Towards the Successful Requirements Change Management in the Domain of Offshore Software Development Outsourcing: Preliminary Results

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Abstract: Majority of the software development industries motivated to adopt the phenomena of global software development (GSD) due to huge return on investment. While adoption of GSD, various challenges are faced by the software industries particularly associated with to requirements change management (RCM). The purpose of the paper is to explore the challenging factors of RCM that faced by GSD organizations. To do this, systematic literature review (SLR) approach is adopted to explore the challenging factors of RCM process in GSD. Using the SLR method, a total 15 challenging factors were identified from the 26 selected primary articles. The investigated challenging factors were further categorized based on firms' types (client-vendor) and time periods (2001-2009 and 2010-2017). The purpose of this categorization is to assess the significance level of each investigated challenging factor with respect to firms' types and time periods. The paper also highlighted the critical challenging factors of RCM process by following the criteria of a factor having frequency $\geq$ 50% as critical. The outcomes revealed that five out of fifteen challenging factors are critical for the executing the RCM activities in GSD. We are confident that the results of this study will be useful in tackling the challenges related to RCM process in GSD that is significant for developing the quality projects.

1. INTRODUCTION

A lot of existing research on traditional software development paradigm assumes that there are only some fixed requirements, and those requirements would not be changed or would not be influenced after being decided [1, 2]. So, it is mostly assumed by the stakeholders that before the initiation of actual project development, they are capable to freeze the requirements [2]. Besides this, in current era, the researchers and practitioners are agree with changing\updating the requirements during the development lifecycle is very significant for producing the quality project according to the expectation of the client [2, 3]. According to Shafiq et al. [4] in initial phase of software development, most requirements are imperfect due to uncertainty of the project objectives, client firm's business domains and unclear vision of client firms.

A deep understanding about the system is developed between the stakeholders after thorough and brief discussion during the development lifecycle, and updating the existing requirements are significant in order to make more efficient and complete software requirements specification (SRS) [2, 4].

Therefore, changes in requirements are requested rapidly because of the changes in user requirements, improving the understandings of stakeholders, expanded vision of project, detailed understanding of requirements, and accessibility of technical solutions [5].

Jayatilleke et al. [6] and Khan et al. [7] indicated that the poor requirements change management is one of the main reasons of the failure of software project. As indicated by Minhas et al. [8] each change has effect on overall cost, schedule, and quality of the software product. To effectively handle the requirements changes, a frequent communication (formal or casual) is significant between stakeholders [7]. However, the communication is one of the key practitioners' coordination dependent activities in software development for both collocated (single site) and global development [1, 7, 10]. Keeping in view of these facts, RCM is not only a simple procedure in collected software development, but it is more complex in GSD [8]. In GSD, if a change occurs at a single site, it may affect at multiple sites simultaneously [3, 11]. In this situation, it is very complicated to assess the effect on the whole system as well as the sub-systems that can be affected by this change [11-15]. A strong requirements management mechanism is needed to handle the

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demanded changes [9, 12]. Otherwise, loss of stakeholders' relationship, budget overrun, bad effect on quality, and project failure will be faced by development firm [16, 17, 25].

The main causes are geographical borders, communication gap, variations in time zones, differences in cultural environment, lack of relevant experience conducted at different global sites and due to poor management of RCM process in GSD [4, 7, 8-12]. Standish Group of International (SGoI) took a survey of 13500 software projects and stated that 29.00% projects are running successfully, 18.00% projects are unsuccessful, and 53.00% software projects are doubtful. The major cause of unsuccessfulness of the projects is poor RCM [19]. Moreover, McGee & Greer conducted another survey study and reported the 60 to 65 percent causes of the changes in requirements [18, 20, 28].

GSD is the recent software development phenomena in which the development teams are separate in different geographical boarders [12, 21]. Due to availing the skilled human resources, economic benefits, round the clock development, availability of latest tools and techniques and attraction with international market, software firms rapidly outsource their development activities across the globe [4, 11, 14, 22]. Besides these benefits, GSD also faces several critical issues such as lack of communication and coordination, lack of trust, lack of regular meetings among offshore RCM practitioners, cultural diversity etc. [4, 10, 22, 23]. These challenges renders that RCM is very complicated software development activity of offshore software development paradigm.

The existing literature highlighted the various techniques to address the problems of RCM. For example, Niazi, et al. [24] presented an RCM model to satisfy the special practices (SP) of capability maturity model integration (CCMI) level-2 (i.e. SP-1.3). This model has six different steps which are used to implement the demanded requirements changes, but there is no way to deal with client and vendor communication. Similarly, Keshta et al. [26] presented a model to address the SP-1.3 of CMMI level-2. The model is developed to manage the required changes in requirements in small and medium scale organizations but not able to deal the requirements changes in large scale software organizations. Minhas et al. [8] suggested a tool to assist the software organizations to address the communication and coordination among the client and vendors perspective. We further identified that Khan et al. [27] proposed an RCM model which is effective to manage the required changes in requirements. In this model, we noted that there is no verification or testing phase that can clarify the effectiveness of implemented changes. Lai et al. [29] developed another model to deal with the required changes in requirements in multisite development environment. We noted that there is no way to deal with the customer and development team in Lai's model. Many other studies are carried out to overcome the barriers of RCM process [4, 15, 20]. Besides, Ramzan et al. [30] conducted a systematic study and indicted that there is a lack of RCM standards and models in collocated (single site)

development environment. This renders the huge gap in the field of RCM in offshore software development paradigm.

