

# A Framework to Address Communication Issues during Requirements Engineering Process for Software Development Outsourcing

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## Abstract

With the advent of global software engineering, Software Development Outsourcing (SDO) has gained momentum. But the failure rate of outsourced software development projects is high. For such projects, Requirements Engineering (RE) involves intensive communication among geographically distributed stakeholders resulting in one of the major causes of the projects' failures. Addressing communication issues during RE is critical for the success of such projects. Therefore, the basic objective of this study is to recommend RE practices for addressing communication issues in such scenarios. Literature review has been performed, questionnaire survey has been completed by involving SDO industry practitioners and their semi-structured interviews have been conducted for data gathering. We have: (i) Identified 32 communication issues of RE process for SDO from literature and industry, (ii) Provided 28 relevant RE practices to address such issues. A framework has been proposed that maps the communication issues to relevant RE practices in the form of RE practices' sets to address corresponding issues.

**Keywords:** Requirements engineering, IT outsourcing, Software development outsourcing, Communication issues, Practices

## 1 Introduction

IT outsourcing (ITO) is divided into four categories [1]:

- (1) Vendor provides services while co-locating with the client.
- (2) On Shoring or Domestic Outsourcing.
- (3) Vendor operating from another country:
  - ① Near Shoring,
  - ② Off Shoring,
- (4) Involvement of multiple service providers:
  - ① Distributed Software Development (DSD),

## ② Global Software Development (GSD).

In case of Software Development Outsourcing (SDO) some or all activities related to software development are contracted out by a client to the vendor(s) [2].

The volume of outsourcing is increasing day by day. Literature provides several reasons of this grand market revolution such as cost reduction, accessibility to high-quality resources, outsourcing of non-core organizational activities and releasing internal resources [3-4]. Moreover, outsourcing of activities uproots organizational constraints to some extent such as problems with the management, shortage of resources and required skills [5].

On the contrary, in recent past many offshoring projects turned out to be unsuccessful [6]. For example, 50% of offshore outsourcing contracts signed by North-American companies failed to give the expected turn over [7], 30 to 50% of the companies involved in offshore outsourcing cancelled their contracts [8], and 20% of outsourcing contracts are cancelled in the first year [9]. During the process, the companies realized that expected cost reductions were much smaller as compared to the problems encountered and as a result many companies abandoned their off shore relationships [10-11]. The risk factors involved in failure of outsourcing projects include lack of communication, misalignment of strategies, lack of client contribution, mismatching Requirements Engineering (RE) practices, and lack of well-defined RE practices [12-13]. However, reasons related to RE are considered as main reasons of outsourced software development projects' failure [13].

RE is the core activity of software development [14] that involves intensive stakeholder communication whereas geographical distance among stakeholders has a direct impact on communication [15]. Failure to maintain adequate communication among stakeholders while carrying out RE activities can cause disasters [13]. Requirements elicitation and communication among stakeholders is one of the four challenges of globally distributed software development projects [16].

Uncertainty of requirements and associated risks must also be addressed in order to mitigate overall project risks [17]. In addition, clash of RE approaches, used at client and vendor sides, is also one of the reasons of project disruption [18]. Since the majority of studies in literature are focused on examining how to manage the outsourced projects, therefore, there is a wide gap of knowledge to understand the RE communication issues faced by the SDO teams [14]. Many studies emphasize the need of resolving communication issues to achieve anticipated benefits of SDO [19-21]. With this context, this study intends to answer the following Research Questions (RQ):

RQ1: Which are literature-based communication issues of SDO RE process?

RQ2: Which are literature-based RE practices to address communication issues of RE process during SDO?

RQ3: Which are communication issues of SDO RE process, other than explored from literature, faced by SDO practitioners and which are RE practices to address those issues?

RQ4: How to formulate and evaluate the framework to address the communication issues of RE process during SDO?

## 2 Related Work

With the advent of software development globalization, communication among geographically dispersed teams has become a challenge. Several recent studies have focused on communication issues when stakeholders are geographically distributed [22-25]. This shows importance of communication among outsourcing teams. Existing studies discuss communication among distributed teams from various aspects.

During requirements change management in case of GSD, effects of terrestrial, cultural and temporal differences on the communication among stakeholders have been discussed in [26]. Through a systematic literature review, study [27] presents the factors which cause risks during the RE process in case of GSD. The study emphasizes RE risks caused because of: (1) communication and distance, (2) cultural, organizational and time zone differences, (3) knowledge management and awareness, (4) management, (5) tools, technologies and standards, (6) stakeholders, (7) project and process, and (8) requirements. A framework has been proposed in [28] for addressing the communication issues during requirements change management in case of GSD. Practices have been recommended to mitigate the communication risks that are generated because of geographical, cultural and temporal distances. Another study [29] focuses on requirements elicitation and negotiations during distributed RE. The study compares face-to-face and synchronous text-based communication among the distributed stakeholders and

reveals that face-to-face communication is not always preferable for distributed RE. In some situations, text-based communication should be adopted for effective results. Findings also unveil that communication medium does not affect the performance of group during distributed requirements elicitation and negotiations. A framework has been developed for analyzing computer support during these activities. According to [30], requirements elicitation during GSD is affected by improper communication among the stakeholders due to time zone differences, cultural disparities and large amount of information. Various types of risks arise during the RE process for GSD. Study [31] divides such risks into seven categories: (1) communication and distance, (2) knowledge management and awareness, (3) cultural differences, (4) management and project coordination, (5) tools to support processes, (6) clients, and (7) miscellaneous. Study also focuses on presenting practices for addressing such risks. In study [32], challenges related to communication and coordination, knowledge acquisition, and alignment of processes and tools have been discussed in the context of global RE. Strategies to deal with these challenges have also been presented. By presenting nine case studies, study [13] describes RE challenges of offshore outsourcing regarding communication and conflicts among stakeholders. For addressing these challenges, a partial framework has been proposed which is based on three dimensions of people, process and technology. SDO may involve multi-site software development. Study [19] describes challenges related to communication among parties involved, knowledge management, culture and time zone differences in such scenarios. Strategies for addressing such challenges have also been recommended. The role of human assistance during computer-mediated requirements negotiations among the distributed groups has been investigated in [33].

There are a number of studies that discuss communication from various aspects including cross-cultural communication [34], customer-vendor trust [35] etc. However, unfortunately there is no such comprehensive study that provides a complete set of the communication issues that arise during SDO RE process and relevant RE practices to address those issues. Therefore, by proposing a theoretical framework, this research aims to provide a comprehensive set of the communication issues of SDO RE and relevant RE practices to address such issues.

## 3 Formulation of the Proposed Framework

Figure 1 shows the data sources for formulation of the proposed framework:

(1) Literature review to find SDO RE process communication issues and RE practices.

(2) Survey with SDO Industry Practitioners.  
 The survey participants were SDO industry practitioners having at least five years experience. The

respondents belonged to three major categories i.e. developer, manager and senior manager [36].

