Barriers of managing cloud outsource software development projects: a multivocal study

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Abstract
Management of COSD projects is a challenging task due to number of distant development locations in different time zones, client and vendor organizations, different cloud deployment models and range of different service level agreements. The objective of this study is to identify the barriers associated with managing COSD projects. We implemented a Multivocal Literature Review (MLR) to identify barriers that influence management of COSD projects. We identified 21 COSD management barriers from 165 primary studies. The comparison between the barriers identified from formal and grey literature indicate that there are similarities between the barriers investigated from both types of literature. Moreover, client-vendor analysis shows that there is no significant difference between COSD management barriers associated with both types of organizations. We believe that the study findings will assist both research and industry community to better understand and manage COSD projects.

Keywords: Cloud outsource software development, Software outsourcing, Cloud computing, Barriers, Multivocal literature review.

1. Introduction

Software outsourcing is a process when companies choose to have custom software solutions developed by a third party[1]. Software outsourcing is a popular software development paradigm, as it potentially helps companies to decrease overall development cost. On the other hand, cloud computing is on-demand access to computing resources and applications hosted at remote data centers managed by a cloud service provider[2]. Cloud computing allows organizations to access shared IT resources via different cloud service and deployment models [3, 4].

Cloud outsourcing software development is a new phenomenon in the industry which refers to the adoption of cloud services to support software outsourcing development projects. A COSD project aims to take advantage of scalability, on demand series and different cloud deployment models for the distributed development across the globe. In a COSD project, organizations use on-demand access to a pool of scalable IT resources; and potentially increase product quality by having access to relatively low-cost skilled human resources. Moreover, COSD has the potential to reduce overall development time using follow-the-sun development model[5, 6], cloud based services and cloud based deployment models [4, 7].

There has been a significant research to better understand management of software outsource development. For example, Niazi et al.[8] reported that organizational structure, communication, and coordination tools; and management skills are key success factors for managing a globally distributed project. Niazi et al.[9] conducted a systematic literature review and a questionnaire survey to identify challenges associated with managing global

software development projects. They identified 19 challenges that impact the success of a global software development project. Similarly, Khan et al. [10] highlighted that due to the language and cultural difference between the geographically distributed teams, the effective communication is problematic.

However, managing COSD projects is a challenge due to adoption of cloud computing in global software development context. COSD requires organizations to adjust their management process due to distributed development sites in different time zones, client, and vendor organizations; and introduction of cloud service and deployment models [11, 12]. However, there is little empirical insight into barriers associated with management of COSD projects. We believe that understanding barriers associated with management of COSD projects can help organizations develop strategies to facilitate successful completion of COSD projects.

The objective of this study is to identify the barriers associated with managing COSD projects. In this study, we define three sub-objectives as follows: (i) identify the barriers of COSD using multivocal literature review, (ii) analyze the investigated barriers with respect to organization types (client-vendor)[13-15]; and (iii) map the investigated barriers into knowledge areas of project management (PMBOK). The study provides a body of knowledge to both researcher and industry community will assist both academia and industry experts to develop strategies to better manage COSD projects.

2. Background and Motivation

2.1 Cloud sourcing

Cloud computing allows organizations to access shared IT resources via different cloud service and deployment models[16]. Cloud computing helps organizations access resources at relatively low cost. Cloud computing also allows organizations to improve agility and time-to-value by facilitating on demand access to enterprise applications. Moreover, cloud computing supports elasticity which helps organizations easily scale software and hardware resources.

Cloud computing supports three common service model, namely, software-as-a-service, platform-as-a-service, and infrastructure-as-a-service. These common service models are defined as follows[2]“Software-as-a-service is application software that is hosted in the cloud and clients access them via a web browser, a desktop client, or an API that integrates with your operating system. Platform-as-a-service provides software developers with on-demand platform and development tools for developing and managing applications. Furthermore, Infrastructure-as-a-service provides on-demand access to computing resources, networking, and storage over the internet on a pay-as-you-go basis”.

2.2 Software Outsourcing

Software outsourcing is a popular software development paradigm, as it potentially helps companies to decrease overall development cost. There has been a significant research to better understand management of software outsource development. For example, Oza et al.[17] highlighted that round the clock adjustment of development activities across the world enables to use the 24/7 development hours. Espino et al.[18] underlined that the outsource software development assists to keep in touch with global market. Despite several potential benefits associated with software outsourcing, organization face a range of challenges in managing such projects. For example, Bohm et al.[4] and Chang et al.[19] argued that that the improper information sharing and coordination among the overseas development teams leads to lack of trust between practitioners. Similarly, Dey et al.[20] indicted that the software development activities are considered as more communication and coordination oriented, however, the physical distance between the geographically distributed teams in offshore software development outsourcing also leads to communication and coordination issues. Similarly, Nguyen et al.[21] conducted a study and underline the relationship between vendor firms in Vietnam and client firms in European and America. Another study conducted by Sabherwal [22] was conducted a study to highlight the role of trust in offshore software development outsourcing. Raj-Kumar and Dawley[23] analyzed the benefits, risks of offshore software development between Indian and US software industry. Narayanaswarmy and Henry [24] conducted a study to understand key factor, which impact the choice of control mechanisms in outsource software development. Similarly, Rainer et al.[25] proposed a model for the success of offshore contracts and related costs to minimize the risks. Moreover, they evaluate the difference levels of offshore contract by applying empirical study.

2.3 Cloud based Software Outsourcing

Cloud outsourcing software development is a new phenomenon in the industry which refers to the adoption of cloud services to support software outsourcing development projects. A COSD project aims to take advantage of scalability, on demand series and different cloud deployment models for the distributed development across the globe. There has been some research to better understand phenomenon of COSD projects. For example, Benlian et al. [26] indicated that the economic gains and on demand self-services are the main drivers affecting executives' perception to employ cloud's services as a software outsource development model. Kandjani [27] argued that the adoption of COSD is not straightforward. Several challenges associated with COSD especially that related to communication and coordination between the overseas software practitioners. Janssen and Anton [28] underlined that the lack of compatibility of outdated systems with cloud system cause the lack of data sharing and work efficiency. As the services of cloud shared with different users, data security and privacy is also a concern in COSD paradigm [29],[30].

Despite the significance of offshore cloud outsourcing in current era, few studies have been conducted to identify management barriers associated with COSD projects. We believe that the identification of the COSD barriers is important for the success of COSD activities. The objective of this study is to identify the barriers associated with managing COSD projects. We believe finding of this study will assist both researchers and practitioners to develop the strategies for managing COSD projects.

3. Research objective and research questions

In this study, first, research problem statement was defined which provides a broad issue that we address in our study. Next, research objective statement was developed which indicates what is the aim of the study. Finally, a set of research questions were developed to specify specific concerns we will answer through the study.
Problem Statement: Management of COSD projects is a challenging task due to number of distant development locations in different time zones, client and vendor organizations, different cloud deployment models and range of different service level agreements.

Research Objective: The objective of this study is to identify the barriers associated with managing COSD projects.

Research Questions: To achieve the objective of the study, we define research questions as follows:

"RQ1: What barriers are reported in the multivocal literature that has a negative impact on COSD paradigm?"
"RQ2: Are the investigated barriers are related to client and vendor COSD organizations?"
"RQ3: Is there any difference between the findings of formal and grey literature?"
"RQ4. How are the investigated barriers related to ten areas of project management?"

