Requirements Change Management Challenges of Global Software Development: An Empirical Investigation

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ABSTRACT The software organizations rapidly adopting global software development (GSD) to gain the economic and strategic benefits. Besides, GSD faces many challenges that mainly concerned with the requirements change management (RCM). This study aims to identify and empirically validate the factors that can negatively influence the RCM process in GSD. To this end, literature review and questionnaire survey were conducted for the investigation and validation of RCM challenges. A total of 31 RCM challenges were identified. We have further classified the identified challenges in organization types, organization size and based on experts' opinions with the aim to provide a clear understanding of the RCM process and its challenges to the practitioners. Based on these identified challenges, we believe that this study can provide a framework for tackling problems associated with RCM activities in GSD environment, which is significant to success and progression of GSD organizations.

INDEX TERMS Requirements change management, challenges, empirical investigations.

I. INTRODUCTION

The requirements change management (RCM) is a difficult and crucial stage in requirements engineering process compared with other engineering aspect [1]. The change in requirements can be demanded at any time and at any stage of development process (from requirements collection to maintenance) [1]. The changes can be causes due to the change in customer requirements, change in market demand, change in organizational policies etc. [2], [3]. In this paper, we consider the definition of Nurmuliani [4], to describe the requirements volatility as "the tendency of requirements to

change over time reacting to the evolving needs of customers, stakeholders, organizations, and the work environment."

The activities of RCM process considered as more communication and coordination oriented that hard to manage in onshore or near shore software development environment [5], [6]. Hence, it is hard to manage the RCM practices in global software development (GSD) context [5], [6]. The GSD is a software development process, where the skilled workers carried software development activities beyond the geographical and cultural boundaries [7]. Therefore, the significant return of investment attracts the software industry to consider GSD paradigm [5], [8]. Standish Group reported that, 20% of software organizations outsource their development activities to developing countries for good business

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gains and other potential benefits of GSD [9]. There is a significant expansion in the adoption of GSD specifically in the low developing countries. They seek to outsource software development activities with the motivation of employing skilled human resources at significant low cost, enjoy round the clock working hours and to easy access the international market [10]–[15].

However, the GSD practitioners faced additional challenges that's not exist while adopting onshore or near shore software development process [16]–[19]. More significantly, the GSD practitioners faced communication and coordination problems that make the RCM process more challenging and complicated [7], [9]. As the RCM activities are considered as more communication and collaboration oriented, so the physical geographical difference between the overseas development teams affect the successfulness of RCM process [6]–[20]. The lack of effective change management could cause the poor quality of end-product and time and cost overrun that eventually cause project failure [20]. Standish Group reported a survey of 13000 software projects and summarized that 18% of the software projects were fail due to lack of proper RCM process execution [20].

Different RCM models and frameworks have been introduced to effectively implement the change management activities [1]. For instance, Niazi *et al.* [20] proposed an RCM model to implement the specific practice (SP 1.3-1) of level-2 of CMMI model. The key phase of model are: "request," "validate," "implement," "verify," and "update." The model is based on the data collected form literature review and by considering the expert's opinions. The Niazi *et al.* model covers all the important aspects of RCM process but lacking to provide the communication and collaboration guidelines. Similarly, Keshta *et al.* [21] introduced an RCM framework to fix the problems faced by the practitioners. The key phases of Keshta *et al.* model are: "initiate," "validate," "implement," "verify," "update" and "release." The model is covers all aspects of RCM process but it just deals with small and medium size organization [21]. We further found that Bhatti [15] introduced a change management model whose key phases are: "initiate," "receive," "evaluate," "approve or disapprove," "implement," and "configure." The model is good to manage the change management activities, but there is not testing and batch phase [22]. Therefore, it is hard to verify the implemented requirements without testing phased, and due to the lack of batch phase, the model is not capable to save the change management history for future [22]. Consequently, Ince's [23] developed an RCM model that cover all fundamental aspects of RCM process and include phases are: "change request," "rejected," "batched," "change implementation" and "updated." In this model the change request is forward to the change control board (CCB) and the member of CCB decide and determine the impact of demanded changes [21]. This model consists of all important parameters of RCM but lacking the verification phase [22]. The above stated models and framework are significant to address and change management process in onshore or single site development environment but not capable to address the RCM activities in GSD [23], [24]. Khan et al. [11] mentioned that the change management process is more complex in GSD context because of the lack of frequent communication between the overseas development teams.

We will present a brief overview of the RCM challenges in a GSD environment. Firstly, a list of RCM challenges was identified using literature review approach. The investigated challenges were further verified with experts by conducting the questionnaire survey study.

Verner *et al.* [25] and Khan *et al.* [26] mentioned that majority of the current studies consider vendor organization instead of client GSD organizations. In this study, we try to address this research problem by analyzing the identified challenging factors in the domain of client-vendor GSD organizations. We seek of this analysis to check the criticality of identified challenging factors with respect to the both types of organizations [9], [25]. Moreover, Khan *et al.* [19] called attention to determine the critical difference in the offshore vendor selection factors based on the size of organization. They have reached to a conclusion that the resulted success factors are equally essential for all types of organization sizes. In addition, Khan *et al.* [9] have studied the critical factors of software process improvement (SPI) by considering organization size. They categorized the barriers of SPI in small, medium and large size organization categories. In addition, Niazi *et al.* [27] conducted an empirical study and compared the demotivating factors of SPI based on the position of the experts. They have classified the respondents position in two major categories i.e. developers and managers. In another study, Niazi *et al.* [28] reported the barriers of SPI in the context of cross-cultural GSD organizations and arranged the identified barriers with respect to the position of experts (i.e. developers and managers). They have identified the significant differences between the reported barriers based on the position of the survey participants. This study focuses in identifying the research gap in the domain of requirements change management. It concentrates on the same concept of organizational size and experts' position-based classification.

We believe that the deep understanding of RCM challenges can assist practitioners in addressing these problems prior to initiate RCM program in GSD environment. Due to the importance of RCM in GSD, we are motivated to develop an RCM maturity model that assist the GSD organization to assess and improve their change management activities. The proposed RCM maturity model will be based on the existing maturity models of other software engineering domains i.e. [25], [29], and the factors that can affect the RCM practices in GSD context.

The proposal of this research project is published in a [30]. Under this research project, we have published three papers in high ranked journals. Firstly, we have identified the success factors using systematic literature review study and the results are published in [31], secondly, the identified success factors were further verified with industry experts and the results are published in [32]. At third phase of this project, we have

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explore the list of RCM challenging factors using systematic literature study [33], in this study, we conducted empirical study to get the insight of industry practitioners with respect to the critical challenging factors of RCM process in GSD. All the identified success factors, and challenges will contribute to the development of RCM maturity levels, as presented in the structure of proposed model (Section-9, Figure-6). In this study, we have proposed the following research questions:

- RQ1: What challenging factors faced by the GSD practitioners during the implementation of RCM process?
- RQ2: Are the identified challenges related to client or vendor organizations?
- RQ3: How are these challenges related to the organization size?
- RQ4: Do the investigated challenges related to the position of experts?
- RQ5: How the identified challenges could be presented in the form of robust framework?

The paper is organized as: Section 2 present the literature review, section 3 define the selected research methodology, the findings of the study are given in section 4 and section 5 consists of the summary and discussion of research questions. Finally, the conclusion and future work are summarized in section 6.

II. LITERATURE REVIEW

The effective RCM practices implementation assists the software organizations to develop and deliver the quality software's according to the customer need and expectations [5], [34]. Nurmuliani *et al.* [35] identify the key causes of requirements changes by conducting a case study with multi-site development environment i.e. "changes in customer needs, change in market demands, developers understanding of the products, and changes in the organizational policy." Lindquist [36] highlighted that due to the poor execution of RCM process activities, 71% software projects were failed. Similarly, Sirvio and Tihinen [37] reported in a survey study, the key cause of 40% software project failure is the poor management of RCM activities. Various studies have been conducted by introducing the new models and frameworks of RCM process [11]. The literature shows that majority of the RCM model were developed in the context single site development environment [12]. The existing model could assist to control the RCM process in collocated development environment. The literature shows that little research has been conducted to develop the guidelines and standards of RCM implementation in GSD context [7], [11], [12], [38]. Khan *et al.* [11] and Ramzan *et al.* [12] underlined the reluctance to develop the guidelines for RCM execution in GSD context. Currently, 8 out of 10 software organizations are carried their developing activates in the context of GSD and due to the lack of RCM guidelines they face critical problems [9], [19]. The challenges faced by the GSD organizations while RCM are distinct. The physical distance between the overseas practitioners make the RCM practice more complicated and hard to manage [11]. Majority of the existing

studies were conducted in the domain of RCM in collocated development environment [12], [17].

