or as a software tool for project managers present both

at the client and at the vendor site. This model will help managers and software practitioners to assess their readiness level in managing global software development projects.

1.3 THESIS OBJECTIVES

The objective of this thesis is to answer our main research questions which are the following:

RQ1: What are the challenges of project management in GSD projects?

RQ2: What are the possible solutions for the identified challenges of project management in GSD projects?

The above two research questions will be answered using the following research methodologies:

1. Systematic literature review (SLR).

2. Empirical study with software industry.

We plan to employ novel approaches for the development of PMCMG. For e.g., we will use the concept of systematic literature review [5] and we will also empirically explore the experiences of experts regarding project management

readiness in global software development projects. In order to accomplish our objective the following tasks are performed.

1. Identify the challenges of project management in GSD with the help of Systematic Literature Review (SLR) methodology.
2. Validate our findings by doing empirical study with software industry experts.
3. Develop a set of guidelines/model i.e. PMCMG, using our empirical findings so as to improve organizations project management readiness.
4. Evaluate PMCMG with the help of case study conducted in real world environment and analyze the results.
5. PMCMG will be available as a documentation guide in order to facilitate practitioners in measuring their organization's global project management readiness level.

1.4 RESEARCH APPROACH

In order to achieve objectives we have designed an appropriate research methodology in which data will be collected from project managers as well as from the published literature (i.e. via a systematic literature review process) [5]. This two-step process will give us confidence in the reliability of the data

collected. In addition to this we also plan to conduct a case study in order to assess the PMCMG model in a real world environment.

A Systematic Literature Reviews (SLR) require more effort than conventional literature reviews, but provides a much stronger base for making claims to answer research questions. An SLR is a defined and methodical way of identifying, assessing, and analyzing published primary studies in order to investigate specific research questions presented in section 1.3. Figure 1.1 explains and gives an overview of a Systematic Literature Review (SLR). The rationale behind doing the SLR is to identify project management challenges in GSD. We will be following the systematic literature review guidelines given by Barbara Kitchenham [5].

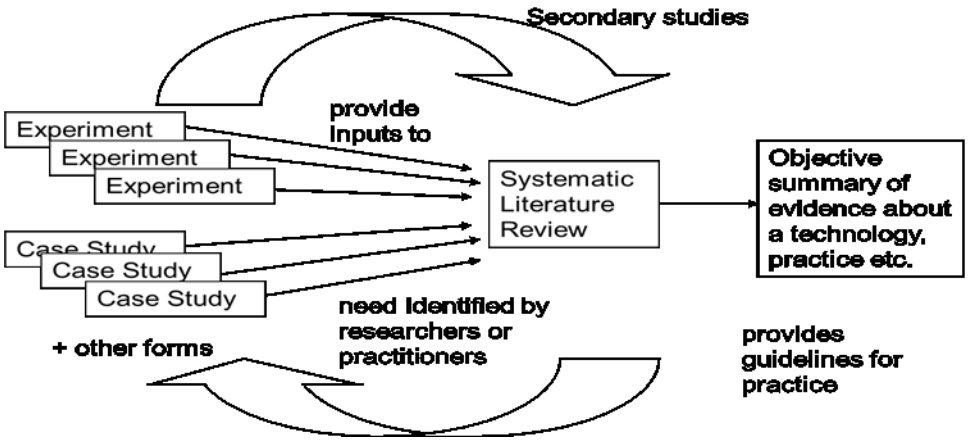

Figure 1.1: Overview of SLR[5].

Any SLR would have the following process in a step by step manner as shown in Figure 2:

1. Description of a systematic review protocol
2. Defining search strategy using major terms from the break up of the research questions.
3. Definition of the inclusion and exclusion criteria for selecting studies.
4. Extraction and synthesis of relevant data answering the research questions.
5. Description of quality assessment mechanisms.

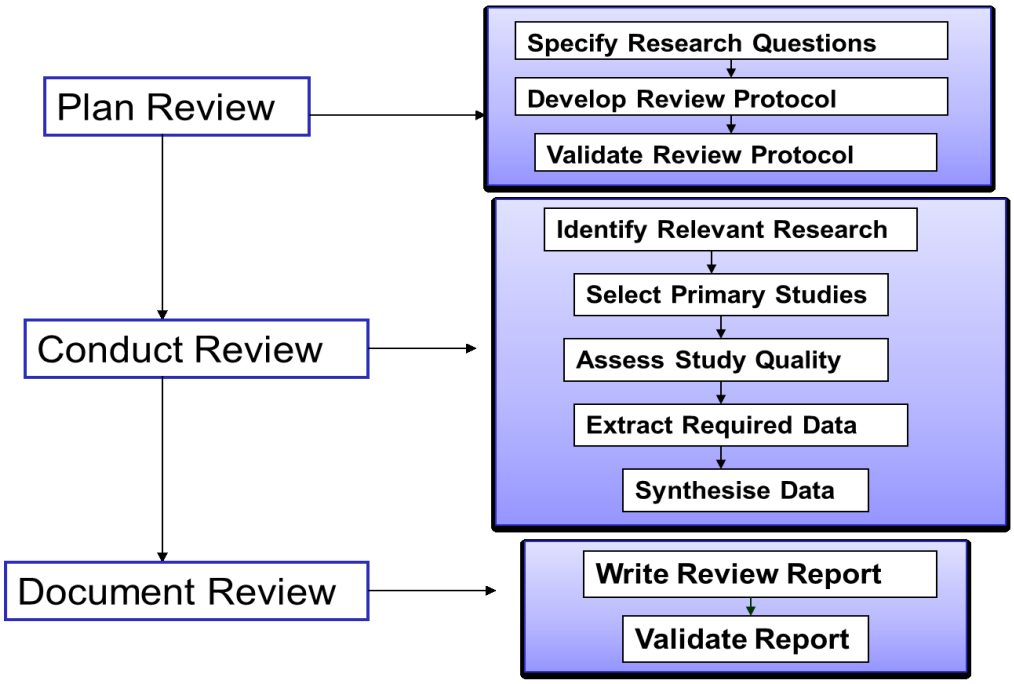

Figure 1.2: A Step by Step process of SLR [5].

Once the data (i.e. challenges of project management in GSD) is collected from published literature we will do a frequency analysis on it to know the

frequently occurring critical challenges. We will then validate our findings using online questionnaire given to industry experts. At the same time we aim to collect best practices to handle the identified challenges from industry with the help of our online questionnaire. This will help us in designing a comprehensive project management challenges model for global software development (PMCMG). After that we plan to evaluate PMCMG by conducting a case study in a real time environment.

Our research methodology and approach can hence be summarized into the following phases:

Phase 1: Systematic Literature Review

In this phase, we aim to search and cover about 5 online research databases (i.e. IEEEXplore, ScienceDirect, ACM, John Wiley and Springer Link) for our SLR.

Phase 2: Empirical Study with Industry Experts

In this phase, we plan to validate our findings with the help of an online questionnaire given to industry experts.

Phase 3: Design PMCMG Framework/Model

Design the framework/model by collecting best practices from industry and using existing assessment tools like Motorola Instrument.

Phase 4: PMCMG Case Study

We then plan to evaluate PMCMG by conducting a case study in a real time environment.

Phase 5: Conclusions

The conclusion of the research is then presented.

1.5 THESIS OUTLINE

The remaining sections of the thesis are organized as follows. Chapter 2 presents basic terminology and background information on GSD. We reviewed the related works in Chapter 3. Chapter 4 presents our two-phased research methodology. In Chapter 5, we present an in-depth analysis of our results. Chapter 6 covers evaluation of the framework using a case study in a real time environment. Finally, Chapter 7 concludes the thesis and suggests some future work.

CHAPTER 2

BACKGROUND AND OVERVIEW

This chapter presents basic terminology and background information on Global Software Development (GSD). Section 2.1 explains about GSD and various types of Global Software Development.

2.1 WHAT IS GLOBAL SOFTWARE DEVELOPMENT?

Global software development, or software development outsourcing, is a recent software engineering paradigm which aims to develop high-quality software in cheaper countries at reduced cost [6]. Software development outsourcing is a contract-based relationship between client and vendor organizations in which a client contracts out all or part of its software development activities to one or more vendor, who provide agreed services in return for financial compensation [7].

Different types of software outsourcing can be grouped into the follow two categories. Figure 2.1 presents the various types of outsourcing [8].

(i) Types of software outsourcing on the basis of geographic location:

On the basis of geographic distance between vendors and clients, outsourcing is categorized into three types: onshore outsourcing, near shore outsourcing and offshore outsourcing [9].

•Onshore outsourcing

Onshore outsourcing is also called domestic outsourcing, which consists of both domestic vendors and domestic clients [10]. This means that both (vendor and client) organizations are positioned in the same country.

•Near shore outsourcing

Near shore outsourcing or simply near shoring is defined as the transfer of software development work to a nearby foreign country to reap lower labor cost advantages [11]. The term Near shore was first introduced in a story about an entrepreneurial software development venture called PRT that was established in the Caribbean island of Barbados during the years 1995-1998[12]. During this period the word "near" referred to closeness to the United States from geographic point of view while "far" referred to the geographic distance of the client firms in the United States from the Indian vendors. An example of the Near shore outsourcing destination for the outsourcers in the United States is Canada [13].

•Offshore outsourcing

Offshore software development outsourcing refers to outsourcing in a geographically distant country. It is also referred to as far shore outsourcing in the published literature but the terms 'offshore outsourcing' or simply 'software outsourcing' have been used more frequently in the literature. The offshore activities have been going on from the past decade and are increasing quickly [14]. The major vendor countries for offshore outsourcing are China, Russia, Ireland and India whereas the client countries are the North America, Australia and Japan [15]. In providing offshore outsourcing services, India has a majority of the IT market share which is then followed by China [16].

(ii) Types of outsourcing on the basis of relationship

Oh and Gallivan [17] have categorized the offshore outsourcing relationships into 4 different types, based on the number of clients and vendors involved in the outsourcing contract. These are Complex Relationships, Co-Sourcing Relationships, Multi-Vendors Relationships, and Simple Dyadic Relationships.

•Simple Dyadic Outsourcing Relationship

In a Simple Dyadic Relationship, there is one client and one vendor involved in the outsourcing contract. The client outsources its software

development activity to a single vendor who is alone responsible for the fulfillment of the job as per the clients' instructions [17].

In the case of a simple dyadic outsourcing relationship, when the relationship between vendor and client is on micro/personal level instead of a macro/organizational level, the outsourcing relationship is called Microsourcing [18].

Microsourcing is also termed 'personal work outsourcing', which is a type of outsourcing relationship on micro/individual level [18]. The situation occurs when an individual (client) outsources his/her own personal software development work to another person/programmer who provides services in return for financial compensation [18].