4. Research Methodology

In this study, we conducted a multivocal literature review based on guidelines presented by Garousi et al. [31]. A multivocal literature review is a form of a systematic literature review which includes both formal and grey literature. A formal literature includes peer reviewed journal and conference papers. On other hand, a grey literature includes white papers, magazines, government reports, videos, and blog reports. As part of the multivocal literature review, grey literature is included in the study to include the large body of knowledge which is constantly produced by industry practitioners outside the academic forums. As a result, a multivocal literature review is useful for both researchers and practitioners as it provides evidence from both the state-of-the-art and state-of-the-practice in a given area. Figure 1 shows different phases of MLR for our study.

4.1 Phase-1 (Planning the MLR)

MLR protocols were developed by the first and third author of the study. Next, second, fourth and fourth authors of the study reviewed the protocol. Finally, the fifth author did a pilot execution of the protocol.

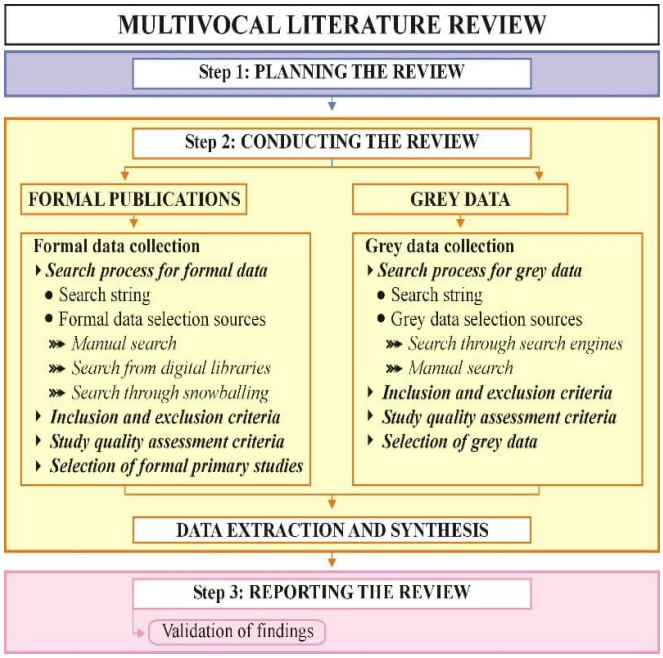

Figure 1: Proposed Methodology

4.2 Phase-2 (Conducting the review)
Next, MLR protocol was executed to identify primary studies from both formal and grey literature. The details are as follows:

4.2.1 Formal literature
To identify relevant primary studies from the formal literature, the following steps were performed:

4.2.1.1 Search process for formal literature
4.2.1.1.1 Search string
In this study, search keywords were defined using 'quasi-gold-standard' [49] and Zhang et al. [48] guidelines. First, five relevant primary studies were manually selected as quasi-gold-standard studies. Next, authors of the study derived potential search keywords from the quasi-gold-standard studies using population, intervention, and outcomes [56] as follows:

"Population": Cloud Outsource Software Development
"Intervention": Project management barriers
"Outcome of relevance": List of barriers in project management of cloud outsource software development projects.

Next, we identified synonyms and similar spellings of the derived search keywords. Finally, we used to Boolean operators to define search string for different databases as shown in Table 1.

Table 1: keywords and their alternative for search string

Related topics	**"Used keywords and alternatives"**
SS1 (Outcomes)	"("barriers" OR "obstacles" OR "hurdles" OR "difficulties" OR "impediments" OR "hindrance" OR "challenges" OR "limitations")"
SS2 (Intervention)	("IaaS" OR "PaaS" OR "SaaS" OR "XaaS" OR "Infrastructure as a Service" OR "Platform as a Service" OR "Software as a Service" OR "IT service" OR "Application Service" OR "ASP")".
SS3 (Population)	"("Outsourcing" OR "global software development" OR "geographically distributed development" OR "offshore development" OR "multisite development" OR "collaborative software development")".
SS4 (Global software	"("cloud computing" OR "cloud platform" OR "cloud provider" OR "cloud service" OR

development)	"cloud offering")".
SS5 (Experimental)	"("grounded theory", "interviews" "case studies", "questionnaire survey", "theoretical studies", "content analyses", "action research")".
"Final search string= (SS1) AND (SS2) AND (SS3) AND (SS4) AND (SS5)"	

4.2.1.1.2 Formal literature selection sources

In order to collect the most appropriate data, we consider the suggestions of Zhang and Babar[32] and White et al. [33], to collect the data from both automated search and manual search.

(i) Manual search

For manual search, we used the guidelines of QGS [33]. The concepts of QGS consider only those studies that are related with study RQs. Initially, we explore the special issues, conferences, and workshops on the journal websites to collect the related primary studies. We also explore the available literature on the Research Gate ("https://www.researchgate.net") for manually searching the primary studies related to research questions.

(ii) Search from digital libraries

In second phase, we collect published primary studies by using the automated search mechanism [34, 35]. For automated search process the selection of appropriated digital databases is significant. However, using the recommendation of Chen et al.[36], Niazi et al.[37], Afzal et al.[34], the following digital repositories were considered:

I. "IEEE Xplore (http://ieeexplore.ieee.org)"
II. "ACM Digital Library (http://dl.acm.org)"
III. "Springer Link (http://link.springer.com)"
IV. "Wiley Inter Science (www.wiley.com)"
V. "Science Direct (http://www.sciencedirect.com)"
VI. "Google Scholar (http://scholar.google.com)"
VII. "IET software (https://digital-library.theiet.org)"

(iii) Search through snowballing

In phase three of primary studies collection, we have performed snowballing approach [34]. The snowballing approach is performed with the reference list of the selected primary studies of both phases (manual and automated search). We used both backward and forward snowballing approach. The backward snowballing approach refer to the studies cited in the paper and forward snowballing refer to the studies by whom the paper is cited [34, 38].

4.2.1.2 Inclusion and exclusion criteria

The inclusion and exclusion criteria indicated that which part of the collected literature included and excluded for further MLR phases. To develop the inclusion and execution criteria, we used the suggestion of Niazi et al.[8], Khan et al.[39] and Khan et al.[40]. The article should publish in journal or conference, study should be about cloud outsourcing concepts, and study should be published between January 2000 to December 2021 For exclusion, the following criteria was used: the study doesn't satisfy objective of the research, study is not written in English, study does not provide the details about the barriers of cloud software development outsourcing and study does not clearly state its research approach.

4.2.1.3 Study Quality Evaluation Criteria

The quality evaluation of primary studies was performed to check the significance of each selected study with respect to the objective of the research. To assess the quality of the selected primary studies, we follow the concepts of the existing systematic literature review studies [5, 35, 41]. For quality evaluation, a format checklist was developed as shown in Table 2. The checklist includes five questions, and each question was assessed using the Likert scale as follows: if a study addresses the question of the checklist, then assign score 1, if the study address the question partially then assign 0.5 and if the study does not address the question of the checklist then 0 score was assigned. By using the questions of the format list, the quality of each article was assessed, and the results are given in Appendix-A.