The economic factor of GSD motivated majority of the organizations to scale their development activities across geographical boundaries [9], [19]. However, it is much challenging for organizations to achieve the benefits offer by the GSD. There are different challenges associated with distributed software development, especially, related to requirements change management [6], [17]. There are very few standards and models available that could manage the requirements change activities [11], [12], [17]. The existing models do not address the geographical aspects of distributed development [6], [35]. A survey study presented by Ramzan *et al.* [12] highlighted the lack of standardization of RCM process especially in collocated software development environment. They further reported that the existing models and frameworks are not detailed enough to address the RCM issues in the real-world environment. There is a lack of comprehensive RCM models and standards that could effectively manage the initiation of RCM processes in GSD. However, the rapid increase in the adoption of GSD phenomena motivated us to investigate the challenging factors related to RCM process implementation in GSD. Various researchers have highlighted the RCM challenges and we have extensively reviewed the existing literature to extract those challenging factors. Khan *et al.* [38] reported lack of 3Cs "communication, coordination & control" as a challenge for change management in GSD environment. 3Cs "communication, coordination & control" is the process of information sharing between the overseas development teams. The control and the coordination has direct association with communication [39].

Generally, change management activities are collaborative in nature, which require strong communication and coordination channels. This drives RCM program in GSD to become more challenging. Budget and time constraints of RCM process, in particular, are significantly challenging for RCM process implementation in GSD, especially in small organizations [21]. It is hard to efficiently deploy the RCM process across the distributed sites due to the budget and time constraints.

In addition, the problem of direct communication between RCM practitioners is discussed by Kumar *et al.* [7]. The absence of this face-to-face communication between RCM practitioners could arise other related problems such as information sharing, distrust, lack of mutual understanding and confidence among the RCM practitioners [38], [40]. Moreover, Patil and Ade [41] highlighted the importance of maintaining organizational support of RCM process implementation in GSD. They define organizational support as "the extent to which the higher and lower level management in an organization support, finance, realize and participate in the implementation of RCM process activities" [14], [17], [35]. This affects the initiation and implementation of organizations change management activities since they require suitable support and motivation of the top management [38]. Having skilful professionals with

knowledge of change management is significant unlike the inexperienced RCM teams, which affect the robustness of the change management program [42]. Inexperienced staffs could influence the success of change management project with their poor understanding of the requested changes [40].

The importance of RCM standards is discussed by Ramzan and Ikram [12], and lack of these standards affect the correctness of the change management process activities. They recommended the RCM model that capable to assess and provides the guidelines for RCM implementation in GSD organizations. Time zone difference is crucial challenge for RCM in GSD; RCM is a communication-based activity while GSD is a temporally distributed. This make RCM more complicated to frequently perform the change management activities [11].

Furthermore, RCM risk management was reported as an important factor for starting the RCM program. Khan *et al.* [39] underlined that it is important to evaluate and RCM barriers as it directly affects the product quality, time and cost, which are critical to lead a project towards failure. Fu *et al.* [24] reported the cost and time are critical factors for in-time project delivery, and the poor RCM may cause the delay of project delivery. Zhu *et al.* [18] stated that the poor consideration to address the RCM problems would absolutely cause a project failure. It is clear that change management program is collaborative in nature and any delay in response would cause critical problems and affect project success. Additional challenge was stated by Fu *et al.* [24] who identified that differences in teams' physical locations and languages hinder the frequent communication and that ultimately cause the delay in responses. Due to the delay in feedback hinders to make frequent decision to address a specific change request [43]. Lai *et al.* [8] and Khan *et al.* [11] mention that the lack of change impact analysis at GSD sits cause the poor estimation of scope of the demanded change. The poor estimation of change scope is because the poor estimation of required time and budget to implement the demanded change and that lead to the project misbalanced [8]. Williams *et al.* [44] clarified the point that RCM process training as essential step to overcome the challenges occurs if lack this training. Bendakir *et al.* [45] mentioned the need to conduct workshops, seminars and training sessions for RCM practitioners to assure the reliability of RCM process implementation in GSD organizations. Concisely, assessment and implantation are the pillars to guarantee clients and stakeholders requirements changes and lack of training and skillful teams could affect this. Additional challenging factors of RCM are classified and presented in (Table 1).

III. RESEARCH METHODOLOGY

We have adopted questionnaire survey approach to collect the data from the RCM practitioners and researchers. The complete research process is discussed in the following sections.

TABLE 1. List of investigated challenges from the literature.

S.NO.	Challenge factors	References
CH1	IT infrastructure differences in distributed sites	[1], [4]
CH2	Requirements tracking and control issues	[6], [9], [10]
CH3	Roles and responsibilities issues	[2], [16]
CH4	Lack of change scope determination	[10], [18]
CH5	Poor RCM planning	[1], [5], [20]
CH6	Geographically distributed CCB (change control board)	[23], [27]
CH7	Lack of similarities in rules and policies of GSD sites	[7], [11], [13]
CH8	Lack of work synchronization	[12], [24]
CH9	Unavailability of skilled requirements manager	[11], [12], [21]
CH10	Controlling RCM practices at overseas sites	[36], [41]
CH11	Unavailability of RCM standards	[10], [11], [21], [28], [32]
CH12	Budget and time constraints of RCM process	[11], [22], [28]
CH13	Lack of updated RCM tools and technologies	[10], [14]
CH14	Lack of organizational support	[14], [17], [29], [30]
CH15	RCM effort estimation issues in distributed sites	[1], [33]
CH16	Time zone differences	[10], [26], [27], [29]
CH17	Lack of Domain Knowledge	[27], [31]
CH18	Change management automation	[38], [40]
CH19	Lack of RCM team management	[4], [7]
CH20	Achieving common understanding of change management	[23], [31], [33]
CH21	Lack of trust in overseas teams	[27], [37]
CH22	Settling change request in overseas sites	[5], [7], [21]
CH23	Lack of change impact analysis in GSD sites.	[19], [9]
CH24	Impact of requirements change on system quality	[15], [8]
CH25	Inexperienced RCM staff	[10], [14], [25], [31], [38]
CH26	RCM risk management	[34], [35]
CH27	Lack of RCM process training	[8], [14], [36], [39]
CH28	Traceability of changes at overseas sites	[8], [10], [12], [27]
CH29	Lack of 3Cs "communication, coordination & control"	[8], [14], [25], [26], [27], [41]
CH30	Delay in response	[26], [27], [36]
CH31	Lack of face to face communication	[7], [21], [28], [40]

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A. DEVELOPMENT OF DATA COLLECTION INSTRUMENT

To validate the findings of literature review and to identify the additional challenging factors, an online questionnaire survey was developed. The questionnaire survey is an effective technique to collect the data form large and targeted population situated beyond the geographical boundaries [39]. The survey method is also assisting to collect the data with is hard using observation method [46]. The developed survey instrument consists of close-ended and open-ended questions. The closed-ended section contains the list of challenges identified via literature review study and in open-ended section, we request to the survey participants to provide additional challenging factors with is not enlisted in the closed-ended section of the questionnaire. To get the observations of survey participants about the challenges enlisted in close-ended section, we have used the five-point Likert scale i.e. "strongly agree, agree, neutral, disagree, and strongly disagree." Finstad [47] mention that the neutral option is important in Likert-scale as it enables the participants to the true and unbiased opinions. The lack of neutral option forces the participants to make the prejudiced decision (negative or positive) [48].

