Communication Medium Sequence for Resolution of Conflicts Related to Requirement Engineering in Global Software Development

Huma Hayat Khan, Syeda Farwa Batool, Himal Arshad, Sundus Jamshed Butt, Qurat-ul-ain Naeem and Iqbal

Abstract – **Software development is largely improved by global software development (GSD) environment. In this environment majority of the software products are developed by the team members who are geographically distinct from each other. Although existing studies have significantly acknowledged the importance of communication medium in global software development, however there is need to focus our attention towards communication medium sequences for conflicts resolutions in requirement engineering. This research deals with the identification of various conflicts that can occur while conducting requirement engineering in global software development environment. Besides, the most appropriate communication medium sequence is investigated to resolve the conflicts. For this purpose, Systematic literature review (SLR), is conducted for conflict identification. Expert's evaluation is performed to review the identified conflicts. Experiment is conducted to suggest the more appropriate communication medium sequence to resolve the evaluated conflicts. As a result, nine conflicts are identified that can occur during requirement engineering in global software development environment. The results of the experiment showed that among the six sequences of communication mediums, "sequence 3" (Phone, Email and Video conferencing) is the most appropriate to resolve the conflicts. It is notified that the participants using 'sequence 3' required less extra information and were more satisfied and clear about the conflict resolution. The results lead to the conclusion that there is a positive impact on conflict resolution by changing the communication medium sequence. This study can act as a guideline for academicians and practitioners to select the appropriate communication medium for conflict resolution, resulting in advancement in existing requirement engineering body of knowledge (REBOK).**

Index Terms – **Conflict, Requirement Engineering, Global Software Development, Communication Medium**

I. INTRODUCTION

In last few decades, trend of global software development (GSD) environment increased tremendously. Worldwide integration of novelty and markets has greatly influenced software advancement. Now a days, most of the software projects are being practice in worldwide environment, and global software development (GSD) is becoming a standard in the software market. To get control on time and distance many firms have pass round software projects across the worldwide to take advantage on international resources pools, good cost structure, continuous advancement to accomplish cycle-time quickening and procure to local markets [1]. Most of the software projects exercise in global environment to get benefits regarding time, quality and cost. Software development organizations are moving toward GSD environment to get a remarkable place in global market [2]. GSD environment is good for organizations to take advantage by international skilled resource pools, cost structure, day- night development cycle and get opportunity for competitive lead in market. GSD environment benefits are marvelous but barriers regarding geographical regions, difference in culture and temporal differences badly affect this system/cycle [3]. These barriers affect software through all its phases. Requirement engineering phase of software development cycle is difficult in traditional software engineering but it becomes more challenging in GSD environment [4]. The biggest challenge during requirement engineering in GSD environment is communication and coordination. Communication and coordination issues occur due to cultural, geographical and temporal distances. Most researchers have concentrated on the needs of effective/best sequence of communication medium so that best negotiation can take place. Requirement conflict and their negotiation as conflict purpose has become an actual/fact in software progress. Communication and coordination are two main problems area in software engineering, considering a good thought to solve the conflict-empowered communication between interest parties [5]. Various synchronous and asynchronous communication mediums are used to overcome communication and coordination challenges like phone, email, instant message etc. [6]. One of these challenges is how to have a successful and logical communication for having best requirement agreements in GSD. Negotiation is the first step in every software development life cycle, but its results have great impact on system's value [6]. Collocated software is such systems by which requirement negotiation held by collocated meetings and face-to-face communication. Global software development is the way of developing software systems in which stakeholders from geographical regions are involved to reach a competitive lead on global market. Requirement engineering (RE) is difficult in collocated software development but it becomes even more challenging when it goes to GSD environment.

As the trend toward worldwide environment distributed software advancement continuous collocated meeting becoming challenging [5]. Most researchers have concentrated on the needs of effective/best sequence of communication medium so that best negotiation can take place. Requirement conflict and their negotiation as conflict

Huma Hayat Khan, Syeda Farwa Batool, Himal Arshad, Sundus Jamshed Butt, Qurat-ul-ain Naeem and Iqbal are with Department of Software Engineering, Faculty of Engineering and Computer Science, National University of Modern Languages, Islamabad, Pakistan. Email: hnauman@numl.edu.pk, syedafarwa054@gmail.com, himalkhan277@gmail.com, sundusbutt06@gmail.com, aineek014@gmail.com. Manuscript received on July 24, 2018**,** revised on Nov 21, 2018 and Feb 14, 2019 and accepted on March 28, 2019.

purpose has become an actual/fact in software progress. Communication and coordination are two main problems area in software engineering, considering a good thought to solve the conflict-empowered communication between interest parties [7]. Require negotiation were more fruitful when the group practiced asynchronous structured discussion of demands problems before to the synchronous negotiation meeting [8]. Many researchers described different styles of communication during the enhancement of software demands. They observed various mixed modes of communication and described how they are interring link to quality, solution satisfaction and process satisfaction. Four major modes of communication are 1) face-to-face 2) synchronous computer conferencing with face-to-face meetings one at the beginning and one at the end of work phase. 3) Asynchronous computer conferencing 4) a combined group with face to face with asynchronous computer conferencing.