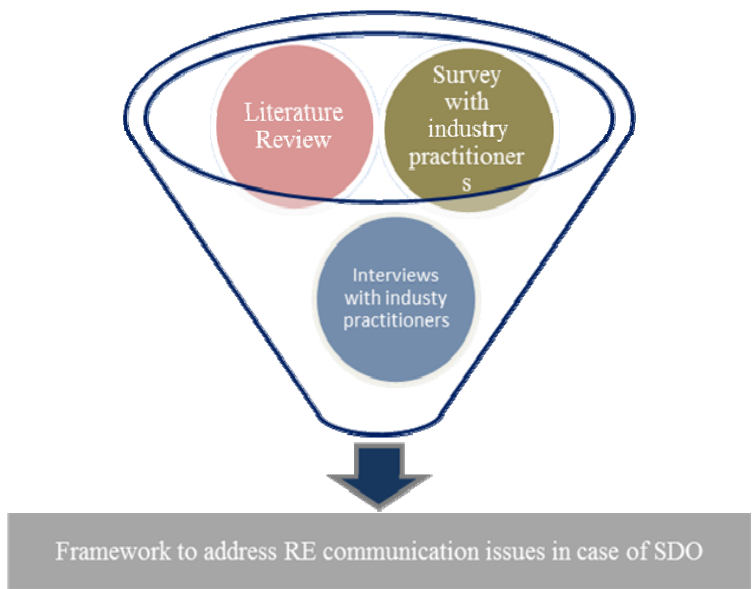


Figure 1. Data sources for the formulation of proposed framework

(3) Interviews with Industry Practitioners  
 After gathering the responses from practitioners, follow up semi-structured interviews were conducted with the 12 SDO practitioners to get clarifications on the responses, remove ambiguities and to gain further insights. The interviews were conducted through Computer Aided Telephone Interviewing (CATI) technique [37].

To address the communication issues, 24 relevant RE practices have been explored from the literature. Such practices have been shown by  $P_1, P_2, \dots, P_{24}$  in Table 1. This provides answer to RQ2.

3.1 The Proposed Framework

From the literature, we have identified 27 communication issues of SDO RE process. Those issues have been represented as  $I_1, I_2, \dots, I_{27}$  in the Table 1. This provides answer to RQ1.

Through the questionnaire survey with industry practitioners, 5 communication issues of RE process for SDO and 4 relevant RE practices have been discovered. Such issues have been denoted by  $I_{28}, I_{29}, \dots, I_{32}$  whereas 4 RE practices have been represented by  $P_{25}, P_{26}, \dots, P_{28}$  in Table 1. This helps to answer RQ3.

The results have been shown in Table 1 in the form of a framework. This partially answers the RQ4.

Table 1. Framework to address communication issues of RE process for SDO

Part-I (Issues identified from literature and relevant RE Practices to address the Issues)	
Communication Issues	Corresponding RE Practices' Sets (REP <sub>i</sub> )
$I_1$ : Face to face communication is required for clarification of requirements and resolution of misunderstandings [43].	REP <sub>1</sub> ={ $P_1, P_2, P_3$ }whereas $P_1$ : Managers should arrange the computer-mediated negotiations, involving all the appropriate stakeholders [44]. $P_2$ : "Get to know" face-to-face gatherings or instance communication through travelling [45]. $P_3$ : Face to face start-off meeting should be scheduled at the start of the project in order to establish personal relationships among key stake holders [19].
$I_2$ : Even through the videoconferencing, it is hard to conduct long and productive negotiations in particular when many stakeholders are involved [46].	REP <sub>2</sub> ={ $P_2, P_4, P_3$ }whereas $P_4$ : Synchronous communication should be supported by asynchronous communication (mixed media) in order to provide time for information processing and sifting through the issues which help to resolve outstanding issues and building common grounds [46].
$I_3$ : Trust among various working groups is affected because of the unavailability of face-to-face meetings [47].	REP <sub>3</sub> ={ $P_2, P_3, P_1, P_5$ }whereas $P_5$ : To encourage informal communication and avail associated advantages, the remote practitioners should have rooms equipped with electronic message "drop in", remote calling and artifacts sharing facilities [48].

**Table 1.** Framework to address communication issues of RE process for SDO (continuation)

<b>Part-I (Issues identified from literature and relevant RE Practices to address the Issues)</b>	
<b>Communication Issues</b>	<b>Corresponding RE Practices' Sets (REP<sub>i</sub>)</b>
I <sub>4</sub> : Propensity of less or non-reporting of the problems caused by distance [47].	REP <sub>4</sub> = {P <sub>6</sub> } whereas P <sub>6</sub> : Special considerations should be given to persuade the professionals that revealing of the issues will not negatively affect their organizational positions, and instead will assist in overcoming the problems and enhancing the performance [47].
I <sub>5</sub> : Arranging the face-to-face gatherings escalates cost [49].	REP <sub>5</sub> = {P <sub>7</sub> , P <sub>21</sub> } whereas P <sub>7</sub> : Conducting requirements workshops [50]. P <sub>21</sub> : A peer-to-peer workshop tool can substitute traditional face to face workshops during which stakeholders work together. P2P applications should provide facilities like: <ul style="list-style-type: none"> <li>• Instant messaging.</li> <li>• Sharing, reviewing and editing documents.</li> <li>• Discussions through audio link.</li> <li>• Autonomy (A peer can pass on information to others but also can apply restrictions, for not passing information to particular peer(s), by using access rights.</li> <li>• Intermittency (disappearing of any peer due to network disconnection that can be intentional or accidental) [51].</li> </ul>
I <sub>6</sub> : The informal contact is needed for establishing trust ties. In case of reduced trust, establishing commitment is avoided [43].	REP <sub>3</sub> = {P <sub>2</sub> , P <sub>3</sub> , P <sub>1</sub> , P <sub>5</sub> }
I <sub>7</sub> : Informal communication lack has adverse effects on relationship building that affects the requirements negotiation process negatively [32].	REP <sub>6</sub> = {P <sub>8</sub> , P <sub>5</sub> } whereas P <sub>8</sub> : Open lines should be maintained for communication among all the stakeholders [32].
I <sub>8</sub> : Poor relationship has negative impact when we attempt for removal of ambiguity with respect to the meaning of some specific requests initiated because of personal interests or political agenda [32].	REP <sub>6</sub> = {P <sub>8</sub> , P <sub>5</sub> }
I <sub>9</sub> : Stakeholders do not use Internet communication technologies for instant messaging. Instead they depend on formal ways like scheduled meetings, and asynchronous ways like emails and documentation [32].	REP <sub>7</sub> = {P <sub>5</sub> , P <sub>9</sub> , P <sub>10</sub> } whereas P <sub>9</sub> : Video conferences or teleconferences should be scheduled [32] daily, weekly, bimonthly, monthly etc. so that there are no or minimal inconvenient hours for all the stakeholders [52]. P <sub>10</sub> : Requirements documents should be prepared collaboratively by the remote stakeholders [53].
I <sub>10</sub> : Lack of deep-rooted relationship avoids the occurrence of spontaneous conversation because of which progress made on one site about the identifications or resolutions of requirements issues, is not conveyed to other sites for a long time resulting in delays [32].	REP <sub>6</sub> = {P <sub>8</sub> , P <sub>5</sub> }
I <sub>11</sub> : Sometimes meetings held to take decisions about the requirements are unproductive [19].	REP <sub>8</sub> = {P <sub>11</sub> } whereas P <sub>11</sub> : For requirements meetings: I: Engaging a human facilitator and using a rich communication media that supports integration of data, videos and audios. II: Preparation of agenda and then following it. III: Relevant participant selection to take part in requirements meetings. IV: Timely exchange of supporting documents to give participants enough time to read the relevant material. V: Participants should be able to access the resources (like chatting messages, emails, documents provided by the clients etc.) that contain information about the requirements [19].