This study has three bold objectives: (i) to identify the RCM related challenges from the existing literature, (ii) to check the significant difference between the investigated challenges with respect to client and vendor offshore software organizations and (iii) to map the investigated challenges into core six categories of project management.

We believe that the deep understanding of RCM challenges will be helpful for RCM practitioners to build strategies in order to eliminate the RCM challenges in GSD environment. In addition, the stat-of-the-art review of RCM literature indicated that there is a lack of standards\models in order to deal the RCM activities in GSD environment. However, this motivates us to propose "software requirements change management and implementation maturity model" (SRCMIMM) that can assist the GSD practitioners to successfully assess, measure, and implement the required changes. This paper is an initial step towards the development of SRCMIMM. The challenges and limitations that have negative impact on RCM procedures in the GSD environment are discussed in this paper. The approach of systematic literature review (SLR) is adopted for identifying the faced challenging factors of RCM program in GSD environment. However, to meet the study objectives, we address the following research questions:

RQ1: what factors have negative impact on RCM process in offshore software development environment?

RQ2: How the investigated challenging factors relate to client and vendor organizations?

RQ3: Do the investigated challenging factors vary with respect to time?

RQ4: What are the most critical challenges investigated in the literature?

RQ5: How the investigated challenges are classified into robust framework?

2. RESEARCH METHODOLOGY

Systematic literature review (SLR) is a secondary study that is selected to perform this research study. SLR is considered as an effective methodology to analyze, identify, and explore all facts associated with study questions in a neutral and iterative manner [31]. Kitchenham and Charters [31] categorized SLR into three steps i.e. planning the review, conducting the review, and reporting the review. These three steps are presented in detail in Figure 1 and briefly discussed in the subsequent sections.

A. Planning the Review

SLR protocol was developed at the first stage of review. SLR protocol presented the instructions to address the study questions, data sources, articles inclusion and exclusion norms, search processes, publishers' worth evaluation, and statistical data extraction [31, 32]. The detail of the SLR activities is described in the subsequent sections.

Step 1: PLANNING THE REVIEW
▸ Research questions
▸ Data sources
▸ Search process
▸ Inclusion / exclusion criteria
▸ Study quality assessment

Step 2: CONDUCTING THE REVIEW
▸ Primary study selection
▸ Data extraction
▸ Data synthesis

Step 3: REPORTING THE REVIEW
▸ Quality attributes
▸ Research methodologies used in selected primary studies

Figure 1.   SLR protocoles

a) Research Questions

The proposed study questions of this research work are discussed in section 1.

b) Data sources

To collect the appropriate studies from the existing literature, the selection of most potential libraries are important. We follow the suggestions provided by khan et al. [32] and the included data sources are: i) "IEEE Xplore", ii) "ACM Digital Library" iii) "Springer Link" iv) "Wiley Inter Science", v) "Science Direct" vi) "Google Scholar". The selected libraries have different search syntax so the search string is formatted accordingly.

c) Search Process

The keywords and their alternatives obtained from the published literature and research questions were used to create the search strings [31-33, 35]. The keywords along with their alternatives were concatenated using the Boolean "OR" and "AND" operators to formulate the search strings: ("barriers" OR "hurdles" OR "impediments" OR "obstacles" OR "challenges" OR "hindrance" OR "difficulties" OR "tools" OR "techniques", OR "process", OR "methods" OR "evaluation") AND ("RCM" OR "requirements engineering" OR "requirements change management" OR "requirements changes" OR "requirements management" OR "requirements change managements practices" OR "requirements volatility" OR "effect of requirements change management", OR "impact of requirements change management") AND ("GSD" OR "Global software development" OR "Offshore software development" OR "Distributed software development" OR "Outsourcing" OR "Multisite software development" OR "Global software teams" OR "Collaborative software engineering" OR "Collaborative software development")

d) Inclusion and Exclusion criteria

Some are the basic rules to keep in mind e.g. the selected primary studies must be published in English language. Every primary research paper must be a book chapter, journal, or conference. We marked on those research literatures in which topics discussed about requirements change management in GSD. After that, more concentration was on those materials that have framework proposals, discussions about RCM challenges, pointed out the usage of best practices, and highlighted the tools as well as techniques to eradicate those challenging factors in GSD situations [31, 33, 34].

