AN EXPLORATORY STUDY OF COMMUNICATION AND COORDINATION CHALLENGES IN OFFSHORE SOFTWARE DEVELOPMENT OUTSOURCING: RESULTS OF SYSTEMATIC LITERATURE REVIEW AND EMPIRICAL STUDY

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ABSTRACT: *Offshore Software Development Outsourcing (OSDO) is the rising business paradigm for Global Software Development. OSDO principals (clients) hire external offshore organizations (vendors) to develop components-of or complete software products based on an outsourcing contract. This paper reports communication and coordination challenges faced by OSDO vendors. A systematic literature review (SLR) identified18 challenges cited in 101 relevant articles. In addition, forty-two experts from six continents responded to a questionnaire survey distributed to outsourcing industry companies (vendors) to validate SLR findings. The authors analyzed the cited challenges with respect to variables such as company size, continental location, study strategies, company type and levels of expert experience. We identified cultural differences, geographic dispersion, lack of face-to-face meetings, lack of ICT/technological cohesion and lack of credibility as significant challenges facing OSDO vendors. These challenges can negatively affect communication and coordination related processes in OSDO relationships. Their validated identification should prove useful to all vendors who seek remedy.*

KEYWORDS: Offshore Software Development Outsourcing, Systematic Literature Review, Empirical study, Challenges

1.0 INTRODUCTION

Recent decades have affected outsourcing business models in an evolving globalized market that seeks cost reduction, productivity increases and competitive advantages. Those engaged in software development are no strangers to the phenomenon and have adapted the distribution of software development to teams that are scattered around the world. Global Software Development (GSD) [1, 2] is an extremely dynamic environment that bears significant impacts on successful project outcomes where in top outsourcing locations are selected to develop competitive products [2]. GSD brought revolutionary changes to conventional software development practices with a forced entry into a new era dominated by smart handheld devices including iOS and android operating systems, mobile applications, games and social networking applications. Hence, associations, meanings and utilitarian software building blocks as well as operating and computer systems have been completely changed as state-of-the-art tools and technologies became available. Software development has accelerated as never before and the market is inundated with innumerable software applications. Under such circumstances, traditional approaches to software development have failed to meet requirements demanded by contemporary IT trends. Consequently, responsive practices designed for innovative software development rapidly replaced traditional approaches to software development [3]. Legacy designs for such agile processes have suitably modified traditional approaches to meet contemporary trends in software development [3]. Agile Software Development benefits GSD by emphasizing customer collaboration, individual interactions, continuous gathering of requirements and the delivery of software on time and within budget constraints, etc. [3]. GSD is rapidly gaining repute due to a number of advantages offered to both clients and vendors. These include geographic proximity to the consumer, competitive advantages, access to global resource pools, and new market opportunities for vendors [4].

GSD offers benefits to onshore organizations as it allows greater access to local knowledge and qualified skilled human resources at lower costs, as well as to new markets while also facilitating flexible responses to diverse local opportunities [4]. Major reasons behind GSD's remarkable growth include the immediate availability of state-of-the-art Information and Communication Technologies (ICTs), round the clock development possibilities, and access to highly qualified skilled persons who produce quality software at low cost [2, 5, 6]. In addition, India and China have made GSD a reality by providing accessibility to assets and skills by value-added big businesses with money making experience and highly qualified professionals [7]. As the world shrinks to a global village, software development processes enjoy cooperation from multiple globalized teams that boast unique capabilities and skills [7].

Conversely, a large body of research [8-11] suggests the expanded globalization of software development produced specific challenges due to cultural and time zone disparities, a lack of trust, language differences, and geographic distance as well as dissimilarities in communication and coordination processes. Geographical distance appears to be the foremost stumbling block to GSD [11]. Communication and coordination processes are the pillars and backbone of successful GSD outcomes but realization is often impeded by language, cultural and geographical disparities [12]. GSD processes also suffer from a lack of face-to-face meetings [13]. Particularly, GSD typically involves stakeholders from different time zones, locations, national and organizational cultures who sometimes use different technologies for collaboration. These temporal, geographic and socio-cultural differences can cause substantial communication, coordination and management challenges that require remedies to fully realize GSD benefits and potential [14]. Khan and Azeem [15] identified 'cultural differences' as a critical challenge that negatively affected OSDO processes. Similarly, 'knowledge sharing management' is an important GSD factor that negatively affects outcomes for want of

synchronous communication due to geographical barriers and the ambiguous nature of knowledge [16]. Verner et al. [11] conducted a tertiary study that revealed numerous challenges such as engineering issues, coordination, risk control, software component integration, cultural differences, issues regarding the selection of an appropriate vendor, communication, collaboration, planning, software development processes, configuration management, training, and architectural design.

2.0 BACKGROUND

2.1 Software Development Outsourcing

Software outsourcing is a common business practice and although outsourcing can simply mean asking somebody outside of the company to perform a task, it typically means shipping the work offshore [10, 17, 18].

2.2 Types of software development outsourcing

Software outsourcing is broadly categorized into three types based on geographic location: onshore, near-shore and offshore [18].

2.2.1 Onshore Outsourcing

Onshore outsourcing (domestic outsourcing)[19] refers to contracts where vendor and client organizations reside in the same country and make use of a domestic IT company for IT enabled products, services, operations and support [20, 21]. Such arrangements reduce the need for internal IT infrastructure, support staff and associated costs [20, 21].

2.2.2 Nearshore Outsourcing

Nearshore outsourcing (nearshoring) is defined as the transfer of software development work to a nearby foreign country to exploit lower labor costs [22]. The term 'nearshore' was first introduced by an entrepreneurial software development venture called PRT, that operated in the Caribbean island of Barbados from 1995 to 1998 [23]. The word 'near' referred to geographic closeness to the USA, while 'far' for example, referred to the distance between client firms in Americaand Indian vendors. Other examples of nearshoring for USA outsourcers (clients) include Canada and Mexico [24]. Stetten et al. [22] compared nearshore to offshore outsourcing on the basis of geographic distance, cultural and time-zone differences, as well as language barriers and travel/transportation costs. They argued that differences between client and vendor were comparatively low in cases of nearshore outsourcing but high in offshore outsourcing [22]. Similarly, language barriers and costs for travel/transportation are comparatively low in nearshore outsourcing [22].

2.2.3 Offshore Outsourcing

Offshore outsourcing refers to contracts between a client and a geographically distant vendor [25]. Many software development companies competed over the last two decades to improve profit margins by (i) improving product-time-to-market outcomes; (ii) hiring software experts living in countries with lower labor costs; (iii)and defying the 'clock' by running projects 24 hours a day. As a result, a large number of software development projects were/are performed under a network of global distribution at many different sites located in several countries. This distributed management approach is called Global Software Development (GSD) or Global Software Engineering (GSE) [26]. Offshore Software Development Outsourcing (OSDO) (i.e., offshore outsourcing) is an important paradigm within GSE for the development of high quality but less expensive software by personnel in low-wage/overhead countries [12]. India, Ireland, China and Russia are major vendor countries while the US, UK, Australia and Japan are leading client countries [27]. India has the largest vendor-market share, followed by China [28]. Researchers also predict that China will overtake India within the next decade [28, 29].

Effective Global Software Engineering (GSE) gained its competitive advantage during the last two decades. Global Software Development (GSD) presents a highly dynamic and competitive environment that selects optimal locations for outsourcing operations with significant long term impacts [12]. As an industry, software outsourcing has grown steadily with an 18-fold increase in IT-enabled business processes in two decades [30]. An important aspect of IT outsourcing is the tendering of software development projects to offshore locations. Client organizations are presently outsourcing more software development [31] as OSDO gains ground for a number of reasons. The primary reason is cost advantage [32]. Intense growth in the ICT industry along with increased demand by clients and Information System professionals in the US and Western Europe have made outsourcing extremely attractive [32]. Moreover, the presence of highly qualified educated personnel and resource availability in the improved business and economic environments of both China and India has made OSDO the real and present reality [7, 32]. Here are the top ten reasons why companies/organizations use software outsourcing [19, 27, 33, 34]:

- Reduce and control operating costs;
- These specific functions are difficult to manage or out of control;
- Acceleration of re-engineering activities;
- The exploitation of offshore capabilities;
- Improve a company's focus;
- To free-up resources for other purposes;
- Reduce time to market;
- Gain access to world-class talent;
- Risk sharing;
- Resources not available internally.

In both the UK and USA, many firms outsource software development projects offshore to quickly access better quality IT services at relatively lower costs [35]. Darga Smite et al. [36] conducted a SLR that suggested OSDO activities most frequently involved the US, UK, India, Germany and China and that the outsourcing vendor country of choice was India [36]. However, since Shanghai's development of China's Silicon Valley in the 1990s, China has gained a greater market share of the outsourcing industry [37].