**Table 1.** Framework to address communication issues of RE process for SDO (continuation)

<b>Part-I (Issues identified from literature and relevant RE Practices to address the Issues)</b>	
<b>Communication Issues</b>	<b>Corresponding RE Practices' Sets (REP<sub>i</sub>)</b>
I <sub>12</sub> : The stakeholders of a project can be positioned in the zones having a time difference that avoids informal communication [54].	REP <sub>9</sub> = {P <sub>12</sub> , P <sub>13</sub> , P <sub>14</sub> , P <sub>5</sub> , P <sub>9</sub> } whereas P <sub>12</sub> : Establishing 'proximity development center' in the region having no or a little time zone difference from the region of client [55]. P <sub>13</sub> : Try to find natural overlapping of working hours [47]. P <sub>14</sub> : Assess 'around-the-clock' capability of working [47].
I <sub>13</sub> : Time zone difference also creates hindrance for coordination among stakeholders that affects communication among stakeholders [56].	REP <sub>9</sub> = {P <sub>12</sub> , P <sub>13</sub> , P <sub>14</sub> , P <sub>5</sub> , P <sub>9</sub> }
I <sub>14</sub> : Asynchronous communication is required because of time zone differences [47].	REP <sub>10</sub> = {P <sub>12</sub> , P <sub>9</sub> }
I <sub>15</sub> : When there is synchronous meeting among the sites having considerable time differences, the stakeholders at least from one site are quite disturbed since either it's too late or too early with respect to daily working schedule [5, 47].	REP <sub>11</sub> = {P <sub>12</sub> , P <sub>14</sub> , P <sub>9</sub> }
I <sub>16</sub> : When there are time zone differences and no overlapping hours, clarification of requirements and decision making can be delayed for several days [43].	REP <sub>12</sub> = {P <sub>12</sub> , P <sub>9</sub> , P <sub>14</sub> , P <sub>16</sub> } whereas P <sub>16</sub> : During videoconferencing meetings share the agenda of meeting and list of issues, and designate a facilitator from each stakeholder [46].
I <sub>17</sub> : Geographical dispersion causes loss of cohesion, trust and 'team ness' [57].	REP <sub>13</sub> = {P <sub>2</sub> , P <sub>3</sub> , P <sub>5</sub> , P <sub>9</sub> , P <sub>10</sub> }
I <sub>18</sub> : Even the skilled professionals can become nervous and inactive because of distance [54].	REP <sub>3</sub> = {P <sub>2</sub> , P <sub>3</sub> , P <sub>1</sub> , P <sub>5</sub> }
I <sub>19</sub> : Attaining common understanding of the requirements is challenging [48].	REP <sub>14</sub> = {P <sub>16</sub> , P <sub>10</sub> , P <sub>17</sub> } whereas P <sub>17</sub> : The remote stakeholders should be involved during the sessions held for requirements analysis [48].
I <sub>20</sub> : As stakeholders are non-fluent in the communication language, therefore, communication is ineffective [48].	REP <sub>15</sub> = {P <sub>18</sub> } whereas P <sub>18</sub> : E-mail can be used as the way of communication [48,57]. Features like checking spellings and grammar, and language translation should be integrated with email facility [58].
I <sub>21</sub> : Electronic communication like email allows covert communication making videoconferencing-meeting decisions ineffective. This hidden communication can propagate misunderstandings about the requirements and create challenges for resolving requirements conflicts [48].	REP <sub>16</sub> = {P <sub>27</sub> , P <sub>28</sub> , P <sub>10</sub> } whereas P <sub>27</sub> : Role of every team member should be defined [industry]. P <sub>28</sub> : Every team member should play only the defined role [industry].
I <sub>22</sub> : Because of inadequate communication stakeholders can look for exerting power and using influence on each other [59].	REP <sub>17</sub> = {P <sub>9</sub> , P <sub>5</sub> }
I <sub>23</sub> : Users do not participate in the RE process appropriately [43].	REP <sub>18</sub> = {P <sub>19</sub> } whereas P <sub>19</sub> : In order to facilitate the communication with the system users, personnel should be appointed for field support [59].
I <sub>24</sub> : Practitioners forget to inform relevant stakeholders about the requirements changes [60].	REP <sub>19</sub> = {P <sub>20</sub> } whereas P <sub>20</sub> : Use Requirements Management(REQM) tool support providing these features: I: Continuous access to requirements related information (like history, who is working on which requirement(s), decisions made etc.). II: On occurrence of certain events (like change in requirements) timely notifying relevant stakeholders [60].