Though, we set aside those materials which did not discuss the RE and RCM barriers while GSD. Those study materials were also avoided which did not presented the detailed information with respect to the RCM process. Most similar papers were not included as well. Furthermore, other than English literatures were also not selected in this research study [32, 33, 36].

e) Study Quality Assessment

After the selection of SLR articles, Quality Assessment (QA) was conducted simultaneously with the information extraction stage. A checklist was developed for quality assessment of the selected materials. The rules and limitations given by [34, 36] were followed to design the said checklist (Table-I). There are five quality assessment (QA) questions in the said checklist and for every given statement (Table-I) (Q1 to Q5) the assessment made as follows.

- The selected studies having response to the checklist questions were allotted 1.0 point.
- The selected studies having fractional response to the checklist questions were allotted 0.5 point.
- The selected studies having no response to the checklist questions were allotted 0 point.

To check the potential of the selected primary studies, the quality of the selected studies is determined.

TABLE I. Study Quality Assessment Criteria

QA questions	Questions checklist
QA1	"Do the adopted research approaches address their research questions?"
QA2	"Does the study discuss any challenge in RCM?"
QA3	"Does the study discuss RCM framework and its implementation in GSD?"
QA4	"Is the collected data related to RCM in GSD?"
QA5	"Are the identified results related to justification of the research questions?"

B. Conducting the review

a) Primary study selection

The selected articles gathered from the selected digital libraries were refined by applying the method proposed by Afzal et al. [37]. He includes five levels as presented Figure 2 and Table-II.

Through search process section c, a total of 725 research articles were collected by employing the inclusion and exclusion criteria (section d) for the selected digital libraries. Furthermore, we used tollgate approach for the selection of high impact research studies. By following all the levels of tollgate approach (Figure-2), we have selected 26 final articles for the use in SLR study. The detail of articles selection is given in Table-II.
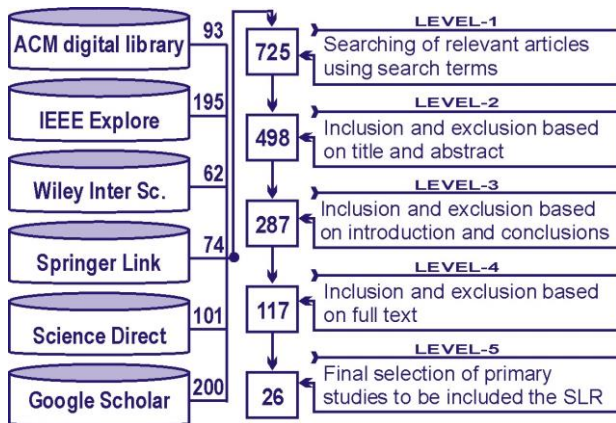
Figure 2.   Levels of tollgate approach

TABLE II.   Tollgate Approach

SD	L-1	L-2	L-3	L-4	L-5	% of final Selected articles (N=26)
AC	93	67	21	12	2	7.7
IE	195	106	81	42	10	38.5
WI	62	47	22	7	3	11.5
SP	74	48	24	6	2	7.7
ScD	101	77	60	29	2	7.7
GS	200	153	79	21	7	27
TL	725	498	287	117	26	100

SD= "Selected Databases", L=level, AC= "ACM Digital Library", IE="IEEE Xplore", WI= "Wiley Inter Science", SP= "Springer Link", ScD="Science Direct", ELS=" Elsevier", GS="Google Scholar", TL="Total", n= "total no of selected primary studies"

b)   Data Extraction

To satisfy the research questions, we extracted the study title, study type, and adopted research approach from every selected article. Most of the data was extracted by the first author of this study. However, to remove the researchers bias, last two authors were arbitrary involved. They randomly selected the articles and performed all the phases of tollgate approach. During data validation process, the authors also evaluated the quality assessment results of the primary studies. The quality assessment results are presented in Appendix-A.

c)   Data synthesis

By employing the tollgate approach [37], lists of challenging factors of RCM process were created by using data obtained from 26 primary selected articles. The evaluation of study questions were assessed by utilizing the data obtained from those selected articles.

C. Reporting the review

a)   Quality attributes

The scores for every selected primary study exposed from the five QA questions (section e) are shown in Appendix-A. A sum of the marks allocated for every QA question is the final QA score for every article presented in Appendix-A. Tollgate approach was already used to remove improper studies. According to the Appendix-A, 74% selected studies scored $\geq$ 70%. This percentage shows that the selected studies are useful to address the proposed research questions of this study (Appendix-A).

b)   Research techniques used in the selected primary studies

We reviewed all the selected articles and found the following research technique i.e. questionnaire survey, case study, grounded theory, action research and mixed method. The frequency analysis of the extracted research methods (Figure 3) indicated that case study 9 (35%) is the most common used research method in the selected primary studies.
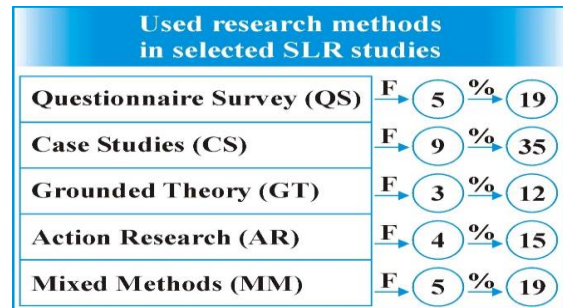

Figure 3.   Used research methods in selected SLR studies

Moreover, we observe that the 'questionnaire survey' 5 (19%) and 'mixed methods' 5 (19%) are the second most commonly used research methodologies in the selected primary studies. This analysis (Figure 3) indicated that the 'case studies' is the most preferred research technique for exploring the findings of empirical studies.