B. PILOT ASSESSMENT OF DATA COLLECTION INSTRUMENT

We selected the experts working in GSD context (i.e. Virtual Forces-Pakistan, and AMAZON-India, Itransition-United Kingdom and universities (i.e. "City University, Hong Kong," "King Fahd University of Petroleum and Minerals, Saudi Arabia") to perform the pilot assessment of the survey instrument. The aim of this pilot assessment is to address the critical problems (with respect to statistical variables) and to increase the understand-ability of the survey questions. The experts recommend some changes regarding the design of questionnaire to they recommend adding questions to get the detail of survey participants. By considering the suggestions and recommendations, the questionnaire instrument was updated. The updated questionnaire includes respondent's bolographic information and the questions related to RCM in GSD context. We assure the survey participants as the collected data is just used for research objective and the identity of the participants does not disclose to third party under any circumstances. The final used questionnaire is given in Appendix-A.

In order to determine the internal reliability of the experts participated in pilot assessment, the Cronbach's alpha test was performed. The presented results (α = 0.899, N=4) in Table 2 shows the experts have similar understanding of the developed survey instrument. This indicated that the pilot assessment team reached consensus with concerning to the developed survey instrument.

C. DATA COLLECTION SOURCES

This study aims to explore the RCM challenging factors in GSD. Therefore, is important to collect the data form the

TABLE 2. Reliability statistics.

Cronbach's Alpha	Number of Items
0.899	4

experts directly involved in GSD projects. We have adopted the snowball sampling technique [39], [49] to collect the data from the experts. The snowballing is cost effective and easy way to approach targeted population. Social media links Facebook, LinkedIn, and Research Gate and Email contact were used to connect to the experts. To collect the data, the online survey was executed during August 2019 to Febuavery-2020. A total of 84 responses were collected during survey execution. All the responses were manually checked and 7 responses were found uncompleted. The final 77 survey responses were considered for analysis. The designation of participates is ranged: "software developer, software analyst, software quality controller, project manager, requirements engineer, academic researcher and organizational management experts." The detail bibliography of the survey participants is presented given in Appendix B.

D. DATA ANALYSIS

In this study, we have used frequency analysis method to analysis the responses of survey participate. As this approach is useful to analyses nominal and ordinal types of data across the variable or group of variables [50]. The survey responses are nominal in types, thus; we have applied the chi-square ("liner-by-linear association") technique in order to find the significant differences across the variables. The same analysis approach has been adopted by various studies for similar type of data [19], [26], [29], [39].

IV. RESULTS AND ANALYSIS

The findings of empirical study are briefly discussed in this section.

A. CHALLENGES INVESTIGATED IN THE EMPIRICAL STUDY

To validate the findings of literature review study, an online questionnaire survey was executed to collect the data from dispersed experts. The participants' responses were categorized into positive, negative and neutral categories (Table 3). Each category contains sub classification as follow: positive includes "strongly agree and agree," negative includes "strongly disagree, disagree," and neutral category contains no sub classification. Thus, positive responses states percentage of survey respondents who considered the identified challenges in the domain of GSD. The negative responses include participants who did not consider the reported RCM challenges in the distributed environment. The last category, neutral, consists respondents who were not sure about the significance of a particular challenge.

The results show that the majority of the survey respondents were agreed with the investigated challenges and

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TABLE 3. Empirically investigated challenges.

Sr. No.	Challenge Factors	Positive (N=77)			Negative (N=77)			Neutral (N=77)	
		SA	A	%	SD	D	%	N	%
CH1	IT infrastructure differences in distributed sites	26	36	81	5	7	16	3	4
CH2	Requirements tracking and control issues	21	31	68	6	8	18	11	14
CH3	Roles and responsibilities issues	17	37	70	4	9	17	10	13
CH4	Lack of change scope determination	19	39	75	5	6	14	8	10
CH5	Poor RCM planning	21	35	73	4	7	14	10	13
CH6	Geographically distributed CCB (change control board)	20	29	64	5	7	16	16	21
CH7	Lack of similarities in rules and policies of GSD sites	23	36	77	4	7	14	7	9
CH8	Lack of work synchronization	28	44	94	1	2	4	2	3
CH9	Unavailability of skilled requirements manager	21	40	79	3	7	13	6	8
CH10	Controlling RCM practices at overseas sites	18	34	68	5	12	22	8	10
CH11	Unavailability of RCM standards	31	40	92	1	4	6	1	1
CH12	Budget and time constraints of RCM process	28	38	86	2	6	10	3	4
CH13	Lack of updated RCM tools and technologies	32	38	91	2	5	9	0	-
CH14	Lack of organizational support	25	36	79	4	6	13	6	8
CH15	RCM effort estimation issues in distributed sites	21	41	81	3	7	13	5	6
CH16	Time zone differences	24	29	69	5	8	17	11	14
CH17	Lack of Domain Knowledge	21	28	64	7	9	21	12	16
CH18	Change management automation	17	32	64	5	7	16	16	21
CH19	Lack of RCM team management	21	39	78	3	9	16	5	6
CH20	Achieving common understanding of change management	22	30	68	3	6	12	16	21
CH21	Lack of trust in overseas teams	24	31	71	4	7	14	11	14
CH22	Settling change request in overseas sites	20	29	64	4	9	17	15	19
CH23	Lack of change impact analysis in GSD sites.	24	36	78	5	3	10	9	12
CH24	Impact of requirements change on system quality	22	35	74	5	7	16	8	10
CH25	Inexperienced RCM staff	19	33	68	5	8	17	12	16
CH26	RCM risk management	22	28	65	4	6	13	17	22
CH27	Lack of RCM process training	27	43	91	2	3	6	2	3
CH28	Traceability of changes at overseas sites	25	29	70	6	9	19	8	10
CH29	Lack of 3Cs "communication, coordination & control"	31	38	90	1	4	6	3	4
CH30	Delay in response	26	40	86	2	3	6	6	8
CH31	Lack of face to face communication	30	37	87	4	3	9	3	4
S.NO= Serial Number, %=Percentage, "SA= Strongly Agree, A= Agree, SD=Strongly Disagree, D=Disagree, N=Neutral"									

more than 63% of the participants considered the given challenges as the key barriers for the RCM process in GSD.

CH8 (lack of work synchronization, 94%) was considered by the survey participants as the most common challenge of RCM activities in GSD [11], [23], [51]. Khatoon *et al.* [10] conducted an organizational case study in order to investigate the challenges of RCM process. They examined the challenges of RCM process, and they found that the work synchronization was an essential challenge in that specific organization. Moreover, Ahmad [13] highlighted that it is crucial to assure work synchronization infrastructure among all other distributed sites. Thus, any decisions taken at one location might negatively affect the activities at other distributed locations because of poor work synchronization [13].

Nevertheless, the team members have to assure the proper collaboration between different locations specifically in executing and managing the requirements change activities and avoid lack of work synchronization [19].

The results further highlighted that *CH11 (unavailability of RCM standards, 92%)* was found as the second most critical challenge by the survey respondents. Ramzan *et al.* [12] underlined the significance of *CH11 (unavailability of RCM standards)* for the effective implementation of the requested changes. There are many models and frameworks available for the RCM process, but they fail to assess and improve the RCM program initiated in GSD organizations [1]. Unavailability of RCM maturity models and frameworks could destroy the importance of the requirements change program [12].

TABLE 4. Client vendor organizations-based analysis.