**Table 1.** Framework to address communication issues of RE process for SDO (continuation)

<b>Part-I (Issues identified from literature and relevant RE Practices to address the Issues)</b>	
<b>Communication Issues</b>	<b>Corresponding RE Practices' Sets (REP<sub>i</sub>)</b>
I <sub>25</sub> : There are language differences or different perceptions about terminologies or improper uses of terminologies and notations [45, 49].	REP <sub>20</sub> ={P <sub>22</sub> , P <sub>23</sub> , P <sub>24</sub> , P <sub>15</sub> } whereas P <sub>22</sub> : A standard language should be decided and used for communication [45]. P <sub>23</sub> : As proficiency in communication language is essential in order to successfully complete IT offshored projects, therefore, courses are offered for the improvement of communication language (for example English) competencies [61]. P <sub>24</sub> : If all the stakeholders cannot express in standard language then cultural liaisons should be appointed to enable fruitful communication. The individuals, who are familiar with the cultures of key stake holders and keep traveling between their locations, should be given priority for this purpose. The key responsibilities of cultural liaisons are to settle conflicts, resolve miscommunication issues, bridging up the gaps between cultures and languages and facilitating communication flow [61]. P <sub>15</sub> : A common glossary should be developed and/or used to create consensus on terminologies [49].
I <sub>26</sub> : Some of the participants can be excluded from the conversation because of their non-fluency in the communication language [57].	REP <sub>21</sub> ={P <sub>22</sub> , P <sub>23</sub> , P <sub>24</sub> }
I <sub>27</sub> : The requirements comprehension is reduced when requirements are conveyed / stated in the non-native language [43].	REP <sub>21</sub> ={P <sub>22</sub> , P <sub>23</sub> , P <sub>24</sub> }
<b>Part-II (Issues identified from SDO industry and relevant RE Practices to address the Issues)</b>	
<b>Communication Issues</b>	<b>Corresponding RE Practices' Sets (REP<sub>i</sub>)</b>
I <sub>28</sub> : Analyst does not communicate with relevant stakeholders and claims to know what user wants [industry].	REP <sub>22</sub> ={P <sub>25</sub> , P <sub>19</sub> } whereas P <sub>25</sub> : Analysts should be encouraged and facilitated to meet relevant stakeholders. Record of such meetings should be maintained [industry].
I <sub>29</sub> : Because of improper communication with relevant stakeholders, requirements are finalized based upon suppositions [industry].	REP <sub>22</sub> ={P <sub>25</sub> , P <sub>19</sub> }
I <sub>30</sub> : Stakeholders do not have proper facilities for communication [industry].	REP <sub>23</sub> ={P <sub>26</sub> } whereas P <sub>26</sub> : All the stakeholders should be equipped with proper facilities to communicate with geographically distributed stakeholders [industry].
I <sub>31</sub> : Some of the stakeholders do not participate or contribute in the conversation because of their non-fluency in the communication language [industry].	REP <sub>21</sub> ={P <sub>22</sub> , P <sub>23</sub> , P <sub>24</sub> }
I <sub>32</sub> : Every team member communicates or can communicate with any stakeholder [industry].	REP <sub>24</sub> ={P <sub>27</sub> , P <sub>28</sub> , P <sub>19</sub> }

#### 4 Definitions and Properties

Some basic definitions and properties used during the development of framework are:

**Definition 1.** An Issue is defined as “A matter that is in dispute between two or more parties [38]” OR “A problem that people are thinking and talking about [39]”.

So a **Requirements Engineering process communication issue** denoted by “I<sub>i</sub>” can be defined as the communication problem about which practitioners think or talk about during Requirements Engineering process and which can create dispute among the parties involved.

Let I be set of all the SDO RE process communication issues, then

$$I = \{I_i\} \text{ Where } i = \{a: a \in \mathbb{N} \wedge 1 \leq a \leq 32\}$$

where N= Set of Natural numbers.

**Definition 2.** A Practice is defined as “The action or process of doing something [40]” OR “A way of doing something that is usual or expected in a particular situation [41]” OR “Repeated performance or systematic exercise for the purpose of acquiring skill or proficiency [40]”.

According to IEEE definition “A software requirement is a condition or capability which is needed by a user to solve a problem or achieve an objective, and it must be met or possessed by a software system or system component [42]”.

Thus **Requirements Engineering Practices** denoted by “Ps” are the actions which are performed customarily during Requirements Engineering process to

successfully:

- (i) Collect, write, validate and organize software requirements,
- (ii) Avoid or eliminate the problems that arise or are expected to arise during software requirements' collection, documentation, validation and organization.

Let  $P$  be the set of all the RE Practices that can be used to address SDO RE process communication issues, then

$$P = \{P_s\} \text{ where } s = \{b: b \in \mathbb{N} \wedge 1 \leq b \leq 28\}$$

where  $\mathbb{N}$ = Set of Natural numbers.

**Definition 3.** A Set of Requirements Engineering Practices denoted by " $REP_t$ " consists of one or more Requirements Engineering practices that can be used to address an SDO RE process issue.

Let  $REP$  be set of all the sets of RE Practices that can be used to address SDO RE process communication issues, then

$$REP = \{REP_t\} \text{ where } t = \{d: d \in \mathbb{N} \wedge 1 \leq d \leq 24\}$$

where  $\mathbb{N}$ = Set of Natural numbers

$$\bigwedge \bigvee REP_t, \{REP_t\} \subset P.$$

From Definitions 1 and 2, Property 1 can be derived as:

**Property 1:** To address an issue, one or more Requirements Engineering Practices can be recommended, and one Requirements Engineering Practice can be recommended to address one or more issues.

$$\text{So } \exists ! I_i, \exists P_s: \exists ! I_i \Rightarrow \exists P_s$$

$$\text{and } \exists ! P_s, \exists I_i: \exists ! P_s \Rightarrow \exists I_i \quad \forall i=(1, 2, \dots, 32)$$

$\wedge$

$$s=(1,2,\dots,28).$$

From Definitions 1 and 3, Property 2 can be derived as:

**Property 2:** To address an issue, only one set of Requirement Engineering Practices can be recommended and one set of Requirements Engineering Practices can be recommended to address one or more issues.

$$\text{So } \exists ! I_i, ! REP_t: \exists ! I_i \Rightarrow \exists ! REP_t$$

$$\text{and } \exists ! REP_t, \exists I_i: \exists ! REP_t \Rightarrow \exists I_i$$

$$\forall i=(1,2,\dots,32) \wedge t=(1,2,\dots,24).$$

Figure 2 presents the framework diagrammatically.