The result of this study elaborated that the combine group work was more effective and achieved highest scores in creativity, quality and process satisfaction. This group also manufactured better requirements than the other groups using other communication modes [9]. According to researchers requirement negotiation using three different software engineering stakeholders role with conflicting goals working with collaboration towards a solution1) the use of shared electronic workspace was especially beneficial in requirement negotiation 2) the use of computer mediated requirement negotiation increase and enhance the participation of geographically alone stakeholders [10]. It makes important participants able to contribute beyond the face-to-face demand fact-finding meetings. With the use of techniques asynchronous negotiation can make better and strong requirement engineering process by giving other precious way of input and agreements that may otherwise be allotted with due to organizational travel and time concerns [10]. Their study has explored the fruitful aspect of computer mediated asynchronous discussion that followed requirements inspections in integrated Business Information System(IBIS) inspection tool in enhancing more best requirements negotiation that are sometime require to solve the problem from such inspections. Through synchronous methods, problems were solved better than asynchronous methods [11]. To enhance the efficiency of distributed requirement negotiation, relay on the proposed of theories on media selection, they emphasize that lean and rich media is necessary. Previous resolution of uncertainties through an asynchronous lean medium can overcome the list of open problems to be negotiated over synchronous rich channel. Furthermore, the media switching theory [12], a more recent theory on CMC has interpreted communication from a cognitive prospective; forcing that rich media is beneficial in producing commitment to the task execution. They permit individuals to sustain lower ability to properly RE process and information willingly, as compared to lean media [13].

As the result of these two theories we analyze that at one side rich synchronous communication is more authentic to solve the problem that arise in the discussion of requirement issues.

In second situation when discussing issues are inspecting requirements documents, stakeholders may also require time to process information properly and solve the issue outside of the meeting willingly and in less interactive manner. When we use asynchronous discussion, it enhances the characteristics of synchronous requirement negotiation [13]. Many theories suggested that face-to-face meetings are more useful communication medium and they are best suited for tasks that needed group negotiation and conflict resolution [14]. Many studies have been conducted in the field of requirement engineering related conflicts but they did not suggest any communication medium sequence for particular RE related conflict in global software development GSD. Therefore, there is an initial need to explore an appropriate conflict in RE in software development to cope the need of recent trends and issues, which are arising in GSD.

II. BACKGROUND

Globally integration of innovation and markets has extraordinarily affected software development. Presently, majority of the software projects are being practice across the globe and global software development (GSD) is turning into a standard in the software field. To gain power on time and distance many firms have gone to round software ventures over the globe to exploit on global assets pools, great cost structure, ceaseless headway to achieve process duration reviving and acquire to nearby markets [1].

Software designing industry is looking towards global software development to achieve a forceful lead on the worldwide market [2]. This is mainly because of many reasons, such as, it engages companies to extract themselves through global distance by having high caliber of HR requiring little to no effort, it expands the business zone by creating software for remote customers, and lastly it gives favorable position of time contrast in regards to longer work day.

On the other hand, Global Software development (GSD) is brimming with dares originating from land, common and distinctive social differences [3], happens for the most part by distance, time and social contrasts [7]. These difficulties rely upon the particular parts of every company. Coordination and correspondence turn out to be more troublesome as software units are source from better places, consequently influencing venture association, extend control and venture quality [8]. Most importantly elements influences software all through its design, construction, testing, deployment and response stage [9]. One of the difficulties is the manner by which to have an effective and consistent correspondence for having best necessity assertions in GSD. Transaction is the initial phase in each product improvement life cycle; however, its outcomes have incredible effect on framework's value [10]. Arranged software is such frameworks by which required negotiation held by one-table meetings and face-to-face communication. Worldwide software advancement is the method for creating software frameworks in which partners from geographical regions are included to achieve an aggressive lead on worldwide market Requirement

engineering (RE) is troublesome in arranged software advancement yet it turns out to be considerably all the more difficult when it goes to GSD environment [4].