•Multi-Vendors Outsourcing Relationship

In a Multi-Vendors Relationship, there is one client and many vendors involved in the outsourcing contract. The client relies on more than one outsourcing vendors for the fulfillment of their software development activities. In this type of agreement/contract one client and many vendors are involved who consult each other to benefit from each other's' expertise and to settle the outsourcing task jointly [17].

•Co-sourcing Relationship

In Co-sourcing Relationship, many clients' firms are involved with one vendor for the OSDO activity. It is the inverse of Multi-Vendors Relationship. In this type of outsourcing, the relationship evolves in a situation where two or more outsourcing clients need common software for their operations. They therefore jointly outsource the software development project to a single vendor. This type of situation arises in organizations like hospitals etc. that need identical or similar software for some of their activities [17].

- **Complex Outsourcing Relationship**

This type of relationship comprises multiple clients and multiple vendors. The situation occurs when two or more outsourcing clients' organizations need a common software solution for their business and hence they outsource the project to multiple vendors who work on its development jointly like partners [17].

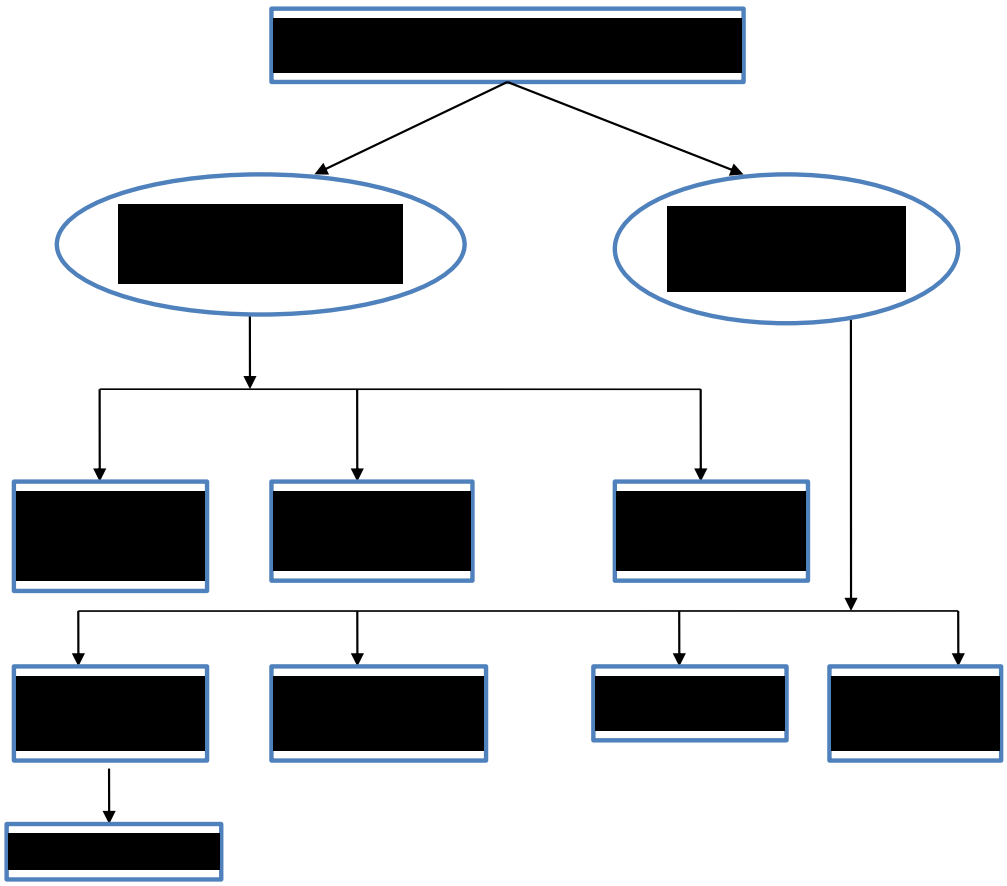

Figure 2.1: Types of Outsourcing[19]

CHAPTER 3

LITERATURE REVIEW

In this section we present a brief review of the related and current literature with respect to motivation, risks and existing work on global software development. Motivations and risks of Global Software Development (GSD) are discussed in section 3.1. Section 3.2 gives an overview of the existing work carried out so far on GSD topic.

3.1 MOTIVATION AND RISKS OF GSD

There are several causes for initiating global software development project [11, 20]. Client organizations benefit from offshore outsourcing because vendors in developing countries (offshore vendors) typically cost 1/3rd less than onshore vendors and even less when compared with in-house operations [21]. Amongst many other reasons for outsourcing, generally client organizations outsource their software development work to offshore locations to gain cost and quality advantages, access to leading-edge technology and the ability to focus on core competencies [11]. Moreover, offshore vendors improvise on their skills and quality of service with the

increase in experience of offshore outsourcing projects [10]. Conversely quite apart from the outsourcing benefits there are many risks in an outsourcing process [22],[23], such as temporal incompatibility, cultural differences and hidden costs.

Reduction of cost is the major promoter for software outsourcing [24]. Other promoters for outsourcing comprises of access to cutting edge technology and to focus on core business model of the organization [25].

Offshore outsourcing is not a risk free activity as significant outsourcing failures have been reported [26]. Islam et al, [3]argue that lack of understanding between the client and vendor organization, ambiguous requirements and ineffective development processes may yield substantial risks. The results of a survey shows that eight out of every ten firms that have outsourced their software development project to an offshore vendor have faced major problems due to insufficient preparation and poor management by both the vendor organizations. King [27] reports that JP Morgan, a world renowned financial firm decided to go for in house software development which lead to non-renewal of USD 5 billion $ contract with IBM.

3.2 EXISTING WORK IN GSD

This section presents a review of the key studies conducted on the topic of global software development. The objective is to summarize and discuss the results of each study in order to better recognize the context of the problem.

- A study was conducted at Hertfordshire University in the UK to examine the various types of outsourcing relationships [28]. The emphasis of this study was to manage offshore software outsourcing relationships and as a result of the study a model was developed. The focus of the model was on Indian IT organizations and their client organizations based out of Europe and USA.

- Nguyen et al. [29] conducted a related study wherein they have examined the offshore outsourcing relationships between the IT vendors in Vietnam and their corresponding clients present in the USA and Europe. In this study the focus of the author was establishing trust in between client and vendor.

- Sabherwal [30] have also worked in domain of trust in software outsourcing relationships where different case studies were conducted with

vendor organizations present in Sri Lanka and India and with client organizations in the UK, USA, Netherland, Oman and Thailand.

• Rajkumar and Dawley [31] have focused their research work on the offshore software outsourcing benefits and risks that are applicable to the Indian IT industry playing the role of vendors with respect to the clients who reside in USA. A similar research study was carried out by Khan et al. [32] to examine the scale and scope of offshore software outsourcing risks and benefits for Indian IT industry. Their research is based on an empirical investigation of the vendor organizations present in India and client organizations present in the United Kingdom. Sakthivel [33] also recognized various risks related with offshore outsourced software development projects. Charalambos and Robbie [34] identified a risk profile of offshore software development projects that have outsourced from client organizations in USA to Indian IT vendors.

• Narayanaswarmy and Henry [35] have focused their research work on the management side of the outsourced software development projects. A research model was suggested in which culture was considered as an important factor affecting the choice of control mechanisms in offshore IT projects.

• Aubert et al. [36] have developed a framework for the completeness of outsourcing contracts and associated costs in order to minimize risks. They conducted an empirical study in order to measure different levels of outsourcing contract.

• Jahns et al, [37] have reviewed the literature to investigate the term offshoring and its driving forces on the environmental and company level. The impact of four environmental segments is widely explored. These segments are economic, socio-demographic and political-legal forces.

• Chou et al, [38] have worked on outsourcing relationships. Based on case study at Taiwanese large sized organizations various pre-contractual relational ties were identified. These relational ties have been categorized into business interdependencies ties, technical source ties, capital funding ties and human capital ties. They claim that the vendor's prior knowledge and experience in outsourcing projects along with the vendor's prior relationships with client organization play a vital role in the success of outsourced projects.

• Hanna and Daim [39] have conducted two interviews, based on a literature survey for outsourcing management practices, with decision-makers in two organizations. The aim was to investigate best management practices

for successful outsourcing relationship. The study identified trust and security as the critical success factors in successful outsourcing relationships.

Most of the existing studies focus on the topics of 'outsourcing relationship' and 'outsourcing trust'. Even though these are important research areas to be addressed , research suggests that 50 % of the organizations that have tried global software development have failed to realize the anticipated results [2]. There are many reasons for these failures. One of the major issues is that many clients endorse global contracts with their vendors prior to testing their project management readiness for the global activity[2]. For example, a recent Systematic Literature Review concludes that the Global Software Engineering field is still nascent and comparatively fewer empirical studies have been conducted in order to provide solutions to the problems in this domain [14]. "The majority of the studies represent problem-oriented reports focusing on different aspects of GSE (Global Software Engineering) management rather than in-depth analysis of solutions for example in terms of useful real-world practices or techniques"[14]. Despite the importance of this problem, little research has been carried out to improve organizations project management readiness for global software development. Understanding issues relating to organizations global project management readiness will help to ensure the positive outcome of projects and to maintain long lasting

relationships between clients and vendors present at various geographical locations [22].

CHAPTER 4

RESEARCH METHODOLOGY

4.1 INTRODUCTION

We followed a two-phase approach in making our research a comprehensive study. In order to address our research questions, we applied the Systematic Literature Review (SLR) and empirical survey approaches. In the first phase we determined the challenges via a Systematic Literature Review (SLR). We then complemented the findings with a Questionnaire survey. We discuss the each of the research methodologies in detail in the following sections. Section 4.2 explains the whole SLR process which includes developing an SLR protocol, clean and processes the findings via initial and final study selection, validation and filtration using quality assessment techniques, data synthesis and proof reading. Section 4.3 explains the Questionnaire Survey in detail which was answered by 41 experts belonging to Fortune 500 companies and various geographical locations across the globe. The participants were asked to rank each challenge on a five-point scale to

determine the perceived importance of each challenge. The survey included challenges identified in during our systematic literature review.

4.2 DATA COLLECTION VIA SLR

SLR is a defined and methodical process of assessing, identifying and analyzing published primary studies in order to investigate a specific research question [5]. Systematic reviews differ from ordinary literature as the surveys are formally planned and methodically executed.

A systematic review protocol was written to describe the plan for the review. The major steps in our methodology are:

•Constructing search strategy and then perform the search for relevant studies.

•Perform the study selection process.

•Apply study quality assessment.

•Extract data and analyze the extracted data. This paper focuses on the challenges of project management in global software development. In order to do that, we are intended to address the following research question:

RQ1: What are the challenges of project management in GSD projects?

Our search strategy is based on the following steps:

- Derive the major terms from Population, Intervention and outcome.
- Find synonyms and similar spellings of the derived terms obtained above.
- Verify these terms in various academic databases
- AND operator is used to connect major terms (if allowed).
- OR operators, is used to connect synonyms and similar spellings. (If allowed).