2.3 Challenges in OSDO

Apart from the numerous benefits cited above, OSDO poses a number of risks and challenges. These include vendor selection; engineering requirements; software developmental process management of architectural design and configuration; cultural and social integration factors that affect training, communications and team collaboration; as well as planning, coordination and overall control [11]. Compared to onshore and nearshore outsourcing, OSDO generally presents more challenges because of the geographic

distance between client and vendor. This increased distance complicates communication as well as project coordination and collaboration due to differences in culture, languages, time zones and knowledge management approaches [8]. Widely distributed environments invite high organizational complexity with respect to scheduling, task assignment and cost estimations that arise as a result of volatile project requirements involving ongoing changes in specifications, especially when time, distance and cultural barriers increase the vacuum created by a lack of informal communications [38]. Khan et al. [39] identified a number of problem areas faced by OSDO vendors and identified a number of communication and coordination challenges that are critical to the client-vendor relationship. It is argued that vendors need to address these challenges with mitigating interventions that will yield successful outcomes for outsourced projects. The present research explores this area with an intensive effort to specifically identify significant risks factors that negatively affect OSDO communications and coordination efforts and also by classifying the most appropriate mitigating practices for vendor implementation.

2.4 Existing Work on Communication and Coordination Challenges in OSDO

2.4.1 Communication

Communication in the OSDO context can be defined as an activity performed for the transfer of information between client and vendor organizations. Communication is the manner by which people use words to request, declare, promise or simply transfer messages from one place to another [40]. The literature reveals the types of communication that may occur at any time in OSDO relationship [40].

i. Verbal or Spoken Communication: telephone, radio, face-to-face, television or other media.
ii. Non-Verbal Communication: gestures, how we dress or act, employ body language and even our scent.
iii. Written Communication: books, letters, magazines, e-mails via the Internet or other media.
iv. Visualizations: graphs, charts, maps, logos and other visualizations can communicate information.

2.4.2 Coordination

Coordinating OSDO contractual relationships refers to the integration of different activities to achieve an organization's objectives [40]. This project management process synchronizes an organization's approach to different fundamental activities within a complex body that enables a collective's coordinated effort to successfully produce a desired outcome [41]. Project coordination is vital to software project management [41]. Hence, communication and project coordination activities need to be carefully addressed and it is here that the relevant literature sheds light as discussed below.

Communication and project coordination are the two major pillars that support successful OSDO relationships [42]. A lack of communication and/or effective project coordination unfavorably challenges any outsourced project [43] and when not addressed in time can lead to project failure. The major reason for such problematic occurrences is the geographical separation between client and vendor. Nonetheless, effective OSDO relationships thrive when communication and project coordination processes are optimized.

Poor communication and ineffective project coordination are major challenges to distributed software development [44] that often cause project failures [41]. As such, time zone and cultural differences appear to be the most significant communication challenges that negatively affect project coordination [45]**.** According to Niazi et al. [46], outsourcing projects with closer geographic and time zone proximity allow for more communications compared to projects assigned to vendors at a greater distance and disparate time zone. They reported that greater geographic dispersion and time zone disparity in distributed projects hamper communication and project coordination. Language differences also complicate OSDO communication and coordination [47, 48]. Language barriers can prevent the implementation of new processes throughout an enterprise and also constrain necessary feedback between diverse departmental agents. As such, language differences negatively affect the achievement of team goals and objectives while also aggravating extant problems in business operations by hindering effective team/project-leader cohesion [48]. Khan and Azeem [15] identified various intercultural challenges faced by vendors in OSDO relationships and argued that cultural differences also negatively impact communication and thus impede collaboration and coordination processes between clients and vendors [15, 49].

GSD's high degree of popularity is largely due to tremendous growth in Information Communication Technology (ICT), although high costs and a lack ICT technology can hamper communication and coordination processes in offshore software outsourcing [11, 50]. Trust is another basic factor that affects software outsourcing relationships [51]. Achieving and preserving trust in OSDO projects is a particularly important element, especially for dispersed team members that are also culturally and temporally distant [14, 52]. OSDO communication and project coordination processes also suffer a lack of informal face-to-face contacts [53, 54] that multiply challenges to outsourcing organizations. The lack of casual fraternization can distort communications by a lack of confidentiality and even healthy resistance (criticism) that then allows the transmission of incomplete/incorrect data with un-cooperative social overtones resulting in rumors, misunderstandings, mistakes and management difficulties— all of which lead to a loss of control and project failure[55].

The cited shortcomings due to the lack of informal communications require a careful management approach wreathed in caution. As a team's size grows larger, products become more complicated, which can then inhibit the process of project coordination and spoil the desired outcome [52, 56]. Hence, distributed teams that lack informal communication venues and team coordination also suffer a lack of team cohesion [57]. Milla and Nazmun [57] identified poor communications, cultural differences, egocentrism, language differences and a lack of leadership as major factors causing poor team cohesion.

Mismanagement of knowledge sharing and structural organizational differences can also impede communication and coordination processes and thus present critical challenges to successful OSDO client-vendor relationships [58-60]. As geographical and time zone differences increase, coordination costs and project complexity autonomously increase and negatively impact all OSDO activities [61]. Sami-Ul-Haq et al. [62] proposed that the most critical challenges in GSD are communication, project coordination and trust development. They proposed that the source of these problems included the following: differences in time zones and culture; process and management issues; ICT infrastructure incompatibility; organizational differences, and disparities over product architectural development.

Persson and Mathiassen [63] argued that lofty task of coupling project segments increased the need for inter-site communications as well as for project coordination and team/process integration. Furthermore, they reported that without careful attention to such inter-site collaboration the number of project failures increased as performance levels plummeted. Ali-Babar et al. [64] conducted a systematic literature review and found that poor communication bandwidth also negatively affected inter-site communiqués and the overall knowledge management processes.

2.5 Research Gaps and Motivation

Our study focused on identifying communication and coordination challenges through a systematic literature review (SLR) and an empirical survey of industry experts. Our SLR revealed no studies on such an approach; hence, this effort represents a *de novo* study to the best of our knowledge and is expected to contribute new knowledge to OSDO literature and industry. We are motivated to provide feedback to OSDO vendor organizations so they might be better enabled to handle the communication and coordination challenges that confront them by improving their readiness. OSDO client organizations will also benefit from this effort by its identification of various communication and coordination challenges. This paper is also an extension of previous efforts [3, 42] and focuses on a need to gain an in-depth understanding of communication and coordination challenges faced by OSDO vendor organizations.

2.6 Research Questions

The following research questions (RQs) guided our efforts:

RQ1. What communication and coordination challenges, as identified in the literature, confront OSDO vendors?

RQ2. What communication and coordination challenges do OSDO vendors confront in the real world?

RQ3. In your opinion, what challenges present significant discrepancies between OSDO literature and industry experience?

RQ4. Do these challenges manifest significant differences in impacts based on company size with respect to OSDO literature reports and industry experience?

RQ5. Do challenges identified in the literature vary from continent to continent?

RQ6. Do challenges identified in the literature vary based on reported strategies?

RQ7. Do challenges identified by empirical study vary based on levels of expert experience?

RQ8. Do challenges identified by empirical study vary based on company type?

We have published findings for RQ1 and RQ2 [12, 65]. The present work attempts a comparative analysis of various communication and coordination challenges faced by OSDO vendors. This paper's novelty is that no prior research has explored a comparative analysis of effects from different variables on OSDO challenges such as continental location, company size and type, study strategy or levels of expert experience.

3.0 RESEARCH METHODOLOGY

We employed a systematic literature review (SLR) as well as a survey questionnaire with purposes and methodologies as discussed below.

3.1 Data Collection and Analysis

Data analysis processes hugely influence data collection methods. For this reason, data collection methods require circumspect review and selection. We used both SLR and a survey questionnaire to gather data. Both procedures were preferred and coordinated in anticipation of the variety and nature of outcome data for analyses. Hence, we collected two types of data. Initially, we used the SLR process to identify communication and coordination challenges faced by OSDO vendors. We then distributed a survey questionnaire to outsourcing industry experts in an attempt to validate SLR findings and also to discover unidentified challenges.

3.1.1 Systematic Literature Review (SLR)

We took the SLR methodological approach to find communication and coordination challenges faced by OSDO vendors [66]. The SLR method helps researchers unearth relevant data by focusing on research questions [66]. We successfully used this method in previous studies [12, 67-72]. To explain the study's strategy, we transcribed an SLR plan in protocol format [73]. Kitchenham and others [5, 66, 74] classified the three major SLR phases as planning, conducting and reporting.

3.1.2 Empirical Study

We also distributed a survey questionnaire to forty-two outsourcing experts in an effort to validate our SLR findings. The empirical survey method assigns a numeric description to a sample in an effort to attain implicit information regarding an exacting event or curious dilemma; thus, the empirical survey is extensively employed to collect relevant data [14, 75]. Other researchers have used comparable techniques [16, 76, 77]. Details regarding design, sampling, survey instruments, execution and validity are discussed in a previous paper [65]. Generally, these findings highlighted our SLR findings [12] and no main divergence between SLR and empirical results was observed [65]. Nonetheless, surveys can also serve to fill in gaps between OSDO industry participants and academics.