S.NO.	Client (N=29)								Vendor (N=48)								"Chi-square Test (Linear-by-Linear Association) $\alpha = 0.05$"		
	Positive			Negative			Neutral		Positive			Negative			Neutral					
	SA	A	%	SD	D	%	N	%	SA	A	%	SD	D	%	N	%	X^2	df	P
CH1	5	11	55	2	5	24	6	21	11	20	65	3	6	19	8	17	.473	1	.491
CH2	4	14	62	0	6	21	5	17	6	27	69	1	7	17	7	15	.105	1	.746
CH3	7	13	69	2	5	24	2	7	4	21	52	4	6	21	13	27	1.320	1	.251
CH4	5	14	66	1	3	14	6	21	7	17	50	3	9	25	12	25	1.236	1	.266
CH5	8	12	69	1	4	17	4	14	3	24	56	0	10	21	11	23	2.139	1	.144
CH6	3	14	59	2	5	24	5	17	11	21	67	4	6	21	6	13	.660	1	.416
CH7	5	15	69	1	4	17	4	14	7	19	54	3	9	25	10	21	1.491	1	.222
CH8	7	12	66	1	3	14	6	21	8	20	58	3	8	23	9	19	1.211	1	.271
CH9	4	15	66	2	4	21	4	14	10	24	71	0	3	6	11	23	1.012	1	.314
CH10	3	10	45	3	5	28	8	28	11	19	63	3	6	19	9	19	2.795	1	.095
CH11	6	12	62	1	5	21	5	17	8	24	67	4	9	27	3	6	.067	1	.795
CH12	**3**	**16**	**66**	**2**	**5**	**24**	**3**	**10**	**14**	**23**	**77**	**0**	**5**	**10**	**6**	**13**	**5.369**	**1**	**.020**
CH13	7	15	76	1	3	14	3	10	12	21	69	3	5	17	7	15	.297	1	.586
CH14	9	12	72	1	3	14	4	14	14	19	69	2	4	13	9	19	.002	1	.966
CH15	6	15	72	1	3	14	4	14	7	19	54	3	7	21	12	25	1.803	1	.179
CH16	5	12	59	2	4	21	6	21	10	23	69	0	4	8	11	23	.652	1	.419
CH17	8	12	69	1	4	17	4	14	5	23	58	4	5	19	11	23	.424	1	.515
CH18	7	13	69	1	3	14	5	17	9	16	52	5	9	29	9	19	2.021	1	.155
CH19	8	14	76	2	2	14	3	10	11	18	60	3	5	17	11	23	.696	1	.404
CH20	4	15	66	1	3	14	6	21	8	25	69	2	4	13	9	19	.011	1	.917
CH21	6	11	59	0	6	21	6	21	13	18	65	5	7	25	5	10	.139	1	.710
CH22	7	10	59	3	5	28	4	14	9	21	63	4	7	23	7	15	.084	1	.772
CH23	6	13	66	2	3	17	5	17	8	25	69	0	6	13	9	19	.033	1	.855
CH24	9	11	69	1	4	17	4	14	11	17	58	5	3	17	12	25	.925	1	.336
CH25	7	14	72	2	3	17	3	10	14	23	77	2	4	13	5	10	.042	1	.838
CH26	6	14	69	3	2	17	4	14	11	24	73	0	3	6	10	21	.703	1	.402
CH27	11	12	79	0	2	7	4	14	15	23	79	4	2	13	4	8	.017	1	.897
CH28	5	13	62	2	3	17	6	21	16	19	73	2	5	15	6	13	.028	1	.866
CH29	9	11	69	2	5	24	2	7	14	20	71	0	8	17	6	13	.201	1	.654
CH30	6	11	59	4	3	24	5	17	8	25	69	5	7	25	3	6	.310	1	.577
CH31	8	10	62	3	3	21	5	17	12	19	65	3	5	17	9	19	.008	1	.930

In the "Negative" category, *CH10 (controlling RCM activities at GSD sites, 22%)* was found to be a least significant challenge. The results presented that 22% of the survey responses did not consider *CH10 (controlling RCM activities at GSD)* as the challenge for RCM activities across the GSD sites. This is because of the evolution in information technology infrastructure and communication channels used to control the change management activities across the distributed sites. Moreover, *CH17 (lack of domain Knowledge, 21%)* was determined as the second least significant factor. This result possibly reached because of the robust understanding of RCM program by the majority of the survey respondents.

CH26 (RCM risk management, 22%) was the most significant challenge in the "Neutral" category. CH6 (geographically distributed CCB (change control board), 21%), CH18 (change management automation, 21%) and CH20 *(achieving common understanding of change management, 21%)* were the second most significant factors in the neutral category. It illustrates that the major portion of the respondents were unconfident about the

significance of the challenges reported in the neutral category.

B. ORGANIZATION TYPE BASED ANALYSIS OF INVESTIGATED CHALLENGES

There is a relation between client and vendor, which have noted in the determined challenging factors. This relation was found by reviewing the bibliography of the survey participants. The bibliographic data of the survey respondents shows that 29 participants were from client countries and 48 for the vendor, as presented in Figure 1. To analyses the significant difference in the investigated challenging factors with respect the client and vendor GSD organizations, the "chi-square test by linear by linear association" was used (Table 4).

The results presented that there are more similarities in the identified challenges with respected to both types of GSD organizations (Table 4). We found significant differences for only a single challenge: *CH12 (budget and time constraints of RCM process, p = 0.020). CH12 (budget and time constraints of RCM process)* has been significantly considered by the
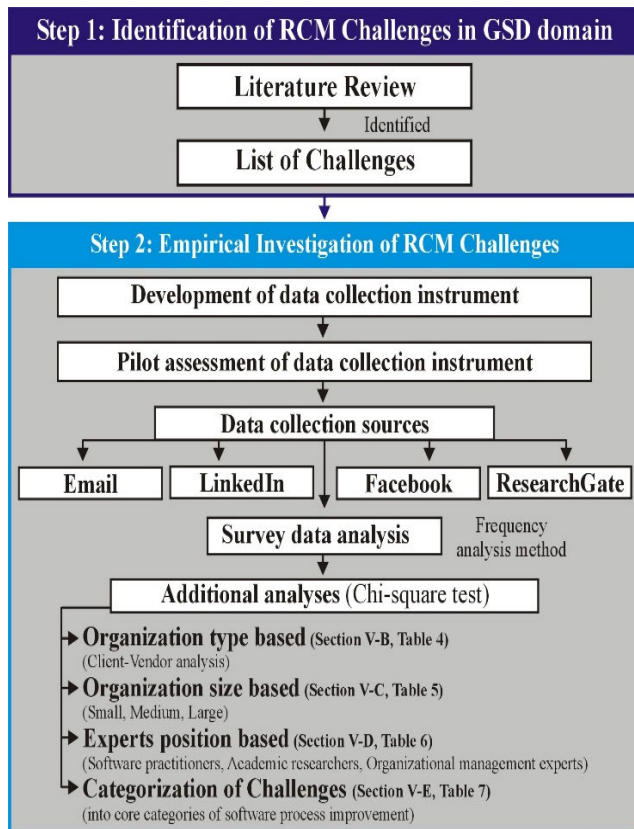
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FIGURE 1. Adopted research steps.

vendor organizations. As most of the vendor organizations are from developing countries and they usually have budget and time constraints [17], [26], [38]. Therefore, participants of the survey study significantly consider the budget and time issues face during the requirements change management program.

Similarly, 79% of the client organizations considered *CH27 (lack of RCM process training)* as the most common challenge for RCM activities. Most of the client organizations follow formal requirement change management techniques and approaches. Therefore, they have recommended the importance of proper RCM training for the distributed teams in GSD environment.

The results shows that CH11 (unavailability of RCM standards, 62% and 67%), CH14 (lack of organizational support, 72% and 69%), CH23 (lack of change impact analysis in distributed sites, 66% and 69%), CH26 (RCM risk management, 69% and 73%), CH 27 (lack of RCM process training, 76% and 79%), CH31 (lack of face to face communication, 62% and 65%) are reported as the most common factors in both types of organizations, respectively.

We have identified challenges in two types of GSD organizations; therefore, we have based our further analyses according to the categorical framework proposed by Ramasubu [17]. He has categorized the software process improvement issues of GSD organizations in different categories [17]. We have assumed the concepts of the same framework [30] and develop the mapping process by computing the occurrence

of each factor in client-vendor categories. For example, 55% of client organizations considered CH1 (IT infrastructure differences in distributed sites) as a significant challenge for RCM practices. Besides, the same factor "CH1" was revealed by the 65% of vendor organizations respondents. Therefore, CH1 was identified as the vendor firs category as it is highlight reported in this category. Using the smiler approach, we have mapped all the identified factors in both types of GSD organizations (Figure 3). The same mapping method has been considered by existing studies [39], [52].

C. ORGANIZATION's SIZE BASE CLASSIFICATION OF CHALLENGES INVESTIGATED IN THE EMPIRICAL STUDY

We have also analysis the identified challenging factors with regard to organization size, i.e. small (SSOs), medium (MSOs), and large-scale (LSOs) organizations. The main aim behind this categorization was to investigate the criticality of the identified challenges in relation to a specific organization size [9], [19]. Different other researchers have also reported the organizational size-based classification in other research domains [9], [19], [29], [53].

