Towards Identifying the Factors for Project Management Success in Global Software Development: Initial Results

Mahmood Niazi [a, b], Sajjad Mahmood [a], Mohammad Alshayeb [a], Abdul Majid Qureshi [a], Kanaan Faisal [a]
[a] Department of Information and Computer Science, King Fahd University of Petroleum and Minerals, Saudi Arabia
[b] Faculty of Computing, Riphah International University Islamabad, Pakistan
{mkniazi, smahmood, alshayeb, g201105290, kanaan}@kfupm.edu.sa

Narciso Cerpa
Faculty of Engineering, Universidad de Talca, Chile
ncerpa@utalca.cl

Abstract – Global Software Development (GSD) is a collaborative development where one company (client) contracts out all or part of its software development activities to another company (vendor), which provides services in return for remuneration. In today's world of high cost commitments and limited budgets, GSD provides a viable option for developing lower cost product with a relatively better quality. However, this comes at the cost of overcoming various challenges of managing a project, which is geographically distributed. The objective of this paper is to identify a set of factors that contributes to the success of project management in GSD. We have performed a Systematic Literature Review (SLR) by applying customized search strings derived from our research question. We have identified success factors, such as organizational structure, project managers' skills, communication, requirement specification, cultural awareness, and trust building. Our ultimate aim is to develop a model in order to measure organizations' project management readiness for GSD activities.

Keywords- Global software development; Software Project Management; Systematic Literature Review; Empirical Study.

I. INTRODUCTION

Low cost software development has always been the preamble of many organizations. If this low cost development comes with the added advantage of the high quality product then it adds to increase long term benefits for the organizations [1]. The search for the high quality and low cost development has led many organizations to use Global Software Development (GSD) model [2]. GSD is the process where a company either has its software developed by geographically distributed teams or contracts all or part of its software development activities in return for remuneration [3]. Majority of companies have adopted GSD to gain several perceived benefits, such as reduced software development time, access to skilled human resources at relatively low cost and increase in product quality [2,4]. GSD is significantly changing the economic drivers of software industry due to round the clock availability of skilled personals at lower cost.

Despite GSD benefits, the cultural differences associated with geographically distributed teams and different time-zones have caused problems for GSD-based projects [5,6]. The key GSD challenges are: lack of client involvement, hidden costs, lack of trust among the outsourcing companies, lack of coordination mechanisms and communication issues [5,6,7]. One of the major challenges is that many organizations endorse global contracts prior to testing their project management readiness for the global development activity. Despite the importance of this issue, little research has been carried out to improve organizations project management readiness for GSD. We believe that a better understanding of the factors associated with successful GSD project management can assist in improving organizations' project management readiness for GSD projects.

The advances in GSD have not been matched by equal advances in the development of new research and practices in academia and software industry, which has resulted in a gap between the software industry and academia. The up-to-date research in this area can help to fill this gap.

In this paper, we aim to identify success factors via SLR that impact project management in GSD projects. Identifying these factors will assist GSD organizations in better preparing for challenges associated with project management. Our long term research goal is to develop a global project management readiness framework to assist software development organizations in measuring and improving their project management readiness prior to starting global activities. To achieve this, we intend to address the following research question in this paper:

RQ: What factors are essential for the success of project management in GSD?

The organization of this paper is as follows: Section 2 provides the background. The research methodology is explained in Section 3. In Section 4, we present and discuss the initial results. Finally, we present the conclusion in Section 5.

II. BACKGROUND

Client organizations benefit from offshore outsourcing because vendors in developing countries (offshore vendors) typically cost one-third less than onshore vendors and even less when compared with in-house operations [4]. Among many other reasons for outsourcing, generally, client organizations outsource their software development work to offshore locations to: gain cost and quality advantages, improve their skills' access leading-edge technologies, and focus on their core competencies [8]. It is professed that

offshore outsourcing vendors can add significant value to their clients' supply chains [9]. Conversely, quite apart from the outsourcing benefits, there are many risks in the outsourcing process, such as temporal incompatibility, cultural differences and hidden costs [5,6]. IT Week magazine reported that eight out of every ten firms that outsourced their software development project to an offshore vendor faced major problems due to insufficient preparation and poor management by both client and vendor organizations [10].