Most scholars have focused on the requirements of powerful/best arrangement of communication medium so that best negotiation can occur. Necessity strife and their arrangement as struggle reason have turned into a real/actuality in software progress. Communication and coordination are two principle issues range in software designing, considering a decent thought to understand the contention enabled correspondence between intrigue parties [5].

Numerous scientists depicted distinctive styles of communication during the up gradation of software requests. They watched different blended methods of communication and depicted how they are entombing connected to quality, arrangement fulfilment and process fulfilment. Four noteworthy methods of communication are 1) face to face 2) Synchronous PC conferencing with face to face meetings one toward the start and one toward the finish of work stage. 3) Asynchronous PC conferencing 4) A consolidated gathering with up close and personal with offbeat PC conferencing. The after effect of this review expounded that consolidate a mass work was more successful and accomplished most elevated scores in imagination, quality and process fulfilment. This group likewise made preferable necessities over alternate gatherings utilizing other communication modes [6]. Their review has investigated the productive part of PC intervened asynchronous discussion. That took after prerequisites assessments in integrated Business Information System (IBIS). Examination instrument in upgrading all the more best necessities negotiation that are at some point require to tackle the issue from such assessments. Through synchronous strategies issues were comprehended superior to asynchronous techniques [11]. To upgrade the effectiveness of distributed requirement negotiation, hand-off on the proposed of theories on media determination, stress is, that lean and rich media is vital. Past determination of uncertainties through an asynchronous lean medium can conquer the rundown of open issues to be consulted over synchronous rich channel.

Besides, the media switching theory [12], a later theory on Communication Management Configuration (CMC) has deciphered communication from a cognitive prospective; compelling that rich media is useful in delivering responsibility regarding the task execution. They allow people to bring down capacity to legitimately RE process and data enthusiastically, when contrasted with lean media [13]. Many reviews have been led in the field of requirement engineering related conflicts yet they didn't propose any communication medium sequence for specific RE related clash in global software development GSD. So there is an underlying need to investigate a suitable conflict in RE in software development to adapt the need of late patterns and issues which are emerging in GSD [14]. In 2010, Nosheen Sabahat and her companions suggested iterative requirement engineering technique to sort out the conflicts raised during requirement elicitation in GSD. This study does not generate communication medium for conflicts [15].

In 2012, a study was conducted by khan et al. [16]. The objective of the study was to find the impact of changing sequence of communication media on conflict resolution during requirements engineering in DSD setting. The study only focused on ambiguity, ignoring all the other remaining conflicts that can occur while performing requirement engineering process in GSD. The conflicts were suggested to be resolved by using agile practices. It was seen in 2014, that researchers [17] have worked on removing conflicts with the help of agile practices but they did not map their work to communication medium sequences. Mehmood Niazi [18] conducted continuing with the identification and resolution of conflicts that can occur during requirement engineering process, a study in 2016. In this study the researchers have identified the requirement engineering related conflicts for GSD but they didn't work on communication medium sequences as a solution to resolve them. It was found that one of study that is conducted in 2016 [19] reported about medium of communication for conflict resolution but they did not specifically discuss about requirement engineering related conflicts that how they can be resolved by using appropriate communication medium sequence.

By reviewing the existing studies, as shown in Table 1, we came to know that there are many existing studies that significantly acknowledge the importance of identification of conflicts that can occur in requirement engineering process in GSD.

Besides, the studies have reported about the importance of selection of appropriate communication medium to interact among team members in GSD. However, there is a lack of work that reports the most appropriate communication medium for resolution of conflicts in GSD. This study aim is to find communication medium sequence for resolution of Requirement engineering conflicts raised in GSD. Following are the research questions. RQ1: What are different types of requirement engineering related conflicts in Global Software Development? RQ2: What is the appropriate sequence of communication medium for particular type of conflicts resolution in GSD project?

III. RESEARCH METHODOLOGIES

This research covers two objectives. First is to find requirement engineering related conflicts. Methods used to achieve this objective is Systematic Literature Review (SLR) and Expert Review. Second research Objective is to find appropriate communication medium sequence for identified conflicts. Experimental Research methodology is conducted to achieve this objective.

Systematic Literature Review (SLR): Systematic review is a type of literature review that collects and critically analyses multiple research studies or papers. Systematic literature review is performed in order to identify the conflicts related to requirement engineering process in global software development environment. In attempt to review, work of Kitchenham [22] is followed. His work is a comprehensive guideline for conducting systematic literature review. The aim of using SLR in this research is to elongate its phases that are review planning, review conduction and

review reporting.