The definition presented by Australian Bureau of Statistics [54] was used to conclude the size of the organizations who have participated in the survey study. Following are the criteria for the given organization size: "small (0–19 employees)," "medium (20–200 employees)" and "large ($\geq$200 employees)." The survey results show that, based on the above criteria, total 17 responses were considered in the small size category, 33 in the medium and 27 in the large size organizations (Table 5). We further used the "chi-square test," to analyses the important differences in specified challenges concerning to organization size [9], [17], [19], [39], [53].

The analysis of the survey results shows that the identified challenges have high similarities with regard to different size of organizations. The significant differences were found for only two challenges: CH2 (requirements tracking and control issues, $p = 0.044$) and CH8 (lack of work synchronization, $p = 0.021$). These two challenges have high positive frequency in the medium size organizations. The practitioners working in medium size organizations have significantly considered the requirements tracking and control issues, as well the challenges of work synchronizations across the distributed sites. Most of the small and medium size organizations follow the informal requirements change management approaches that make it difficult to synchronize the RCM activities and it could negatively affect the requirements traceability and control activities [18].

We further identified the following challenges as the most common negative factors for SSOs: CH25 (inexperienced RCM staff, 82%), CH5 (lack of change management planning, 76%), CH11 (unavailability of RCM standards, 71%), CH12 (budget and time constraints of RCM process, 71%). CH25 (inexperienced RCM staff) is the most important challenge for SSOs. It indicates that small organizations are
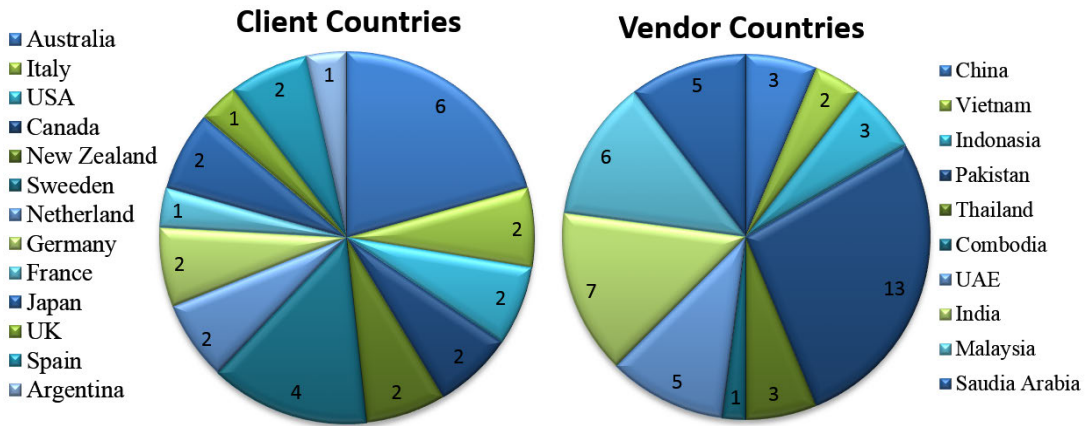
FIGURE 2. Country based client-vendor categorization of the survey respondents.
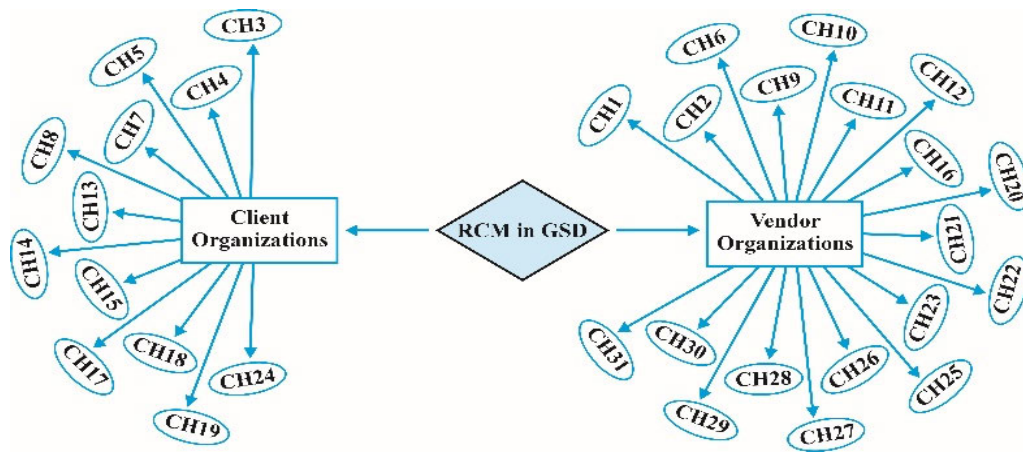

FIGURE 3. Client-vendor based conceptual mapping of the identified challenges.

facing the issues of the unavailability of skilled employees. Small organizations usually have informal organizational structure and limited resources, which are the key factors to attract the expert and skilled individuals [19]. CH5 (lack of change management planning) is the second most major challenge of the RCM process in small size GSD organizations. This is because the unavailability of proper roadmap and guidance that provide step by step instructions from the very beginning (planning) towards the end (finalizing the requirements change). CH11 (unavailability of RCM standards) and CH12 (budget and time constraints of RCM process) are rated as the third most common challenges for the small size GSD organizations. RCM process is an activity that has a great impact on budget and time. The limited budget and time constraints in small size organizations is the reason behind the difficulty of applying the RCM process activities effectively.

We have also identified the following challenges as the most common obstacles of the RCM program in the medium scale GSD organizations: CH29 ("lack of 3Cs "communication, coordination & control," 79%), CH4 (unclear scope

of requested changes, 75%), CH17 (lack of domain knowledge, 73%) and CH27 (lack of RCM process training, 73%).

RCM is considered a collaborative process and the team members need to have close communication and coordination to perform the requirement change activities. Therefore, majority of the medium size organizations considered lack of 3Cs as an important challenge. The geographical distance between the GSD team is a challenge for a suitable and continual communication coordination and control of the RCM activities. The CH4 (unclear scope of requested changes, 75%) was the second most significant challenge based on the survey participants for the medium size organizations. It is important to request the requirements change with the clear scope, because it could impact different other software development activities. The demanded changes with clear scope could be used to allocate the proper budget and time for RCM activities [21].

For large size organizations, the most common challenges are CH13 ("lack of RCM technological tools," 78%), CH29 (lack of 3Cs "communication, coordination & control, 78%), CH1 ("IT infrastructure differences in distributed

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TABLE 5. Classification of challenges based on organization size.