3.   RESULTS AND DISCUSSIONS

This section shows the outcomes acquired from the SLR study in relation with each of the research question.

A. Challenging factors identified using SLR (RQ 1)

A total of 15 challenging factors of RCM process are identified from the selected 26 primary studies. To answer RQ1, the frequencies and percentages of the explored challenges were determined as presented in Figure 4 and Table-III.
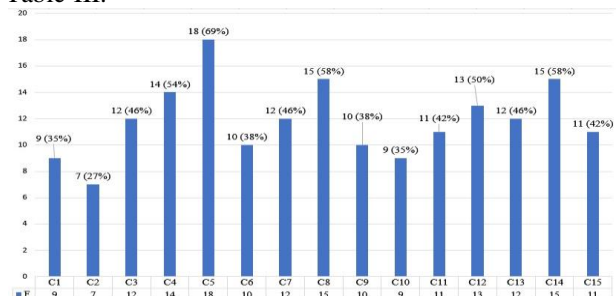

Figure 4.   Frequency analysis of investigated challenges

According to the frequency analysis, the highest reported challenging factors in the selected studies are: C4 (lack of synchronizing work among involved sites, 54%), C5 (lack of formal implementation of RCM methodology, 69%), C8 (lack of change impact analysis, 58%), C12 (inexperienced staff involvement, 50%), C14 (lack of risk assessment at distributed sites, 58%).

TABLE III.   LIST OF INVESTIGATED CHALLENGES

S.No	Challenge factors	F(N=26)	%
C1	Lack of tracking and control tools	9	35
C2	Organizational politics	7	27
C3	Lack of time adjustment between different sites	12	46
C4	Lack of synchronizing work among involved sites	14	54
C5	Lack of formal implementation of RCM methodology	18	69
C6	Lack of trustworthiness	10	38
C7	Lack of organizational support	12	46
C8	Lack of change impact analysis	15	58
C9	Environmental constrain at overseas sites	10	38
C10	Lack of expert project management	9	35
C11	Lack of client-vendor relationships in offshore development	11	42
C12	Inexperienced staff involvement	13	50
C13	Lack of training	12	46
C14	Lack of risk assessment at distributed sites	15	58
C15	Lack of economic maturity	11	42
S.NO.= Serial Number, F= Frequency, %= Percentage			

C5 (Lack of formal implementation of RCM methodology, 69%) was found as the most significant challenge to RCM process implementation. The need for an effective RCM implementation methodology in GSD was highlighted by Avritzer [SP14]. They argued that the methodology should consist of a complete requirement management strategy including RCM improvement activities, procedures, and progress measures. A number of the RCM professionals serving in GSD situation trusted that the lack of proper RCM process implementation procedures and approaches can encumber the successful execution of RCM activities [SP16]. Fewer RCM implementation methods and standards have been developed for use in GSD, than for conventional RCM methods [SP2, SP5, SP16]. C8 (lack of change impact analysis, 58%) was as the second most significant reported challenging factor for RCM process implementation in GSD in the selected primary studies. According to Ali [SP11] due to the distributed and parallel project development, the impact analysis of demanded changes in all the development sites have a significant importance to estimate the scope, effort, cost and required time to implement the change. Bokhari et al. [SP24] suggested that the demanded change should have impact on the whole project and determining the impact is the key activities in RCM procedure for successful change implementation and project execution. Bano et al. [SP18] stated that the poor analysis of the scope of demanded change causes the poor time, cost and effort estimation that may cause to the project failure. C12 (inexperienced staff involvement, 50%) was cited by the primary selected studies as a challenging factor for RCM process implementation in GSD. Beller et al. [SP21] indicated that the inexperienced staff member corresponds the absence

of appropriate knowledge regarding RCM implementation which leads to the poor implementation of RCM process activities. Chitchyan et al. [SP25] underlined that the GSD organizations with experienced and skillful experts in their RCM process improvement teams have effectively implemented RCM programs.

B. Client and vendor classification (RQ 2)

The basic purpose of client-vendor classification is to determine the significance of the identified challenging factors with respect to client and vendor offshore firms. Many other researchers also used this classification in various studies [32, 38, 39]. We studied client-vendor association by evaluating every selected article in our SLR study. A total of 15 studies were conducted for client and 11 for vendor countries, as presented in Figure 5. Verner et al. [38] and Khan et al. [32] observed that mostly published literature concentrate on vendor organizations rather than clients. Therefore, we employed the chi-square test [32, 33, 36] to check the significant difference among the reported challenging factors with respect to client-vendor GSD firms (Table-IV).

The chi-square test results show more similarities than difference in the investigated challenging factors with respect to client-vendor firms.