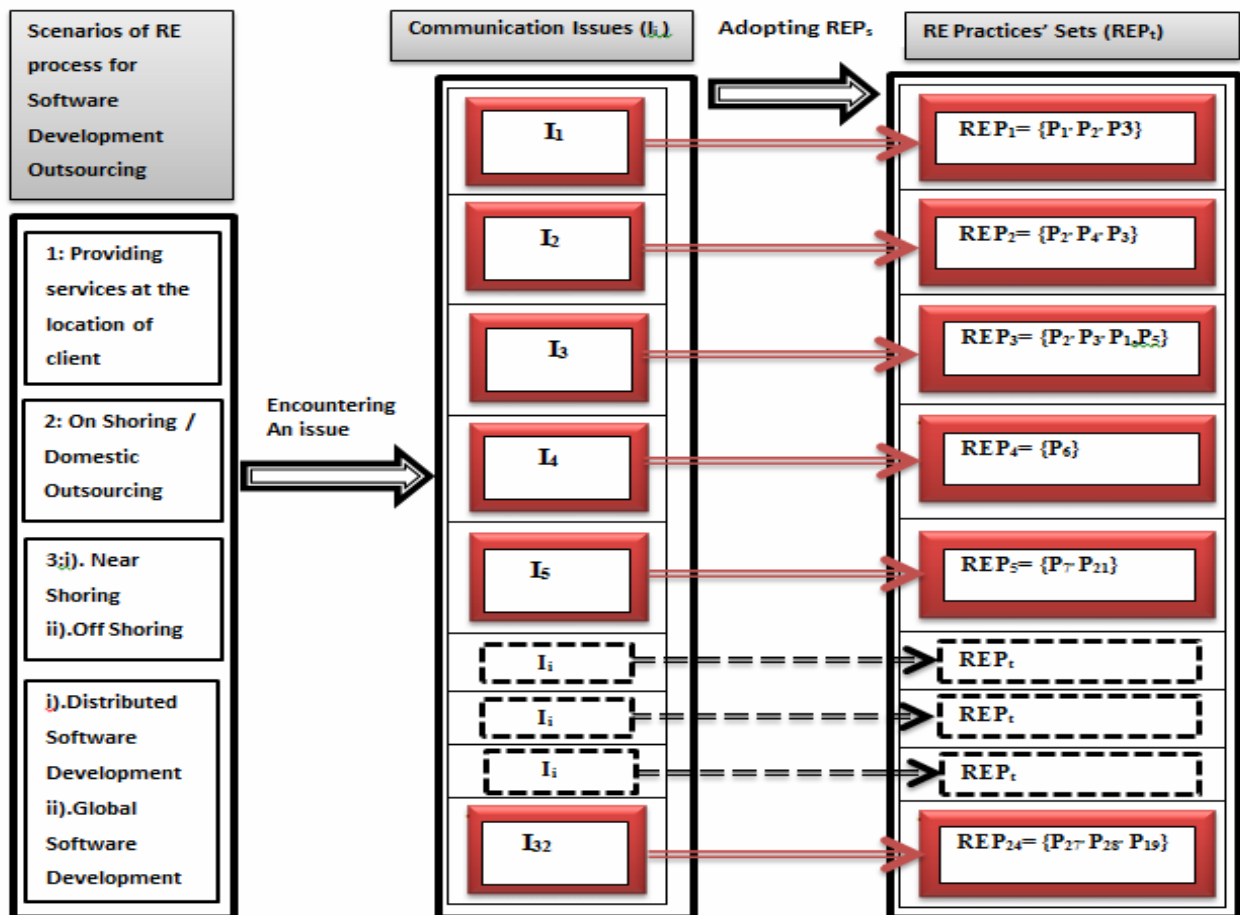


Figure 2. Framework to address communication issues of RE for SDO

### 5 Evaluation of the Framework

The framework has been evaluated from: (1) academic point of view, (2) SDO industry perspective.

#### 5.1 Evaluation through Academicians and Researchers

For evaluation through academicians and researchers, an online questionnaire survey has been conducted. Three experts having research and academics background with at least 10 years’ of experience have participated in the evaluation. The questionnaire contained 6 questions (Q1, Q2,..., Q6).

**The criteria for evaluation of framework from academicians and researchers.** The three criteria for evaluation of the framework from academicians and researchers are: (1) completeness, (2) applicability and (3) usefulness.

**Scale to rank.** A seven-point Likert scale has been used to rank the three given criteria:

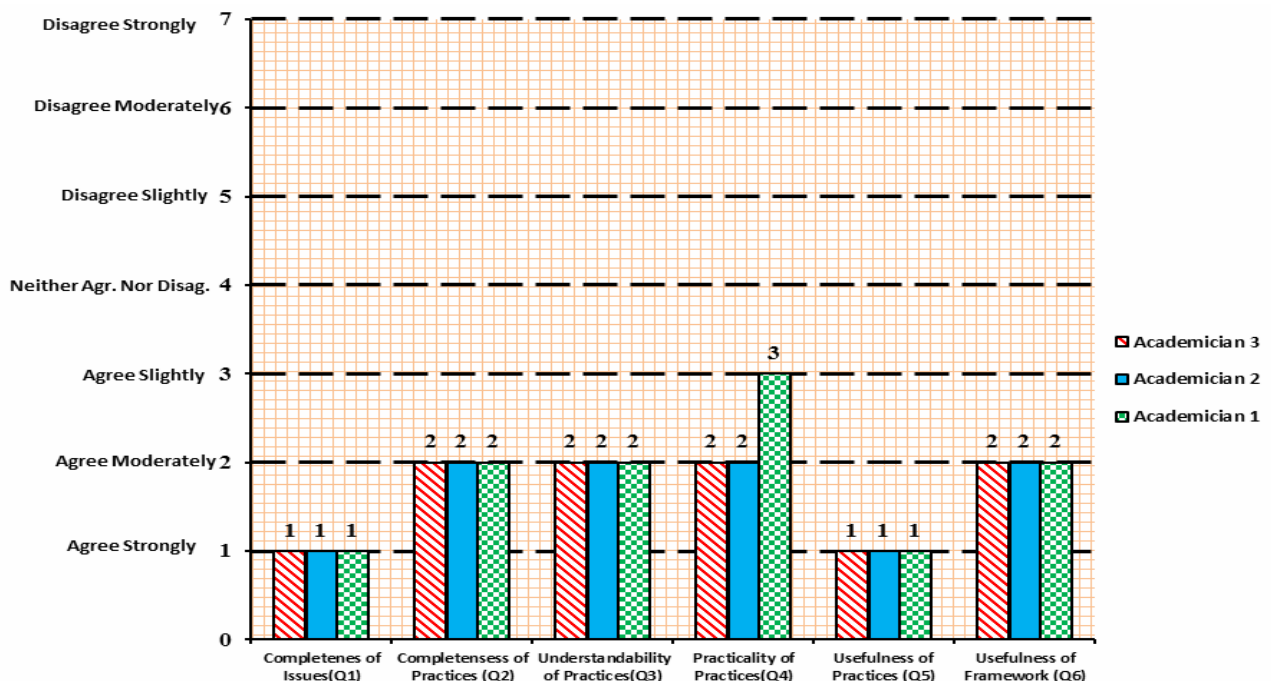
(1) Agree Strongly, (2) Agree Moderately, (3) Agree Slightly, (4) Neither Agree nor Disagree, (5) Disagree Slightly, (6) Disagree Moderately, (7) Disagree Strongly.

**Online survey responses.** Results of the online questionnaire survey have been presented in Table 2.

**Table 2.** Results of the online evaluation questionnaire survey with academicians and researchers

Criterion	Evaluation Focus	Expert 1	Expert 2	Expert 3
Completeness	communication issues (Q1)	1	1	1
	RE practices (Q2)	2	2	2
Applicability	RE practices description to understand(Q3)	2	2	2
	RE practices to adapt(Q4)	2	2	3
Usefulness	RE practices to address corresponding communication issues(Q5)	1	1	1
	Overall framework to support RE process(Q6)	2	2	2

Figure 3 shows evaluation results graphically. The X-axis shows “evaluation questions” and Y-axis represents “scale to rank” the responses of academicians and researchers. Through Q1 we have asked that is the given set of communication issues contains almost all the frequently occurring issues of RE process for SDO. Figure 3 exhibits that all the three experts, having academic and research background, “agree strongly” with the statement that given set of communication issues is complete. Through Q2 we have inquired that does each set of RE practices contains sufficient practices for addressing corresponding communication issues. This can be observed from the Figure 3 that experts “agree moderately” with the statement that each set of practices is complete. Q3 is about clarity and unambiguousness of recommended RE practices. Like Q2 again experts “agree moderately”.