Table 2: quality assessment criteria for formal primary studies

Checklist Questions	Likert scale
"Does the used research approach address the research questions?"	"Yes=1, Partial=0.5, NO=0"
"Does the study, discuss any barrier of COSD?"	"Yes=1, Partial=0.5, NO=0"
"Does the study, discuss software development outsourcing by using cloud computing?"	"Yes=1, Partial=0.5, NO=0"
"Is the collected data related to cloud outsourcing?"	"Yes=1, Partial=0.5, NO=0"
"Are the identified results related to the justification of the research questions?"	"Yes=1, Partial=0.5, NO=0"

4.2.1.4 Selection of formal primary studies

To address the study objectives, "the data were collected thorough three different ways as indicated in section 4.2.1.1.2. In first phase, we followed the guidelines of QGS [33] and 5 studies were selected. In second phase, the selected digital libraries were searched using the search string shown in Section 4.2.1.1.1. The search string was executed on selected seven digital databases (section 4.2.1.1.2); and initially, 1855 articles were collected after apply inclusion and exclusion criteria given in section 3.2.1.2. Following the tollgate approach [34], all the selected studies were reviewed and finally 82 studies were considered for data extraction process. In third phase the snowballing approach was applied. Figure 2 shows details of the selection of primary studies from the formal literature.

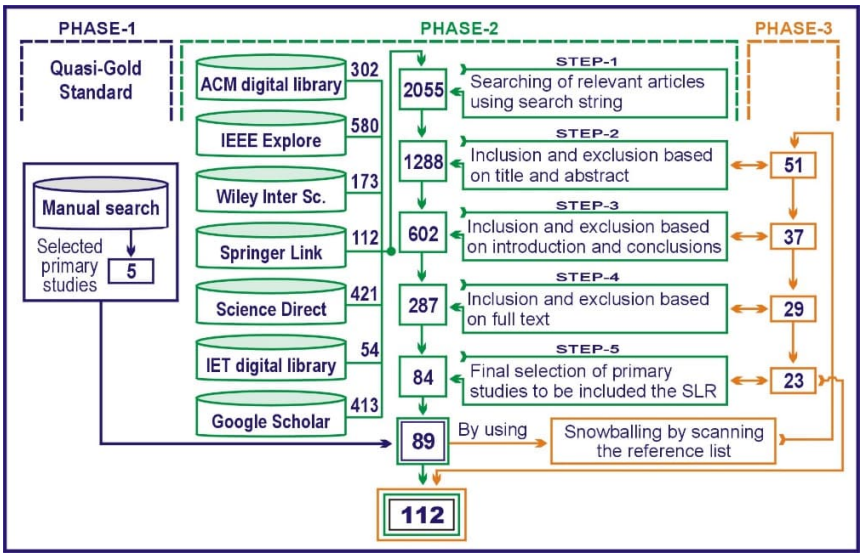

Figure 2: Refinement of formal studies

4.2.2 Grey literature

To collect the potential grey literature, the adopted steps are as follows:

4.2.2.1 Search process for grey literature

In this study, we applied both automated and manual search process. The details are as follows:

4.2.2.1.1 Search through search engines

We have selected the most popular web search engines to collect the appropriate literature considering the aim of this study. The considered search engines are as follows:

- "http://www.google.com"
- "https://www.bing.com"
- "http://www.opengrey.eu"
- "https://www.arxiv.org"
- "https://www.stackoverflow.com"

- “https://www.agilealliance.org”
- “https://www.istqb.org”
- “https://www.idc.com”

The developed search string (“Section 4.2.1.1.1 – Search String”) was executed to find relevant grey literature for the study.

4.2.2.1.2 Manual search

For manual searching, we approached relevant practitioner through their official websites, Facebook and LinkedIn profiles, personal emails, and organizational contacts. The practitioners were requested to share unpublished data (e.g., organizational standards, research registers, case study results, experts’ opinions etc) with the research team. Appendix-C present the detail information of the participants.

4.2.2.2 Inclusion and exclusion criteria for grey literature

The inclusion and exclusion criteria were applied following the Garousi et al. guidelines [31]. The grey literature was included as a primary study which was related to the research questions of the study and their findings were based on real-world practices. We excluded grey literature which was not written in English language and did not provide details about barriers associated with COSD projects.

4.2.2.3 Quality assessment (QA) criteria for grey literature

To QA of selected grey literature, we have applied criteria presented in Table 3. All the questions of QA criteria were assessed by using the Likert scale presented in Table 3. The format of the QA criteria was developed by using the guidelines of Garousi et al.[31]. The quality assessment criteria were performed along with the data refinement process. The final score of grey literature through web engines is presented in Appendix-B and the collected results of grey literature which is collect directly from practitioners is presented in Appendix-C.

Table 3: Quality assessment criteria for grey literature

Criteria type	Questions of QA	Likert scale
Authority of the producer	“C1: Is the publishing organization reputable? E.g., the Software Engineering Institute (SEI)”	“Yes=1, Partial=0.5, NO=0”
	“C2: Is an individual author associated with a reputable organization?”	“Yes=1, Partial=0.5, NO=0”
	“C3: Has the author published other work in the field?”	“Yes=1, Partial=0.5, NO=0”
	“C4: Does the author have expertise in the area? (e.g. job title principal software engineer)”	“Yes=1, Partial=0.5, NO=0”
Methodology	“C5: Does the source have a clearly stated aim?”	“Yes=1, Partial=0.5, NO=0”
	“C6: Does the source have a stated methodology?”	“Yes=1, Partial=0.5, NO=0”
	“C7: Is the source supported by authoritative, contemporary references?”	“Yes=1, Partial=0.5, NO=0”
	“C8: Are any limits clearly stated?”	“Yes=1, Partial=0.5, NO=0”
	“C9: Does the work cover a specific question?”	“Yes=1, Partial=0.5, NO=0”
	“C10: Does the work refer to a particular population or case?”	“Yes=1, Partial=0.5, NO=0”
Objectivity	“C11: Does the work seem to be balanced in presentation?”	“Yes=1, Partial=0.5, NO=0”
	“C12: Is the statement in the sources as objective as possible? Or, is the statement a subjective opinion?”	“Yes=1, Partial=0.5, NO=0”
	“C13: Is there vested interest? E.g., a tool comparison by authors that are working for particular tool vendor”	“Yes=1, Partial=0.5, NO=0”
	“C14: Are the conclusions supported by the data?”	“Yes=1, Partial=0.5,

		NO=0”
Date	“C15: Does the item have a clearly stated date?”	“Yes=1, Partial=0.5, NO=0”
Source Position	“C16: Have key related GL or formal sources been linked to/ discussed?”	“Yes=1, Partial=0.5, NO=0”
Novelty	“C17: Does it enrich or add something unique to the research?”	“Yes=1, Partial=0.5, NO=0”
	“C18: Does it strengthen or refute a current position?”	“Yes=1, Partial=0.5, NO=0”
Impact	“C19: Normalize all the following impact metrics into a single aggregated impact metric (when data are available): Number of citations, Number of backlinks, Number of social media shares (the so-called alt-metrics), Number of comments posted for a specific online entries like a blog post or a video, Number of page or paper views.”	“Yes=1, Partial=0.5, NO=0”

3.2.2.4 Selection of grey literature

The search string presented in Section 4.2.1.1.1 was executed on the selected search engines with the aim to collect the grey literature which addresses study research questions. Initially, we collected 133 documents after applying the inclusion and exclusion criteria (section 3.2.2.2). Next, we refined the collected grey literature by adopting the tollgate approach suggested by Afzal et al.[34]. All the authors participated in final data refinement process. All the phases of tollgate approach were applied carefully (Figure 4) and finally 31 pieces of grey literature were selected for data selection process. The sources of 31 pieces of grey literature are presented in Appendix-B. Moreover, a total of 29 responses were collected form the practitioner’s and by applying the tollgate approach Figure 3, 22 responses were finally included form data extraction process. The demographic data of the respondents are presented in Appendix-C. Finally, a total of 53 (31+22) documents from the grey literature were included in the study. Details of grey literature are provided in Appendix-B and Appendix-C respectively.