TABLE IV.   CATEGORIZATION OF INVESTIGATED CHALLENGING FACTORS WITH RESPECT TO CLIENT AND VENDOR FIRMS.

S.NO.	Client (N=15)		Vendor (N=11)		"Chi-square Test (Linear-by-Linear Association) $\alpha = 0.05$"		
	F	%	F	%	X	df	P
C1	6	40	7	64	1.364	1	.243
C2	8	53	5	45	.152	1	.697
C3	7	47	8	73	1.698	1	.193
C4	7	47	5	45	.004	1	.952
C5	10	67	8	73	.105	1	.746
C6	9	60	6	55	.074	1	.785
C7	4	27	7	64	3.417	1	.065
C8	12	80	8	73	.182	1	.670
C9	8	53	7	64	.265	1	.606
C10	7	47	5	45	.004	1	.952
C11	6	40	5	45	.074	1	.785
C12	9	60	6	55	.074	1	.785
C13	7	47	6	55	.152	1	.697
C14	10	67	7	64	.025	1	.875
C15	6	40	6	55	.519	1	.471

In client-vendor firms, the most common challenging factors are: C4 (lack of synchronizing work among involved sites, 47% and 45%), C6 (lack of trustworthiness, 60% and 55%), C10 (lack of expert project management, 47% and 45%), C11 (lack of client-vendor relationships in offshore development, 40% and 45%), and C12 (inexperienced staff involvement, 60% and 55%), respectively.

On average, C8 (lack of change impact analysis) was the highest cited challenging factor for the success of RCM process execution in GSD. According to Zahoor et al [SP7] due to the distributed and parallel project development, the impact analysis of demanded changes in all the development processes are significant to estimate the scope, effort, cost and required time to implement the change but proved challenging because of the sites are not on the same Gantt chart. Avritzer et al. [SP14] suggested that the demanded change should have impact on the whole project and determining the impact is the main challenge to successful execution of RCM activities in GSD. Beller et al. [SP21] stated that the poor analysis of the scope of demanded change causes the poor time, cost and effort estimation that may cause to the project failure.

In addition, we classified the investigated challenging factors in client-vendor organizations by following the model presented by Khan et al. [32] and Shameem et al. [39]. For this classification, we have calculated the percentage of frequency occurrence (Table-IV) and divided them into client-vendor organizations as shown in Figure 6. For instance, 40% of client firms assumed C1 (lack of tracking and control tools) as a significant challenging factor for RCM process in GSD. However, the challenging factor C1 was stated in 64% of vendor firms. So, C1 was considered in the vendor organizations category. Similarly, we have classified all the other challenging factors in both client and vendor categories (Figure 6). Furthermore, the comparison of all the investigated challenging factors with respect to client-vendor firms is presented in Figure. 7.
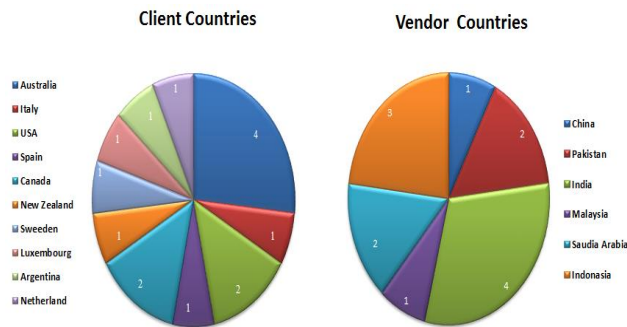

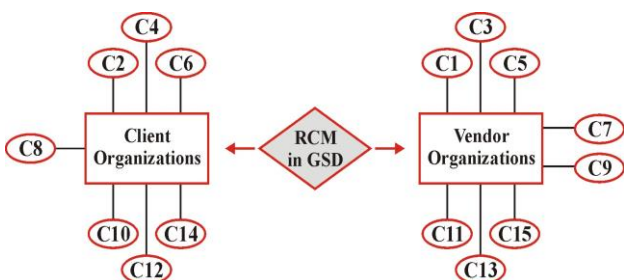
Figure 5.   Client-vendor countries

Figure 6.   Conceptual mapping of identified challenging factors in client-vendor firms
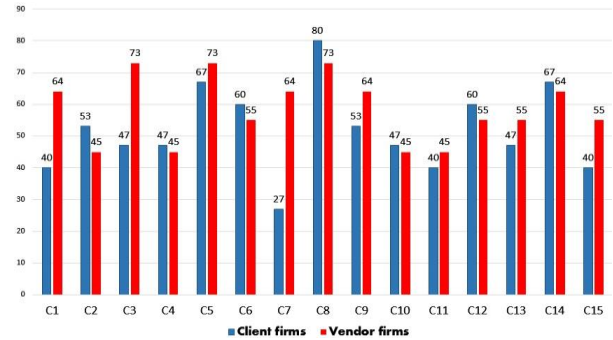

Figure 7.   Comparison of investigated challenging factors with respect to client and vendor firms

C. Time based analysis of reported challenges (RQ3)

Khan et al. [40], Khan et al. [41] underlined that due to the technological advancement and due to the fluctuation in market or user demand, the challenging parameters of any development activity also change. Hence, in order to check the significant difference among the reported challenging factors with respect to the time, we apply chi-square test analysis. Though, we observed that the primary selected studies were published from 2001 to 2017. However, the selected studies were divided into two sub-periods as: first sub-period 2001-2009 and the second sub-period is 2010-2017. The Table-V indicated that out of total 26 selected SLR studies 10 were published in first sub-period and 16 were published in second sub-period.