Based on the above search strategy we have constructed the following search terms:

- POPULATION: Global Software Development (GSD) organizations.
- INTERVENTION: Project management challenges and barriers.
- OUTCOME OF RELEVANCE: challenges and barriers in project management of GSD.
- EXPERIMENTAL DESIGN: SLRs, empirical studies, theoretical studies and expert opinions.

We tested our terms in various academic databases and the following terms shows potential relevance to the topic:

•GLOBAL SOFTWARE DEVELOPMENT: Global Software Development OR GSD OR distributed software development OR multisite software development OR multi-site software development OR global software teams.

•PROJECT MANAGEMENT: Software Project Management OR Software Development Management OR Software Process Management.

•CHALLENGES: Challenges OR Barriers OR Problems OR Difficulties OR Complications OR Obstacles OR Hurdles OR Risks.

After trial search we have designed the final search string:

{Global Software Development OR GSD OR distributed software development OR multisite software development OR global software teams} AND {Software project management OR software development management OR software process management} AND {Challenges OR problems OR difficulties OR complications OR obstacles OR barriers OR hurdles OR risks}

Based on the available access, the following digital libraries were used:

- ACM Digital Library. (http://dl.acm.org)
- IEEE Explore. (http://ieeexplore.ieee.org)
- Science Direct. (http://www.sciencedirect.com/)

- Google Scholar (http://scholar.google.com/)
- ISI Web of Science. (http://wokinfo.com/)
- Springer Link. (http://link.springer.com/)

Since these libraries differ in their search mechanism and capability, we tailored our search strings accordingly.

The following inclusion criteria were used:

1. Conference Proceedings, Magazines and Journals published after 1980.
2. Papers published in any of the primary or secondary resources mentioned previously.
3. Studies focus on answering our research question.
4. Studies focus on enhancing collaboration, communication or productivity.
5. Studies focus on motivation factors or de-motivation factors.
6. Studies foresee the future of social computing tools in aiding software projects.

The following exclusion criteria were used:

1. Papers published before 1980 are excluded since Internet starts after that date.
2. Manuscripts written in non-English language are excluded.
3. Poor English writing papers are excluded as it may cause ambiguity.
4. Pure psychology or motivation studies are rejected.
5. Papers that show adoption of collaboration tools in a single department are excluded.
6. Technical reports and white papers are excluded.
7. Graduation projects, mater thesis and PhD dissertation are excluded
8. Textbooks whether in print or electronic are excluded from this systematic review.
9. Studies in other domains of knowledge like civil engineering projects are excluded

For any paper to pass the initial phase, a quality assessment was done. We have to assess the quality of the literature selected after final selection for its quality. The quality assessment activity for the relevant literature will be carried out at the same time during the extraction of relevant data so as to

ensure that a valuable contribution is made to the SLR. We will detail a quality assessment checklist that will provide means to quantitatively assess the quality of the evidence presented by these studies. However, these checklists are not meant to be a form of criticism of any researchers' work and any changes to the quality assessment criteria as such will be documented. Four quality criteria were prepared as shown in Table 4.1.

TABLE 4.1: STUDY QUALITY ASSESSMENT TABLE

Criteria	Notes
Are the findings and results clearly stated in the paper?	Yes =1 No =0
Is there any empirical evidence on the findings?	Yes =1 No =0
Are the arguments well-presented and justified?	Yes =1 No =0
Is the paper well referenced?	Yes =1 No =0

After the final selection of primary studies depending upon the quality assessment criteria we have to start with the data extraction phase of the systematic literature review process. We will use the data extraction form to extract the data. The data will be extracted by a single reviewer and will be assessed by a PhD supervisor in a random manner. Table 4.2 represents the data extraction form which will be used for the purpose of extracting relevant data from primary studies:

TABLE 4.2: DATA EXTRACTION FORM

Data Item	Value	Supplementary Notes
Study Information Data		
Paper ID		
Date of Review		
Title		
Author(s)		
Year of publication		
Geographical Location		
Reference type	Journal/Conference/Thesis/Unpublished	
Type of Study	SLR/Interview/Case Study/Report/Survey	
Publisher		
Data Relevant to Answering Research Questions		
Challenges of project management		
Solutions to the identified challenges		

The data extracted from the primary studies will be saved as a Microsoft Excel document in < paper id >_<author name>_<year of publication> format. After the extraction of data we will use the data synthesis form as shown in Table 4.3, to summarize and compile the extracted data from the primary studies so as to answer each of the research questions. This form helps to carry out various types of statistical analysis so as to draw conclusions.

TABLE 4.3: DATA SYNTHESIS FORM

RQ1: What are the challenges of project management in GSD?						
Paper ID	Quality (score)	Population (e.g. project management)	Geographical location	Year of study	Type of Study	Challenges of project management in

After data extraction and synthesis we have finally selected 83 articles which met our inclusion and quality criteria. From the finally selected papers, we have extracted data in order to address our research question. The following data was extracted from each paper: Publication Type, Authors, Publisher, Publication Name, Publication Date, Organization Size, Project Size and Project Management Challenges. The total number of results retrieved after inputting the search terms in the electronic databases are shown in Table 4.4. After the initial round of screening by reading the title and abstract, about 187 studies belonging to five different electronic research databases were selected. After full text readings in the second screening, 83 primary studies were finally selected.

TABLE 4.4: INITIAL RESULTS FROM SEARCH EXECUTION

Resource	Total Results	Initial Selection	Final Selection
IEEExplore	786	87	43
ACM	73	13	7
Science Direct	353	28	10
Springer Link	648	41	18
John Wiley	39	18	5

Total	1899	187	83

4.3 DATA COLLECTION VIA QUESTIONNAIRE SURVEY

Based on our SLR findings, we developed the empirical survey questionnaire to identify challenges of project management in GSD. An empirical survey is suitable for collecting self-reporting qualitative and quantitative data from a large number of participants [40]. A survey research method can use one or a combination of data techniques such as self-administered questionnaires, interviews and others [41]. We decided to use a questionnaire-based survey as a data collection instrument in order to collect data from diverse range of experts present in the IT software industry who are involved in GSD projects.

We developed a closed format questionnaire as an instrument to collect self-reported data at King Fahd University of Petroleum and Minerals, Saudi Arabia. The questionnaire was based on the 19 challenges (identified via systematic literature review) that are important for managing GSD projects. The questionnaire also included some open ended questions that provided an opportunity to participants to include additional challenges or suggestions. The questionnaire was designed to elicit importance of identified challenges

from the industry's perspective. The survey participants were asked to rate each challenge's relative importance as either 'strongly agree', 'agree', 'strongly disagree', 'disagree', or 'not sure'.

The questionnaire was tested by the means of a pilot study by involving five software engineers from industry. Based on this pilot study, the final version of the questionnaire was developed. The final version of the questionnaire is divided into three sections: section one is about demographics data, section two presents the challenges in the GSD projects; and in section three, survey participants provide a list of practices or solutions which can best handle those challenges. Confidentiality of information and data was notified to the participants before they participated in the survey, as the data was used only for academic and research purposes only. The objective of this research is to identify and understand the key challenges of project management GSD; and hence, there is a need to collect data from diverse range of participants involved in GSD across the word. The participants for this study were recruited by using the snowball technique [40]. The participants were contacted via different sources such as personal contacts, LinkedIn, previous company employees, colleagues etc. to invite them to participate in our empirical study. Once agreed, the participants were emailed the link for the web-based survey, which they were asked to forward on to other potential

participants within their organizations. We invited 70 people, out of which about 41 participants completed the survey with a response rate of 58%. The completed questionnaires were manually reviewed for correctness and completeness so as to exclude and prevent any irrelevant entries into the survey. However, no irrelevant entries were found. These participants are from 3 different continents with a majority from Asia and North America. These participants work for organizations that are involved in software development projects ranging from business intelligence to data processing systems. Furthermore, the participants' role in the organizations ranged from software developers to software project managers with direct experience in GSD projects.

In total, 41 participants completed the survey. The completed questionnaires were manually reviewed for correctness and completeness so as to exclude and prevent any irrelevant entries into the survey. However, no irrelevant entries were found. We used the frequency analysis method to organize the data into group scores as it is helpful for the treatment of descriptive information. Frequency tables will help in showing the number of occurrences and percentages of each data variable. Frequencies are helpful for comparing and contrasting within groups of variables or across groups of variable and can be used for ordinal, nominal or numeric data. In order to

analyze the strength of identified challenge, the occurrence of number of agreements on each challenge present in the questionnaire was counted and then compared with respect to other challenges.

CHAPTER 5

RESULTS AND DISCUSSION

5.1 INTRODUCTION

In this chapter we present the results and analysis from our two phased research methodology. Section 5.2 explains about the findings from the SLR. Findings from the questionnaire survey are explained in Section 5.3. Section 5.4 compares the results between the research approaches using various types of statistical analyses. We further discuss and consolidate the results in the discussion section present in 5.5. We then discuss the limitations of our research in Section 5.6.

5.2 FINDINGS FROM SLR

This section presents the initial SLR-based literature survey results. The total number of results retrieved after inputting the search terms in the electronic databases are shown in Table 4.4. After the initial round of screening by reading the title and abstract, about 187 studies belonging to five different

electronic research databases were selected. After full text readings in the second screening and application of inclusion and exclusion criteria, about 83 primary studies were finally selected. We analyzed each publication and extracted about 19 relevant challenges. The identified list of 19 challenges for project management in Global Software Development is shown in Table 5.1.

TABLE 5.1: LIST OF CHALLENGES

Challenges	Freq. (n=83)	%
Lack of cultural understanding in teams	73	88
Lack of Communication	48	58
Time zone problem.	34	41
Lack of co-ordination	32	39
Lack of knowledge management and transfer among teams	30	36
Geographical distance	25	30
Lack of trust	25	30
Lack of Control	22	27
Requirement Engineering activities.	21	25
Lack of team awareness	19	23
Change management activities.	17	20
Lack of a uniform process among different development sites	17	20
Conflict management	14	17
Integration activities	14	17
Allocation of tasks	13	16
Risk Management	11	13
Lack of proper IT infrastructure	10	12
Protection of Intellectual property	9	11
Cost and effort estimation	8	10

Table III answers our first research question (RQ1) i.e. on challenges of project management present in the published literature. In our study, the most common project management challenge in GSD is the 'lack of cultural

understanding in team' (88%). The fact that in a global software development environment the team members are spread across the globe and may belong to different cultures is a challenge for the project manager to handle. In some cultures it is considered impolite to speak in team meetings without being asked to do so [42]. Due to cultural differences it is always difficult for both the client and vendor organizations to communicate with each other as the native language will generally not be the same [43]. Another issue is different levels of understanding of a common language (generally English) [44]. Messages can be misinterpreted by team members from different cultures which can cause confusion and misunderstandings between different teams [45]. Hence, we can deduce that 'lack of cultural understanding' challenge gives rise to other project management challenges like lack of communication and lack of trust which can impact the whole GSD process in a negative way.