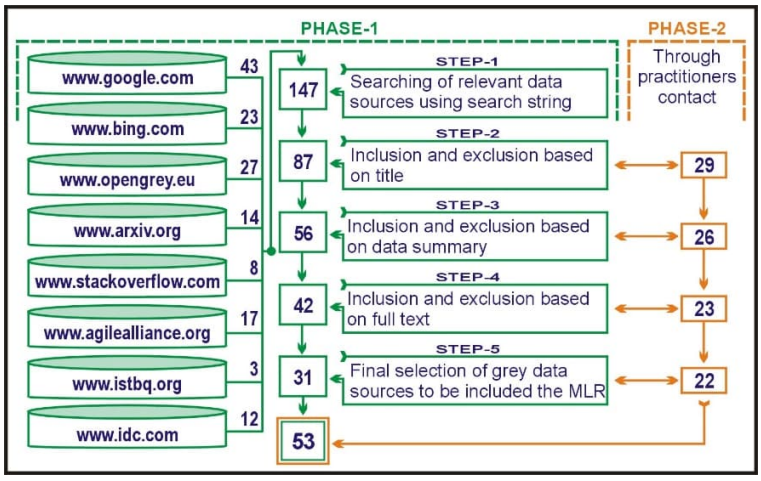

Figure 3: Refinement of grey data sets

4.2.2.5 Data extraction and synthesis

Coding scheme of Grounded Theory approach [42] was adopted to analyze the selected primary studies from both formal and grey literature. All collected data was carefully reviewed and the ideas, themes and findings from the selected literature were extracted and labeled to the general categories of the barriers. The frequency of all barriers from both data sets were also recorded. In initial phase, a total of 31 categories (ideas, statements etc.) of the barriers were recorded. In the second phase, we systematically compared the similar barriers, and the related barriers were merged into 21 final barriers categories.

4.3 Phase-3 (Reporting the review)

4.3.1 Quality assessment of primary selected studies.

Quality assessment of primary studies selected from the formal literate show that 78% of the studies scored more than 70%. The detail quality assessment results are presented in Appendix-A. Similarly, quality assessment of primary studies selected from the grey literate show that 81% of the studies scored more than 80%. The detail quality assessment results of grey literature are presented in Appendix-B and Appendix-C respectively.

4.3.2 Data growth analysis

Data growth base analysis was conducted to check the frequency of data publication in formal and grey literature across the years (i.e., 2001 to 2021). The results presented in Figure 4, shows that from 2007 to 2013, the formal publication frequency is much higher than grey literature. We further noted that currently (2015 to 2021) the publication frequency of grey data is significantly increased as compared to formal publications. As the frequency of grey literature is higher in recent years, this renders the increase in research interest of industry experts in cloud based outsource software development paradigm.

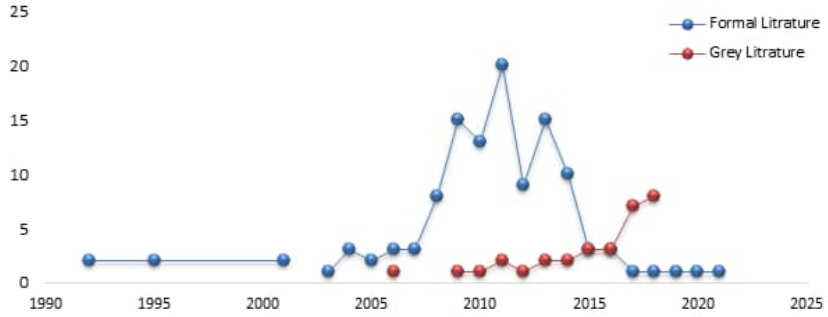

Figure 4: Comparison of data growth based on time

4.3.3 Identification of review

All the identified barriers are arranged with respect to the frequency of occurrences. The final list of the investigated cloud outsourced software development barriers and the performed additional analysis are presented in section 5.

5. Results and discussions

5.1 Identified barriers.

A total of 21 barriers of COSD are identified by using the MLR approach from the selected 161 select data sets. All the identified barriers are given in Table 4.

Table 4: list of investigated barriers

Sr.NO	List of barriers	F (N=165)	Percentage
B1	Data security issues	106	65
B2	Lack of coordination between business goals and IT goals	94	58
B3	Lack of standardization	91	57
B4	Conflict management issues	88	55
B5	Compatibility issues (connecting legacy systems with cloud applications)	87	54
B6	Vendor lock-in	84	52
B7	Less control on overseas development activities	81	50
B8	Outdated technology skills	75	47
B9	Communication problems between overseas practitioners	67	42
B10	Quality control and compliance issues	65	40
B11	Lack of knowledge management and transfer among teams	63	39
B12	Lack of time differences management	58	36
B13	Dubious accessibility	57	35
B14	Hidden costs	55	34
B15	Limited control on cloud servers	52	32
B16	Fuzzy focus	52	32
B17	Issues of intellectual property protection	50	31
B18	Operational and transaction risk	48	30

B19	Problems with consistency and oversight	49	30
B20	Lack of trust and trustworthiness	46	29
B21	Legal issues	42	26

Rockart[43] introduced an idea of critical factors, by considering the importance of key information which are needed by a chief executive of an organization. This idea is derived from the perception literature of project management[44]. Niazi et al.[37], underlined that the critical factors presets the area which needs special consideration of top decision makers of an organizations for successful execution of projects. The critical areas or factors may vary as they based upon the position of the individuals, project type, development site and over time [5, 10, 40, 41].

By following the guidelines of existing literature, we used the following criteria to determine the critical barriers of COSD paradigm.

- If the frequency of occurrence of a barrier is ≥50% in the selected literature, then it is consider as critical barrier.

By adopting the same criteria, the following seven investigated barriers were declared as most critical (Table 4) for the successful implementation of software development activities in the context of COSD.

B1 (Data security issues, 65%) was cited as the most significant barrier for software project management in the context of COSD environment in the selected literature. Böhm et al. [SF5] indicated that the data security is vital in the context of COSD, as all the data and information is stored on the cloud rather than on-site storage. Schneider, S. and A. Sunyaev [SF13] emphasized that the services of CC share their resources over the globe which causes the hackers attack. They further stated that every business organization want to sure their data security, but the use of cloud computing services threatens to the organizations about data security. Gens [SF21] suggested that the software organizations must investigate the robustness of cloud services provider organization, especially with respect to the data security.

B2 (Lack of coordination between business goals and IT goals, 58%) was reported as the second most important barrier of software development in the context of COSD. In COSD paradigm, the client organizations outsource their development activities to low-cost countries (vendor organizations) e.g., hiring freelancer services. The vendor organizations do not understand the key business objective and business model of the client organizations [SF11]. The overseas development teams of vendor organizations work on the provided requirements specifications in a general prospective which mislead the vendor organization to get key business objective of the client organizations. Sheard et al. [FS23] indicated that the lack of close coordination between the client and vendor organization, outsource activities cannot be performed accurately and effectively.

B3 (Lack of standardization, 57%) was reported as the third most important barrier for the management of software development activities in the domain of COSD. Lian et al. [FS28] emphasized that the standard and procedures are important to evaluate the existing COSD capabilities and improve them in an effective way. Nedev [FS24] and Martens et al. [FS32] emphasized that the standards and procedures are important to manage that software development activities in geographically distributed environment. They further indicated that the lack of standard and procedure is a critical issue while adopting COSD paradigm. Several project management standards have been developed to manage the project management activities but there is lack of standard and procedure in the context of COSD.