4.0 RESULTS

4.1 Crossways Comparison of Communication and Coordination Challenges faced by OSDO vendors: two data sets (SLR vs. Survey Questionnaire)

We validated OSDO vendor challenges discovered via SLR with a survey questionnaire follow up and then undertook comparative analysis of both outcome data sets. This analysis predictably leaned towards radiating extant similarities and disparities between SLR and survey outcomes (See: Table 1).

Table 1 Comparison of all communication and coordination challenges identified via SLR and Survey

#	Communication and Coordination Challenges in OSDO	Occurrences in SLR (N=101)		Positive Agree % in the Questionnaire Survey (N=42)		d	d^2
		%	Rank	%	Rank		
1	Geographical Dispersion	80	1	98	1.5	-0.5	0.25
2	Cultural Differences	75	2	98	1.5	0.5	0.25
3	Language Differences	60	3	88	4.5	-1.5	2.25
4	Lack of ICT/Technological Cohesion	53	4	78	13	-9	81
5	Lack of Informal/Face-to-Face Communication	46	5	88	4.5	0.5	0.25
6	Lack of Credence	40	6	71	16.5	-10	100
7	Lack of Training in Communication and Collaboration Tools	27	7	79	12	-5	25
8	Lack of Team Cohesion	23	8	80	11	-3	9
9	Incongruity in Infrastructure, Processes and Goals	22	9	88	4.5	4.5	20.25
10	Lack of Knowledge Management and Transfer among Teams	20	10	88	4.5	5.5	30.25
11	Lack of Change Management Activities	14	11	73	15.5	-4.5	20.25
12	Increased Coordination Cost	13	12	85	9	3	9
13	Lack of Frequent Feedback	12	13.5	76	14	-0.5	0.25
14	Legal, Political and Intellectual Property Rights Issues	12	13.5	73	15.5	-2	4
15	Haziness	6	15.5	93	3	12.5	156.25
16	Lack of Common Understanding of Requirements	6	15.5	93	8	12.5	56.25
17	Inappropriate Task Coupling	6	15.5	86	10	7.5	30.25
18	Lack of Antagonism Management Activities	3	18	71	16.5	1.5	2.25
n=18							$\sum d^2 = 547$

Spearman rank correlation = (R) $= 1 - \frac{6 \sum d^2}{n^3 - n}$ Equation (1)

$= 1 - \frac{6 \times 547}{5814}$

$= 1 - 0.56$

$= 0.44$

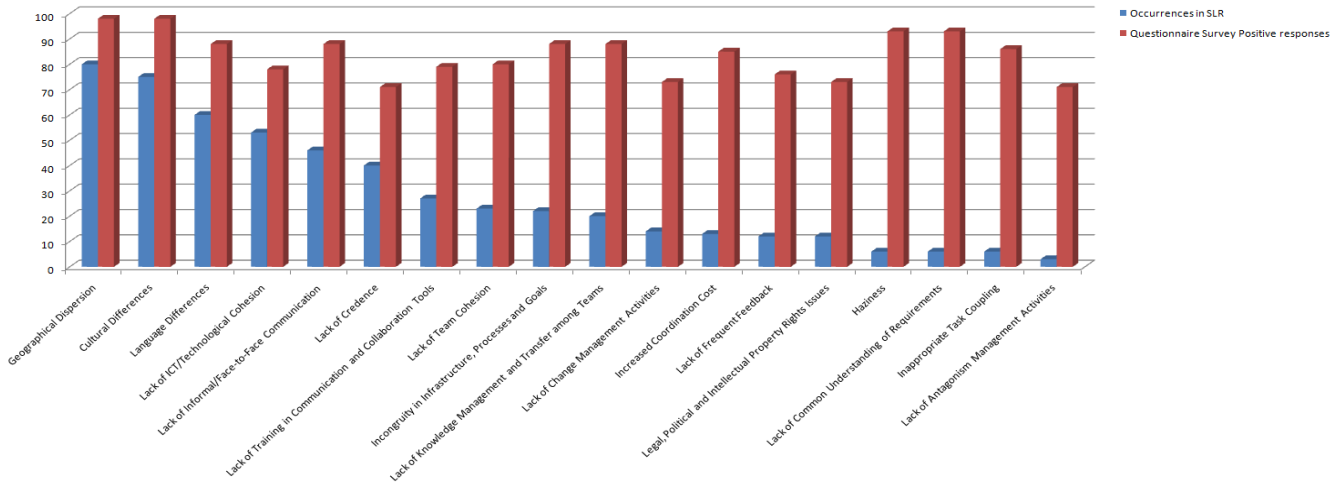

Figure 1 Graphical representation of all communication and coordination challenges identified via SLR and Survey

Table 1 presents bare SLR findings minus any classification assignments. However, we assigned values to survey data as positive (slightly agree / moderately agree / extremely agree), negative (slightly disagree / moderately disagree / extremely disagree), or neutral (neither positive nor negative).

Table 1 presents a comparative analysis of both data sets using only positive values from the survey questionnaire. Lowest ranks were assigned to highest values. Whenever similar values occurred, we assigned an average rank and then approximated the value of the next rank. Both result sets had low responses for 'frequent feedback' and 'legal, political and intellectual property rights' issues. Thus, they shared ranks 13 and 14 and were assigned an average rank of 13.5. Subsequent challenges received a rank of 15.5 since 13 and 14 had been used. We also placed open-ended questions in the survey to obtain tacit knowledge on cited challenges and possibly discover un-cited challenges. However, we did not identify any un-cited challenge. For this reason, Table 1 shows little variance between both data sets and also demonstrates that none of the cited challenges bore zero frequency in our survey results.

We further noted that rankings for cited challenges across both data sets were not exactly similar. For example,

the 'lack of ICT/Technological cohesion' obtained '4' in the SLR data set but '13' in the empirical data set. We use Equation (1), the Spearman Rank Correlation test (formula), and identified a value of R = 0.44, reflecting the frequency of a challenge's reference in the SLR correlation with its citation frequency among survey participants. This allows a relative appraisal for the similarity of importance for each SLR challenge compared to survey results. In answer to RQ3, Table 1 shows that both SLR and survey outcomes share more similarities than differences. Table 1 therefore allows us to present a total of 18 challenges as cited in both data sets.

We also plot the comparison of all communication and coordination challenges identified via SLR and Survey in Figure 1. It can be seen that, for each challenge, the positive responses of questionnaire survey are maximum then SLR occurrences. We conclude that the first four challenges have high than 50% occurrences in SLR articles, whereas all challenge reported by questionnaire survey has more than 70% occurrences. The cultural differences challenge has maximum occurrence of 80% in the SLR results. Overall, we analyze that in the real industry, with comparison of literature review results, all the challenges have importance for the OSDO vendor organizations.

4.2 Comparison of Communication and Coordination Challenges faced by OSDO Vendors Related to Company Size (SLR vs. Survey)

Our SLR identified challenges were taken from a rigorously selected sample of 101 articles. Our validating survey of the outsourcing industry returned forty-two expert respondents from six different countries. We followed the definition of the Australian Bureau of Statistics [78] for the classification of company size which states that a company with ≤19 employees is SMALL; a company with>19 but <199 employees is MEDIUM; and a company with 200-plus employees is LARGE. Our SLR findings were taken from 30 *Small*, 25 *Medium* and 46 *Large* companies, whereas survey results were taken from 9 *Small*, 26 *Medium* and 7 *Large* companies (See: Table 2).

In Table 2, 'A' represents the occurrence of a literature-cited challenge and the rate with which survey participants 'strongly agreed' with the challenge's positive influence on OSDO relationships. Our analysis indicated that *large* companies would do well to focus on 'geographical dispersion', 'haziness' and 'cultural differences' to better sustain client relations. Cristina et al. [79] conducted an empirical study in a large IT multinational with offices spread worldwide, having development teams in US, Brazil and India. The authors argued the company had unsolved issues of 'time zone' and 'geographical differences'. Casey and Richardson [80] reported that communication and coordination activities in the GSD environment significantly suffer from geographical distance. Neeraj Parolia *et al*. [81] conducted a survey of IS project

Table 2 Comparison of all communication and coordination challenges identified via SLR and Survey based on company size