The second highest frequently mentioned challenge in our study is 'lack of communication' (58%). Since the development sites are spread across geographical boundaries, communication between different sites is an issue. Different studies have described 'lack of communication' issue in GSD projects: Tsuji et al. [20]concluded that communication capabilities have a significant impact on the results of GSD projects; Ericksen and Ranganathan[46] have described the case of one offshore software development outsourcing project

which completely failed due to the lack of adequate communications. Communication is generally of two types i.e. synchronous and asynchronous. By synchronous communication we mean face to face meetings and discussion with team members and client. As GSD is different from a collocated development due to the geographically distributed teams (as shown in Figure 5.1), communicating face to face is not possible unless team members travel between development sites. Lack of face to face meetings can cause other project management challenges like misunderstanding of requirements, lack of team awareness and lack of trust in GSD [44]. Hence, GSD relies on other synchronous and asynchronous communication channels such as e-mail, voice mail, instant messenger, teleconferencing and web conferencing to promote communication.

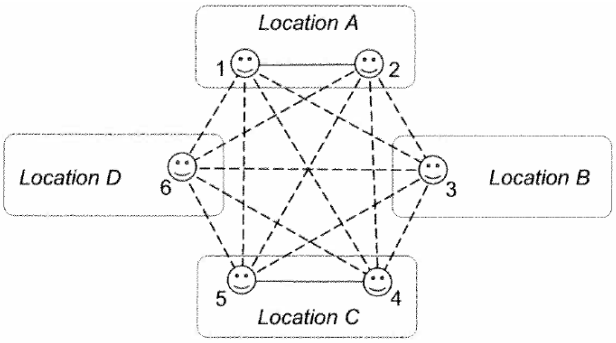

Figure 5.1: Communication in GSD[19].

More than 40% of the articles mentioned 'time zone problem/ graphical distance as the challenge of project management in GSD projects. This challenge generally arises if the development sites are situated in different time-zones [44]. The reason behind this challenge is non-overlapping of business hours between the development sites. This reduces the possibility of having a synchronous communication between team members [22]. This also becomes a difficult challenge with the increase in the number of development sites in GSD. This challenge can negatively impact GSD projects by causing delays in response time.

Lack of co-ordination has been mentioned in about 39% of the articles. The main reason for this challenge is the difference in time zone between different development sites [47]. The other reasons for this challenge include geographical and socio-cultural distance [48]. This challenge becomes even more difficult to handle if the size of the project is too large. When the team members are dispersed, it is difficult for the project manager to co-ordinate with every team member. Often decrease in communication among team members can lead to lack of team awareness which causes delayed or improper feedback on project status. In addition to this, lack of co-ordination can give rise to and affect many other project management challenges such as change

management activities, lack of trust and conflict management among all stakeholders.

About 36 % of the articles in our study described 'lack of knowledge management and transfer among teams' as another major challenge faced by project managers in GSD projects. This is a very critical challenge as knowledge transfer (KT) is a must for any kind of project transition (e.g. a project hand over) or if new employees are joining to a particular team [45]. Since staff turnover is generally high in offshore locations, improper knowledge transfer can lead to project management challenges such as poor quality of software artifacts and documents and lack of team awareness.

Nearly quarter of the articles has mentioned 'geographical distance' as a challenge. It is quite an evident challenge given the nature of the GSD. Geographical distance should be measured with respect to ease of relocation rather than in terms of kilometers [22]. For various GSD activities such as promoting informal communication, carrying out requirements engineering activities, cultural understanding and knowledge management, many employees often need to travel between different sites.

Logistical issues such as flight connectivity, visa issuance and ease of local transport determine the geographical distance between two development sites

[22]. Hence, two locations having proper transport infrastructure are geographically close even if the physical exist. A high geographical distance can cause loss of communication, delays, conflicts among stakeholders, lack of project visibility and requirement elicitation problems [22].

One of the key challenges in GSD projects is creating confidence and trust among different teams [49]. This has been depicted in our SLR study where more than 30% of the articles have mentioned this as a project management challenge in GSD projects. In general, researchers agreed that trust refers to an aspect of a relationship between client and vendor in which the parties are willing to establish a relationship that will result in a positive desired outcome. It is always difficult to create such a relationship unless one is fully familiar with all members of the globally distributed team.

Our second research aspect focuses on the type of study strategies used to identify the challenges present in the literature. Table 5.2 and Table 5.3 gives the summary of challenges found in each type of study strategy found in the published literature.

TABLE 5.2: STUDY STRATEGIES USED

Study Type	Count
Case Studies	37
Interviews	7
Experience Reports	12
Systematic Literature Reviews	10

Survey	7
Literature Reviews	8
Delphi Study	2
Total	83

We have grouped the papers found through SLR into seven study strategies, which are commonly used in the empirical software engineering, as shown in Table 5.2. These study strategies are classified as case studies, interviews, experience reports, systematic literature review (SLR), survey, Literature Reviews and Delphi Study. These seven study strategies were initially identified by the primary reviewer during the data extraction process. However, secondary reviewer has validated these study strategies using the inter-rater reliability test.

Table 5.3 depicts the distribution of the identified challenges across the seven study strategies. Our results show that all the 19 identified challenges were present in the case study approach. Out of the 19 challenges, 10 challenges in case studies, 5 challenges in literature and 4 challenges in experience reports have been cited in more than 50 % of the total selected papers. 'Lack of cultural understanding' is the most frequently cited challenge (89%) in case studies which is then followed by 'Lack of communication' cited by (59%) of case studies conducted so far. 'Time zone' problem is frequently cited challenge (57%) in Interviews and 'Lack of knowledge management and

transfer among team's a significant cited challenge (75%) in Literature Reviews.

Our aim is also to find whether these challenges differ from one study type to another. This will help us to know the similarities and differences in these challenges which are found in the several of type of study strategies. For that purpose we have used chi square statistical test. As the data was of ordinal nature, linear by linear association chi-square test was used in order to find significant differences between challenges across the study strategies. The linear by linear association test is preferred when testing the significant difference between ordinal variables because it is more powerful than the regular Pearson chi-square test.

TABLE 5.3: CHALLENGES BASED ON STUDY STRATEGIES

Challenges	**Study Strategies**							**Chi-square Test (Linear-by-Linear Association) $\alpha = .05$**		
	Case Study (n=37)	Interviews (n=7)	Experience Reports (n=12)	SLR (n=10)	Survey (n= 7)	LR (n=8)	Delphi Study (n=2)			
	Freq	Freq	Freq	Freq	Freq	Freq	Freq	X^2	df	P
Lack of cultural understanding in teams	33	4	11	9	6	8	0	.016	1	.900
Lack of Communication	22	3	4	6	7	4	2	.591	1	.442
Time zone problem.	11	4	5	6	4	3	1	3.087	1	.079
Lack of co-ordination	15	2	4	5	3	2	1	.153	1	.696

Lack of knowledge management and transfer among teams	**9**	**2**	**4**	**5**	**3**	**6**	**1**	**5.270**	**1**	**.022**
Geographical distance	11	2	3	6	2	1	0	.438	1	.508
Lack of trust	10	3	3	5	1	3	0	.005	1	.946
Lack of Control	10	3	2	3	2	2	0	.076	1	.782
Requirement Engineering activities.	**8**	**0**	**2**	**2**	**3**	**4**	**2**	**6.749**	**1**	**.009**
Lack of team awareness	7	1	2	5	3	1	0	.356	1	.551
Change management activities.	3	2	3	6	0	2	1	1.303	1	.254
Lack of a uniform process among different development sites	5	0	7	2	2	0	1	.785	1	.376
Conflict management	6	1	0	4	0	2	1	0.010	1	.919
Integration activities	3	0	5	2	1	1	2	1.151	1	.283
Allocation of tasks	4	3	1	3	0	2	0	.095	1	.758
Risk Management	5	1	2	0	0	2	1	.031	1	.859
Lack of proper IT infrastructure	2	0	1	3	3	1	0	3.470	1	.063
Protection of Intellectual property	1	0	3	3	0	1	1	1.649	1	.199
Cost and effort estimation	3	1	1	1	0	2	0	1.590	1	.207

Comparison of the challenges identified in the 7 study strategies indicates that there are more similarities than differences between the challenges. We have found only two significant differences between 7 study

strategies as shown in Table 5.3. Our findings show that 'Lack of knowledge management and transfer among teams' and 'Requirement Engineering activities' are the most common challenges across several types of study strategies as their respective p values are < 0.05.

Third research aspect focuses on how these challenges are distributed across continents. In order to interpret the results of our research in a more productive way, we classified the papers published in different continents so as to understand which challenge is more common and tough to handle in different geographical zones present on the globe. Due to space limitation we merged some of the continents which have more or less the same demographics.

From Table 5.4, we can say that 'Lack of cultural understanding in teams' (82%, 93% and 89%), 'Lack of Communication' (54%, 80% and 52 %), 'Time zone problem' (36%, 26% and 48%), 'Lack of co-ordination'(36%, 46% and 37%), 'Lack of knowledge management and transfer among teams' (45%, 46% and 28%) are the most common challenges across the continents. An important observation is to know that about 40 % of organizations in Asia see 'Lack of Trust' at workplace as a challenge because of the job uncertainty due to dependence on western economic market during tough economic conditions such as recession. Even in Table 5.4, we have used Linear-by-Linear Chi-Square

test for the identification of significant difference amongst challenges across the three continents. We found that the p value is less than .05 only for one of the challenges i.e. 'Cost and effort estimation'. Hence, we can say that we found more similarities than differences among challenges across various continents present in the SLR.