There are many reasons for these problems [10,11]. 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 [1]. For example, a recent SLR concluded that the Global Software Engineering field is still nascent and comparatively very few empirical studies have been conducted, which can help to resolve the problems in this domain [12]. Understanding issues related to organization's global project management readiness will help to ensure the successful outcome of projects and to maintain long lasting relationships between clients and vendors in different geographical locations [3]. Hence, in this paper we conduct a SLR to identify project management challenges in GSD projects. The collected data focuses on factors that are essential for the success of project management in GSD.

III. RESEARCH METHODOLOGY

A SLR process [13] was used as the approach for data collection. SLR is a defined and methodical process of identifying, assessing, and analyzing published primary studies in order to investigate a specific research question. Systematic reviews differ from ordinary literature surveys in being formally planned and methodically executed. In finding, evaluating and summarizing all available evidence on a specific research question, a systematic review may provide a greater level of validity in its findings than might be possible in any one of the studies surveyed in the systematic review. 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 identifying the factors for successful project management in GSD, and therefore, we intended to address the following research question:

RQ: What factors are essential for the success of project management in GSD?

A. Search Strategy

The search strategy has been based on 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
- Use Boolean operators (AND operator is used to connect major terms. OR operator is used to connect synonyms and similar spellings).

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

- *POPULATION:* Global Software Development (GSD) organizations.
- *INTERVENTION:* Project management success factors.
- *OUTCOME OF RELEVANCE:* Factors for successful project management of GSD.
- *EXPERIMENTAL DESIGN:* SLRs, empirical studies, theoretical studies and expert opinions.

We test our terms in various academic databases and the following terms show 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.
- *FACTORS:* Factors OR causes OR agents OR elements OR aspects OR determinants OR constituents OR ingredients.
- *CONTRIBUTE:* Contribute OR furnish OR provide OR supply.
- *SUCCESS:* Success OR advance OR progress OR favorable OR effective.
- *IMPLEMENT:* implement OR apply OR utilize OR device OR mechanize.
- *PRACTICE:* procedure OR form OR method OR perform OR exercise.

The final search string is a combination as follows:

{Global Software Development OR GSD OR distributed software development OR multisite software development OR global software teams} AND {Factors OR causes OR agents OR elements OR aspects OR determinants OR constituents OR ingredients} AND {Contribute OR furnish OR provide OR supply} AND {Success OR advance OR progress OR favorable OR effective}

B. Digital Libraries used

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

- ACM Digital Library.
- IEEE Explore.
- Science Direct.
- Google Scholar.
- ISI Web of Science.
- Springer Link.

C. Inclusion and Exclusion Criteria

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

The following inclusion criteria were used:

- Conference Proceedings, Magazines, and Journals published after 1980.
- Papers published in any of the primary or secondary resources mentioned previously.
- Studies focus on answering our research question.

The following exclusion criteria were used:

- Papers published before 1980 are excluded since Internet starts after that date.
- Manuscripts written in non-English language are excluded.
- Technical reports and white papers are excluded.
- Graduation projects, master theses and PhD dissertations are excluded
- Textbooks whether in print or electronic are excluded from this systematic review.

D. Selection Process

The planned selection process had two parts: an initial selection from the search results of papers that could plausibly satisfy the selection criteria, based on a reading of the title and abstract of the papers, followed by a final selection from the initially selected list of papers that satisfy the selection criteria, based on a reading of the entire papers. In order to reduce the researcher's bias, we have performed the inter-rater reliability test.

TABLE I. QUALITY ASSESSMENT

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

For any paper to pass the selection process, a quality assessment was done. Four quality criteria were prepared as shown in Table I. We have finally selected 118 articles, which meet our inclusion and quality criteria.

E. Data extraction

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, success factors and best practices.

IV.   INITIAL RESULTS AND DISCUSSION

The total number of articles retrieved after using the search terms in the five electronic databases are shown in Table II. After the initial round of screening by reading the title and abstract, 292 studies relating to five different electronic databases were selected. After full text readings in

the second screening, 118 primary studies were finally selected.