#	Communication and Coordination Challenges in OSDO	Occurrences in SLR (N=101)						Positive Agree % in the Questionnaire Survey (N=42)					
		Small (N=30)		Medium (N=25)		Large (N=46)		Small (N=9)		Medium (N=26)		Large (N=7)	
		A	Rank	A	Rank	A	Rank	A	Rank	A	Rank	A	Rank
1	Cultural Differences	21	1	20	1.5	30	2	8	4.5	26	1	7	4.5
2	Geographical Dispersion	18	3.5	20	1.5	37	1	8	4.5	25	2.5	7	4.5
3	Haziness	3	15	1	17.5	28	3	8	4.5	4	18	7	4.5
4	Increased Coordination Cost	5	10.5	2	14.5	4	15.5	9	1.5	22	6.5	6	9.5
5	Incongruity in Infrastructure, Processes and Goals	8	9	7	8.5	9	10.5	7	10.5	25	2.5	4	17.5
6	Inappropriate Task Coupling	2	16.5	2	14.5	2	17	8	4.5	23	4.5	5	15.5
7	Language Differences	16	6	20	1.5	19	6	8	4.5	23	4.5	7	4.5
8	Lack of Team Cohesion	5	10.5	7	8.5	16	7	8	4.5	22	6.5	6	9.5
9	Lack of Knowledge Management and Transfer among Teams	10	7	4	10.5	7	12.5	9	1.5	22	6.5	6	9.5
10	Lack of Informal/Face-to-Face Communication	18	3.5	11	5.5	21	4	7	10.5	22	6..5	6	9.5
11	Lack of Common Understanding of Requirements	4	12.5	1	17.5	4	15.5	9	1.5	20	12.5	7	4.5
12	Lack of Training in Communication and Collaboration Tools	9	8	8	7	12	9	7	10.5	20	12.5	6	9.5
13	Lack of Credence	18	3.5	11	5.5	14	8	6	14.5	19	15	5	15.5
14	Lack of Change Management Activities	4	12.5	4	10.5	7	12.5	6	14.5	18	16.5	6	9.5
15	Lack of Frequent Feedback	2	16.5	4	10.5	9	10.5	7	10.5	20	12.5	7	4.5
16	Legal, Political and Intellectual Property Rights Issues	4	12.5	4	10.5	6	14	6	14.5	21	10.5	4	17.5
17	Lack of ICT/Technological Cohesion	19	2	15	4	20	5	5	17.5	21	10.5	7	4.5
18	Lack of Antagonism Management Activities	2	16.5	2	14.5	1	18	5	17.5	18	16.5	7	4.5

managers in a large project management institute in the USA. They identified peculiar challenges faced by IT projects such as 'requirement haziness' and 'changes in project scope' that created coordination problems. Yuan and Vogel [82] conducted a qualitative analysis and reported that 'haziness' tempers communication and coordination processes in the software outsourcing development paradigm. Darja Smite et al. [14] did an empirical study of Ericsson, a large-scale developer of software systems with sites around the world, particularly in Sweden, China and India. They suggested that the main challenges to communication, coordination and control were due to geographical, time zone and cultural differences. J. M. Verner et al. [11] argued that cultural bias could result in wrong decisions and insecurity regarding participants' qualifications, as well as negatively impact communication, coordination and collaboration efforts.

Our SLR analysis revealed four challenges that were cited more often among 18 communication and coordination challenges for *medium* companies: 'cultural differences', 'geographical dispersal', 'language disparities' and 'lack of ICT/technological cohesion'. They showed the highest citation percentages for *medium* companies, which clearly indicate that if *medium*-sized companies desire long lasting relations with their clients they should focus on these problematic areas. Ivaldir et al. [83] did a literature review and case study with 12 GSD professionals from ten *medium*-sized companies in Brazil, Canada and USA. They identified major risks faced in software outsourcing as 'cultural differences', 'temporal differences', 'geographical dispersion', 'linguistic barriers', 'coordination and selection of communication technologies', 'collaboration tools' and 'task distribution' [83].

In addition to the cited four major challenges, our SLR results identified seven challenges that were cited more often for *small*-sized companies as follows: 'cultural differences', 'geographical dispersion', 'lack of informal/face-to-face communication', 'lack of credibility', 'lack of ICT/technological cohesion' and 'language differences'. All of the latter citations had the highest percentages of citations for *small*-sized companies. Srinivas Nidhra et al. [84] conducted an SLR and industry validation survey that suggested *small* companies had problems with 'cultural differences', 'language differences' and a 'lack of credibility'.

Additionally, our results specified that 'geographical', 'cultural and language differences' as well as the 'lack of ICT/technological cohesion' were critical challenges facing all companies, regardless of size. Among the cited 18 communications and coordination challenges, 'geographical dispersion' based on company size showed a significant difference compared to other challenges. Our results revealed clearly showed that the 'geographical dispersion' challenge had significant impacts on all OSDO vendors; again, regardless of size.

Spearman's Correlation of SLR and Survey based on Small Size Company			**SLR**	**Survey**
Spearman's rho	SLR	Correlation Co-efficient	1.000	.008
		Sig. (2-tailed)	.	.975
		N	18	18
	Survey	Correlation Co-efficient	.008	1.000
		Sig. (2-tailed)	.975	.
		N	18	18
Spearman's Correlation of SLR and Survey based on Medium Size Company			**SLR**	**Survey**
Spearman's rho	SLR	Correlation Co-efficient	1.000	.526*
		Sig. (2-tailed)	.	.025
		N	18	18
	Survey	Correlation Co-efficient	.526*	1.000
		Sig. (2-tailed)	.025	.
		N	18	18
*. Correlation is significant at the level 0.05 level (2-tailed)				
Spearman's Correlation of SLR and Survey based on Large Size Company			**SLR**	**Survey**
Spearman's rho	SLR	Correlation Co-efficient	1.000	.358
		Sig. (2-tailed)	.	.145
		N	18	18
	Survey	Correlation Co-efficient	.358	1.000
		Sig. (2-tailed)	.145	.
		N	18	18

To determine differences between SLR vs. Survey outcomes, we used Spearman's correlation coefficient to comparatively analyze all challenges based on company size (See: Tables 2–5). Our empirical study clearly validated SLR results. Table 2 demonstrates very little variance between both data sets and also shows that none of the challenges had a zero frequency outcome in the survey. However, challenge rankings across both data sets were not identical.

The Spearman rank correlation test served to compare ranking values, i.e., the frequency of a challenge cited by SLR vs. the frequency cited by survey. For *small* companies, $p < 1$ (0.975), allowed us to assess the relative importance of each challenge, also indicating that SLR vs. Survey results were quite similar (See: Table 3). Likewise, the Spearman index for *medium* companies was $p < 0.05$, indicating that the relative importance of each challenge was very similar for SLR vs. Survey results. The Spearman index for *large* companies was $p < 1$ (0.145), again granting similarity (See: Table 5). In answer to RQ4, Tables 2–5 all

indicate more semblance than disagreement for both data sets.

We also plot the comparison of all communication and coordination challenges identified via SLR and Survey in based on various company sizes in Figure 2 & 3. The main astonishing point from these two figures is the maximum occurrence of large sized company reports are in SLR results, while maximum occurrences of medium sized company in survey results.

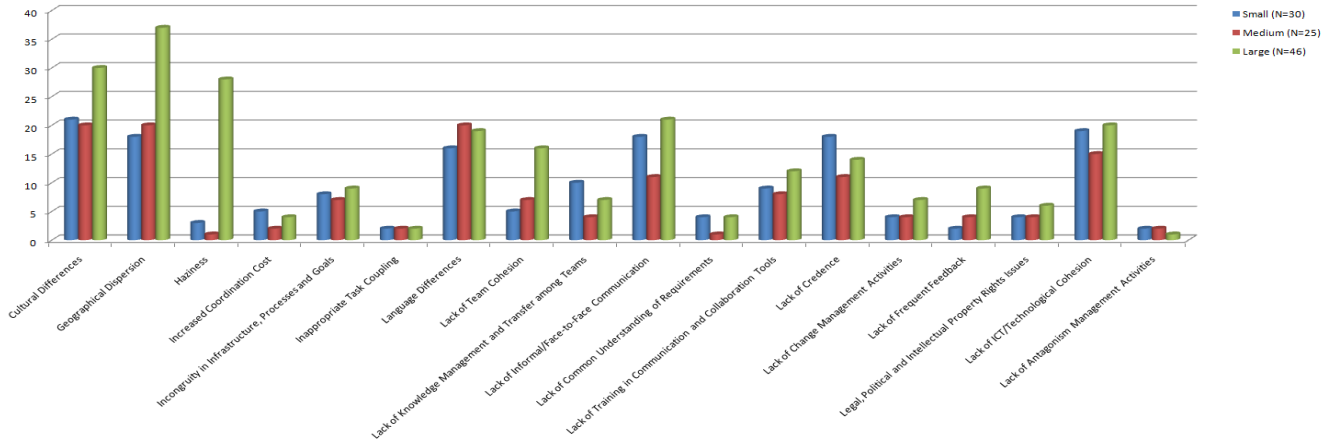

Figure 2 Graphical representation of all communication and coordination challenges based on Company size identified via SLR