B4 (Conflict management issues, 55%) was declared as the fourth most critical barriers for managing the development activities in the context of COSD. Morgan and Conboy [FS35] highlighted that the conflict can occur between the overseas teams working across the globe and in between the cloud service provided organizations. For example, it is the key property of the cloud services to provide the opportunity to the user to share the data with every level of user where is the location is not concern. However, the security of data is also a key concern of every organization. Though this conflict is a critical barrier for the cloud services provider and COSD organizations. Marston et al. [FS47] indicated that lack of frequent and effective communication and coordination between the overseas COSD team causes the conflicts while implementation development activities. In another study Brender

[FS43] indicated that poor planning is one of the key reasons of conflict between the development activities and the cloud services provider.

B5 (Compatibility issues (connecting legacy systems with cloud applications, 54%) was indicated as an important barrier in COSD environment. Saripalli et al. [FS45] indicated that the compatibility issues can arise when a client organization perform some of their development activities in-house and some are outsourced. Yin et al. [FS58] underlined that the different use of development environment can cause the compatibility issues of different software modules. They further highlighted that the COSD organizations outsource their development activities in developing countries and there is a lack of updated IT infrastructure. Though, when the overseas sites trying to connect the legacy systems with the updated cloud services, the compatibility issue may arise. Bahli et al. [FS55] argued that the compatibility is also one of the key reason due to the differences in service provider applications, as there is no standardization across the cloud services platforms. Bahli et al. further emphasized that the compatibility issues made the clients dependent on their services, as they can't switch to other cloud service provider without sacrificing the invested cost.

B6 (Vendor lock-in, 52%) was reported as the critical barrier for the successful implementation of COSD paradigm. Look-in problem refers to the dependency of customer on the cloud service provider [FS11, FS32]. Saripalli et al. [FS45] indicated that the COSD organizations cannot move from one service provider to other in future due to the legal and technical constraints. They further stated that when a software firm hire the cloud services to outsource the development activities then they should complete their project with the same cloud service provides as there is no mechanisms to move from one cloud provider to any other. Conboy [FS35] also highlighted the vendor lock-in as a critical barriers of cloud service provider.

B7 (Less control on overseas development activities, 50%) was also a critical barrier for the successful implementation of software development activities in COSD environment. Böhm et al. [SF5] indicated that in COSD environment the development activities are outsourced to the vendor organizations, and the development process is totally dependent overseas practitioners. They further indicated that in COSD there is a lack of visibility of development activities. Moreover, in COSD environment a client firm totally depend on the third party, trusting on their expertise, services, and resources. However, if the client organization not satisfied with the outsourced development work, then this leads to the project failure.

5.2 Client and vendor analysis

Next, we performed a client and vendor analysis to better understand COSD project management barriers from both client and vendor organization perspectives. The following hypothesis has been developed to examine the significant difference between the barriers from client and vendor organizations:

- "Null hypothesis (H0): There is no significant difference between the client and vendor COSD organizations with respect to investigated barriers."
- "Alternate hypothesis (H1): There is significant difference between the client and vendor COSD organizations with respect to investigated barriers."

The Null hypothesis (H0) accepted if the calculated significance value of $p>0.05$, else the alternative hypothesis (H1) is accepted.

Table 5: Client and Vendor based analysis

	Client (N=69)		Vendor (N=97)		"Chi-square Test "$\alpha = 0.05$"		
S.NO	F	%	F	%	X^2	df	P
B1	57	85	47	50	2.565	1	0.109
B2	36	54	58	62	0.622	1	0.430
B3	50	75	41	44	0.966	1	0.326
B4	37	55	51	54	1.049	1	0.306
B5	43	64	44	47	3.273	1	0.070
B6	42	63	42	45	1.453	1	0.228
B7	44	66	37	39	0.843	1	0.359
B8	36	54	39	41	0.358	1	0.550

B9	27	40	40	43	1.173	1	0.279
B10	24	36	41	44	1.679	1	0.195
B11	26	39	37	39	3.519	1	0.061
B12	25	37	33	35	0.324	1	0.569
B13	30	45	27	29	0.064	1	0.800
B14	29	43	26	28	0.978	1	0.323
B15	29	43	24	26	1.688	1	0.194
B16	21	31	29	31	1.453	1	0.228
B17	26	39	22	23	1.688	1	0.194
B18	27	40	22	23	0.324	1	0.569
B19	36	54	19	20	1.426	1	0.232
B20	21	31	21	22	0.843	1	0.359
B21	18	27	16	17	1.173	1	0.279

The results presented in Table 5, shows that there is no significant difference between the barriers of COSD process with respect to client and vendor organizations. Hence, the Null hypothesis (H0 is) accepted. We have further noted that B9 (Communication problems, 40% and 43%), B11 (Lack of knowledge management and transfer among teams, 39% and 39%), B12 (Lack of time differences management, 37% and 35%) and B16 (Fuzzy focus, 31% and 31%) are common barriers between the client and vendor organizations, respectively.

B1 (Data security issues, 85%) was most significant cited barrier in the context of client COSD organizations. As the client organizations (developed countries) hire services from vendor organization (developing countries), though the security of data is more important for client organization as compared to vendor organizations. Brunzel and Giacomo [FS69] highlighted that risk of data security is more significant for client organization as they are key investor for in COSD paradigm. The important information and development activities are carried out on the cloud services; therefore the security is the main concern for client outsource software development organizations [FS13].

Moreover B2 (Lack of coordination between business goals and IT goals, 62%) was declared as the highest reported barrier for vendor COSD organizations. In COSD paradigm, the development activities are carried out offshore in geographically distributed development environment. However, the geographical distance between the development teams causes the lack of coordination between COSD practitioners. Aubert et al. [FS83] highlighted that the activities involved in software development are more communication and coordination oriented. They further stated that the lack of coordination among the overseas practitioners is an important barrier in the context of COSD paradigm. Barthelemy and Geyer [FS83] also highlighted the coordination barriers in COSD development process.

5.3 Comparison of both data sets

A comparison analysis was performed to analyze potential differences between both data sets (i.e., formal, and grey literature). Frequency of each barrier in both data sets is presented in Table 6. Based on the frequency analysis (Table 6, Figure 5), the ranks for each barrier in both data sets were calculated. The calculated ranks were used to check the correlation in both data sets with respect to the identified barriers. This comparison analysis approach has been adopted by various existing studies of other software engineering domain e.g. [8, 41]. In this study, we adopted Spearman correlation analysis to check the similarities and difference in data sets [8, 41]. The Spearman correlation offers the linear dependence among the data sets, with the values ranging from -1 to +1, where 1 indicating a perfect correlation [35].

The results (r_s=0.667, p=0.001) presented that there is a positive correlation between the ranks of both data sets. The detailed results are presented in Table 7 and in the form of scatter plot in Figure 6.

Furthermore, an independent t-test was conducted to measure the mean difference between the formal and grey literature. Levene's test was applied and the calculated value similarities and difference between the ranks of barriers obtain in both data sets. The results (t=0.539 and p=0.802) demonstrated that there are more similarities between the ranks of both data sets (Table 8). Moreover, the results of group data statistics are presented in Table 9.