TABLE V.   CLASSIFICATION OF INVESTIGATED CHALLENGING FACTORS BASED ON TIME DURATIONS

S. No	1st sub-period		2nd sub-period		"Chi-square Test (Linear-by-Linear Association) α = 0.05"		
	F	*%*	*F*	*%*	*X*	*df*	*P*
C1	7	70	8	50	0.278	1	0.598
C2	5	50	9	56	0.636	1	0.425
C3	6	60	7	44	0.159	1	0.690
C4	6	60	12	75	0.477	1	0.490
C5	8	80	14	88	2.475	1	0.116
C6	3	30	8	50	3.394	1	0.065
C7	7	70	11	69	0.179	1	0.672
C8	8	80	10	63	0.636	1	0.425
C9	7	70	10	63	3.361	1	0.069
C10	6	60	9	56	0.159	1	0.690
C11	8	80	6	38	0.513	1	0.037
C12	6	60	11	69	0.250	1	0.617
C13	5	50	9	56	0.923	1	0.337
C14	6	60	7	44	0.026	1	0.873
C15	7	70	13	81	0.234	1	0.629

The results of Table-V indicated that there are more similarities instead of differences among the identified RCM barriers with respect to both sub-periods. However, we observe significant difference only in one reported challenging factor i.e. C11 (lack of client-vendor relationships in offshore development, p=0.037). According to the results presented in Table-V, the C11 is highly significant in first sub-period. This may be attributed that due to the technological advancement in communication infrastructure, the frequent communication causes the good relationship among client and vendor offshore organizations. Zahoor et al. [SP7]

underlined that the frequent communication is significant for understanding the arguments of client-vendor organization management. They further stated that the communication is significant for good relationship among overseas development team members and for high level management.

However, the most common reported challenging factors in both sub-periods are: C2 (Organizational politics, 50% and 56%), C7 (lack of organizational management support, 70% and 69%), C10 (Lack of expert project management, 60% and 56%) and C13 (lack of training, 50% and 56%) in client and vendor organizations, respectively.

In first sub-period, C5 (lack of formal implementation of RCM methodology, 80%), C8 (Lack of change impact analysis, 80%) and C11 (lack of client-vendor relationships in offshore development, 80%) are declared as the highest reported challenging factors.

Similarly, the results (Table-V) indicated that the highest reported challenging factor in second sub-period is C5 (Lack of formal implementation of RCM methodology, 88%). The second most significant challenging factor of RCM process implementation is C15 (lack of economic maturity, 81%).

However, all the investigated challenging factors are important for the successful execution of RCM activities in the context of offshore software development environment. According to Niazi et al. [46], Khan et al. [40] and Khan et al. [41] the factors have >50% frequency are very significant to address for the success and progress of GSD organizations.

Additionally, we map the reported challenging factors into two sub-periods by following the mapping model proposed by Khan et al. [32] and Shameem et al. [39]. The frequency analysis method was used to map the challenging factors into two sub-periods. For example, the results of Table-V shows that C1 is 70% significant for first sub-period and 50% for second sub-period. However, as the C1 is highly coated in second sub-period, so it is allotted to the first sub-period category (Figure 8). All the other reported challenges are also mapped by using the frequency analysis as presented in Table-V.

Figure 8.   Conceptual mapping of identified challenging factors based on time period

D. Critical Factors (RQ4)

As per Niazi [42] the critical factors are revealing the main zones where the organizational management should concentrate to accomplish the particular business objectives. They further stated that less consideration given to critical challenging zone may affect the business efficiency. Critical challenging factors (CCFs) may vary from individual to individual as it relies upon the post of

person hold in the firm [32, 41]. Critical challenges depend upon the geological areas of the managers and may vary with respect to time [40]. In this study, to determine the criticality of the investigated challenging factors, we have used the following criteria:

Factor should be declared as critical if the frequency of challenging factor ≥50%. A similar criterion has been utilized in various studies of other software engineering domains [32-41]. Through utilizing the above said criteria, the critical challenging factors are: C4 (lack of synchronizing work among involved sites), C5 (lack of formal implementation of RCM methodology), C8 (lack of change impact analysis), C12 (inexperienced staff involvement), and C14 (lack of risk assessment at distributed sites). The detailed description of the critical challenges is indicated in Figure 9.
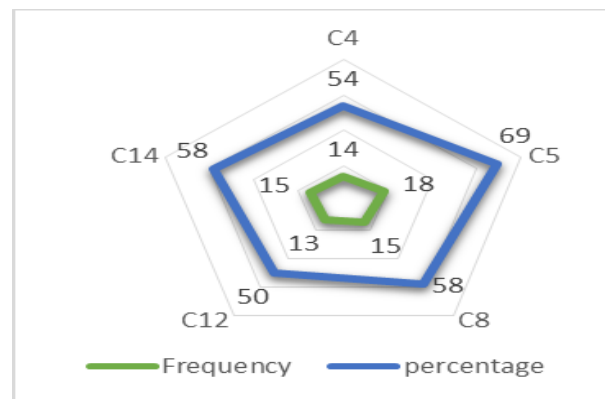