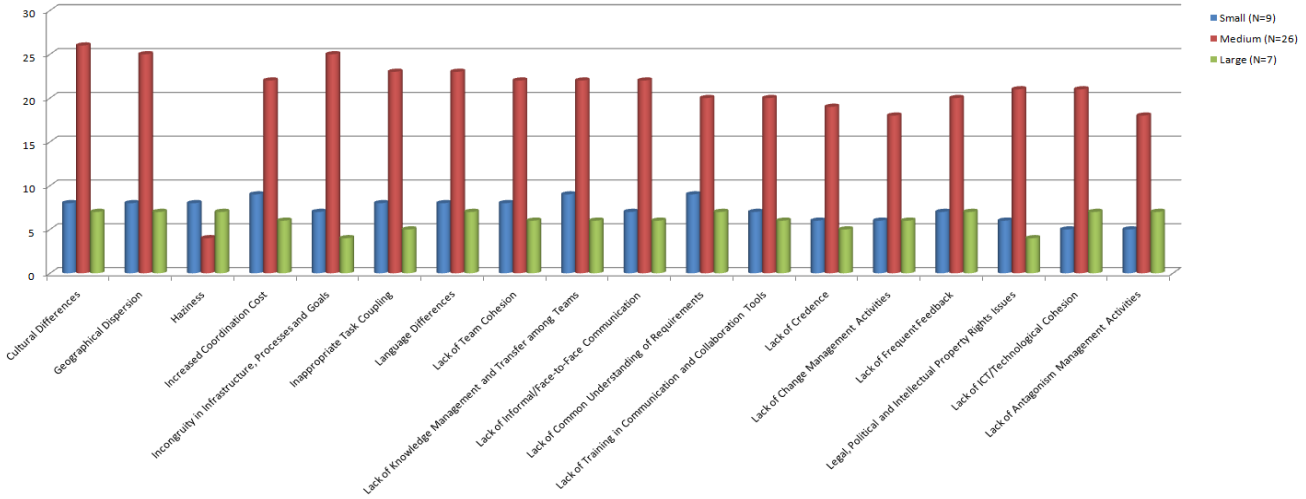

Figure 3 Graphical representation of all communication and coordination challenges based on Company size identified via Questionnaire Survey

We can further predicted that the challenges such as, "cultural differences", "geographical dispersion", "haziness", "language differences", "lack of ICT/Technological cohesion" and "lack of credence" has maximum occurrence in the large sized companies, according to SLR results. However, all the challenges except haziness have maximum occurrences in the medium sized companies, according to the survey results. It can be seen that, for each challenge, the positive responses of questionnaire survey are maximum then SLR occurrences. Overall, we analyze that in the real industry, with comparison of literature review results, all the challenges have importance for the OSDO vendor organizations.

4.3 Analysis of Communication and Coordination Challenges: SLR Citations Related to Continents

In answer to RQ5, Table 6 lists cited challenges related to different continents, classed as follows: Asia, America Europe and Mixed (combination of two or more continents).

We had hoped to determine whether or not cited challenges differed from continent to continent or remained uniform. As the data set created in SPSS was ordinal, we used the Chi-square linear-by-linear association test. Moreover, the literature recommends the linear-by-linear association test when testing for significant dissimilarity between ordinal variables, as it is more powerful than the Pearson Chi-square test [85]. Results (See: Table 6) demonstrated more

similarities than differences for 16 challenges cited in Asia, 16 challenges cited in Europe, 18 challenges cited in America, and 18 challenges cited in the 'Mixed' category. However, 'lack of antagonism in management activities' and 'inappropriate task coupling' had zero occurrences in Asia. Similarly, 'inappropriate task coupling' and 'lack of common understanding of requirements' had zero occurrences in Europe.

We found only one significant difference, i.e., 'inappropriate task coupling' across all four continents (See: Table 6). This challenge was not found in Asia (0%) or Europe (0%), whereas in America its occurrence was 6% while in the 'Mixed' category its citation occurrence was highest (11%). We argue that 'inappropriate task coupling' is critical for America compared to Asia and Europe. This might also account for communication and coordination barriers that OSDO vendors encounter with their American counter parts (clients).

In summary, results demonstrated that 'geographical dispersal', 'cultural difference', 'language difference' and 'lack of ICT/technological cohesion' were the most critical challenges facing vendors on all continents, which indicates that the remaining challenges ('lack of antagonism management activities', 'legal, political and intellectual property rights issues', 'lack of common understanding of requirements', 'lack of frequent feedback', 'inappropriate task coupling', 'lack of training in communication and collaboration tools' and 'haziness') are low intensity problems. However, the latter should not be ignored when addressing higher intensity challenges, as the following comments taken from the literature indicate.

- The 'lack of antagonism/conflict management' arises when a team consists of members from different functional, organizational and cultural units, indicating that communications are hampered and members of virtual teams rarely meet face-to-face and do not really know each other [86].
- External environment: external factors and the macro environment include market forces, political, legal, cultural and economic issues, as well as technological development and quality of education; all of which can negatively impact OSDO communication and coordination activities [87].
- GSD projects face other challenges such as the 'lack of change' in management activities, 'requirement haziness/uncertainty', 'change in project

Table 6: Summary of Communication and Coordination Challenges: SLR citations related to continents

#	Communication and Coordination Challenges in OSDO	Occurrences in SLR (N=101)								Chi-square Test (Linear-by-Liner Association) α = .05		
		Asia (N=12)		Europe (N=27)		America (N=17)		Mixed (N=45)		X^2	Df	P
		Freq	%	Freq	%	Freq	%	Freq	%			
1	Cultural Differences	8	70	21	78	12	71	34	76	.092	1	.762
2	Geographical Dispersion	8	70	22	82	11	65	39	87	1.663	1	.197
3	Haziness	1	8	2	7	2	12	1	2	1.035	1	.309
4	Increased Coordination Cost	3	25	4	15	1	6	5	11	1.319	1	.251
5	Incongruity in Infrastructure, Processes and Goals	1	8	5	19	5	29	11	24	1.368	1	.242
6	Inappropriate Task Coupling	0	0	0	0	1	6	5	22	4.249	1	.039
7	Language Differences	7	60	15	56	9	53	29	64	.436	1	.509
8	Lack of Team Cohesion	2	17	6	22	5	29	10	22	.088	1	.767
9	Lack of Knowledge Management and Transfer among Teams	4	33	4	15	3	18	9	20	.171	1	.679
10	Lack of Informal/Face-to-Face Communication	3	25	11	41	10	59	22	49	1.995	1	.158
11	Lack of Common Understanding of Requirements	1	8	0	0	2	12	3	7	.272	1	.602
12	Lack of Training in Communication and Collaboration Tools	2	17	8	30	5	29	12	27	.109	1	.742
13	Lack of Credence	5	42	9	33	10	59	16	36	.013	1	.908
14	Lack of Change Management Activities	2	17	3	11	4	24	5	11	.095	1	.758
15	Lack of Frequent Feedback	1	8	4	15	2	12	5	11	.007	1	.936
16	Legal, Political and Intellectual Property Rights Issues	2	17	3	11	3	18	4	9	.413	1	.520
17	Lack of ICT/Technological Cohesion	6	50	15	56	10	59	22	49	.114	1	.736
18	Lack of Antagonism Management Activities	0	0	1	4	1	6	1	2	.009	1	.924

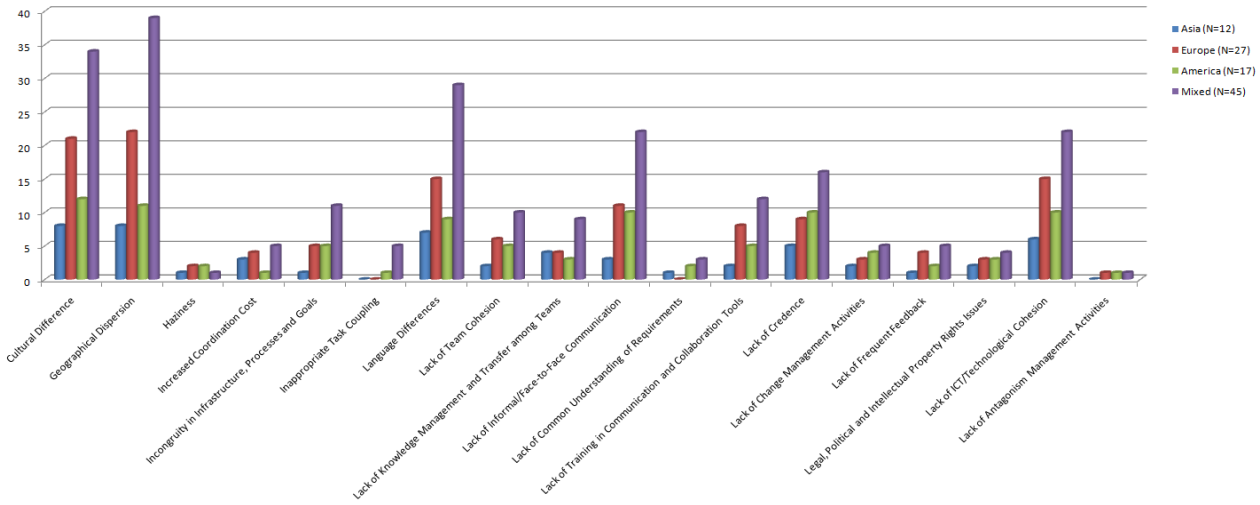

Figure 4 Graphical representation of Communication and Coordination Challenges: SLR citations related to continents

scope', 'phased implementation', 'distributed implementation teams', and personnel involved in several tasks [81].