Table 6: Ranks obtain from forma and grey literature

S.NO	Formal Literature			Grey Literature		
	F(n=112)	%	Rank	F (n=53)	%	Rank
SF1	67	62	1	37	70	2
SF2	67	62	1	27	51	6
SF3	60	56	2	31	58	3
SF4	57	53	3	31	58	3
SF5	46	43	7	41	77	1
SF6	56	52	4	28	53	5
SF7	51	47	5	30	57	4
SF8	47	44	6	28	53	5
SF9	41	38	8	26	49	7
SF10	37	34	10	28	53	5
SF11	41	38	8	22	42	8
SF12	40	37	9	18	34	11
SF13	37	34	10	20	38	9
SF14	33	31	12	22	42	8
SF15	33	31	12	19	36	10
SF16	36	33	11	16	30	13
SF17	33	31	12	17	32	12
SF18	30	28	14	18	34	11
SF19	33	31	12	16	30	13
SF20	32	30	13	14	26	14
SF21	26	24	15	16	30	13

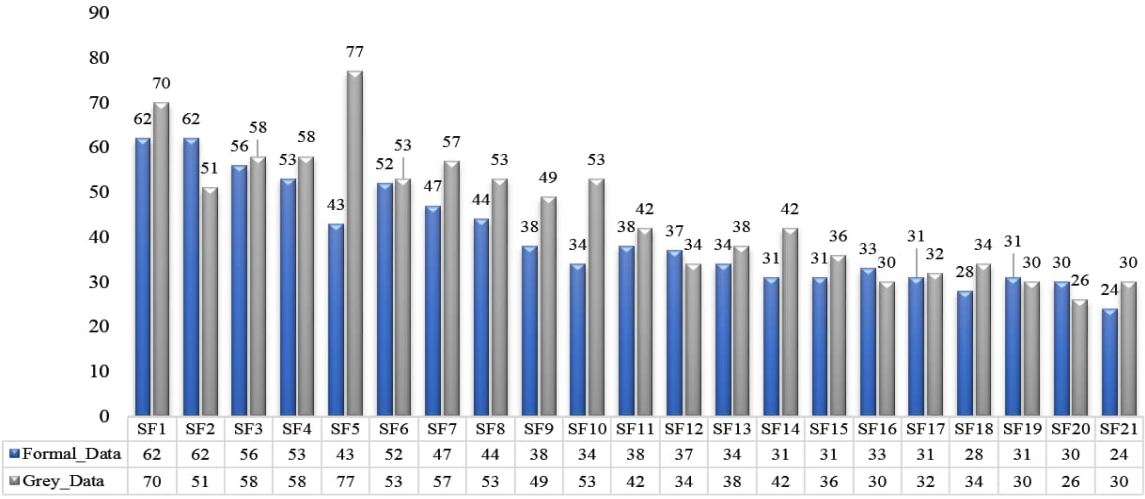

Figure 5: Frequency based comparison of both data sets.

Table 7: Correlation results

			Formal_Literature	Grey_Literature
"Spearman's rho"	"Formal_Literature"	"Correlation Coefficient"	1.000	0.667**
		"Sig. (2-tailed)"	.	0.001
		N	21	21
	"Grey_Literature"	"Correlation Coefficient"	0.667**	1.000
		"Sig. (2-tailed)"	0.001	.
		N	21	21
**. Correlation is significant at the 0.01 level (2-tailed).				

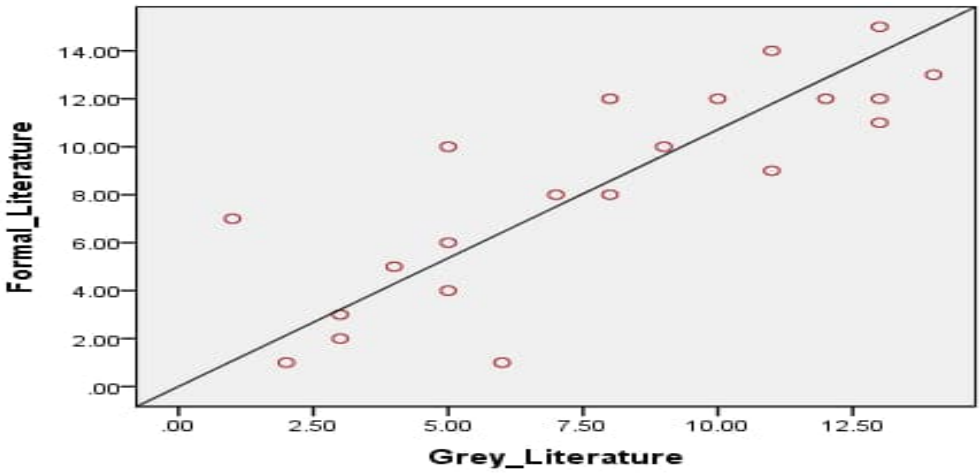

Figure 6: Scatter plot of ranks of both data sets

Table 8: Independent Samples Test

		"Levene's Test for Equality of Variances"		"t-test for Equality of Means"						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Ranks	"Equal variances assumed"	0.064	0.802	0.539	40	0.663	0.57143	1.30062	-2.05722	3.20008
	"Equal variances not assumed"			0.539	39.827	0.663	0.57143	1.30062	-2.05758	3.20043

Table 9: Group Statistics

	Group	N	Mean	Std. Deviation	Std. Error Mean
Ranks	0.00	21	8.3333	4.35125	0.94952
	1.00	21	7.7619	4.07314	0.88883

We have further conducted a two-sided Pearson Chi-square test, to determine the significant differences between the two data sets. The results (X^2=0.578>0.5) presented in Table 10, shows that there is no significant difference between both types of data sets. This renders that the investigated barriers from both data sets (formal and grey literature) have more similarities than difference. Moreover, this indicated that there is no significant difference between the barriers reported by researchers (in formal literature) and highlighted by the industry practitioners (in grey literature).

Table 10: Chi-Square Test

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	177.625[a]	182	0.578
Likelihood Ratio	86.961	182	1.000
N of Valid Cases	21		
"a. 210 cells (100.0%) have expected count less than 5. The minimum expected count is .05."			

5.4 Mapping of investigated barriers into ten knowledge area of PMBOK

We have mapped the identified barriers into ten knowledge areas of PMBOK [45] as it is a de-facto industry standard for project management. The mapping gives insight to the practitioners about which barriers are important

in each knowledge area for successful project management of COSD projects. The mapping will assist practitioners in developing strategies for successful management of COSD projects. Moreover, the mapping will also help researchers to develop techniques and tools to better manage priority management areas for COSD projects.