Figure 9.   Critical reported barriers

E. Robust framework (RQ5)

Ramasubbu [44] presented a framework to classify and map the influencing factors into core six categories of project management namely "software methodology, project administration, human resources management, coordination, technology factors, and knowledge integration". Every category described the key capabilities that must be established by project administrators for successful completion of software project [32, 39].

The ultimate objective of the present research is the development of "software requirements change management and implementation maturity model" (SRCMIMM) in GSD context, therefore, we employed the same framework for the mapping of the challenging factors of RCM process investigated through SLR. In the process of mapping, first three authors were engaged to label and grouped the challenging factors related to a specific relating field. The mapping outcomes demonstrate that majority of the challenges were relevant to project administration category as indicated in Figure 10. As per our experience, the classification can serve as a knowledge base for researchers and professionals serving with RCM in a GSD enabling them to concentrate upon the challenges as per their interesting category.

4. THREATS AND VALIDITY

The first author of the study has obtained the most data through the SLR method. Nevertheless, we endeavored to reduce this risk by identifying any unclear issues, and we discussed them as well. However, a high risk exists because a single researcher could be biased and may constantly obtain false data. Therefore, the co-authors were participated to arbitrarily examine the phases of SLR.

In mapping process of investigated challenging factors into six categories, an informal method is adopted. This may a threat towards the validity of the mapping process. But several other studies also used the same techniques to map the investigated factors into some particular knowledge areas [32, 39, 43].
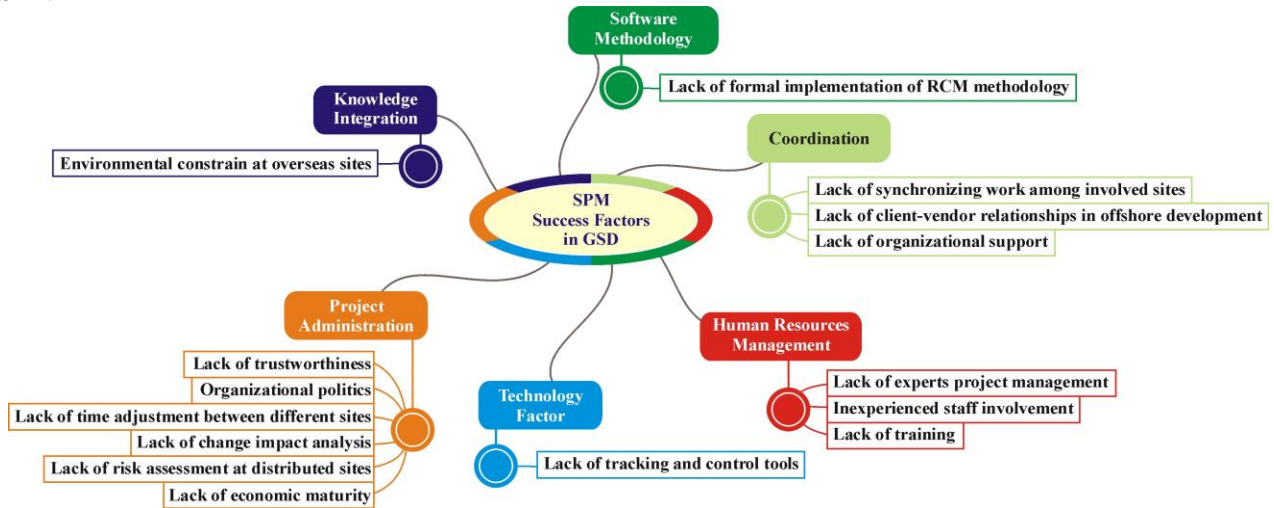

Figure 10. Robust framework

Finally, certain related literatures might be excluded as consequence of the large number of research articles on RCM and GSD. Though, it was not a systematic exclusion as in other available SLR studies [32-33, 37, 40, 41].

5. SUMMARY AND DISCUSSION

The main purpose of the study is to develop "Software requirements change management and implementation maturity model" (SRCMIMM) for GSD. The present study is an initial phase of this model in which we identify the challenging factors faced by the RCM practitioners while implementing the RCM process model in GSD. The summary of the findings is listed in Table-VI.