We have grouped the papers found through SLR into three broad study strategies, which are commonly used in the empirical software engineering, as shown in Table III. Most of the articles have used survey research method. These study strategies were initially identified by one researcher during the data extraction process. However, second researcher has validated these study strategies.

TABLE II. SEARCH EXECUTION

Resource	Total Results	Initial Selection	Final Selection
IEEE Xplore	639	238	92
ACM	29	14	7
Science Direct	27	10	4
Springer Link	28	13	7
John Wiley	31	17	8
Total	754	292	**118**

TABLE III. STUDY STRATEGIES USED

Study Type	Count
Case Studies	43
Systematic Literature Reviews (includes literature reviews)	23
Survey (includes interviews, experience reports, Delphi studies)	52
Total	118

In Table IV, we show the countries where research was conducted for the papers included in our SLR study. Not surprisingly, the maximum number of studies (a total of 43) was carried out in the United States. This might be due to the fact that most of the multinational giants in the United States prefer GSD mode of development in collaboration with third world countries like India and China.

On the other hand, many studies have also been carried out in eastern countries like India, China, and Pakistan as these countries are providing vendor services in GSD projects. Other geographic locations include Netherlands, Ireland, and United Kingdom, where the communication is carried out in English language and culturally these countries are more or less similar.

TABLE IV. STUDY COUNTRIES

Country	Count	Country	Count
Australia	4	New Zealand	1
Brazil	5	Latvia	3
Canada	2	Malaysia	2
China	5	Netherlands	5
Singapore	1	Croatia	1
Finland	5	Pakistan	1
Germany	3	South Africa	1
Hawaii	4	Spain	2
India	10	Sweden	1
Iran	1	Saskatoon	1
Ireland	9	United Kingdom	5
Berlin	3	USA	43

In total, 18 factors that lead to the success of project management in GSD projects have been identified as shown in the table V. Initially, we have identified 29 success factors. After a few iterations, these factors were reduced to 18 as many factors had similar meaning. These factors have been arranged in decreasing order of their frequencies (frequency here is a measure of the number of times each factor has been suggested/mentioned in the selected study).

In our study, the most common project management success factor in GSD is the 'organizational structure' (62%). The organizational structure includes the entire dynamics of the GSD is risk-prone and hence require special as processes and people. GSD organizations follow different structures in order to successfully manage global projects as shown in Figure 1 [14]. Figure 1 contains an organizational structure to develop and implement a new software tool in five countries with all program managers located in the UK. The software is developed in three countries (project manager is located in the UK and the project team members are located in the UK, Singapore and Mexico). The pilot implementation project is in the UK. The local implementation projects in the United Arab Emirates, Singapore, Mexico and Canada. In such complex project structures, it is important that organizations make strategic IT investments by improving enterprise architecture in order to ensure that IT infrastructure is integrated and standardized to be effectively used in GSD.

Our results show that organizational structure plays an important role in the success of GSD project management.

Table V shows that more than half of the articles have cited "project managers' skills" as a project management success factor in GSD. A highly skilled and experienced project manager is essential for monitoring and controlling projects [15]. GSD is risk-prone and hence requires special set of leadership and decision making skills by the project manager or the project management team on the whole. Project management team's prior experience in handling GSD projects plays a prominent and imminent role for the project success.

The 'communication' (54%) is the third frequently mentioned success factor in our study. Since the development sites are spread across geographical boundaries, communication between different sites is very important. Different studies have described the impact of communication on GSD projects: Tsuji et al. [16] concluded that communication capabilities have a significant impact on the results of GSD projects; Ericksen and Ranganathan [17] 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, communicating face-to-face is not possible unless team members travel between development sites. Lack of face to face meetings can impact on other project management challenges like misunderstanding of requirements, lack of team awareness and lack of trust in GSD [7,18]. 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.

TABLE V. LIST OF FACTORS

Factors	Freq. (n=118)	%
Organizational structure	73	62
Project managers' skills	69	58
Communication	64	54
Requirement specification	48	41
Cultural awareness	47	40
Trust building	41	35
Collaboration	40	34
Work dynamics	38	32
Shared Knowledge	34	29
Team commitment and structure	31	26
Time-zone difference awareness	27	23
Cost assessment	23	19
Roles and responsibilities	17	14
Shared goals	14	12
Customer awareness	11	9
Training	10	8
Time to delivery	9	8
Incremental cycles	7	6

Requirements specification factor has been mentioned by 41% of the articles. We consider requirements specification important because it is an official statement of the system requirements for customers, end-users, software-developers, system test engineers and system maintenance staff. Indeed, the requirements document can act as a contract between customers and developers. The key to requirements specification is to present the idea of a shared understanding. In other words, all parties should be able to read this document as if it is their own.