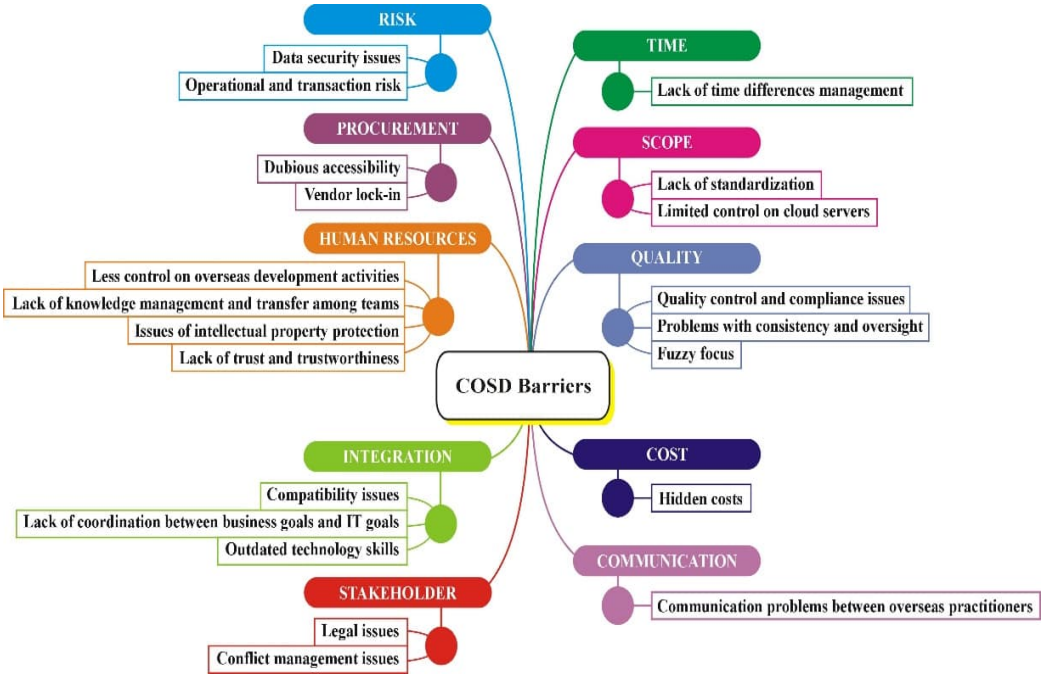

Figure 7: Mapping of investigated barriers into knowledge areas of PMBOK.

Grounded Theory based coding scheme [42] was used to map the investigated barriers of COSD into ten PMBOK areas. To perform the mapping, three researchers were participated. They labeled and grouped the barriers into ten most related knowledge areas. The mapping result, as shown in Figure 7, show that human resources management is most significant knowledge area for COSD projects. We believe the project managers need to pay more focus to address the barriers of human resource management category.

6 Study Implication

The objective of this study is to identify the barriers associated with managing COSD projects. We implemented a Multivocal Literature Review (MLR) to identify barriers that influence management of COSD projects. We believe that study findings will assist both research and industry community to better understand and manage COSD projects. The study provides a list of barriers which practitioners should consider in their management of COSD projects. The study provides a body of knowledge to both researchers and industry community that will assist both academia and industry experts to develop strategies for better management of COSD projects. Furthermore, the identified barriers are also mapped into ten knowledge areas of the PMBOK, which can assist industry experts to consider most related knowledge area of barrier in their respective project contexts.

Moreover, as part of our ongoing research project, we aim to develop a readiness model for cloud outscoring software development which will help the organizations to assess and improve their COSD process. The findings of this study contribute to one component of the readiness model (identification of COSD barriers) as shown in Figure 8. The readiness model will help the organizations to assess and improve their COSD processes effectively and efficiently.

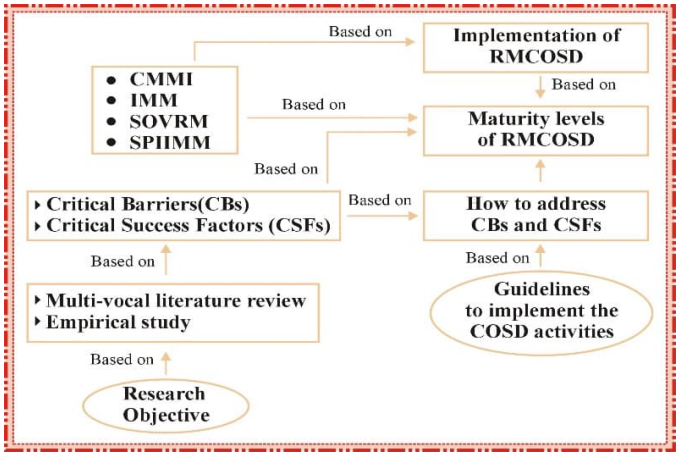

Figure 8 structure of the RMCOSD

7 Study Limitations

Incompleteness of multivocal literature is one of the potential limitations of the study. To minimize the impact of this threat to validity, search keywords were defined using well established 'quasi-gold-standard' [49] and Zhang et al. [48] guidelines. We also identified synonyms and similar spellings of the derived search keywords. Moreover, with the increasing number of grey literatures published on this topic, some recent publications could have been missed at the time of consolidating the results of the study. However, we believe that by following the well-established search process, results presented in the study are comprehensive and cover the most relevant formal and grey literature. Another threat to validity is potential bias introduced by the researchers involved in data extraction and synthesis process. We mitigated this threat by evaluating inter-rater agreement between reviewers. The results showed a strong degree of agreement between data extracted and synthesized by different researchers involved in the study.

8. Conclusion and Future Work

Management of COSD projects is a challenging task due to number of distant development locations in different time zones, client and vendor organizations, different cloud deployment models and range of different service level agreements. The objective of this study is to identify the barriers associated with managing COSD projects. We implemented a Multivocal Literature Review (MLR) to identify barriers that influence management of COSD projects. Study results indicate that 7 out of 21 identified barriers are critical to for successful management of COSD projects. The results of client-vendor analysis indicate that the identified barriers are equally important for both types of COSD organizations.

Moreover, we found that there is a positive correlation between the frequencies of occurrence of both data sets (formal and grey literature). This indicate that there is no significant difference between the investigated barriers from both researcher and practitioner community. In addition, the study provides a theoretical framework by categorizing the investigated barriers into 10 knowledge areas of project management PMBOK. The results indicate that human resource management is the most significant knowledge area of the investigated barriers.

In future, we aim to develop a readiness model for cloud outscoring software development which will help the organizations to assess and improve their COSD process. The findings of this study contribute to one component of the readiness model (identification of COSD barriers) as shown in Figure 1. The readiness model will help the organizations to assess and improve their COSD processes effectively and efficiently. We plan to conduct questionnaire survey study to validate the investigated barriers. Moreover, we also have plan to identify the best practices to address the critical barriers of managing COSD projects.

For appendixes, please visit the following links:

Appendix-A: Selected formal literature (*https://tinyurl.com/y676a4jt*)
Appendix-B: Selected grey literature from Search Engines (*https://tinyurl.com/y547kcmb*)
Appendix-C: Grey literature collected from experts through personal contact (*https://tinyurl.com/yxlr8lw4*)