TABLE 5.4: SUMMARY OF CHALLENGES ACROSS CONTINENTS

Challenges	**Occurrence in SLR (n=83)**						**Chi-square Test (Linear-by-Linear Association) α = .05**		
	Asia (N=22)		**Americas (N=15)**		**Europe & Australia (N=46)**		X^2	df	p
	Freq	**%**	**Freq**	**%**	**Freq**	**%**			
Lack of cultural understanding in teams	18	82	14	93	41	89	.032	1	.858
Lack of Communication	12	54	12	80	24	52	.067	1	.796
Time zone problem.	8	36	4	26	22	48	.959	1	.327
Lack of co-ordination	8	36	7	46	17	37	.003	1	.958
Lack of knowledge management and transfer among teams	10	45	7	46	13	28	1.369	1	.242
Geographical distance	6	27	3	20	16	35	.147	1	.701
Lack of trust	9	40	5	33	11	24	2.102	1	.147
Lack of Control	6	27	5	33	11	24	.685	1	.408
Requirement Engineering activities.	8	36	4	26	9	20	1.580	1	.209
Lack of team awareness	5	22	4	26	10	22	.083	1	.773
Change management	5	22	7	46	5	11	2.056	1	.152

activities.									
Lack of a uniform process among different development sites	3	13	1	6	3	7	.845	1	.358
Conflict management	5	22	5	33	4	9	1.575	1	.209
Integration activities	6	27	3	20	5	11	2.172	1	.141
Allocation of tasks	3	13	5	33	5	11	.379	1	.538
Risk Management	4	18	1	6	6	13	.002	1	.966
Lack of proper IT infrastructure	2	9	5	33	3	7	.994	1	.319
Protection of Intellectual property	2	9	5	33	2	5	1.916	1	.166
Cost and effort estimation	**6**	**27**	**1**	**6**	**1**	**2**	**9.673**	**1**	**.002**

5.3 QUESTIONNAIRE SURVEY FINDINGS

In the second step of our research, we developed an empirical study survey questionnaire based on the challenges identified in the SLR-based literature study. Industry experts gave their opinion to answer our research questions. Table 5.5 shows the rankings of the challenges identified from our empirical study. This explains the view of the industry practitioners to assess a particular challenge of project management in GSD. The table has been divided into 3 columns, i.e. 'Positive', 'Negative' and 'Neutral'. The values present in the 'Positive' column shows the percentage of respondents who agrees with the identified challenges of project management in GSD. Whereas, the values present in the 'Negative' column shows the percentage of respondents who feel the challenge might not be present during project

management in GSD. At the end of the survey we asked the practitioners to provide best practices as per their vast experience to handle those challenges successfully. These best practices will help us in developing our PMCMG model.

Interestingly, out of the 41 experts who answered our questionnaire, a majority of them agreed that all the 19 identified challenges can negatively impact a project which can lead to failures. This is evident from the 'Positive' column where most of the values are above 68 % except for a few. Industry experts feel that 'Allocation of tasks' is a major challenge (i.e. 80%) of project management in GSD. This is true to the fact that in globally distributed teams a Project Manager might not be fully aware of the competencies and expertise of other team members. Due to this task allocation can become a major challenge if effective utilization of human resources has to be met. Our results also show that 'Lack of knowledge management and transfer in teams' (i.e. 78%) is the 2nd most significant challenge of project management in GSD. This is due to the nature of IT recruitment industry; technical experts often find a lucrative job which makes them resign on a shorter notice period without carrying out the knowledge transfer (KT) process. Apart from this, the other significant challenges are 'Lack of Communication', 'Lack of cultural

understanding in teams' and 'Time Zone Problem' (i.e. more than 70%) in our positive column.

TABLE 5.5: SUMMARY OF CHALLENGES FROM REAL WORLD PRACTICE

Challenges	Experts' Observation (n=41)							
	Positive			Negative			Neutral	
	Strongly Agree	Agree	%age	Strongly Disagree	Disagree	%age	Not Sure	%age
Lack of cultural understanding in teams	17	12	70	2	9	27	1	2
Lack of Communication	9	22	76	1	8	22	1	2
Time zone problem	6	23	71	2	10	29	0	0
Lack of co-ordination	13	15	69	1	12	31	0	0
Lack of knowledge management and transfer among teams	13	19	78	1	8	22	0	0
Geographical distance	9	14	56	3	15	44	0	0
Lack of Trust	9	15	59	3	13	39	1	2
Lack of Control	10	21	75	0	10	24	0	0
Requirement Engineering Activities	14	15	71	1	9	24	2	5
Lack of Team Awareness	9	18	66	11	3	34	0	0
Change management Activities	7	21	68	3	9	29	1	2
Lack of a uniform process among different development sites	9	17	63	0	13	32	2	5
Conflict management	11	18	71	1	11	29	0	0
Software Integration activities	14	16	73	0	10	24	1	2
Allocation of tasks	7	26	80	0	8	20	0	0
Risk Management	7	22	71	3	9	29	0	0
Cost and effort estimation	12	18	73	0	10	24	1	2
Lack of proper IT infrastructure	14	14	68	2	9	27	2	5
Protection of Intellectual Property	11	15	64	1	11	29	3	7

Our research aspect enquires about the significant challenges faced by practitioners present in various types of organizations based on their size. A total of 41 experts have participated in this research. We defined the size of the organization based on the number of employees present in the organization in three categories as Small (< 20 employees), Medium (20 to 199 employees) and Large (200 + employees). Our results show that out of all the 19 identified challenges, 18 have been agreed by the experts from smaller organizations. Among the 18 challenges, one challenge i.e. 'Lack of knowledge management and transfer among teams' has been cited by more than 75 % of the participants for smaller organizations. We found 'Lack of Trust' as the least significant challenge. This is because since the team size is small then trust issues will be negligible.

For medium organizations, we found four significant challenges i.e. 'Lack of Communication', 'Lack of Knowledge management and Transfer among Teams', 'Lack of Control' and 'Lack of Proper IT infrastructure' which have been agreed by more than 70% of the experts. Whereas, for large organizations three challenges namely 'Lack of cultural understanding in teams', 'Allocation of tasks' and ' Cost and effort estimation' are agreed by more than 80% of the participants.

TABLE 5.6: SUMMARY OF FREQUENT CHALLENGES ACROSS COMPANY SIZE

Critical Challenges	Small (n=4)	Medium (n=14)	Large (n=23)
	% of Agree	% of Agree	% of Agree
Lack of Communication	50	71	74
Lack of Knowledge management and transfer among teams	75	79	70

Our final research aspect explains the challenges experienced by practitioners present across the continents. Table 5.7 explains the summary of challenges experienced by experts across three continents namely Asia, North America and Europe. Out of the 41 experts who participated in survey, 75% were present in Asia, 23 % were present in North America and remaining from Europe.

In Asia, except for 'Geographical Distance' challenge, all challenges were significant and were cited by more than 65 % of the Asian respondents. North American participants felt that 'Lack of a uniform process among different development sites' was the least significant challenge due to the fact that most organization present in the American continent are process oriented. For European participants, 'Geographical Distance' and 'Risk Management' seemed to be a less significant challenge for them.

TABLE 5.7: SUMMARY OF CHALLENGES FROM REAL WORLD PRACTICE BASED ON CONTINENTS

Challenges	**Experts' Observation (n=41)**						**Chi-square Test (Linear-by-Linear Association) $\alpha = .05$**		
	Asia (N=31)		**North America (N=8)**		**Europe (N=2)**		X^2	df	p
	Agree	**%**	**Agree**	**%**	**Agree**	**%**			
Allocation of tasks	24	78	7	85	2	100	3.769	1	.052
Change management activities.	19	61	7	87	2	100	2.746	1	.097
Conflict management	19	61	7	87	2	100	2.188	1	.139
Cost and effort estimation	**20**	**68**	**8**	**100**	**2**	**100**	**5.770**	**1**	**.016**
Geographical distance	15	48	7	87	1	50	2.186	1	.139
Integration activities	21	68	7	87	2	100	1.602	1	.206
Lack of a uniform process among different development sites	19	61	5	62	2	100	.033	1	.856
Lack of Communication	21	68	8	100	2	100	1.565	1	.211
Lack of Control	**21**	**68**	**8**	**100**	**2**	**100**	**7.759**	**1**	**.005**
Lack of co-ordination	19	61	7	87	2	100	3.844	1	.050
Lack of cultural understanding in teams	**19**	**61**	**8**	**100**	**2**	**100**	**7.914**	**1**	**.005**
Lack of knowledge management and transfer among teams	24	78	6	75	2	100	.781	1	.377
Lack of proper IT infrastructure	20	65	6	75	2	100	.304	1	.581
Lack of team awareness	**17**	**55**	**8**	**100**	**2**	**100**	**7.414**	**1**	**.006**
Lack of trust	**15**	**48**	**6**	**75**	**2**	**100**	**4.465**	**1**	**.035**
Protection of Intellectual property	17	55	7	87	2	100	2.182	1	.140
Requirement	**19**	**61**	**8**	**100**	**2**	**100**	**7.598**	**1**	**.006**

Engineering activities.									
Risk Management	21	68	7	87	1	50	2.488	1	.115
Time zone problem.	**19**	**61**	**8**	**100**	**2**	**100**	**7.670**	**1**	**.006**

We suggest that understanding the similarities and differences in these challenges can contribute to the body of knowledge of software project management. This is because respondents from different continents consider that certain challenges may have impact on project management or on the overall outcome of the project. Hence, we did a linear by linear association chi-square test on Table 5.7 and documented values in the last column. For the 6 challenges whose p values < 0.05 we have highlighted them, indicating these 6 challenges are the most common across all the three continents.

5.4 COMPARISON OF TWO RESULTS

This section discusses comparative analysis of challenges identified in SLR and the questionnaire survey. This will help in understanding the similarities and differences among the outcomes of two data sets. Table 5.8 gives an overview of average rank of challenges identified through SLR and questionnaire survey. The data present in the SLR has not been subject to any categorization whereas the data present in questionnaire survey was

categorized as Strong Agree, Agree, Disagree, Strongly Disagree and Not Sure. The reason for having same number of challenges in both data sets is due to the fact that no new challenge was identified from the questionnaire survey. An important observation is to note that ranking of the challenges in questionnaire survey differs from individual to individual and does not map to the frequency of occurrence in the SLR. For example,' Lack of cultural understanding in teams' is a high frequency challenge whereas in the questionnaire it is ranked 7th in order.

TABLE 5.8: COMPARISON OF CHALLENGES BETWEEN SLR AND SURVEY

Challenges	**Occurrence in SLR (n=83)**		**Agreed for challenge in questionnaire (n=41)**		**Average Rank**
	%	Rank	%	Rank	
Lack of cultural understanding in teams	88	1	70	7	4
Lack of Communication	58	2	76	3	3
Time zone problem.	41	3	71	6	5
Lack of co-ordination	39	4	69	8	6
Lack of knowledge management and transfer among teams	36	5	78	2	4
Geographical distance	30	6	56	14	10
Lack of trust	30	6	59	13	10
Lack of Control	27	7	75	4	6
Requirement Engineering activities.	25	8	71	6	7
Lack of team awareness	23	9	66	10	10
Change management activities.	20	10	68	9	10
Lack of a uniform process among different development sites	20	10	63	12	11
Conflict management	17	11	71	6	9
Integration activities	17	11	73	5	8
Allocation of tasks	16	12	80	1	7
Risk Management	13	13	71	6	10

Lack of proper IT infrastructure	12	14	73	5	10
Protection of Intellectual property	11	15	68	9	12
Cost and effort estimation	10	16	64	11	14

In order to further explain the statistical dependence between the ranks of two variables (i.e. SLR and Survey); Table 5.9 represents Spearman's Rank Order Correlation. The statistical analysis shows that there is no correlation between the challenges (rs (19) = .054, p=.825) found in results of SLR and survey. To support the statistical results further the scatter plots in figure 5.2 shows more differences than similarities.