**Figure 3.** Results of online questionnaire survey for evaluation from academicians and researchers



Q4 deals with the adaptability of recommended RE practices in different situations. Two experts “agree moderately” but one expert “agree slightly” that each set of RE practices is easy to adapt in the most of scenarios. This may be because of the fact that various organizations prefer to follow certain practices and do not utilize certain practices because of the organizational rules and structures. Through Q5 it has been inquired that whether in case of each communication issue, recommend set of RE practices is beneficial enough to address the corresponding issue or not. Experts “agree strongly” that endorsed sets of RE practices can address the corresponding issues. Q6 is regarding usefulness of the overall framework for addressing communication issues during RE process for SDO. This is evident from the Figure 3 that while agreeing moderately, experts are of the point of view that the proposed framework is useful for addressing communication issues of RE process for SDO and hence supports such process.

To analyze the level of consensus among the experts, Inter-Rater Reliability Analysis has been performed.

**Inter-rater reliability analysis.** To measure the degree of consensus among the three experts from academics and research background, Cohen’s kappa coefficient (k) has been calculated for each pair of experts. Kappa coefficient helps to measure the degree of agreement between evaluators [62-63]. Usually Kappa coefficient’s value greater than .60 is considered an acceptable degree of agreement between experts [64]. Table 3 shows kappa values for each pair of experts.

**Table 3.** Values of Cohen’s Kappa coefficient

Expert Pair	Kappa Value
Expert 1 vs. Expert 2	1.00
Expert 1 vs. Expert 3	.70
Expert 2 vs. Expert 3	.70

Table 3 shows that:

Value of Cohen’s Kappa coefficient in case of Expert 1 vs. Expert 2 is= 1.00

Value of Cohen’s Kappa coefficient in case of Expert 1 vs. Expert 3 is= .70

Value of Cohen’s Kappa coefficient in case of Expert 2 vs. Expert 3 is= .70

This confirms the “completeness”, “applicability”, and “usefulness” of the framework according to the perception of academicians and researchers.

## 5.2 Evaluation from SDO Industry Practitioners

The industrial evaluation of the framework has been carried out through a questionnaire based survey with 60 SDO industry practitioners having at least five years’ experience.

**The criterion for the evaluation of framework from SDO practitioners.** The criterion for the evaluation of the framework from industrial perspective is ‘usefulness of the recommended set of RE practices to address the corresponding communication issue of RE process for SDO’.

**Scale to Rank the “Usefulness of the recommended RE practices sets”.** In case of each SDO RE process communication issue, practitioners have been solicited to rank the matched set of RE practices according to perceived benefits of those practices to address corresponding issues. Perceived benefits have been divided into four categories of ranks [65-66]:

- High Perceived Benefits (H<sub>c</sub>, 4): An RE practice belonging to this category is compulsory and is almost always used.
- Medium Perceived Benefits (M<sub>c</sub>, 3): An RE practice from “medium perceived benefits” category is not compulsory but widely used.
- Low Perceived Benefits (L<sub>c</sub>, 2): “Low perceived benefits” category RE practice is utilized in case of some specific projects.
- Zero Perceived Benefits (Z<sub>c</sub>, 1): An RE practice from this category is never or hardly used.

If according to the perception of 50% or more practitioners, the benefits of RE practices’ sets belong to “high perceived benefits” and the “medium perceived benefits” categories then “degree of usefulness” of such RE practices’ sets will be considered satisfactory and such RE practices’ sets will be considered beneficial for addressing the corresponding SDO RE process communication issues. The 50% criterion has been successfully used in several studies [36, 66, 67].

To apply the 50% criterion, first we need to calculate the percentages of responses for “high perceived benefits” and “medium perceived benefits” categories in case of each issue. Prominence Level (PL) represents such percentages and is calculated as:

$$PL = [(H_c + M_c) / T] \times 100.$$

**Survey responses.** Table 4 shows responses. At least 50 value of PL proves that recommended set of RE practices is beneficial enough to address the corresponding communication issue. This can be observed from the Table 4 that in case of all the 32 issues (i = 32), the value of PL is more than 50. This reveals that all the RE Practices’ sets recommended for addressing corresponding communication issues are considered effective by the SDO industry practitioners.