S.NO.	Small Scale Organizations (SSOs) (N=17)					Medium Scale Organization (MSOs) (N=33)					Large Scale Organization (LSOs)(N=27)					"Chi-square Test (Linear-by-Linear Association) α = 0.05"		
	Positive		Negative		Neutral	Positive		Negative		Neutral	Positive		Negative		Neutral			
	SA	A	SD	D	N	SA	A	SD	D	N	SA	A	SD	D	N	X^2	df	P
CH1	3	4	2	3	5	8	15	2	4	4	7	13	0	3	4	.806	1	.369
CH2	2	6	0	6	3	6	17	1	3	6	4	14	2	4	3	4.049	1	.044
CH3	4	7	1	3	2	4	11	4	7	7	3	10	2	5	7	1.442	1	.230
CH4	1	3	2	7	4	6	19	0	3	5	4	10	2	4	7	5.825	1	.05
CH5	5	8	0	1	3	3	12	3	8	7	6	9	2	5	5	1.165	1	.280
CH6	1	7	2	1	6	8	14	0	6	5	6	13	1	2	5	2.052	1	.152
CH7	0	5	1	3	8	5	15	2	3	8	5	13	2	3	4	2.746	1	.098
CH8	0	4	2	5	6	6	15	0	5	7	4	12	3	3	5	6.397	1	.021
CH9	2	5	0	5	5	2	14	0	9	8	2	13	0	6	6	.392	1	.531
CH10	1	3	2	3	8	5	14	2	2	10	3	9	2	5	8	.007	1	.931
CH11	4	8	0	2	3	5	13	2	3	10	4	13	0	3	7	.123	1	.726
CH12	3	9	1	3	1	4	12	0	6	11	5	10	2	4	6	.066	1	.797
CH13	3	2	2	5	5	6	13	1	6	7	6	15	0	3	3	2.576	1	.108
CH14	0	5	1	3	8	3	17	1	6	6	3	17	0	4	3	.022	1	.881
CH15	2	6	2	4	3	4	16	1	4	8	2	13	1	5	6	.356	1	.551
CH16	0	4	1	4	8	7	14	2	5	5	4	11	2	3	7	1.927	1	.165
CH17	1	5	2	4	5	5	19	0	3	6	6	11	0	3	7	.006	1	.938
CH18	0	6	0	3	8	2	15	2	6	8	6	11	1	3	6	.222	1	.637
CH19	2	10	2	0	3	3	16	2	5	7	4	12	2	3	6	.157	1	.692
CH20	3	6	1	3	4	9	11	3	5	5	4	14	1	4	4	.229	1	.633
CH21	1	6	2	3	5	6	16	0	6	5	3	14	1	1	8	2.691	1	.101
CH22	1	5	0	5	6	3	14	2	7	7	8	10	2	3	4	3.173	1	.075
CH23	2	4	1	3	7	7	12	4	2	8	6	8	4	2	7	.160	1	.689
CH24	3	2	2	4	6	8	14	3	3	5	3	12	4	2	6	.270	1	.603
CH25	5	9	1	0	2	7	10	4	5	7	5	10	2	2	8	.976	1	.323
CH26	0	4	4	2	7	7	11	0	6	9	7	9	3	2	6	.265	1	.607
CH27	4	6	3	1	3	6	18	2	2	5	3	14	2	5	3	.037	1	.848
CH28	3	3	2	4	5	11	9	5	2	6	6	11	3	3	4	1.178	1	.278
CH29	4	7	1	2	3	9	17	0	3	4	7	14	1	1	4	.614	1	.433
CH30	4	3	2	2	6	8	12	2	4	7	7	12	3	2	3	.910	1	.340
CH31	0	8	3	2	4	6	14	3	4	6	6	11	2	1	7	3.128	1	.077

sites," 74%) and CH14 ("lack of organizational support," 74%). The results shows that 78% of the respondents agreed to choose CH13 (lack of RCM technological tools) to be the major challenge of the RCM process in large scale GSD organizations. Damian [21] argued that it is important for GSD organization to used technological tool to address the RCM activities. The lack of effective RCM techniques and technological tools casus the failure of RCM process execution [35].

The SSOs exposed to different challenges compared with the MSOs and LSOs. However, the MSOs and LSOs face similar challenges in the GSD environment. Generally, we have noticed that CH11 (unavailability of RCM standards) and CH29 (lack of 3Cs "communication, coordination & control") considered the most significant challenges for all types of organization size.

Moreover, the identified challenges were mapped into three size of organizations, which are SSOs, MSOs and LSOs. The mapping is based on how frequent the identified challenges are. Such as, CH1 (IT infrastructure differences in

distributed sites) was faced by 41% of SSOs, 70% MSOs and 74% LSOs. Since this challenge has a high frequency in LSOs, it is allocated in LSOs category. Using the same approach all the other identified challenging factors were mapped in SSOs, MSOs and LSOs categories, as shown in Figure 4. According mapping results, most of the identified challenging factors were related to LSO organization compared with SSOs and MSOs. It is significant or the organizations to focus on the challenging factors with regard to their organization size. The same classification approach has been previously adopted by existing studies of GSD domain [39], [52].

D. CLASSIFICATION OF THE INVESTIGATED CHALLENGES BASED ON THE EXPERT's POSITION

The positions of the survey respondents were classified into the groups of experts including: academic researchers, software practitioners, and organizational management experts. The aim of the position-based classification
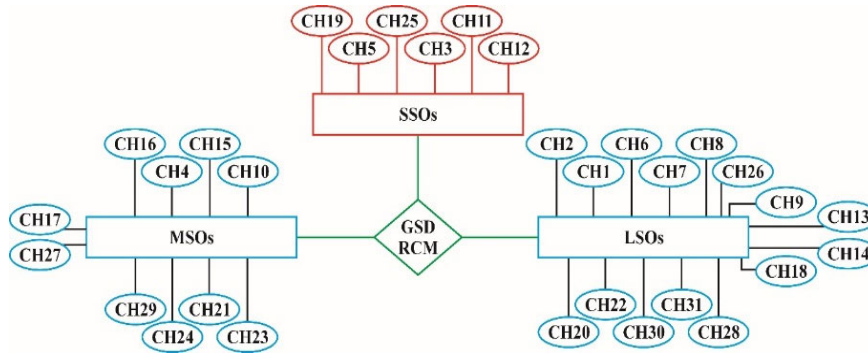
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FIGURE 4. Size based mapping of the identified challenges.

highlights the perceptions of different experts working on change management programs in the GSD environment. These experts have ranked the identified challenges based on their expertise and understanding. The same categorization has been done in other research studies [27], [28], [55]. The chi-square analysis test was applied to specify the significant differences between the reported challenges for different sets of RCM experts [9], [27], [28], [55].

The results reported in Table 6 shed light that there are big differences between the set of experts for two challenges: CH3 (roles and responsibilities issues, p = 0.002) and CH13 (lack of RCM technological tools, p = 0.004). CH3 (roles and responsibilities issues) has been significantly considered by the organizational management experts involve in the RCM activities. Organizational management is responsible to develop the teams and assign the roles and responsibilities to the team members [19], [38]. However, the distributed RCM activities in GSD environment make it challenging to properly manage the issues of roles and responsibilities [19], [35]. Limited attention given to the project roles and responsibilities across the geographical boundaries could lead towards the poor change management program [11], [14].

The results also indicate that CH13 (lack of RCM technological tools) is more significant for the software developers group as compared to the researchers and the organizational management. Developers deals with the technical aspects of the RCM activities; therefore, they have considered the importance of the technological tools and standards [11], [20]. Moreover, RCM process in more collaborative in nature and there is need of strong communication and coordination tools that could assist to manage the change management program in GSD environment [39].

Furthermore, CH19 (lack of RCM team management) was considered by 100% of the respondents in the organizational management group. It shows the significance of RCM team management in GSD organizations. The distributed GSD sites are facing challenges due to the geographical, socio-cultural and temporal boundaries, which make it difficult to manage the RCM teams [17], [19], [35], [53]. There is a need of expert project management team that could handle and manage the distributed RCM teams [53].

E. CLASSIFICATION OF THE INVESTIGATED CHALLENGES INTO A ROBUST FRAMEWORK

The identified challenging factors were mapped into six main knowledge areas of software process improvement proposed by Ramasubbu [17]. These areas include: "project administration," "coordination," "software methodology," "human resources management," "knowledge integration," and "technology factor." These knowledge areas have been considered by other existing studies conducted in GSD context [39], [52] to scale the factors in the six areas and develop a framework.

The identified challenging factors were mapped by considering two issues: their impact on RCM process in GSD and the level of understanding of mapping team. To perform the mapping process, we have established a mapping team that consists of five members. The first two authors continually involved and map the investigated challenging factors into their respective knowledge areas. The authors no three and four were participated to verify the mapping process. Author no five (research advisor) arbitrarily involved to validate the mapping process.

Moreover, we performed the inter-rater reliability text aiming to check the researcher's bias. To perform this test, two external experts from "Virtual Force-Pakistan" and "city university of Hong-Kong" were invited. They mapped the list of challenges into six knowledge area according to their own understanding. Based on the results of study authors and external experts, we have calculated the non-parametric Kendall's coefficient of concordance (W), whereas, the value of W=1 indicates the perfect agreement and W=0 presents the complete disagreement. The determined results (W=0.92, p=0.006) present the strong agreement between the mapping results of study authors and external experts. To summarize, based on the of inter-rater reliability test, the mapping process is consistent and unbiased.

This classification will serve as the base for practitioner to critical focus of the most significant challenging areas. The mapping results is also beneficial for academic researcher to consider the most critical challenges in their future research. Moreover, the developed framework help the academic researchers and industry practitioners to develop the

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TABLE 6. Classification of identified challenges based on expert's opinion.