TABLE VI.   SUMMARY OF THE ADDRESSED RESEARCH
QUESTIONS

Research questions	Description
RQ1	Lack of tracking and control tools, organizational politics, lack of time adjustment between different sites, lack of synchronizing work among involved sites, lack of formal implementation of RCM methodology, lack of trustworthiness, lack of organizational support, lack of change impact analysis, environmental constrain at overseas sites, lack of expert project management, lack of client-vendor relationships in offshore development, inexperienced staff involvement, lack of training, lack of risk assessment at distributed sites, and lack of economic maturity
RQ2	All the investigated challenges in SLR. However, there is no significant difference among the investigated challenging factors with respect to client-vendor firms. C4 (Lack of synchronizing work among involved sites,

	47% and 45%), C6 (Lack of trustworthiness, 60% and 55%), C10 (Lack of expert project management, 47% and 45%), C11 (Lack of client-vendor relationships in offshore development, 40% and 45%), and C12 (Inexperienced staff involvement, 60% and 55%), respectively.
RQ3	There are more similarities than differences among the identified RCM challenging factors with respect to both sub-periods. However, we observe significant difference only in one reported challenging factor i.e. C11 (lack of client-vendor relationships in offshore development, p=0.037).
RQ4	From the total of 15 investigated challenging factors only 5 factors are declared as critical. C4 (Lack of synchronizing work among involved sites), C5 (Lack of formal implementation of RCM methodology), C8 (Lack of change impact analysis), C12 (Inexperienced staff involvement), and C14 (Lack of risk assessment at distributed sites).
RQ5	The investigated challenging factors are categorized in to six key knowledge areas (Table-VI). Majority of the investigated challenging factors are belongs to project administration area that means the project administration area is the most significant to address for successful implementation of RCM process in GSD.

6. CONCLUSION

The phenomenon of GSD is increasingly adopted by various software organizations due to economic and strategic gains. The rapid increase in the adoption of GSD motived us to investigate the challenging factors faced by practitioners during the RCM process implementation. SLR method is used to investigate the challenging factors from the 26 primary selected articles. A total of 15

challenging factors were investigated from which 5 factors were declared as critical for the implementation of RCM process in GSD.

Furthermore, we have classified the investigated challenges in client and vendor firms to show the significance of each challenging factor with respect to client and vendor GSD firms. The outcomes indicated that client and vendor firms are facing more similar challenging factors while execution of RCM process model in GSD. The purpose of client-vendor categorization is to provide the broad picture of investigated challenging factors faced while the execution of RCM process in GSD.

Moreover, the identified challenging factors are also classified based on time duration. The purpose of time based classification of reported challenging factors is to check the variances in the challenging factors in accordance with the time. However, our results indicated that there are more similarities between the challenges with respect to time.

Furthermore, the investigated challenging factors are classified into six knowledge areas of software process improvement model. According to the conceptual mapping of investigated challenging factors, majority of the challenging factors are belongs to project administration category of this model. This classification will useful for both real-world practitioners and for RCM researchers to concentrate on the very crucial part of RCM process model. We trust that the findings of present study will be beneficial to address anomalies related to RCM process implementation in GSD that is significant to the accomplishment and progress of GSD firms.

7. FUTURE WORK

The basic purpose of the study is to develop "Software requirements change management and implementation maturity model" (SRCMIMM). The SRCMIMM is based on the existing maturity models of other software engineering domains i.e. CMMI [45], IMM [46], R-CMM [47], SPIIMM [48]. Figure 11 shows the relationships of the maturity levels of the proposed SRCMIMM. The maturity levels of the proposed SRCMIMM are based on the critical success factors (CSFs) and critical challenging factors (CCFs). Under this project, we have published some articles that are [49-51]. This study only presents the critical challenging factors of RCM activities in offshore software development paradigms. Therefore, in future we have plan to explore the additional challenging factors and validate them by using empirical study (questionnaire survey). Furthermore, we will conduct SLR study to investigate the success factors and the best practices which are needed to address the maturity levels of proposed SRCMIMM. We are confident that the proposed SRCMIMM will help the GSD firms to evaluate and assess the RCM related activities.
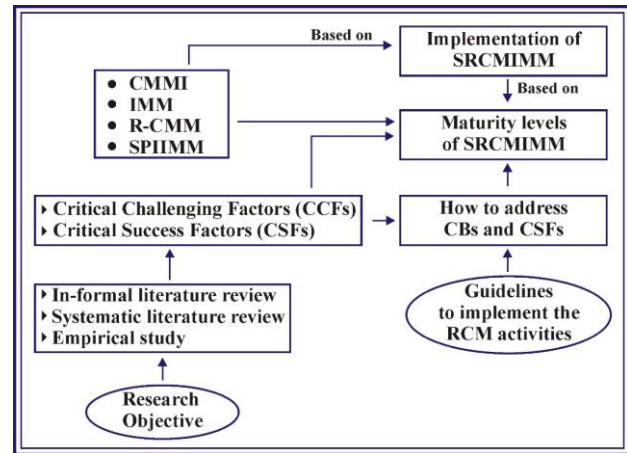

Figure 11. Structure of proposed SRCMIMM

APPENDICES

Please visit the link to explore the Appendix-A: https://tinyurl.com/yc8aun3b

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