**Table 4.** Results of evaluation questionnaire survey with SDO practitioners

Issues' IDs	RE Practices' Sets (REP <sub>t</sub> )	Assesses Ranks				PL
		H <sub>c</sub>	M <sub>c</sub>	L <sub>c</sub>	Z <sub>c</sub>	
I <sub>1</sub>	REP <sub>1</sub> ={P <sub>1</sub> , P <sub>2</sub> , P <sub>3</sub> }	30	20	10	0	83.33
I <sub>2</sub>	REP <sub>2</sub> ={P <sub>2</sub> , P <sub>4</sub> , P <sub>3</sub> }	25	27	08	0	86.67
I <sub>3</sub>	REP <sub>3</sub> ={P <sub>2</sub> , P <sub>3</sub> , P <sub>1</sub> , P <sub>5</sub> }	23	30	07	0	88.33
I <sub>4</sub>	REP <sub>4</sub> ={P <sub>6</sub> }	28	26	06	0	90.00
I <sub>5</sub>	REP <sub>5</sub> ={P <sub>7</sub> , P <sub>21</sub> }	33	21	06	0	90.00
I <sub>6</sub>	REP <sub>3</sub> ={P <sub>2</sub> , P <sub>3</sub> , P <sub>1</sub> , P <sub>5</sub> }	34	22	04	0	93.33
I <sub>7</sub>	REP <sub>6</sub> ={P <sub>8</sub> , P <sub>5</sub> }	33	24	03	0	95.00
I <sub>8</sub>	REP <sub>6</sub> ={P <sub>8</sub> , P <sub>5</sub> }	30	25	05	0	91.67
I <sub>9</sub>	REP <sub>7</sub> ={P <sub>5</sub> , P <sub>9</sub> , P <sub>10</sub> }	26	22	07	05	80.00
I <sub>10</sub>	REP <sub>6</sub> ={P <sub>8</sub> , P <sub>5</sub> }	34	24	02	0	96.67
I <sub>11</sub>	REP <sub>8</sub> ={P <sub>11</sub> }	35	25	0	0	100.0
I <sub>12</sub>	REP <sub>9</sub> ={P <sub>12</sub> , P <sub>13</sub> , P <sub>14</sub> , P <sub>5</sub> , P <sub>9</sub> }	25	26	09	0	85.00
I <sub>13</sub>	REP <sub>9</sub> ={P <sub>12</sub> , P <sub>13</sub> , P <sub>14</sub> , P <sub>5</sub> , P <sub>9</sub> }	26	23	11	0	81.67
I <sub>14</sub>	REP <sub>10</sub> ={P <sub>12</sub> , P <sub>9</sub> }	28	25	07	0	88.33
I <sub>15</sub>	REP <sub>11</sub> ={P <sub>12</sub> , P <sub>9</sub> , P <sub>14</sub> }	20	22	18	0	70.00
I <sub>16</sub>	REP <sub>12</sub> ={P <sub>12</sub> , P <sub>9</sub> , P <sub>14</sub> , P <sub>16</sub> }	21	23	16	0	73.33
I <sub>17</sub>	REP <sub>13</sub> ={P <sub>2</sub> , P <sub>3</sub> , P <sub>5</sub> , P <sub>9</sub> , P <sub>10</sub> }	23	27	10	0	83.33
I <sub>18</sub>	REP <sub>3</sub> ={P <sub>2</sub> , P <sub>3</sub> , P <sub>1</sub> , P <sub>5</sub> }	23	22	15	0	75.00
I <sub>19</sub>	REP <sub>14</sub> ={P <sub>16</sub> , P <sub>10</sub> , P <sub>17</sub> }	27	26	07	0	88.33
I <sub>20</sub>	REP <sub>15</sub> ={P <sub>18</sub> }	15	21	18	6	60.00
I <sub>21</sub>	REP <sub>16</sub> ={P <sub>27</sub> , P <sub>28</sub> , P <sub>10</sub> }	25	26	09	0	85.00
I <sub>22</sub>	REP <sub>17</sub> ={P <sub>9</sub> , P <sub>5</sub> }	21	21	18	0	70.00
I <sub>23</sub>	REP <sub>18</sub> ={P <sub>19</sub> }	33	24	03	0	95.00
I <sub>24</sub>	REP <sub>19</sub> ={P <sub>20</sub> }	21	24	15	0	75.00
I <sub>25</sub>	REP <sub>20</sub> ={P <sub>22</sub> , P <sub>23</sub> , P <sub>24</sub> , P <sub>15</sub> }	25	27	08	0	86.67
I <sub>26</sub>	REP <sub>21</sub> ={P <sub>22</sub> , P <sub>23</sub> , P <sub>24</sub> }	26	23	11	0	81.67
I <sub>27</sub>	REP <sub>21</sub> ={P <sub>22</sub> , P <sub>23</sub> , P <sub>24</sub> }	25	26	09	0	85.00
I <sub>28</sub>	REP <sub>22</sub> ={P <sub>25</sub> , P <sub>19</sub> }	30	20	10	0	83.33
I <sub>29</sub>	REP <sub>22</sub> ={P <sub>25</sub> , P <sub>19</sub> }	25	27	08	0	86.67
I <sub>30</sub>	REP <sub>23</sub> ={P <sub>26</sub> }	26	26	08	0	86.67
I <sub>31</sub>	REP <sub>21</sub> ={P <sub>22</sub> , P <sub>23</sub> , P <sub>24</sub> }	28	23	09	0	85.00
I <sub>32</sub>	REP <sub>24</sub> ={P <sub>27</sub> , P <sub>28</sub> , P <sub>19</sub> }	30	23	07	0	83.33

Table 4 shows 24 sets of RE Practices represented by REP<sub>t</sub> (t = 1, 2... 24); the frequencies of different ranks denoted by H<sub>c</sub>, M<sub>c</sub>, L<sub>c</sub> and Z<sub>c</sub> (c = 1, 2... 32) for high, medium, low and zero perceived benefits respectively.

Whereas  $\forall REP_t$

$$\sum_{c=1}^i (H_c + M_c + L_c + Z_c) = T$$

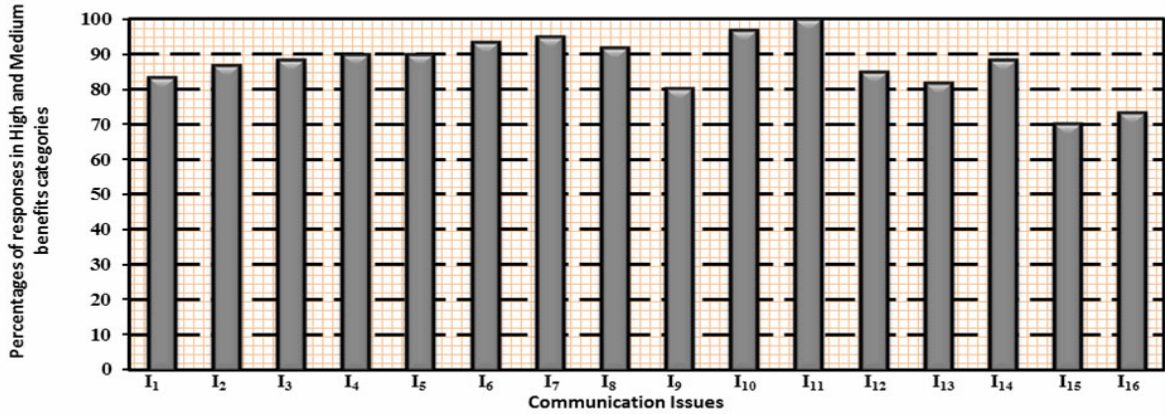
And also  $0 \leq \sum_{c=1}^i (H_c \vee M_c \vee L_c \vee Z_c) \leq (i \times T)$

Section 5.1 and Section 5.2 complete answer to RQ4.

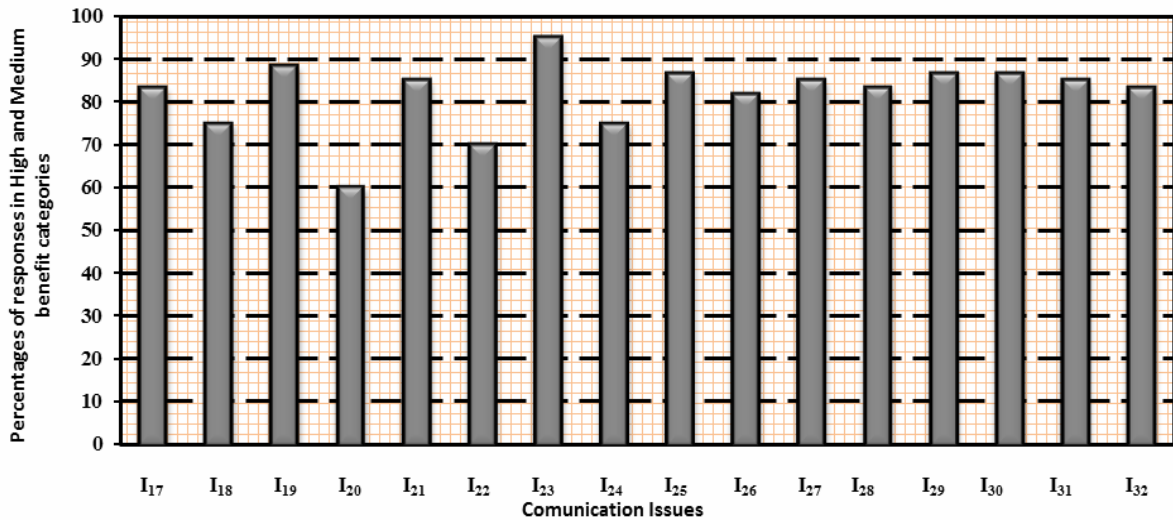
Figure 4 and Figure 5 show results of evaluation from SDO practitioners. Figure 4 shows practitioners' responses for issues from I<sub>1</sub> to I<sub>16</sub> whereas Figure 5 shows results for issues from I<sub>17</sub> to I<sub>32</sub>.