Review planning includes plan regarding data sources used in searching, generating string formation criteria, selection of publication period of papers, generating criterion according to which papers are selected, generating quality assessment criteria through which final papers are selected and designing data extraction strategy about how data will be extracted from papers. Figure 1 shows the detail representation of the executed plan.

Index Terms: Conflict, Requirement Engineering, Global Software Development, Communication Medium

Queries:
1-Requirement Engineering AND Conflicts AND GSD
2-Requirement Engineering AND Conflicts AND DSD

Database:
IEEE/Elsevier-40 PAPERS Each
Springer-20 PAPERS
ScienceDirect-38 PAPERS

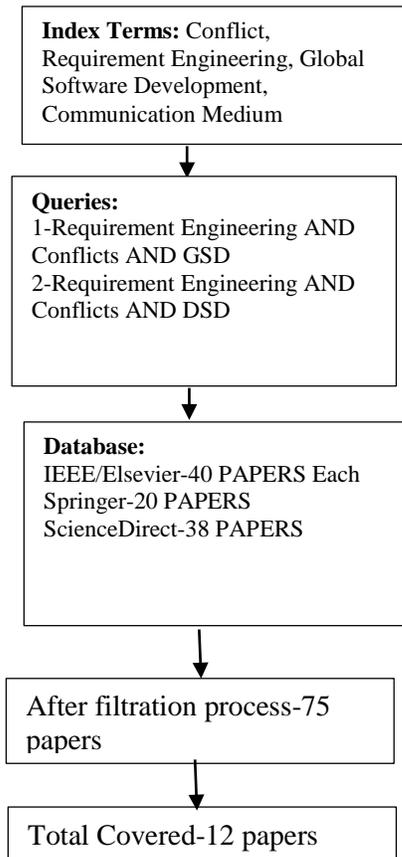After filtration process-75 papers

Total Covered-12 papers

Fig. 1   Executed Plan

As shown in figure 1, at first the keywords were identified which were then used to generate our query. We have then executed the query in four different databases i.e. IEE, Elsevier, springer ad science direct. From each of the database various papers were extracted. Upon these papers inclusion exclusion criteria was applied, resulting in 75 papers out of 138 in total. These 75 papers were further assessed for their quality, resulting in '12' papers. Each of these 12 papers were carefully read and managed to extract twelve raw conflicts. Table I shows the identified raw conflicts. It comprises of four columns. The detail results of SLR are reported in section 1.

Expert Review: After executing the SLR, expert review is conducted to evaluate the naming conventions and terminologies of the identified raw conflicts. The steps to conduct expert review are adapted from the work of Boeing [23] and Ayyub [24]. Process of "Expert Review" started from the criterion of choosing experts.

TABLE I. RAW CONFLICTS

S.NO	Paper ID	Raw Conflicts
01	P1 [15]	Conflicts regarding ambiguous requirements
02	P2 [17]	Cultural conflict, Cultural Distance
03	P3 [16]	Organizational Conflict
04	P4 [23]	Interest Conflict
05	P5 [26]	Conflicts regarding community relationship
06	P6 [25]	Conflicts regarding incorrect requirement
07	P7 [24]	Conflicts due to lack of understanding and stating requirement, Inadequate understanding of system, language barrier
08	P8 [20]	Conflicts based on incorrect assumption about the system
09	P9 [19]	Requirement management conflict
10	P10 [22]	Conflicts regarding lack of coordination and collaboration among stakeholders, language barrier, problems in collaboration among stake holders
11	P11 [21]	Conflicts regarding lack of awareness of innovative approaches for communication and coordination
12	P12 [18]	Conflicts regarding planning risk, coordination risk, control risk, management risk.

Our selected experts were software engineering professionals, specialized in requirement engineering and had deep knowledge about global software development. After selection of experts, next phase was to give list of identified raw conflicts (as shown in Table 1) to researchers for their intellectual advice regarding naming conventions and terminologies. Once the reviewed list of conflicts was gathered from the experts, the conflicts were induced in one of the selected software requirement specification (SRS) document. This SRS having induced conflicts is then used in experiment for identifying the most appropriate communication medium sequence to resolve them. Table 3 in the "finding" section shows the reviewed list of conflicts. *Experiment Conduction*: Experiment was conducted to achieve the most appropriate communication medium sequence to resolve any requirement engineering related conflict in GSD environment. For experiment, students from software engineering department were selected as participants. Selected students had same education level and all were having software engineering background. There were three roles in the experiment namely; customers, users,

and developers. The Customers, users and developers belonged to the same university. For experiment conduction, there were six groups. Each group comprised of five members, one customer, two users and two developers. The reviewed conflicts were given to each group after inducing it