S.NO.	Software Practitioners (N=17)		Academic Researchers (N=28)		Organizational Management Experts (N=32)		"Chi-square Test (Linear-by-Linear Association) α = 0.05"		
	F	%	F	%	F	%	X	df	P
CH1	15	88	21	75	26	81	0.798	1	0.372
CH2	11	65	19	68	22	69	0.074	1	0.786
CH3	**8**	47	**20**	71	**26**	81	**9.191**	**1**	**0.002**
CH4	14	82	19	68	25	78	0.010	1	0.919
CH5	10	59	20	71	26	81	2.799	1	0.094
CH6	10	59	14	50	25	78	2.754	1	0.097
CH7	13	76	22	79	24	75	0.012	1	0.912
CH8	16	94	25	89	31	97	0.335	1	0.563
CH9	14	82	20	71	27	84	0.162	1	0.687
CH10	14	82	17	61	21	66	0.825	1	0.364
CH11	14	82	26	93	31	97	2.913	1	0.088
CH12	16	94	20	71	30	94	0.228	1	0.633
CH13	**17**	100	**26**	93	**23**	72	**8.225**	**1**	**0.004**
CH14	16	94	16	57	29	91	0.162	1	0.687
CH15	16	94	18	64	28	88	0.001	1	0.977
CH16	10	59	21	75	22	69	0.280	1	0.597
CH17	16	94	10	36	23	72	0.600	1	0.439
CH18	11	65	17	61	21	66	0.019	1	0.890
CH19	13	76	15	54	32	100	2.205	1	0.138
CH20	15	88	10	36	27	84	0.342	1	0.559
CH21	16	94	11	39	28	88	0.174	1	0.677
CH22	11	65	17	61	21	66	2.571	1	0.109
CH23	14	82	17	61	29	91	3.308	1	0.069
CH24	12	71	21	75	24	75	0.089	1	0.765
CH25	17	100	10	36	25	78	0.540	1	0.463
CH26	11	65	16	57	23	72	0.480	1	0.488
CH27	15	88	24	86	31	97	1.448	1	0.229
CH28	12	71	15	54	27	84	2.053	1	0.152
CH29	17	100	22	79	30	94	0.045	1	0.832
CH30	15	88	23	82	28	88	0.004	1	0.952
CH31	16	94	23	82	28	88	0.210	1	0.647

new strategies and plans for the successful execution of RCM activities in GSD context.

V. SUMMARY AND DISCUSSION

A. SUMMARY OF RESEARCH QUESTIONS

This study main goal is to explore the main factors that could negatively affect the RCM process in GSD environment. The results of this study serve as knowledge base for researcher and practitioner to successful address the critical areas of RCM process while adopting GSD environment. The key aim of this study is to develop a RCM maturity model that will help the GSD organizations to assess and improve their change management practices. The current study will concentrate on developing only one of the components of the proposed model, which is RCM challenging factors.

To address the RQ1, we have studied literature review and identified 31 challenges that can negatively influence the RCM process in GSD domain.

The identified challenging factors were also validated by experts. This validation was made using questionnaire survey approach. The results prove that the survey participants concentrate on considered that the identified challenging factors are significant to address the success and progression of software process in GSD environment.

To answer RQ2, the identified challenges were classified based on the kind of GSD organizations i.e. client and vendor. The results and analysis of the empirical study shed light that both client and vendor organizations have more similarities with respect to the reported challenges (Table 4). The significant difference was found only for a single challenge, i.e. CH12 (budget and time constraints of RCM process, $p = 0.020$).

The RQ3 was developed to classify the identified challenges depended on the organization size, i.e. small, medium and large (Table 5). The classification of the organization size was based on the data collected using the questionnaire
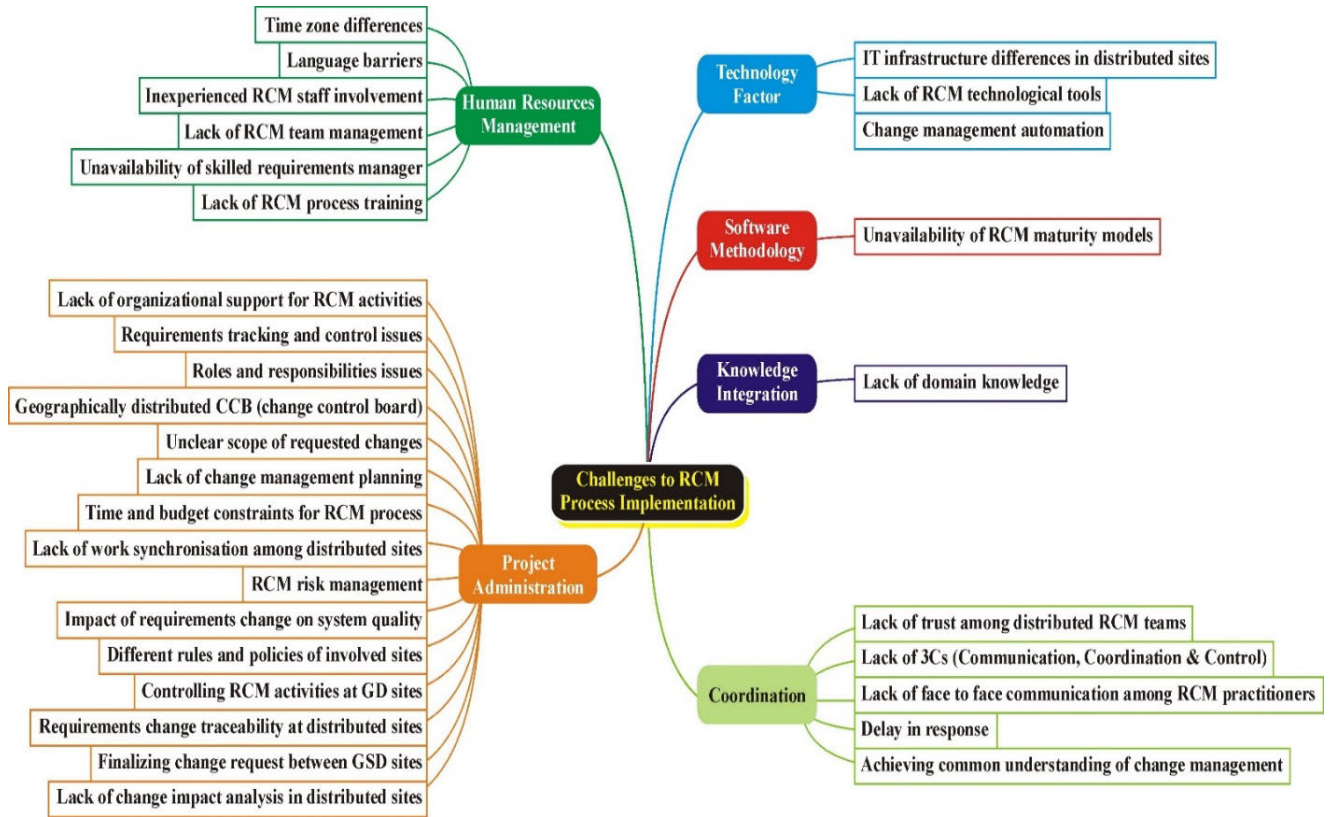
FIGURE 5. Categorical classification of the identified challenges.

survey study. Furthermore, the data were statistically analyzed in order to inquire the significant differences between the identified challenges based on the given organization size (SSOs, MSOs, LSOs). The results given in Table 5 show that there are more similarities than difference in the identified challenges with respect to the size.

In order to address the RQ4, the investigated challenges were classified based on respondent categories, i.e. academic researchers, software practitioners and organizational management experts. The results reported in Table 6 indicate that there are notable differences between the groups of experts for two challenges: CH3 (roles and responsibilities issues, $p = 0.002$) and CH13 (lack of RCM technological tools, $p = 0.004$).

For RQ5, we have mapped the identified challenges in the six core categories of RCM challenges and most of the challenges were assigned to the "project administration." It shows that the practitioners and researchers need to a serious focus to dealing with the challenging factors of "project administration" area. According to the Figure-5, "coordination" and "human resources management" are identified and they respectively considered the second and the third most significant areas of identified challenging factors. The brief detail summary of the results is provided in Table 7.

B. STUDY IMPLICATION
This study offers an overview of the challenging factors faced by the practitioners while processing the RCM practices in

GSD organizations. The study investigates the challenging factors in a developed framework. This framework will provide the base knowledge to the practitioner and researcher. The framework helps to consider the most critical part that need to be deal with to implement RCM activities in GSD context successfully.