TABLE 5.9: CORRELATIONS RANK ACROSS TWO DATA SETS

			SLR	Survey
Spearman's rho	SLR	Correlation Coefficient	1.000	.054
		Sig. (2-tailed)	.	.825
		N	19	19
	Survey	Correlation Coefficient	.054	1.000
		Sig. (2-tailed)	.825	.
		N	19	19

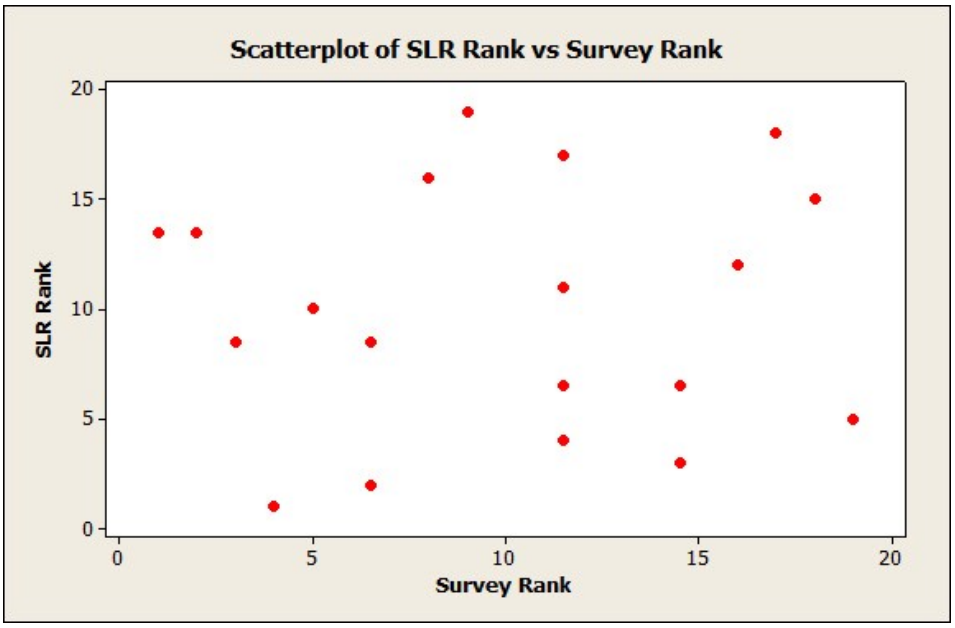

Figure 5.2: Scatter Plot

5.5 DISCUSSION

The challenges present in managing the global software development projects have been identified through our empirical study. Our research goal is to develop a global project management readiness framework so as to measure organization's project management readiness for successful GSD activities. The identified challenges represent some key project management knowledge areas where management should focus their attention to have better control for managing GSD projects. In order to decide the criticality of a particular challenge, we have used the following criterion:

• The challenge is considered significant if it is cited in the literature with a frequency percentage >= to 50%, or if the challenge is answered as agree in the survey questionnaire with a frequency percentage >= to 50%.

This criterion has been used in previous research studies [49]. However, software practitioners can define their own criteria to define the criticality of a particular challenge. In order to address RQ1, using the above criteria we identified two critical challenges i.e. 'Lack of cultural understanding in teams (88%)' and 'Lack of Communication (58%)'. However, other challenges which have frequency >= 30% like 'Time zone problem', 'Lack of co-ordination', 'Lack of knowledge management and transfer among teams', 'Geographical distance' and 'Lack of trust' are important to solve. Second research aspect explains about the distribution of challenges across various types of studies present in the literature. Table 5.10 below shows the summary of study strategies used in the SLR process.

TABLE 5.10: SUMMARY RESULTS OF STUDY STRATEGY IN SLR PROCESS

Study Strategy	No. of Challenges	No of Significant Challenges (cited in >= 50% of the literature)
Case Studies (n=37)	19	2 Challenges: • Lack of cultural understanding in teams • Lack of Communication
Interviews (n=7)	14	6 Challenges: • Lack of cultural understanding in teams • Lack of Communication

		• Time zone Problem • Lack of Trust • Lack of Control • Allocation of Tasks
Experience Reports (n=12)	18	2 Challenges: • Lack of cultural understanding in teams • Lack of a uniform process among different development sites
SLR (n=10)	18	8 Challenges: • Lack of cultural understanding in teams • Lack of Communication • Time zone problem. • Lack of co-ordination • Lack of knowledge management and transfer among teams • Geographical distance • Lack of trust • Change management activities.
Survey (n= 7)	13	3 Challenges: • Lack of cultural understanding in teams • Lack of Communication • Time zone problem.
LR (n=8)	19	4 Challenges: • Lack of cultural understanding in teams • Lack of Communication • Lack of knowledge management and transfer among teams • Requirement engineering activities.
Delphi Study (n=2)	11	11 Challenges: • Lack of Communication • Time zone problem. • Lack of co-ordination • Lack of knowledge management and transfer among teams • Requirement engineering activities. • Change management activities. • Lack of a uniform process among different development sites • Conflict management • Integration activities • Risk Management • Protection of Intellectual property

Third research aspect deals with distribution of identified challenges present in the literature across various continents. Only two challenges were above 50% i.e. 'Lack of cultural understanding in teams' and 'Lack of Communication' across all continents ranging from Asia, Europe and Americas. Thereby looking into this analysis with respect to literature we can say almost all challenges present in the literature have been agreed by the experts present in the industry.

To discuss with respect to the size of the organizations, we collected data accordingly in our questionnaire survey so as to analyze whether employee strength of the organization have significance in terms of project management challenges being faced in GSD. We found that larger companies face all the 19 challenges and have been agreed by more than 50 % of the experts present in the industry. The summary of our findings is given in Table 5.11.

TABLE 5.11: SUMMARY RESULTS OF CHALLENGES BASED ON COMPANY SIZE

Organization Size	No. of Challenges	No of Significant Challenges (cited as agreed by >= 50% of respondents)
Small (n=4)	18	2 challenges: • Lack of Communication • Lack of Knowledge management and transfer among teams
Medium (n=14)	19	18 Challenges: • Lack of cultural understanding in teams

		• Lack of Communication • Time zone problem. • Lack of co-ordination • Lack of knowledge management and transfer among teams • Geographical distance • Lack of trust • Lack of Control • Requirement Engineering activities. • Lack of team awareness • Change management activities. • Lack of a uniform process among different development sites • Conflict management • Integration activities • Allocation of tasks • Risk Management • Lack of proper IT infrastructure • Protection of Intellectual property
Large (n=23)	19	19 Challenges: • Lack of cultural understanding in teams • Lack of Communication • Time zone problem. • Lack of co-ordination • Lack of knowledge management and transfer among teams • Geographical distance • Lack of trust • Lack of Control • Requirement Engineering activities. • Lack of team awareness • Change management activities. • Lack of a uniform process among different development sites • Conflict management • Integration activities • Allocation of tasks • Risk Management • Lack of proper IT infrastructure • Protection of Intellectual property • Cost and effort estimation

In order to compare the challenges identified from two data sets i.e. SLR and Questionnaire, we calculate Spearman's rank order correlation. We can draw the following from the correlation results:

- Both the SLR and the Empirical study conclude that 'Lack of cultural understanding in teams' and 'Lack of Communication' are significant challenges.

- The statistical analysis shows that there is no correlation between the challenges ($r_s(19) = .054$, $p=.825$) found in the results of SLR and survey.

- Example: 'Geographical Distance' and 'Lack of Trust' are cited high in the SLR, whereas they were cited low in the Questionnaire survey.

5.6 THREATS TO VALIDITY

The research study conducted in this paper applies a combined SLR and empirical study approach. The scope of the SLR was limited to project management challenges in global software development. We limited our SLR study to 5 reputed research publication databases (i.e. IEEEXplore, ACM, John Wiley, Science Direct and Springer Link). However, there may be other related research databases such as Scopus and Google Scholar which have been left out in our research. With increasing number of research papers on this topic,

some recent publications could have been missed at the time of consolidating the results of our SLR study. Nevertheless, we can say that our research has been most comprehensive till date and covered most of the relevant and published literature.

With respect to the questionnaire survey, the participants were mainly from big companies where a standard process and policies are followed. Even though a majority of participants were from big firms most of them agreed to the identified challenges they face during project management in GSD. As a majority of industry experts were from Asia, we therefore may not be able to generalize our research findings across all the continents of the globe. In order to reduce bias in our questionnaire survey, we tried to include participants from various Fortune 500 companies having varied experience in project management for GSD and have clients all over the world. We also encouraged our respondents to enter those challenges which they would face at their work place and were not present in the survey. Moreover; the survey respondents were independent in answering their questions without the influence of the researchers. Hence, this study needs to be considered by keeping in view of its limitations, since the data present in literature and industrial experiences are both dynamic in nature and it should be considered as an on-going work to be revised and extended by future researchers.

CHAPTER 6

PMCMG MODEL AND EVALUATION

In this chapter we summarize our research findings and present it in the form of model based framework which is called as PMCMG model. The identified challenges along with best practices collected from industry and SLR are mapped into different knowledge areas of project management. Section 6.1 explains the proposed framework. We then evaluate our framework using Motorola's assessment instrument with the help of a case study conducted in real time environment.

6.1 PROPOSED MODEL

In this section we have developed Project Management Challenges Model for Global Software Development (PMCMG) as shown in figure 6.1, in order to measure organizations' project management readiness for global software development activities. Managers of software development organizations will be able to use the PMCMG in evaluating their strength and weaknesses in terms of designing, implementing, improving and measuring suitable

strategies to manage their global development activities. PMCMG is developed using the 19 identified challenges and best practices.