in SRS document. Each group was allocated with its own unique communication medium sequence for conflicts resolution. Figure 3 shows the experiment conduction protocol.
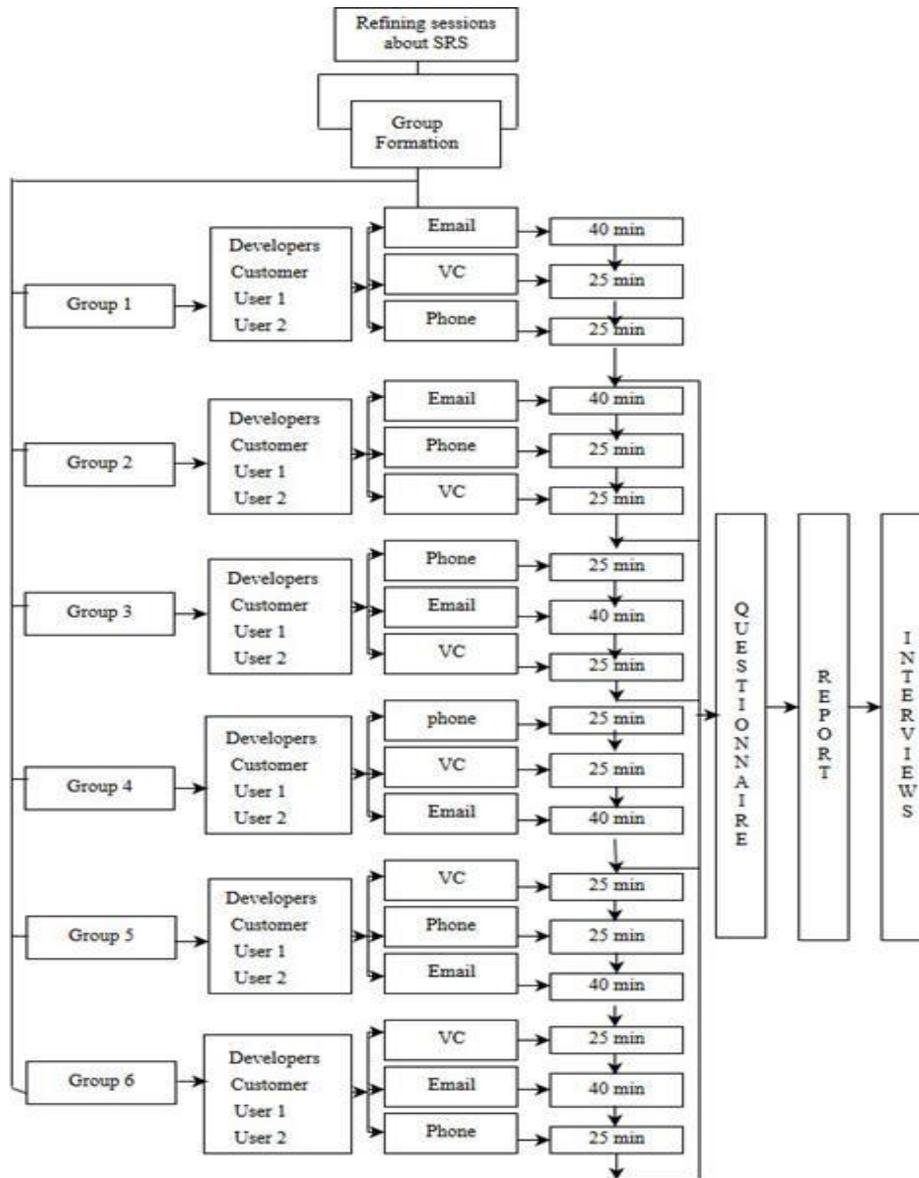

Fig. 2   Experiment Conduction Protocol

As shown in figure 2, at first the 'SRS' was prepared by inducing conflicts in it. Once the SRS was prepared, then group formation took place. The experiment comprised of 6 groups. Each of the group consisted of 5 members i.e. Developers, customers and two users. The role of the customer is to own the system. The role of user is to use the system and developers are the people, who are the development team members. Three communication mediums were used i.e. Email, video call and phone (combinations of synchronous. and asynchronous mediums). Each of the group was provided with unique sequence of the communication mediums. Each of the

medium was allocated with some duration. Participants were asked to use specific medium for that allocated time. There were '9' reviewed conflicts that were induced in the provided SRS. Each of the group resolved those 9 conflicts with their allocated sequence of communication mediums. Table II shows the mapping of groups, sequences and the conflicts. There are three columns in table 2 namely 'Groups' 'sequences', and 'Conflicts'. Six groups are notated by G1 to G6. Six sequences of communication mediums are notated by S1 to S6. Nine conflicts are notated by C1 to C9.