- Communication, coordination and integration processes are also affected by high task coupling between task segments [63]. High task coupling between task segments can involve ineffective project coordination mechanisms that are difficult to overcome due to the absence of face-to-face interactions in addition to problematic task coupling, different time zones, local holidays, weakened social networks, and unclear lines of communication [63].
- Communication is complicated due to increases in project team sizes, geographically dispersed teams, different time zones, languages and cultural differences. To manage such complications, effective communication and collaboration tools are absolutely necessary [88].
- Offshore and onshore collaboration teams experience difficulties due to technical issues such as differences in infrastructure, technology availability and organizational standards [89].

We also plot the comparison of all communication and coordination challenges identified via SLR based on various continents as shown in Figure 4. This figure shows that there are maximum numbers of communication and coordination challenges faced to Europe vendor organizations in OSDO relationships. Some challenges are also faced to mixed category, such as the astounding maximum occurrence of "cultural difference", "geographical dispersion", "language differences", "lack of Informal/face-to-face communication" and "lack of ICT/Technological cohesion". Further we noted that in Europe the challenges "cultural difference", "geographical dispersion", "language differences" and "lack of ICT/Technological cohesion" has maximum occurrences. Asia vendor organizations had faced maximum the "cultural difference", "geographical dispersion" and "language differences" challenges.

4.4 Analysis of the Communication and Coordination Challenges Cited in SLR Based on Study Strategies Used in the Literature

To answer RQ6, we analyzed results based on different study strategies (See: Table 7). Our rigorously selected SLR sample size included 101 articles from which we extracted data regarding study strategies and methodologies from each paper according to a pre-defined data extraction format given in the SLR protocol.

Table 7 Distribution of Communication and Coordination Challenges Identified via SLR based on Study Strategies

#	Communication and Coordination Challenges in OSDO	Occurrences in SLR (N=101)												Chi-square Test (Linear-by-Liner Association α = .05) df=1	
		Case Study (N=36)		Interviews (N=9)		Survey (N=7)		OLR (N=32)		SLR (N=9)		Mixed (N=8)			
		Freq	%	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%	X^2	P
1	Cultural Difference	26	72	4	44	3	43	27	84	9	100	6	75	3.079	.079
2	Geographical Dispersion	29	81	6	67	4	57	27	84	8	89	6	75	.216	.642
3	Haziness	1	3	3	33	1	14	1	3	0	0	0	0	1.176	.278
4	Increased Coordination Cost	5	14	1	11	0	0	4	13	2	22	1	12	.040	.841
5	Incongruity in Infrastructure, Processes and Goals	4	11	0	0	2	29	11	34	2	22	3	38	6.287	.012
6	Inappropriate Task Coupling	0	0	1	11	1	14	2	6	1	11	1	12	2.127	.145
7	Language Differences	25	69	1	11	2	29	22	69	5	56	5	63	.083	.773

8	Lack of Team Cohesion	9	25	1	11	3	43	6	19	2	22	2	25	.060	.807
9	Lack of Knowledge Management and Transfer among Teams	9	25	1	11	1	14	5	16	4	44	0	0	.553	.457
10	Lack of Informal/Face-to-Face Communication	15	42	4	44	4	57	16	50	3	33	4	50	.133	.716
11	Lack of Common Understanding of Requirements	2	6	1	11	1	14	1	3	0	0	1	12	.031	.860
12	Lack of Training in Communication and Collaboration Tools	9	25	1	11	2	29	11	34	2	22	2	25	.299	.585
13	Lack of Credence	14	39	3	33	3	43	13	41	2	22	5	63	.296	.586
14	Lack of Change Management Activities	5	14	1	11	2	29	4	13	2	22	0	0	.238	.625
15	Lack of Frequent Feedback	6	17	2	22	0	0	3	10	0	0	1	12	1.407	.236
16	Legal, Political and Intellectual Property Rights Issues	4	11	0	0	1	14	4	13	1	11	2	25	.877	.349
17	Lack of ICT/Technological Cohesion	21	58	3	3	2	29	17	53	6	67	3	50	.004	.948
18	Lack of Antagonism Management Activities	1	3	0	0	1	14	0	0	1	11	0	0	.015	.902

We thus identified the following six strategies: case studies, interviews, surveys, ordinary literature review (OLR), SLR, and a mixed combination of two or more methods. Accordingly (See: Table 7), the majority of communication and coordination challenges were reported through case studies and OLR. We noted six challenges cited in ≥41% of articles among the 18 challenges extracted from case studies and OLR. These six case study challenges were 'geographical dispersal' (81%); 'cultural differences' (72%); 'language differences' (69%); 'lack of ICT/technological cohesion' (58%); 'lack of informal/face-to-face communication' (42%); and 'lack of credibility' (41%). Similarly, challenges identified by OLR were 'geographical dispersal' (84%); 'cultural differences' (84%); 'language differences' (69%); 'lack of ICT/technological cohesion' (53%); 'lack of informal/face-to-face communication' (50%); and 'lack of credibility' (41%)'.

Of note, the following communication and coordination challenges had the highest citation rates for case studies: 'geographical dispersal', 'cultural differences, 'language differences, 'lack of ICT/technological cohesion' at 81, 72, 69 and 58%, respectively; and 84, 84, 69 and 53%, respectively for OLR. Results also demonstrated that 'geographical dispersal', 'cultural differences, 'language differences and 'lack of ICT/technological cohesion' had the highest citation rates for all three strategies (case study, OLR and SLR) (See: Table 7). We used the linear-by-linear Chi-Square test to identify statistically significant differences between study strategies to examine the following hypotheses:

Null Hypothesis (H_0): In the discovery of communication and coordination challenges, there is no significant difference between studies strategies used to reveal a particular challenge.

Alternative Hypothesis (H_1): In the discovery of communication and coordination challenges, significant differences exist between studies strategies used to reveal a particular challenge.

We considered H_0 if $p > 0.05$ for communication and coordination challenges; otherwise, H_1 was considered. Our analysis assumes no significant differences between the majority of communication and coordination challenges; meaning we expected no great difference between challenges cited across various study strategy categories. The challenge, 'incongruity in infrastructure, processes and goals', was reported with citation frequencies of 11, 0, 29, 34, 22 and 38% for case study, interview, survey, OLR, SLR and mixed study strategies, respectively. These results revealed a clear difference, indicating statistical significance. Indeed, Table 7 reveals it was the only challenge with $p < 0.05$. Hence, in this case, H_0 was rejected and H_1 accepted. Whereas $H_1$was rejected and H_0 accepted for all remaining challenges listed in Table 7.

Our findings thus revealed more similarities than differences and also demonstrated the relative importance of various study strategies. These results identify which study strategy robustly provides superior knowledge in support of empirical software engineering when constructing research designs. We plan to explore this area in the future.

We also plot the comparison of all communication and coordination challenges identified via SLR based on study strategies as shown in Figure 5. This figure shows that maximum numbers of communication and coordination challenges reported in case studies, such as 36.

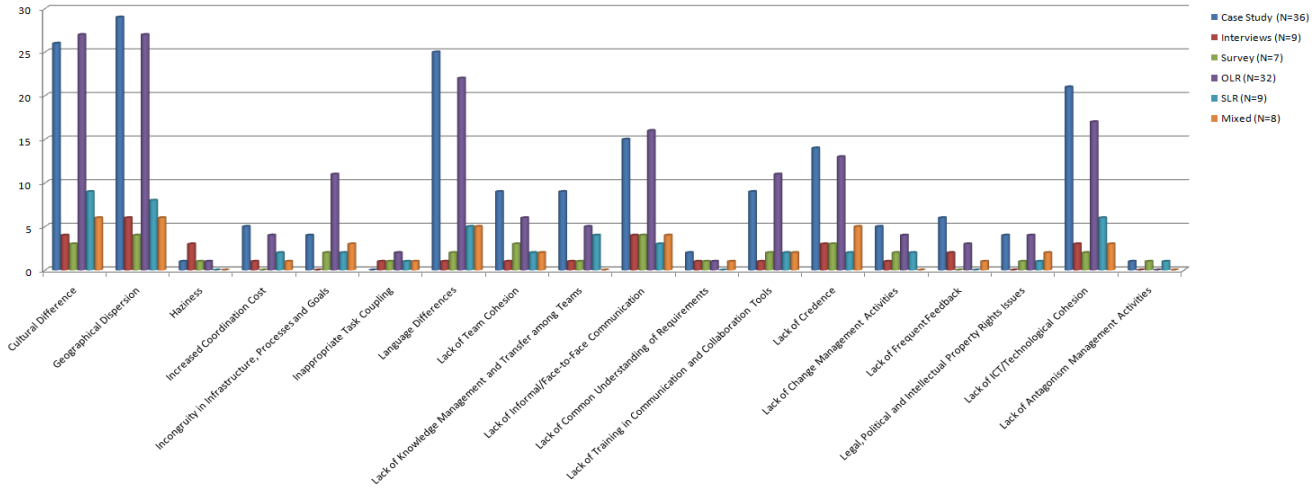

Figure 5 Graphical representation of Communication and Coordination Challenges Identified via SLR based on Study Strategies

We, conclude that the challenges "cultural difference", "geographical dispersion", "language differences", "lack of Informal/face-to-face communication", "lack of credence" and "lack of ICT/Technological cohesion" are majority reported in the case study results. Similarly, these 6 challenges also had maximum occurrences in the OLR, SLR, Survey, Interviews and Mixed type of study.