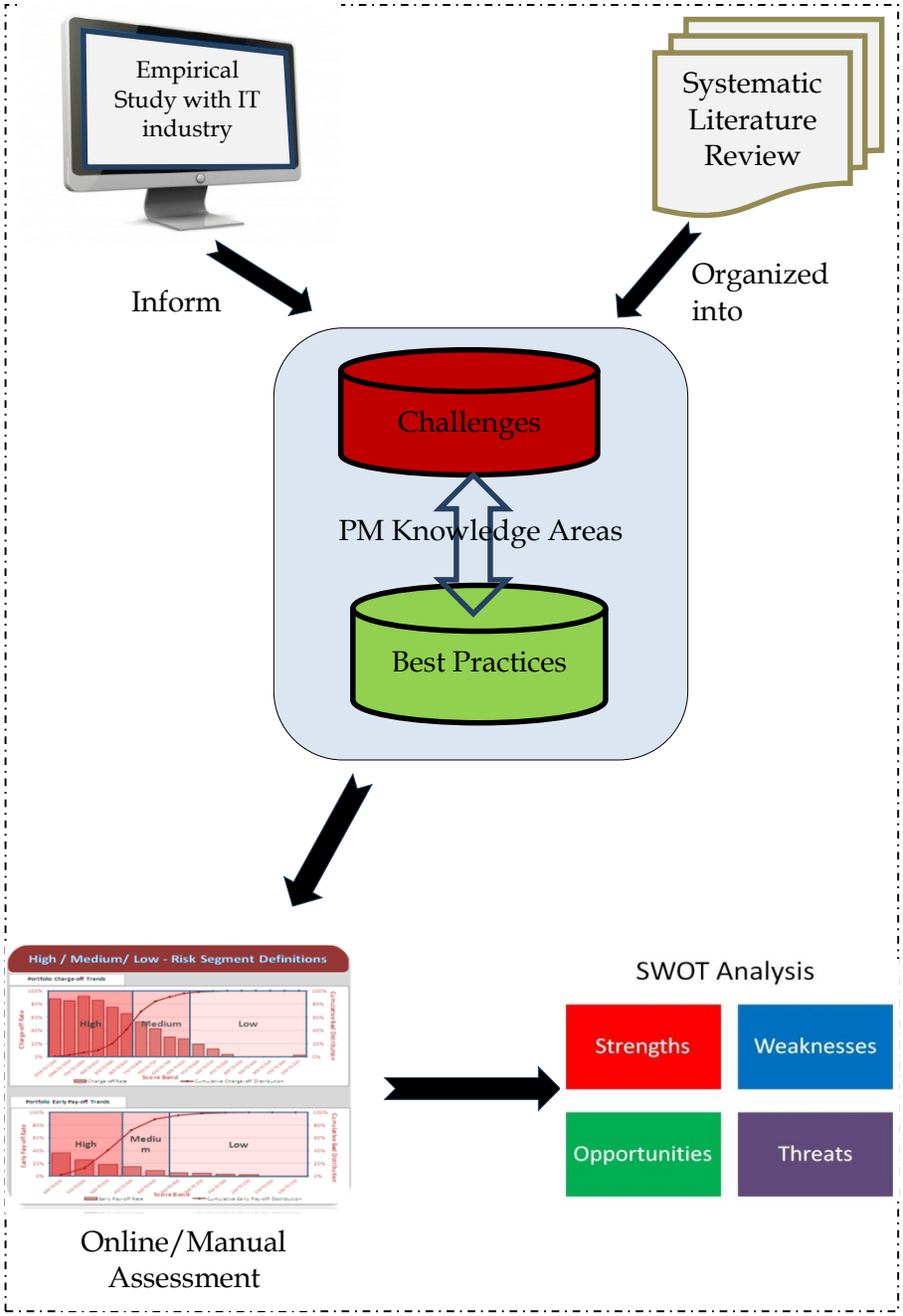

Figure 6.1: PMCMG Framework Model

There are ten project management knowledge areas namely; integration, scope, time, cost, quality, human resources, communication, risk, procurement and stakeholder management. Each of the 19 identified challenges was mapped into the appropriate knowledge area as shown in Table 6.1.

TABLE 6.1: CHALLENGES MAPPED TO KNOWLEDGE AREAS

Knowledge Areas	Challenges
1. Integration	• Lack of co-ordination • Integration activities
2. Scope	• Requirement engineering activities. • Change Management activities
3. Time	• Time zone problem • Allocation of tasks
4. Cost	• Cost and effort estimation
5. Quality	• Lack of a uniform process among different development sites.
6. Human Resources	• Lack of knowledge management and transfer among teams • Lack of trust • Lack of Control • Conflict management • Lack of cultural understanding in teams
7. Communication	• Lack of cultural understanding in teams • Lack of Communication • Time-zone problem • Geographical Distance
8. Risk	• Protection of Intellectual property • Lack of proper IT infrastructure • Integration activities • Risk Management
9. Procurement	• Lack of trust (vendor side) • Lack of co-ordination
10. Stakeholder	• Lack of cultural understanding in teams

	• Lack of co-ordination • Lack of Team Awareness

For each of the 19 challenges, we have identified best practices with help of questionnaire survey conducted with experts present in the IT industry. We will use metrics to measure how effectively that practice has been implemented (to address the challenge) in any organization. For example, if an organization is assessing 'Human Resources Management' area of project management then the best practices to handle the challenge 'Lack of knowledge management and transfer among teams' are shown in figure 6.2.

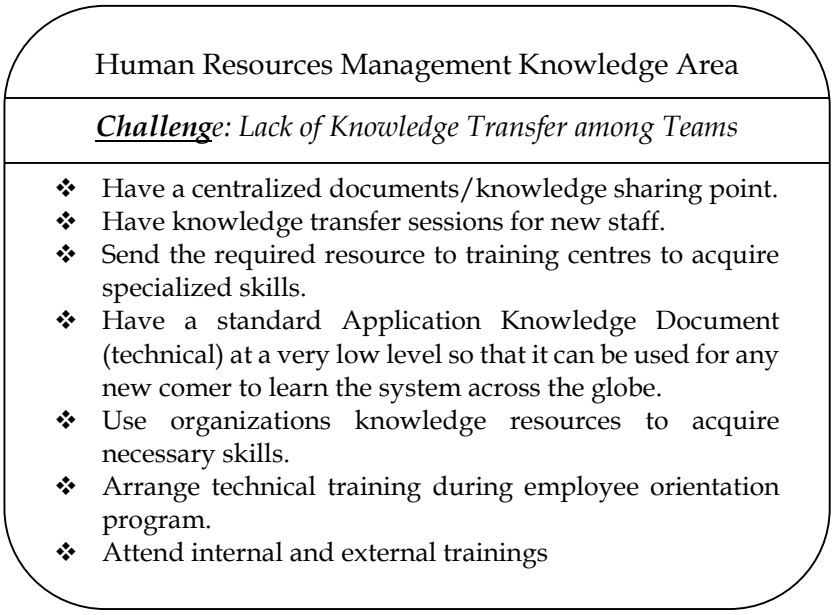

Figure 6.2: Lack of KT-Best practices under HR Management Area

6.2 ASSESSMENT OF PMCMG MODEL

Once the knowledge areas are mapped with specific challenges and best practices, metrics are required to judge the degree of readiness of an organization for a particular knowledge area of project management. For this very purpose we will be using Motorola's assessment instrument [50]. Motorola's assessment instrument has the following three evaluation dimensions.

1. Approach: Criteria here, is the commitment of organization and management support for the practice as well as the organization's ability to implement the practice.

2. Deployment: Continuous implementation of the practice across the project areas and how well the practice has been deployed.

3. Results: Criteria here are the positive results over time and across project areas after implementation of a particular practice.

For each dimension, a score from 0-10 (i.e. even numbers 0, 2,4,6,8 and 10) is provided. All the best practices for a particular challenge are graded along these dimensions i.e. approach, deployment and results. The 3-dimensional scores for each practice are added together, divided by 3 and

rounded up to the nearest integer. The score for each practice is then summed then an average is used to gain an overall score for each challenge. A score of 7 or higher for each challenge or success factor indicates that a specific challenge has been successfully achieved. A score that falls below 7 is considered as an area of weakness and corrective measures are required [50].

6.3 EVALUATION OF MODEL USING CASE STUDY

In order to measure the efficiency and effectiveness of our model, we conducted case study in real time environment. This case study was conducted with a project manager who had 16 years of diverse project management experience and has handled global software development projects. A snapshot of the case study is shown in the table 6.2 for one knowledge area (i.e. Human Resources Management) and one specific challenge (i.e. Lack of knowledge management and transfer among teams) for illustrative purpose.

TABLE 6.2: HR MANAGEMENT KNOWLEDGE AREA

***Challenge:* Lack of knowledge management and transfer among teams**

Practice	**Approach** (score range: 0,2,4,6,8,10)	**Deployment** (score range: 0,2,4,6,8,10)	**Results** (score range: 0,2,4,6,8,10)	**Average Score of the three dimensions values)**
1. Have a centralized documents/knowledge sharing point.	6	8	4	6
2. Have knowledge transfer sessions for new staff.	10	10	10	10
3. Send the required resource to training centers to acquire specialized skills.	2	2	2	2
4. Have a standard Application Knowledge Document (technical) at a very low level so that it can be used for any new comer to learn the system across the globe.	8	8	8	8
5. Use organizations knowledge resources to acquire necessary skills.	6	4	6	6
6. Arrange technical training during employee orientation program.	8	6	8	8
7. Attend internal and external trainings	6	4	6	6
8. Coordinate the work among different people using standards documentation.	4	2	4	4
9. Use web based tools to keep a track of project activities.	0	0	0	0
Overall Score : (Dividing 'Sum of average scores' by 'total no. of practices') =				5

Here in this case, the overall score for the 'Lack of knowledge management and transfer among teams' is 5 which is less than 7. This implies that this particular challenge needs to be further addressed by implementing few more practices completely across the three dimensions

which have low individual score. Likewise, we covered all the 10 knowledge areas and 19 challenges mapped into them as shown in table 6.1. Table 6.3 gives the overview of the case study and the best practices for each of the challenges are present in the Appendix section. Out of the 19 challenges, only 7 challenges have an overall score of more than 7, whereas the remaining 12 challenges should be addressed by the organization to achieve a high project management readiness score. According to the feedback given by the project manager, PMCMG was a very useful framework which helps and guides him to excel in all the knowledge areas of project management. In addition to this, PMCMG gives us the direction to overcome the specific knowledge areas of weakness by following the specified best practices.

TABLE 6.3: OVERALL CASE STUDY RESULT

Challenges	Assessment Score
Lack of cultural understanding in teams	6
Lack of Communication	5
Time zone problem.	4
Lack of co-ordination	5
Lack of knowledge management and transfer among teams	5
Geographical distance	6
Lack of trust	8

Lack of Control	5
Requirement Engineering activities.	7
Lack of team awareness	9
Change management activities.	3
Lack of a uniform process among different development sites	8
Conflict management	4
Allocation of tasks	8
Risk Management	7
Lack of proper IT infrastructure	8
Protection of Intellectual property	7
Cost and effort estimation	7

CHAPTER 7

CONCLUSION AND FUTURE WORK

The GSD is a modern software engineering paradigm. Many companies are adopting the GSD domain to reduce software development cost. Vendor organizations are struggling to compete internationally in attracting software development projects. Due to the increasing trend of GSD we were interested to discover project management challenges in GSD projects. In our results the frequently cited challenges for project manager are lack of cultural understanding in team, lack of communication, time zone problem, and lack of coordination, lack of knowledge management, graphical distance and lack of trust. We have also discussed how one challenge impacts and leads to other project management challenges. In this research, we have identified project management challenges in GSD projects via SLR and empirical study with the software industry. We also found that there was no correlation between the findings from the SLR and empirical study, however all the identified challenges were agreed by the industry experts thereby making our study and findings more concrete and appropriate. During the process of the survey we asked our survey participants to identify best practices according to their

experience which can be used to encounter these identified challenges. The reason behind collection of best practices was to use them as a fundamental building block of our PMCMG model. This research project helps to assist software development organizations in measuring and improving their project management readiness prior to starting global activities. Our case study conducted in real time so as to validate our framework, gave us very positive results and feedback about the significance of PMCMG model and its relevance in assessing the areas of strengths and weaknesses and overcoming it by completely implementing the best practices. As part of future work, GSD is an ongoing research area which implies that one can continuously update newer versions of PMCMG model by identifying newer challenges and best practices to counter them.