TABLE II.   MAPPING OF GROUPS WITH COMMUNICATION MEDIUM SEQUENCE AND CONFLICTS

Gro-ups	Communica tion Medium Sequenc es	Conflicts								
		C 1	C 2	C 3	C 4	C 5	C 6	C 7	C 8	C 9
G1	S1(Email, Phone and VC)	S 1	S 1	S 1	S 1	S 1	S 1	S 1	S 1	S 1
G2	S2(Email, VC and Phone)	S 2	S 2	S 2	S 2	S 2	S 2	S 2	S 2	S 2
G3	S3(Phone, Email and VC)	S 3	S 3	S 3	S 3	S 3	S 3	S 3	S 3	S 3
G4	S4(Phone, VC and Email)	S 4	S 4	S 4	S 4	S 4	S 4	S 4	S 4	S 4
G5	S5(VC, Phone and Email)	S 5	S 5	S 5	S 5	S 5	S 5	S 5	S 5	S 5
G6	S6(VC, Email, Phone and Email)	S 6	S 6	S 6	S 6	S 6	S 6	S 6	S 6	S 6

At first 'group1' was called. They were assigned with communication medium in the following sequence. First user and customers used email as medium to communicate with developers for 40 minutes. After 40 minutes the participants shifted to video call and used this medium for 25 minutes. In the end the phone was used as a medium for 25 minutes. The session was ended with a post experiment questionnaire. They were also asked to write a report on their experiment experience. In the end an interview session was conducted to further ask about their less understanding responses. The same process was followed for all the remaining groups but for their allocation communication medium sequences.

IV. RESULTS ANALYSIS AND VALIDATION

A. *Conflicts Faced in RE Process in GSD*

Based upon the SLR results, we managed to find various conflicts that can be raised while conducting RE projects in GSD. Table III reports the reviewed list of conflicts and their sources. Column 'Papers' reports ID's of '12' papers with P1 to P12. Column conflicts shows '9' conflicts ID's with C1 to C9.

TABLE III.   CONFLICTS AND RESOURCES

Papers	C1	C2	C3	C4	C5	C6	C7	C8	C9
P1[15]	x								
P2[17]		x	x						
P3[16]			x						
P4[23]							x		
P5[26]				x					
P6[25]		x							
P7[24]					x				
P8[20]					x	x			
P9[19]							x		
P10[22]								x	x
P11[21]		x			x			x	
P12[18]							x	x	

As shown in table 3 paper with ID P1 [15] reports about conflict regarding ambiguity (C1). Papers with ID 'P2', 'P6', and 'P11' [17, 25, 21] report about socio cultural conflicts (C2). Paper with ID P [16] reports about organizational cultural conflict (C3). Papers with IDs P [23, 19, 18,] report about Requirement management conflict (C7). Paper with ID P [26] reports about Community relationship conflict (C4) Papers with IDs P [24, 20, 21] report about conflict of understanding problems (C5). Papers with IDs P [22, 21, 18] reports about conflicts regarding productive knowledge sharing (C8). Paper with ID P [22] reports about Conflicts due to lack of awareness of innovative approaches of communication and coordination (C9).

A. *Communication Mediums to Resolve RE Conflicts*

An experiment was conducted (explained in section 2). Data gathered from the experiment was analyzed. We managed to conclude about most appropriate communication medium sequence for resolving the 9 conflicts. The selection of most appropriate communication medium was done on the basis of three constructs i.e. clarification, satisfaction and extra information required. Table IV shows the detail of experiment responses.

TABLE IV.   POSITIVE RESPONSE EVALUATION

S. No.	Variables	Customer		Customer Independent response (Positive response)	User 1		User 1 Independent response (positive response)	User 2		User 2 Independent response (positive response)
		Yes	No		Yes	No		Yes	No	
G1	Clarification	4	7	36.36	6	5	100	5	6	45.45
	Solution Satisfaction	3	3	50	4	2	66.66	2	4	33.33
	Extra Information Required	3	3	50	2	4	33.33	3	3	50
G2	Clarification	4	7	36.36	4	2	100	5	6	45.45
	Solution Satisfaction	3	3	50	4	2	66.66	2	4	33.33
	Extra Information Required	3	3	50	2	4	33.33	3	3	50
G3	Clarification	9	2	81.81	7	4	63.64	8	3	72.73
	Solution Satisfaction	6	0	54.54	5	1	83.33	4	2	66.66
	Extra Information Required	4	2	66.67	2	4	33.33	2	4	33.33
G4	Clarification	8	3	72.73	0	11	0	7	4	63.64
	Solution Satisfaction	4	2	66.66	0	6	0	4	2	66.67
	Extra Information Required	4	2	66.66	2	4	33.33	3	3	50
G5	Clarification	10	1	90.90	6	5	54.54	6	5	54.54
	Solution Satisfaction	5	1	83.33	4	2	66.67	2	4	33.33
	Extra Information Required	4	2	66.66	3	3	50	3	3	50
G6	Clarification	5	6	45.45	4	7	36.36	4	7	36.36
	Solution Satisfaction	4	2	66.66	2	4	33.33	1	5	16.67
	Extra Information Required	4	2	66.66	5	1	83.33	1	5	16.67