4.5 OSDO Vendor Communication and Coordination Challenges Identified by Empirical Study based on Levels of Expert Experience

Forty-two outsourcing experts participated in our survey study. We established three categories for these participants based on their level of experience. Experts with1–5 years of experience were considered 'Level-1' (total of 34); those with 6–10 years of experience were considered 'Level-2' (total of 4); and those with >10 years of experience were considered 'Level-3' (total of 4). In answer to RQ7, Table 8 lists empirical responses from different outsourcing experts.

Results indicated that of 18 challenges, 'Level-1' experts agreed that 8 challenges negatively affect OSDO organizations. These included 'cultural differences' / 'geographical dispersion' / 'haziness' / 'increased coordination cost' / 'incongruity in infrastructure, processes and goals' / 'language differences' / 'lack of team cohesion' / and 'lack of knowledge management and transfer between teams'. All 'Level-2' experts agreed that 11 of 18 challenges negatively impacted OSDO business. These included 'cultural differences' / 'geographical dispersion' / 'haziness' / 'increased coordination cost' / 'language differences' / 'lack of team cohesion' / 'lack of knowledge management and transfer between teams' / 'lack of informal/face-to-face communication' / 'lack of common understanding of requirements' / 'lack of training in communication and collaboration tools' /and 'lack of frequent feedback'. 'Level-3' experts agreed that 2 of 18 challenges negatively affected OSDO vendors. These were 'cultural differences' and 'geographical dispersion'.

A full 75% of 'Level-1–3' experts agreed that the following 12 challenges negatively affected OSDO vendors: 'cultural differences' / 'geographical dispersion' / 'haziness' / 'increased coordination cost' / 'inappropriate task coupling' / 'language differences' / 'lack of team cohesion' / 'lack of knowledge management and transfer between teams' / 'lack of informal/face-to-face communication' / 'lack of common understanding of requirements' / 'lack of training in communication and collaboration tools' / 'lack of frequent feedback' . Our analysis also showed only one challenge with a statistical significance ($p < 0.05$), that being 'incongruity in infrastructure, processes and goals' (See: Table 8).

Table 8 Vendor Communication and Coordination Challenges cited in Empirical Study based on Expert's Level

#	Communication and Coordination Challenges in OSDO	Expert Responses = 42									Chi-square Test (Linear-by-Liner Association α = .05) df=1	
		Level 1 (N=34)			Level 2 (N=4)			Level 3 (N=4)				
		A	DA	NS	A	DA	NS	A	DA	NS	X^2	P
1	Cultural Difference	33	0	1	4	0	0	4	0	0	0.207	0.649
2	Geographical Dispersion	32	2	0	4	0	0	4	0	0	0.424	0.515
3	Haziness	32	1	1	4	0	0	3	0	1	1.946	0.163
4	Increased Coordination Cost	31	1	2	3	0	1	3	0	1	1.930	0.165
5	Incongruity in Infrastructure, Processes and Goals	31	1	2	3	1	0	2	0	2	5.977	0.014
6	Inappropriate Task Coupling	29	3	2	4	0	0	3	0	1	0.386	0.534
7	Language Differences	31	2	1	4	0	0	3	1	0	0.126	0.722

8	Lack of Team Cohesion	30	0	4	3	1	0	3	1	0	1.003	0.955
9	Lack of Knowledge Management and Transfer among Teams	31	0	3	3	0	1	3	1	0	0.335	0.563
10	Lack of Informal/Face-to-Face Communication	28	4	2	4	0	0	3	0	1	0.237	0.626
11	Lack of Common Understanding of Requirements	29	1	4	4	0	0	3	0	1	0.100	0.751
12	Lack of Training in Communication and Collaboration Tools	26	5	3	4	0	0	3	0	1	0.012	0.913
13	Lack of Credence	24	1	9	3	1	0	3	0	1	0.134	0.714
14	Lack of Change Management Activities	24	5	5	3	0	1	3	0	1	0.033	0.856
15	Lack of Frequent Feedback	27	3	4	4	0	0	3	0	1	0.011	0.918
16	Legal, Political and Intellectual Property Rights Issues	26	4	4	3	1	0	2	1	1	0.733	0.392
17	Lack of ICT/Technological Cohesion	27	0	7	4	0	0	2	1	1	0.124	0.725
18	Lack of Antagonism Management Activities	24	3	6	4	0	0	2	0	2	0.551	0.458

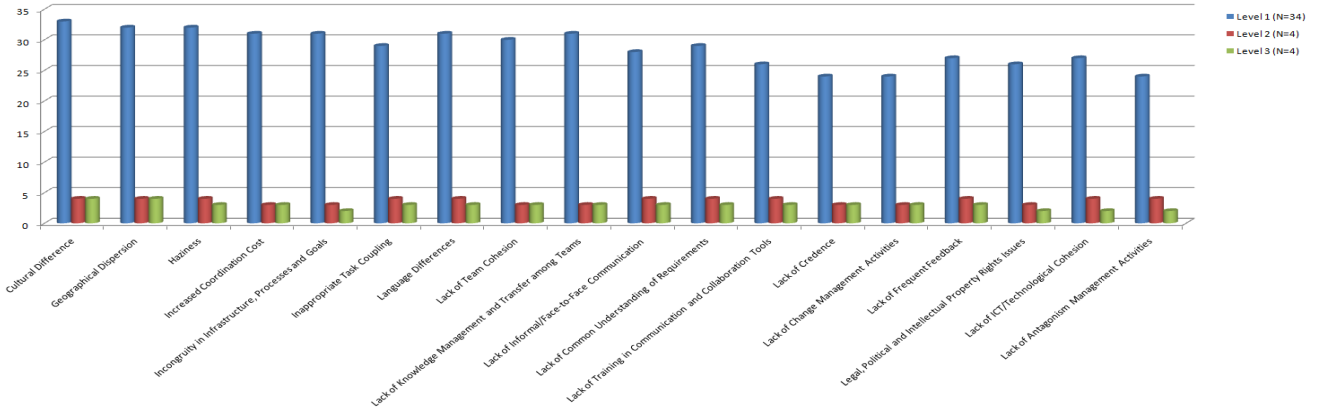

Figure 6 Graphical representation of Communication and Coordination Challenges cited in Empirical Study based on Expert's Level

We also plot the comparison of all communication and coordination challenges identified via survey based on expert's experience level in Figure 5. This figure shows that maximum numbers of communication and coordination challenges gives the positive response of occurrences by the Level-1 experts, such as 36. We, conclude that all changes have more importance to the vendor organizations according to Level-1 experts.

4.6 Vendor Communication and Coordination Challenges Cited by Survey and Based on Company Type

A total of 42 outsourcing experts participated in our survey in which we also categorized participants according to company type, i.e., 'National', 'Multinational' or 'Both' combined. There were 23 'National', 10 'Multinational' and 9 'Both' company types. To answer RQ8, Table 9 presents empirical survey results according to outsourcing company type. ('A' represents agree; 'DA' represents disagree; and 'N' represents 'neither agree nor disagree').

Results indicated that out of 18 challenges, 10 were such that >75% of National companies agreed that these challenges could negatively affect OSDO organizations. These were 'cultural differences' / 'geographical dispersion' / 'haziness' / 'increased coordination cost' / 'incongruity in infrastructure, processes and goals' / 'inappropriate task coupling' / 'language difference', 'lack of team cohesion' / 'lack of knowledge management and transfer among teams' / and 'lack of common understanding of requirements'.