This is evident from the Figure 4 that in case of sets of RE practices recommended for issues I<sub>1</sub> to I<sub>16</sub>, percentages of responses in high and medium benefits' categories are greater than 50%. This proves that these sets of RE practices are useful for addressing corresponding communication issues of RE process for SDO.

Figure 5 shows that in case of sets of RE practices recommended for issues I<sub>17</sub> to I<sub>32</sub>, percentages of responses in high and medium benefits' categories are greater than 50%. This proves that these sets of RE practices are useful for addressing corresponding communication issues of RE process for SDO.



**Figure 4.** Percentages of responses in high and medium perceived benefits categories for RE practices sets in case of issues I<sub>1</sub> to I<sub>16</sub>



**Figure 5.** Percentages of responses in high and medium perceived benefits categories for RE practices sets in case of issues I<sub>17</sub> to I<sub>32</sub>

## 6 Results and Discussions

We have identified 27 SDO RE process communication issues and 24 relevant RE practices to address those issues through an extensive literature review. We have also conducted a questionnaire-based survey to find out the communication issues faced by SDO industry practitioners and relevant RE practices they recommend to address those issues. We have been successful in exploring 5 issues and 4 related RE practices to handle those issues.

The identified issues and relevant RE practices, mapped out after analysis of results, have been presented in the form of a framework in Table 1. Part-I shows SDO RE process communication issues identified from the literature and relevant RE practices to address those issues. In the part-II, we have described the SDO RE related communication issues obtained through SDO industry survey and appropriate RE practices to handle those issues.

Literature supports face to face communication of

stakeholders where possible to avoid the misunderstandings, device solution of conflicts and develop trust among them. Conflict resolution is very important for satisfying customer needs and developing the right product in time, and so is to maintain trust among teams for smooth working. Therefore, many possible ways have been suggested in literature to catch up the stakeholders i.e. travel to meet the team members face to face in distributed team settings [45] and arranging start-up meetings at the beginning of the project to get the stakeholders introduced with each other [19].

To overcome the communication issues created because of distance (I<sub>13</sub>, I<sub>14</sub>, I<sub>15</sub>, I<sub>16</sub>, I<sub>17</sub>), several practices have been recommended like establishing ‘proximity development center’ in the region having no or a little time zone difference from the region of client (P<sub>12</sub>), utilizing natural overlapping of working hours if possible (P<sub>13</sub>), assessing ‘around-the-clock’ capability of working (P<sub>14</sub>) and video conferencing or teleconferencing (P<sub>9</sub>). This would help the SDO teams to overthrow their RE problems and to resolve them

without any organizational or reputational constraints. However, sometimes video conferencing is not productive (I<sub>2</sub>). In such situation, synchronous communication should be supported by asynchronous communication (mixed media) in order to provide time for information processing and sifting through the issues which help to resolve outstanding issues and building common grounds (P<sub>4</sub>).

Albeit, face to face meetings are highly endorsed in literature (e.g. [19, 45]) to resolve conflicts and uproot misunderstandings among SDO teams, but entail high cost and greater expenditure (I<sub>6</sub>). To cut the cost down and manage the project budget, computer mediated requirements workshops can be held by using commercially available tools that support instant messaging, discussion boards etc. (P<sub>7</sub>, P<sub>21</sub>). In addition, language issues can be resolved by use of tools equipped with translation, grammar and spell checking to avoid confusions and misunderstandings (P<sub>18</sub>). Further steps to deal with language issues are deciding standard language for communication (P<sub>22</sub>), helping employees in improving the communication language (P<sub>23</sub>), appointing cultural liaisons (P<sub>24</sub>) and developing common glossary (P<sub>15</sub>).

The SDO industry practitioners reported on the issues like lack of communication with stakeholders, unavailability of infrastructure to communicate with the distributed stakeholders frequently, language barriers among stakeholders from different cultures and 'free-style' communication (I<sub>28</sub>, I<sub>29</sub>, I<sub>30</sub>, I<sub>31</sub>, I<sub>32</sub>). To counter these issues and to facilitate the practitioners with frequent communication across the continents, proper infrastructure should be established (i.e. online forums, interactive communication enabling work areas etc.) and assured that it works properly [68]. Role of every team member should be well defined (P<sub>27</sub>) and every team member should play only the defined role (P<sub>28</sub>) to safeguard proper communication and to evade miscommunication or over communication. Furthermore, analysts should be encouraged to meet relevant stakeholders to resolve the RE issues. Such meetings should be recorded (P<sub>25</sub>). In addition, communication liaisons can be appointed (P<sub>19</sub>) to avoid unnecessary communication among stakeholders.

Summarizing the above discussion we can say that face to face meetings, computer mediated communication (e.g. video conferencing, large interactive touch screens, video chat tools etc.) and informal communication are the possible ways to resolve challenges like creating and maintaining trust, misunderstandings and conflicts' resolutions among geographically apart teams. The usage of online cross-collaboration social networks and forums can enhance the rapport among teams and thus can help to reduce conflicts. Language issues can be resolved by making use of the commercially available linguistic tools. Moreover, teams should be supported to come close to each other to establish better relationship and trust for

frequent and informal information exchange [69].

## 7 Conclusions

While conducting RE activities in the case of SDO projects, communication among the stakeholders is of the foremost importance. Many outsourced projects fail due to improper communication or miscommunication among teams, and misinterpretation of requirements. This shows that resolving the communication issues of RE process in the case of SDO is critical for successful project completion. Therefore, this research was aimed to identify the SDO RE process communication issues from literature and industry, and to map identified issues with the relevant RE practices to resolve those issues.

Based on the results retrieved from literature review, industrial survey and semi-structured interviews of SDO industry practitioners, a framework has been proposed that provides a comprehensive list of SDO RE process communication issues and relevant RE practices to address those issues. The framework has been evaluated by: (1) Involving 3 experts from academic and research background through an online questionnaire survey, (2) Analyzing responses from 60 SDO industry practitioners obtained by conducting a questionnaire survey. The evaluation results exhibit that framework is "complete", "applicable" and "useful" to address the communication issues of SDO RE process.

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