Table IV has eight columns namely "variables", "Customer", "customer independent percentage (positive responses)", "User 1", "User 1 independent percentage", "User 2" "User 2 independent percentage (positive responses)".

The analysis was done on basis of three variables named as Clarification, Extra information required and solution satisfaction. The groups illustrate the percentage of customer with respect to clarification, solution satisfaction and extra information required.

Group 1 (G1) percentage of customer responses of clarification is 45.45 and percentage of solution satisfaction is 33.33. Extra information required percentage of customer is 50. Similarly, user 1 clarification percentage is 36.36. Percentage of its solution satisfaction is 50 and Extra information required percentage is 50. Clarification percentage of user2 is 45.45. Its solution satisfaction percentage is 33.33 and percentage of Extra information required is 50.

Group 2 (G2) illustrates the percentage of customer responses of clarification are 36.36 and percentage of Solution satisfaction required responses is 50. Extra information required percentage for customer is 50.

Similarly, user 1 clarification percentage is 100. Percentage of its solution satisfaction is 66.66 and extra information required percentage is 33.33. Clarification percentage of user2 is 45.45. Its solution satisfaction percentage is 33.33 and parentage of Extra information required is 50.

Group 3 (G3) illustrates the Percentage of customer clarification is 81.81 and percentage of Solution satisfaction is 66.67. Extra information required percentage of customer is 54.54.

Similarly, user 1 clarification responses of percentage are 63.64. Percentage of its solution satisfaction responses is 83.33 and extra information required percentage responses are 33.33. Clarification percentage of user2 is 72.73. Its solution satisfaction percentage of responses is 66.66 and parentage of Extra information required is 33.33.

Group 4 (G4) illustrates the percentage of customer clarification responses is 72.73 and percentage of extra information required responses is 66.66. Solution satisfaction percentage of customer is 66.66.

Similarly, user 1 clarification percentage is 0. Percentage of its solution satisfaction responses is 0 and extra information required percentage response is 33.33.

Clarification percentage response of user2 is 63.64. Its solution satisfaction percentage response is 66.67 and parentage of Extra information required responses is 50.

Group 5 (G5) illustrates the percentage of customer responses of clarification is 90.90 and percentage of extra information required is 83.33. Solution satisfaction response percentage is 66.66.

Similarly, user1 clarification percentage is 54.54. Percentage of its solution satisfaction response is 66.66 and extra information required response percentage is 50. Clarification percentage of user2 response is 54.54. Its solution satisfaction percentage response is 33.33 and parentage of Extra information required response is 50.

Group 6 (G6) illustrates the percentage of customer clarification response is 45.45 and percentage of extra information required response is 66.66. Solution satisfaction percentage response is 66.66.

Similarly, user 1 clarification percentage response is 36.36. Percentage of its solution satisfaction response is 33.33 and extra information required percentage response is 83.33. Clarification percentage of user2 is 36.36. Its solution satisfaction percentage response is 16.67 and percentage of Extra information required response is 16.67.

V. DISCUSSIONS

A. RE conflicts and their resolution via most appropriate communication medium in GSD platform

After performing literature review, nine conflicts were identified. These identified conflicts were resolved in a controlled experiment through communication medium sequences. The result of experiment was analyzed and found the results for total number of positive responses in percentage for each of the group. Table V shows the positive responses in percentage.

TABLE V. Number of positive responses

S. No.	Participant role	No of positive responses (Out of 23)	Positive responses as percentage %
Group 1	Customer	10	43.47
	User1	10	43.47
	User2	10	43.47
Group 2	Customer	10	43.47
	User1	12	52.17
	User2	10	43.47
Group 3	Customer	19	82.60
	User1	14	60.86
	User2	14	60.86
Group 4	Customer	16	69.56
	User1	2	8.69
	User2	14	60.86

Group 5	Customer	19	82.60
	User1	13	56.52
	User2	10	43.47
Group 6	Customer	13	56.52
	User1	11	47.82
	User2	6	20.08

Table V has three columns. First column is participant role, second column is Number of positive responses and third column is positive response with respect to percentage for first sequence. 'Participant role' column has three rows. First row is for customer, second is for user1 and third is for user2. Customer, User1 and User2 record of number of positive responses and their percentages are in respective columns.