Table 9 OSDO Vendor Communication and coordination challenges cited by empirical survey based on company type

#	Communication and Coordination Challenges in OSDO	Expert Responses = 42									Chi-square Test (Linear-by-Liner Association α = .05) df=1	
		National (N=23)			Multinational (N=10)			Both (N=9)				
		A	DA	N	A	DA	N	A	DA	N	X^2	P
1	Cultural Difference	22	0	1	10	0	0	9	0	0	0.683	0.409
2	Geographical Dispersion	21	2	0	10	0	0	9	0	0	1.400	0.237
3	Haziness	20	1	2	10	0	0	9	0	0	1.983	0.159
4	Increased Coordination Cost	20	1	2	10	0	0	7	0	2	0.398	0.528
5	Incongruity in Infrastructure, Processes and Goals	20	0	3	8	1	1	8	1	1	0.267	0.606
6	Inappropriate Task Coupling	19	3	1	9	0	1	8	0	2	0.000	1.000
7	Language Differences	19	3	1	10	0	0	9	0	0	2.602	0.107
8	Lack of Team Cohesion	19	1	3	8	1	1	9	0	0	1.291	0.256
9	Lack of Knowledge Management and Transfer among Teams	19	1	3	9	0	1	9	0	0	1.592	0.207

10	Lack of Informal/Face-to-Face Communication	17	3	3	9	1	0	9	0	0	3.537	0.060
11	Lack of Common Understanding of Requirements	18	1	4	9	0	1	9	0	0	2.355	0.125
12	Lack of Training in Communication and Collaboration Tools	17	3	3	8	2	0	8	0	1	0.628	0.428
13	Lack of Credence	15	1	7	7	1	2	8	0	1	1.580	0.209
14	Lack of Change Management Activities	15	3	5	8	2	0	7	0	2	0.437	0.509
15	Lack of Frequent Feedback	16	3	4	9	0	1	9	0	0	3.515	0.061
16	Legal, Political and Intellectual Property Rights Issues	14	4	5	8	2	0	9	0	0	5.660	0.017
17	Lack of ICT/Technological Cohesion	16	1	6	8	0	2	9	0	0	3.088	0.079
18	Lack of Antagonism Management Activities	15	2	6	7	2	1	8	0	1	1.316	0.251

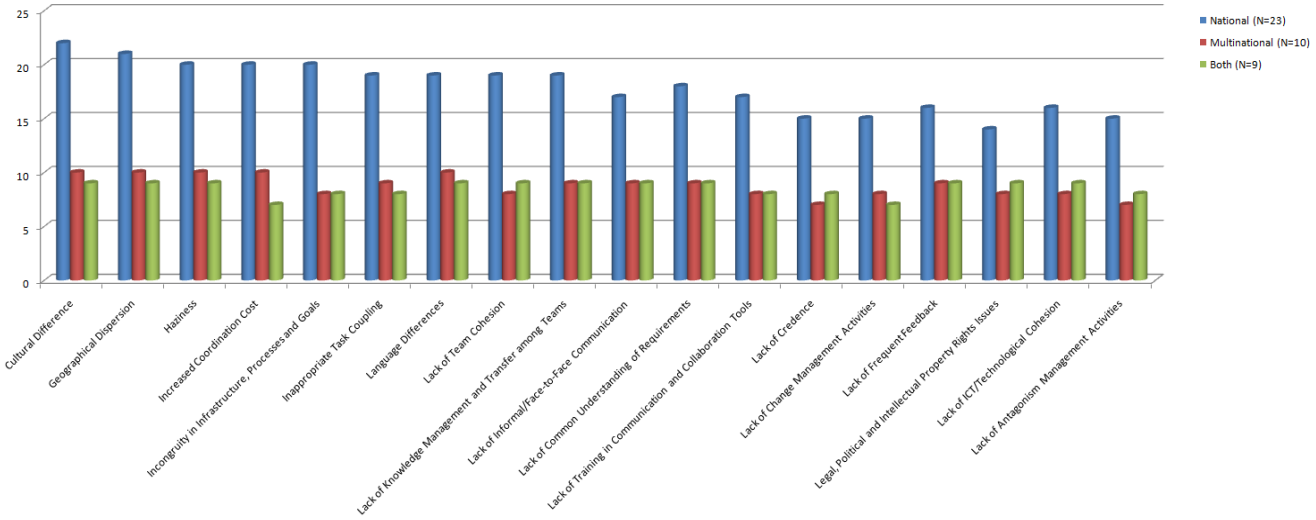

Figure 7 Graphical representation of Communication and Coordination Challenges cited in Empirical Study based on various Company Types

More than 80% of Multinational companies agreed that 16 of 18 cited challenges negatively affected OSDO vendors. These were 'cultural differences' / 'geographical dispersion' / 'haziness, increased coordination cost' / 'incongruity in infrastructure' / 'processes and goals' / 'inappropriate task coupling' / 'language difference' / 'lack of team cohesion' / 'lack of knowledge management and transfer between teams' /'lack of informal/face-to-face communication' /'lack of common understanding of requirements' / 'lack of training in communication and collaboration tools' / 'lack of change management activities' / 'lack of frequent feedback' / 'legal, political and intellectual property rights issues' / and 'lack of ICT/Technological cohesion'.

Table 9 presents the 18 challenges that >77% of companies in the 'Both' category agreed affected OSDO vendors. Only one challenge, 'legal, political and intellectual property rights issues', demonstrated a statistical significant difference based on company type (p<0.05).

We also presented the graphical representation of these challenges reported by the questionnaire survey based on various company types as shown in Figure 7. The figure clearly shows that there national company involve in our results and reported that all changes have importance for the vendor organization in OSDO relationships. Further, the other two types of companies also reported that all the changes should be under consideration for the OSDO vendor organizations.

5.0 SUMMARY AND DISCUSSION

Using an SLR and empirical survey, this research effort systematically identified 18 commonly encountered communication and coordination challenges that confront OSDO vendors. Such results can positively impact the OSDO knowledge base and business sector. We comparatively analyzed well-cited challenges affected by different variables as shown in several tables. OSDO vendor organizations are advised to develop new capabilities based on the evaluation of these challenges in order to optimize their business opportunities. These challenges describe key areas that require vendor management attention and innovative planning. OSDO vendors can exploit these results to obtain practical insights regarding what their clients actually demand and desire.

Our findings demonstrate that OSDO vendors are well advised to establish trustworthy company profiles based on informed capabilities with enhanced communications and reliable management strategies that secure and maintain good relationships with their clients. We identified a list of important challenges in response to both RQ1 and RQ2. Our collective recommendation is for OSDO vendors to focus on the most frequently cited challenges to better compete in the OSDO business sector. We plan to develop appropriate support mechanisms and instruments to facilitate the design and implementation of suitable OSDO relationship strategies. The present work clearly identified specific high-value

problem areas cited by rigorously selected literature reports that demand focused attention in any OSDO initiative. The outcomes of the present work will hopefully provide other researchers and practitioners with a firm knowledge basis upon which to develop novel approaches and solutions. Innovative OSDO processes can surely be developed to address the high number of OSDO failures currently reported in the literature. Moreover, results from this effort can also provide OSDO practitioners with the appropriate knowledge to determine if vendor companies actually are actually prepared to establish contractual confidence. As such, OSDO practitioners can better comprehend current process strengths and weaknesses and address areas that need attention.

6.0 LIMITATIONS OF RESEARCH DESIGN

Our study was limited to seven research publication databases and we did not consider other related databases that might hold relevant publications. Furthermore, we might have missed germane studies at the time of collating SLR results due to an ever-increasing number of published papers. Nonetheless, we accept obtained outcomes as factual, having covered the over whelming majority of available literature. Equally true, this is not a systematic omission as reported by other SLR researchers [64]. Even so, we must ask the following: 'How safe is it to simplify these outcomes concerning risks to external validity'? Our sample size comprised articles from diverse international sources. With respect to constructs covered by the survey questionnaire, validation focused on metrics that denoted attributions under scrutiny. These significations were extracted from a substantial body of research reported in guidelines provided by Kitchenham and Charters [66] and a rigorous SLR [12]. Furthermore, responses to a pilot questionnaire undertaken prior to final implementation indicated that all attributions considered were relevant.

Internal validity concerns the overall assessment of research results. Our pilot study demonstrated an acceptable level of validity as variables were extracted from a rigorous SLR. Our survey respondents were asked to rank a pre-selected list of possible OSDO challenges, which demonstrates a major disadvantage that was partly addressed by providing relevant open-ended questions. On the other hand, external validity concerns results for all domains of inquiry. Here, an undeniable disadvantage was the limited number of our foreign survey participants. Of 42 respondents, only 6 were from abroad. Perhaps more reliable results could have been obtained but due to scarce resources and time it was not possible to include additional foreign participants, which complicates any generalization of the study's results. Nonetheless, we are confident our empirical outcomes have served as validation because they fully complement our SLR findings [12] and also because no major disparities were noted between SLR and empirical results [65]. Moreover, our empirical study followed similar approaches employed by other researchers [1, 16, 77]. Hence, we anticipate that our report will help fill a gap between academic opinions and industry experience in the OSDO context.

7.0 CONCLUSION AND FUTURE WORK

Through a relevant SLR, we identified 18 communication and coordination challenges faced by OSDO vendors. Moreover, our survey questionnaire of 42 outsourcing industry experts complemented our SLR findings. In addition, we comparatively analyzed all challenges with respect to impacts from company size, continental location, company type, research methodologies and levels of expertise and found no major differences between SLR and survey results.

We plan to develop a Communication and Coordination Challenges Mitigation Model (CCCMM) for use by OSDO vendor organizations. Such a model will assist them to identify, analyze and mitigate communication and coordination challenges within formed solutions. We intend this CCCMM's implementation to be a software tool that generates diverse assessment reports and performs sundry other functions related to OSDO relationships. As such, the CCCMM instrument should guide OSDO vendors towards successful assessments of their organization's ability to mitigate challenges. The current study also identified other research gaps that we plan to address in the future. These include:

- The service climate of offshore and onshore teams involved in OSDO relationships.
- Identification of challenges from the client's perspective.

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