Moreover, the study provides the deep knowledge of RCM challenging factors in GSD context in the context of organization types, organization size and concerning with expert's positions (software practitioners, academic researchers, organizational management). This study can greatly help the GSD experts to consider the identified challenging factors with respect to their organization's type, size and the experts' opinions. To summarize, this study offers the deep overview of the RCM literature and opinions of RCM experts which has not been conducted before.

C. STUDY LIMITATIONS
We have identified the challenging factors via literature review, which may be a threat to the results validity as some related studies might be unintentionally missed. Taking into consideration the other existing studies, this omission is not systematic [9], [26], [39].

In addition, another significant threat to the validity of study finding sis related to the construct validity. We have identified the RCM challenging factors from the state-of-the-art literature and validated them by experts using questionnaire survey study. The response of the survey experts

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TABLE 7. Summary of the research questions.

Research Questions	Discussions
RQ1: "What are the challenges faced by the GSD organizations during the implementation of RCM process?"	"IT infrastructure differences in distributed sites, requirements tracking and control issues, roles and responsibilities issues, unclear scope of requested changes, lack of change management planning, geographically distributed CCB (change control board), different rules and policies of involved sites, lack work synchronization, unavailability of skilled requirements engineers, controlling RCM activities at GD sites, unavailability of RCM standards, budget and time constraints of RCM process, lack of RCM technological tools, lack of organizational support, RCM effort estimation issues in distributed sites, time zone differences, lack of domain Knowledge, change management automation, lack of RCM team management, achieving common understanding of change management, lack of trust among distributed RCM teams, finalizing change request between GSD sites, lack of change impact analysis in distributed sites, impact of requirements change on system quality, inexperienced RCM staff, RCM risk management, lack of RCM process training, requirements change traceability at distributed sites, lack of face to face communication among RCM practitioners, delay in response, lack of face to face communication".
RQ2: "Are the identified challenges related to client or vendor organizations?"	"All of the 31 investigated challenges were related to both types of GSD organization (Client-Vendor). However, we found significant difference between the client and vendor organizations for a single challenging factor: *CH12 (budget and time constraints of RCM process,* p= 0.020*)*".
RQ3: "How are these challenges related to the organization size?"	"All of the 31 challenges are related to the size of the organizations. However, we found significant differences among the SSOs, MSOs, and LSOs for two challenges *CH2 (requirements tracking and control issues,* p= 0.044*)* and *CH8 (lack of work synchronization,* p= 0.021*)*".
RQ4: Do the investigated challenges related to the position of experts?	"The identified challenges were categorized based on the position of the survey respondents and we found significant differences between the groups of experts for two challenges: *CH3 (roles and responsibilities issues,* p= 0.002*)* and *CH 13 (lack of RCM technological tools,* p= 0.004*)*".
RQ5: "How the identified challenges could be presented in the form of robust framework?"	"The reported challenges were presented in the form of framework by classifying them into the six core categories (section V-E). The results presented in Figure 5 shows that most of the challenges were mapped into the "project administration" category. Hence, "project administration" was found as the main category of RCM challenges and "human resources management" as the second most significant category".

revolved that the identified challenging factors are critical to address for the implementation of RCM activities in GSD context successfully. The internal validity refers to the data extracted instrument. The data were collected from geographically distributed experts through a questionnaire survey. To verify the usability of survey instrument; pilot assessment with different experts has been conducted. The external validity refers to the generalization of the study findings. In addition, the survey participants were involved from all over the world, and for all types and size of organizations. Therefore, the results of this study are generalizable.

VI. CONCLUSION
The rapid increase in the adoption of global software development (GSD) motivated us to investigate the challenging factors of RCM process. We have conducted literature review and 31 RCM challenges were identified. The identified challenging factors were also validated with experts by conducting questionnaire survey. The results of empirical study revolved that the identified factors are highly needed to be

addressed to get a successful implementation of RCM activities in GSD.

Moreover, the identified challenging factors were further analyzed in the context of client and vendor GSD organizations. Results shows that there is high similarities than differences between the identified challenging factors with respect to both types of organizations.

The challenging factors were also analyzed with respect to the organization size i.e. small-scale organizations (SSOs), medium scale organizations (MSOs), and large-scale organizations (LSOs). The results revolved that MSOs and LSOs are experienced more similar challenging factors; besides the SSOs faced somewhat different challenging factors. The GSD organization need to consider the challenges, which are more important with regard to their organization size.

The identified challenges were further organized based on the position of the survey respondents. We have developed three core categories of the survey participants: academic researchers, software practitioners and organizational management experts. The experts have assessed each identified
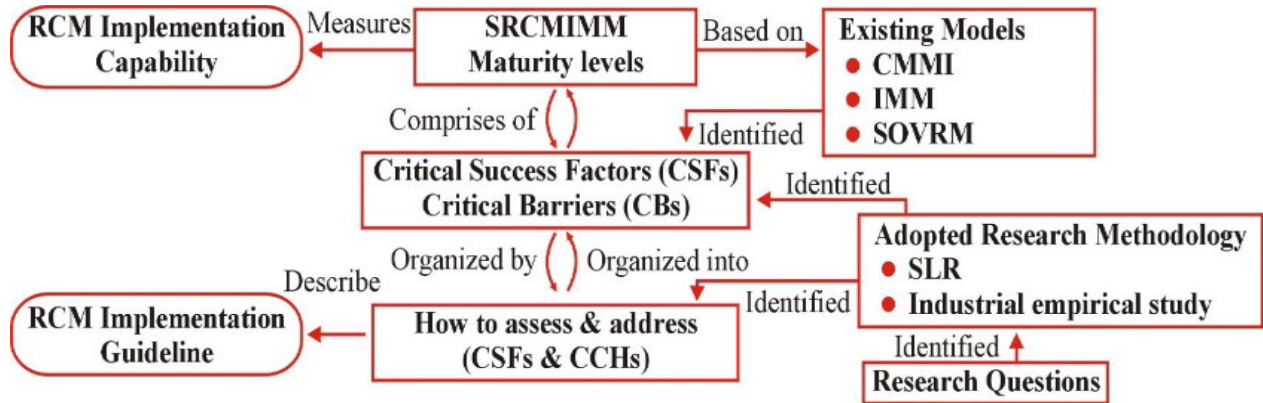
FIGURE 6. Architecture of the SRCMIMM.

challenge and rate based on their experience. It provides insight of expert opinions regarding the RCM activities in a GSD domain.

Furthermore, we have proposed a framework by classifying the challenging factors to six main knowledge areas (section 5.5). Most of the investigated challenging factors were associated to project administration area. This renders that the GSD organizations should carefully consider the challenging factors that's related to project administration knowledge areas. We trust that the results of this study assist to explore the challenges of RCM process in the GSD environment.

The ultimate aim of this study is to develop a "software requirements change management and implementation maturity model (SRCMIMM)" that will help the industry experts to evaluate and improve their RCM activities in GSD environment (Figure 6). The current study just contributes towards the development of only one components of proposed model i.e. RCM challenges. We are confident that the results of this study will help to address the RCM challenges in GSD domain.

Figure 6 shows the complete architecture of the proposed model. The components of the proposed model is depended on the existing maturity models (i.e. "CMM, CMMI, IMM, SOVRM etc.") and the influencing factors of RCM in GSD context. The structure of the model is based on three main components, i.e. "maturity level component," "factors component (critical challenges, critical success factors)" and "assessment component." The maturity level component used to assess the maturity level of an organization with respect to change management activities. The factors components contain the "critical challenges" and "critical success factors" that present the critical area that need to be considered for the successful implementing of RCM process in GSD. The assessment components help to evaluate the readiness of RCM program in an organization and recommend the best practices. For completing this research project, we will conduct addition survey study to find additional challenges and success factors of RCM in GSD. We intend to conduct literature review and empirical study to identify the best

practices used by the experts to implement the RCM activities in GSD context. Finally, we will conduct the cased study to design and evaluate the proposed RCM maturity model.

The appendixes of this study are:

Appendix-A: Sample of questionnaire survey:
https://tinyurl.com/yb4rrmlb

Appendix-B: Respondents bibliographic data:
https://tinyurl.com/y7dtu3lk

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