As shown in Table 5 the positive responses defined by 'Group 1' is 10 and its percentage is 43.47%. Similarly, positive response for user1 data is 10 and its percentage is 43.47%. Number of positive response for user2 data is 10 and its percentage is 43.47%.

The positive responses defined by customer of 'Group 2' is 10 and its percentage is 43.47%. Similarly, positive response for user1 data is 12 and its percentage is 52.17%. Number of positive response of user2 data is 10 and its percentage is 43.47%.

Group 3 defined positive responses of customer is 19 and its percentage is 82.60%. Similarly, positive response for user1 data is 14 and its percentage is 60.86%. Number of positive response of user2 data is 14 and its percentage is 66.86%.

Group 4 defined positive responses of customer is 16 and its percentage is 69.56. Similarly, positive response for user1 data is 2 and its percentage is 8.69%. No of positive response of user2 data is 14 and its percentage is 60.86.

Group 5 defines the positive responses of customer is 19 and its percentage is 82.60. Similarly, positive response for user1 data is 13 and its percentage is 56.52%. No of positive response of user2 data is 10 and its percentage is 43.47%.

Group 6 defined the positive responses of customer is 13 and its percentage is 56.52%. Similarly, positive response for user1 data is 11 and its percentage is 47.82%. No of positive response of user2 data is 6 and its percentage is 20.28%.

After conducting the analysis, it is concluded that various sequences of communication medium were having different conflict resolution results. Among the six sequences in total, 'sequence 3' (Phone-Email-VC) of communication mediums showed the positive responses. According to the analysis, 'group 3' using 'sequence 3' has managed to resolve the conflicts in much higher percentage than the other sequences of communication mediums. It was noted that the participants using 'sequence 3' were having higher level of satisfaction and clarification regarding conflicts resolution. Besides, the participants using 'sequence 3' required less extra information for resolving the conflicts. Furthermore, the varying percentage of conflicts resolution with varying sequences of communication mediums

concludes that "change in sequences of communication medium effects the rate of conflict resolutions".

The objectives of this research have been achieved. Nine conflicts are identified along with their appropriate communication medium sequence. In future same experiment can be conducted for more conflicts that can be occur in RE phase in GSD. In future same experiment can be conducted in real industry environment. In near future researchers can also extend this work for other challenges that can occur while implementing SDLC and by finding the appropriate communication mediums to resolve them.

B. Limitations

In this study, Researchers attempt to overlay utmost information available related to the topic. Researcher's first preference was to consider most relevant studies, but still it is possible that some knowledgeable studies may be skipped. Those research papers that are relevant to requirement engineering phase are considered, so that requirement engineering conflicts can be identified easily. This study covers small sample of population for experiment. Students acted as participants in the experiment. It would have been more accurate results, if the experiment will be conducted in pure industry requirement.

VI. CONCLUSION

Software development is largely improved by global software development (GSD) environment. In this environment majority of the software products are developed by the team members who are geographically distinct from each other. Requirement Engineering is a complicated task, and it becomes even more difficult when it is performed in GSD environment. Various conflicts that can occur while conducting RE process in GSD makes it complicated. In this research, requirement engineering related conflicts in Global software development environment are identified through systematic literature review and expert review. This study contributes to identify nine requirement engineering related conflicts in GSD environment. Appropriate communication medium sequence is generated for identified conflicts through Experimental Research.

This study concludes that "Change of communication medium sequence has positive impact on group sequence". An experiment was conducted. The experiment was to find most appropriate communication medium sequence for identified conflict. Six groups were given different sequences through which conflicts were resolved. After conduction of experiment, on the basis of results it is concluded that

although every group has managed to resolve the conflict but the participants of group '3' with sequence '3' (Phone, Email and VC) were much more satisfied and happy with their sequences. They comfortably resolved the conflicts and did not need any further information regarding resolving conflicts. This study contributes to the body of knowledge specifically to requirement engineering body of knowledge (REBOK) by allocating nine requirement engineering related conflicts in GSD. The other contribution of this study is to suggest appropriate communication medium sequence for identified conflicts. This study may guide practitioners to select the most appropriate medium of communication for the related conflicts resolution while conducting RE process in GSD.

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