In our study, 40% of the articles have mentioned 'cultural awareness' as one of the project management success factors in GSD projects. This is due to the fact that in a global software environment the development sites are spread across the globe, which invites cultural challenges for the project manager to handle. 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 [19]. Messages can be misinterpreted by different cultures, which can cause confusion and misunderstandings between different teams [20]. Hence, we can deduce that cultural awareness can improve other project management success factors, such as communication and trust, etc.

One of the project management success factors in GSD projects is creating confidence and trust among different teams [3,5]. This has been depicted in our SLR study where 35% of the articles have mentioned this as a project management success factor in GSD projects. In general, researchers agree that trust refers to an aspect of a relationship between client and vendor in which 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.
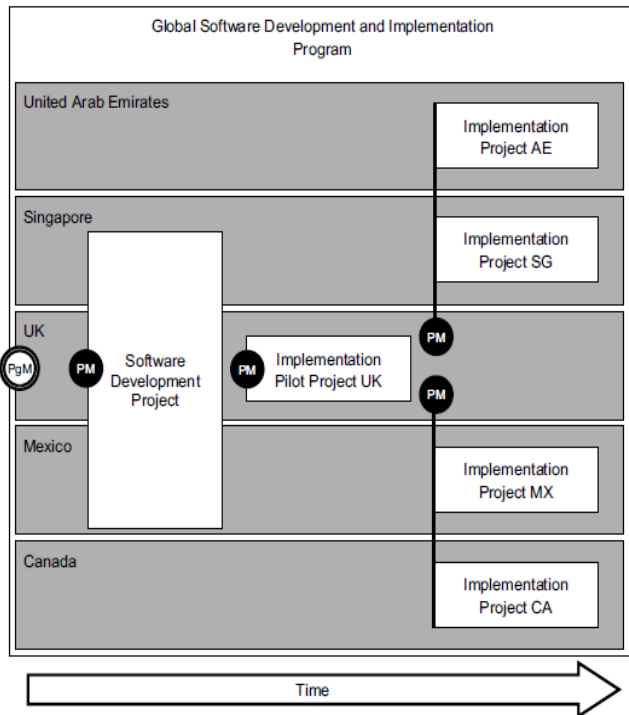

Figure 1 Local program of global projects [14]

Collaboration has been mentioned in about 34% of the articles. The main reason for this factor is the difference in time zone between different development sites [21]. The other reasons for this factor include geographical and socio-cultural distance [22]. This factor can have impact on other project management factors in GSD projects such as change management activities, trust and conflict management.

Other challenges are less frequently mentioned as shown in Table V. In work dynamics, there is a continuous change and progression in the work activities, which may lead to a better outcome. This success factor has been mentioned in 32% of the articles. About 29% of the articles have described shared knowledge as a project management success factor in GSD projects. This is a very important factor as knowledge sharing is essential for any kind of project transition [20]. Since staff turnover is generally high in offshore locations, improper knowledge sharing can lead to project management issues, such as poor quality of software artifacts and documents and lack of team awareness.

V. CONCLUSION AND FUTURE WORK

The GSD is a modern software engineering paradigm. Many companies are adopting GSD to reduce software development cost and improve quality. Vendor organizations are struggling to compete internationally in attracting software development projects. Due to the increasing trend of GSD we are interested in discovering project management challenges in GSD projects. In this paper, we identified a list of success factors for project management in GSD. Among the 18 identified factors, we found that organizational structure, project manager's skills and communication and are the most common success factors.

The second phase of this research involves conducting an empirical study with the software industry to validate our findings and to provide a set of best practices, which can be used to implement these factors. The overarching objective of this research work is to develop a global project management framework to assist software development organizations in measuring and improving their project management readiness prior to starting any GSD activities.

VI. ACKNOWLEDGEMENT

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