APPENDIX

List of 19 identified challenges with their respective best practices and mapped knowledge areas.

Challenge 1: Lack of Co-ordination

Knowledge Area: Integration Management

Best Practices:

1. Organize more regular connects within the team
2. Organize regular meetings and regular feedback from team leads/project managers
3. Have a proper plan, share and buy-in the plan by taking the commitment from all stakeholders
4. Define a stringent protocol of communication
5. Provide better definition of roles and responsibilities among team members
6. Have a mailing group in Outlook and all communication must be documented and circulated to the team group
7. Organized daily status meetings
8. Have a regular status update meetings
9. Divide the large projects into small workable tasks to improve coordination

Challenge 2: Lack of Cultural understanding in teams.

Knowledge Area: Communication Management

Best Practices:

1. Conduct training on cultural awareness program
2. Arrange team visits to different places to meet other team members to learn and understand each other culture.
3. Encourage friendly interaction within team
4. Arrange training based on client's culture.
5. A few resources should be exchanged on a rotational basis.
6. Hire employees with international experience.
7. Have employee orientation programs.
8. Have employee exchange programs.
9. Interact more with onshore and offshore teams through calls, events and team meetings.
10. Avoid words, phrases or idioms that defile others' cultural values.
11. Avoid meetings on regional and national holidays and weekends of other teams.

Challenge 3: Lack of Communication

Knowledge Area: Communication Management

Best Practices:

1. Have a communication plan in place.
2. Encourage more of mail (written) communication.
3. Establish periodic meetings, Minutes of Meeting (MOM) and follow ups
4. Offer training of common languages such as English among the team (Soft skills training).
5. Let everyone give his/her opinion and give sessions on technical and Non-technical aspects

6. Establish state of the art instant communication systems of multiple features like file sharing, logging, remote access, sharing over cloud etc.
7. Use multiple communication channels with respect to number of stakeholders.
8. Have a single point of contact (SPOC) present in each distributed team.
9. Encourage frequent meet ups and interaction through team activities apart from work.
10. Assess regularly the appropriate communication requirements for the projects
11. Share project objectives before-hand via team meetings.
12. Establish communication systems that provide privacy and restrictions at different levels for security.

Challenge 4: Time zone awareness

Knowledge Area: Communication Management

Best Practices:

1. Allow flexible work hours.
2. Allocate tasks to increase productivity in the team.
3. Have work hours which will overlap timings
4. Increase the use mail communication
5. Follow 24 hour development cycle if sites are remotely distributed.
6. Arranged meetings in a way that they are convenient for all the teams in the process.
7. Use RAD tools to ensure delivery on time.
8. Respect rest time and holidays in other countries.

Challenge 5: Lack of Knowledge management and transfer among teams.

Knowledge Area: Human Resources Management

Best Practices:

1. Have a centralized documents/knowledge sharing point.
2. Have knowledge transfer sessions for new staff.
3. Send the required resource to training centers to acquire specialized skills.
4. Have a standard Application Knowledge Document (technical) at a very low level so that it can be used for any new comer to learn the system across the globe.
5. Use organizations knowledge resources to acquire necessary skills.
6. Arrange technical training during employee orientation program.
7. Attend internal and external trainings
8. Coordinate the work among different people using standards documentation.
9. Use web based tools to keep a track of project activities.

Challenge 6: Geographical Distance

Knowledge Area: Communication Management

Best Practices:

1. Have promotional onsite visits based on employee performance.
2. Exchange program should be implemented.
3. Have work hours which will overlap timings
4. Increase the use mail communication

5. Have handshake mechanism between the teams
6. Use web conferences to promote face to face meetings.
7. Use various online/offline communication mediums to overcome the physical distance.
8. Hold critical meetings and workshops at one physical site where the team gathers.

Challenge 7: Lack of Trust

Knowledge Area: Human Resources Management

Best Practices:

1. Get all stakeholders involved.
2. Create a friendly environment
3. Take the team to party
4. Have strong organization policies to encourage employee performance.
5. Promote video calls and face to face meetings.
6. Promote team visits and team outings.
7. Have frequent communication and icebreakers between team members
8. Have fair employee reward programs based on performance reviews.
9. Establish plan for trust building and long term business relationships with clients
10. Establish sound processes to deal with issue escalation
11. Provide equal opportunity for competition to all employees.

12. Delegate decisions to related members and team leaders "no one man show".
13. Build trust by using recognizing contributions and work commitments

Challenge 8: Lack of Control

Knowledge Area: Human Resources Management

Best Practices:

1. Have an organizational hierarchy model which is known by all staff.
2. Follow best practices of Project Management like PMI or PRINCE2.
3. Have stringent plan in place - Communication plan, Project Plan, Risk plan, Quality Plan etc. and track them closely.
4. Use web based tools to keep a track of project activities.
5. Use tools like MS project to have an overall view of the project to meet the triple constraints (Scope, Time and Cost).
6. Have a certified PMI Project Manager.
7. Use more standard tools for centralized management.
8. Establish risk mitigation process in project

Challenge 9: Requirement Engineering Activities

Knowledge Area: Scope Management

Best Practices:

1. Use prototyping tools to elicit more requirements
2. Follow IEEE standard template for preparing Software Requirement Specification (SRS) documents

3. Use tools like Enterprise Architect, Desktop sharing tools like Team Viewer etc. to elicit more precise requirements
4. Have experienced software analyst and Business Analyst working together in the same geographical location
5. Use Standard template to document requirement
6. Have review process in place
7. Follow requirements engineering processes (elicitation, analysis, documentation and validation)

Challenge 10: Lack of Team Awareness

Knowledge Area: Human Resources Management

Best Practices:

1. Arrange daily Scrum meetings to ensure whole team is on the same path.
2. Have effective communication from project managers and customer.
3. Train all members to work in a team.
4. Organize technical seminars based on project needs.
5. Conduct frequent team meetings.
6. Keep the team informed with clear roles and responsibilities assigned to them.
7. Organize more team events to promote awareness of each other and of the project.

Challenge 11: Change Management Activities

Knowledge Area: Scope Management

Best Practices:

1. Maintain proper documentation for any change

2. Have a dedicated change configuration manager depending on the need of the project
3. Follow a standard change management process
4. Make all the stakeholder aware of the process
5. Have the sign-off mechanism in place for change
6. Estimate effort and cost for the change and take approval to proceed further
7. Have a good versioning and document naming practices
8. Have a Change Configuration Board (CCB) in place which should validate and authorize changes to be carried out
9. Use tools for change management

Challenge 12: Lack of uniform process among different development sites.

Knowledge Area: Quality Management

Best Practices:

1. Arrange proper process based training for new employees.
2. Have uniform development environment across all sites.
3. Have management level workshops to sync global processes.
4. Follow standard processes and tools.
5. Follow a single process among all the teams.
6. Follow documentation standards

7. Use a shared project plan that is easily accessible to all team members
8. Adapt standards for the assessment of processes
9. Establish process training programs in your organization

Challenge 13: Conflict Management

Knowledge Area: Human Resources Management

Best Practices:

1. Establish a conflict resolution plan
2. Interact with the team regularly
3. Team members should resolve the conflicts under the guidance of the project manager.
4. Have detailed discussion in presence of a senior management staff.
5. Have face to face meetings with a moderator in between to have a fair discussion.
6. Involve important stakeholders in resolving any conflicts early in the project life cycle.
7. Establish a plan for trust building and long term business relationships between teams

Challenge 14: Integration Activities

Knowledge Area: Risk Management

Best Practices:

1. Develop the project management plan
2. Have a proper Integration framework to ensure seamless integration of project management activities.
3. Integrate project management activities one by one and review them before proceeding further.

4. Have a dedicated Integration team to handle integration activities.
5. Use known configuration management tools
6. Monitor and control project work

Challenge 15: Allocation of tasks

Knowledge Area: Time Management

Best Practices:

1. Task allocation should be done based on domain experience and technical expertise.
2. Distribute work among different teams and reduce dependency.
3. Define clear roles and responsibilities.
4. Define lead roles based on need
5. Give leads authority to delegate their task to their team members accordingly.
6. Have fair allocation of tasks - Allocate tasks depending on team proficiency and geographical location.
7. Allocate tasks based on priority set by the client and the team lead.

Challenge 16: Risk Management

Knowledge Area: Risk Management

Best Practices:

1. Have a proper risk identification, management and mitigation plan.
2. Have weekly review of existing risks and brainstorm about new risks
3. Retire the risks that have not happened and move risks into issues if that happened.

4. Allocate proper resource for contingency.
5. Have a proper risk response strategy.
6. Identify risks early in the project life cycle stage.
7. Perform qualitative and quantitative risk analyses
8. Monitor and control risks

Challenge 17: Lack of Proper IT Infrastructure

Knowledge Area: Risk Management

Best Practices:

1. Use state of the art technologies based on client and project needs.
2. Have state of the art data centre using virtualization techniques like cloud computing.
3. Make stakeholders aware of proper infrastructure
4. Upgrade or procure them accordingly.
5. Implement ISO standards and follow ITIL framework for IT Service Management.
6. Upgrade IT Infrastructure depending on client needs if the project is concerned with IT Service Management.
7. Establish disaster recovery procedures
8. Establish risk management plan relating to infrastructure

Challenge 18: Protection of Intellectual Property

Knowledge Area: Risk Management

Best Practices:

1. Use data encryption techniques to safe guard client's business needs.

2. Make all stakeholder aware of the policy
3. Mention clearly Intellectual property rights in the Service Level Agreements (SLA).
4. Involve information security team for securing clients confidential data.
5. Establish a dedicated IP office/team to deal with such IP infringement issues depending on company's budget.
6. Ensure proper data security mechanisms are in place.
7. Use licensed software in the organization

Challenge 19: Cost and effort estimation

Knowledge Area: Cost Management

Best Practices:

1. Use standard tools to estimate cost and effort
2. Continuously monitor cost and effort against estimates
3. Use parametric way/ expert judgment for estimating effort.
4. Estimate cost using past experiences and number of man hours required to complete the task.
5. Estimate effort and cost for the change and take approval to proceed further.
6. Develop action plans against hidden costs and implement them.

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