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References

[1] J. Binder, "Global project management: communication, collaboration and management across borders," Strategic direction, 2009.
[2] P. Mell and T. Grance, "The NIST definition of cloud computing," 2011.
[3] S. Dhar, "From outsourcing to Cloud computing: evolution of IT services," Management Research Review, 2012.
[4] M. Böhm, S. Leimeister, C. Riedl, and H. Krcmar, "Cloud computing–outsourcing 2.0 or a new business model for IT provisioning?," in Application management, ed: Springer, 2011, pp. 31-56.
[5] S. U. Khan, M. Niazi, and R. Ahmad, "Factors influencing clients in the selection of offshore software outsourcing vendors: An exploratory study using a systematic literature review," Journal of systems and software, vol. 84, pp. 686-699, 2011.
[6] N. Ramasubbu, "Governing software process improvementsin globally distributed product development," IEEE Transactions on Software Engineering, vol. 40, pp. 235-250, 2013.
[7] S. Marston, Z. Li, S. Bandyopadhyay, J. Zhang, and A. Ghalsasi, "Cloud computing—The business perspective," Decision support systems, vol. 51, pp. 176-189, 2011.
[8] M. Niazi, S. Mahmood, M. Alshayeb, A. M. Qureshi, K. Faisal, and N. Cerpa, "Toward successful project management in global software development," International Journal of Project Management, vol. 34, pp. 1553-1567, 2016.
[9] M. Niazi, S. Mahmood, M. Alshayeb, M. R. Riaz, K. Faisal, and N. Cerpa, "Challenges of project management in global software development: initial results," in 2013 Science and Information Conference, 2013, pp. 202-206.
[10] A. A. Khan, J. W. Keung, and M. Abdullah-Al-Wadud, "SPIIMM: Toward a model for software process improvement implementation and management in global software development," IEEE Access, vol. 5, pp. 13720-13741, 2017.
[11] B. L. Kedia and D. Mukherjee, "Understanding offshoring: A research framework based on disintegration, location and externalization advantages," Journal of World Business, vol. 44, pp. 250-261, 2009.
[12] C. Kahraman, O. Engin, Ö. Kabak, and İ. Kaya, "Information systems outsourcing decisions using a group decision-making approach," Engineering Applications of artificial intelligence, vol. 22, pp. 832-841, 2009.
[13] M. A. Akbar, S. Mahmood, A. Alsanad, M. Shafiq, A. Gumaei, and A. A.-A. Alsanad, "Organization Type and Size based Identification of Requirements Change Management Challenges in Global Software Development," IEEE Access, 2020.
[14] M. A. Akbar, J. Sang, A. A. Khan, S. Mahmood, S. F. Qadri, H. Hu, et al., "Success factors influencing requirements change management process in global software development," Journal of Computer Languages, vol. 51, pp. 112-130, 2019.
[15] T. Kamal, Q. Zhang, and M. A. Akbar, "Toward successful agile requirements change management process in global software development: a client–vendor analysis," IET Software, 2019.
[16] P. M. Mell and T. Grance, "Sp 800-145. the nist definition of cloud computing," ed: National Institute of Standards & Technology, 2011.
[17] N. V. Oza, T. Hall, A. Rainer, and S. Grey, "Trust in software outsourcing relationships: An empirical investigation of Indian software companies," Information and software Technology, vol. 48, pp. 345-354, 2006.
[18] T. F. Espino-Rodríguez and V. Padrón-Robaina, "A review of outsourcing from the resource-based view of the firm," International journal of management reviews, vol. 8, pp. 49-70, 2006.
[19] Y. B. Chang and V. Gurbaxani, "Information technology outsourcing, knowledge transfer, and firm productivity: An empirical analysis," MIS quarterly, vol. 36, 2012.
[20] D. Dey, M. Fan, and C. Zhang, "Design and analysis of contracts for software outsourcing," Information Systems Research, vol. 21, pp. 93-114, 2010.
[21] P. Nguyen, M. Ali-Baber, and J. Verner, "Trust in software outsourcing relationships: an analysis of Vietnamese practitioners' views," Evaluation and Assessment in Software Engineering, pp. 10-19, 2006.
[22] R. Sabherwal, "The role of trust in outsourced IS development projects," Communications of the ACM, vol. 42, pp. 80-81, 1999.

[23] T. Rajkumar and D. L. Dawley, "Problems and issues in offshore development of software," Strategic Sourcing of Information Systems, Perspectives and Practices," Wiley, 1998.
[24] R. Narayanaswamy and R. M. Henry, "Effects of culture on control mechanisms in offshore outsourced IT projects," in Proceedings of the 2005 ACM SIGMIS CPR conference on Computer personnel research, 2005, pp. 139-145.
[25] A. Rainer and T. Hall, "Key success factors for implementing software process improvement: a maturity-based analysis," Journal of Systems and Software, vol. 62, pp. 71-84, 2002.
[26] A. Benlian, T. Hess, and P. Buxmann, "Drivers of SaaS-adoption–an empirical study of different application types," Business & Information Systems Engineering, vol. 1, p. 357, 2009.
[27] H. Kandjani, M. Tavana, P. Bernus, L. Wen, and A. Mohtarami, "Using extended Axiomatic Design theory to reduce complexities in Global Software Development projects," Computers in Industry, vol. 67, pp. 86-96, 2015.
[28] M. Janssen and A. Joha, "Challenges for adopting cloud-based software as a service (saas) in the public sector," in ECIS, 2011, p. 80.
[29] L. P. Willcocks and M. C. Lacity, Advanced outsourcing practice: Rethinking ito, bpo and cloud services: Springer, 2016.
[30] C. Wang, K. Ren, and J. Wang, "Secure optimization computation outsourcing in cloud computing: A case study of linear programming," IEEE transactions on computers, vol. 65, pp. 216-229, 2016.
[31] V. Garousi, M. Felderer, and M. V. Mäntylä, "Guidelines for including grey literature and conducting multivocal literature reviews in software engineering," Information and Software Technology, vol. 106, pp. 101-121, 2019/02/01/ 2019.
[32] H. Zhang, M. A. Babar, and P. Tell, "Identifying relevant studies in software engineering," Information and Software Technology, vol. 53, pp. 625-637, 2011.
[33] V. J. White, J. M. Glanville, C. Lefebvre, and T. A. Sheldon, "A statistical approach to designing search filters to find systematic reviews: objectivity enhances accuracy," Journal of Information Science, vol. 27, pp. 357-370, 2001.
[34] W. Afzal, R. Torkar, and R. Feldt, "A systematic review of search-based testing for non-functional system properties," Information and Software Technology, vol. 51, pp. 957-976, 2009.
[35] M. Niazi, S. Mahmood, M. Alshayeb, M. R. Riaz, K. Faisal, N. Cerpa, et al., "Challenges of project management in global software development: A client-vendor analysis," Information and Software Technology, vol. 80, pp. 1-19, 2016.
[36] L. Chen, M. Ali Babar, and H. Zhang, "Towards an evidence-based understanding of electronic data sources," 2010.
[37] M. Niazi, D. Wilson, and D. Zowghi, "Critical success factors for software process improvement implementation: an empirical study," Software Process: Improvement and Practice, vol. 11, pp. 193-211, 2006.
[38] C. Wohlin, "Guidelines for snowballing in systematic literature studies and a replication in software engineering," in Proceedings of the 18th international conference on evaluation and assessment in software engineering, 2014, p. 38.
[39] A. A. Khan, J. Keung, S. Hussain, M. Niazi, and S. Kieffer, "Systematic literature study for dimensional classification of success factors affecting process improvement in global software development: client–vendor perspective," IET Software, vol. 12, pp. 333-344, 2018.
[40] S. U. Khan, M. Niazi, and R. Ahmad, "Barriers in the selection of offshore software development outsourcing vendors: An exploratory study using a systematic literature review," Information and Software Technology, vol. 53, pp. 693-706, 2011.
[41] A. A. Khan, J. Keung, M. Niazi, S. Hussain, and A. Ahmad, "Systematic literature review and empirical investigation of barriers to process improvement in global software development: Client–vendor perspective," Information and Software Technology, vol. 87, pp. 180-205, 2017.
[42] J. M. Corbin and A. Strauss, "Grounded theory research: Procedures, canons, and evaluative criteria," Qualitative sociology, vol. 13, pp. 3-21, 1990.
[43] J. F. Rockart, "Chief executives define their own data needs," Harvard business review, vol. 57, pp. 81-93, 1979.
[44] T. M. Somers and K. Nelson, "The impact of critical success factors across the stages of enterprise resource planning implementations," in Proceedings of the 34th Annual Hawaii International Conference on System Sciences, 2001, p. 10 pp.
[45] J. K. Crawford, Project management maturity model: Auerbach Publications, 2014.