

# Investigation of Time Delay Factors in Global Software Development

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**Abstract**—Global Software Development (GSD) projects are passing through different boundaries of a company, country and even in other continents where time zone differs between both sites. Beside many benefits of such development, research declared plenty of negative impacts on these GSD projects. It is important to understand problems which may lie during the execution of GSD project with different time zones. This research project discussed and provided different issues related to time delays in GSD projects. In this paper, authors investigated some of the time delay factors which usually lie in GSD projects with different time zones. This investigation is done through systematic review of literature. Furthermore, the practices to overcome these delay factors which have already been reported in literature and GSD organizations are also explored through literature survey and case studies.

**Keywords**—Case Studies, Global Software Development, Global Software Engineering, Temporal Difference, Time Delay

## I. INTRODUCTION

THE term "Globalization" brought many challenges in software development field. Globalization of the world is on a doorstep, economic growth and rapidly new inventions are compelling the software industry to boost up development speed in order to cope with these challenges. Global Software Development (GSD) is a strategy in which the software development is performed beyond organizational, contextual, cultural, geographical, temporal, and political boundaries. In GSD, the software life cycle activities are distributing among teams across different boundaries [1]. The diverse distribution of the activities among different organizations all over the world causes a number of questions that need to be answered about realization and successful execution of GSD projects [2]. The need of GSD is brought in order to reduce time, cost and resources [2, 3, 4, and 5]. Success of a project could be measured in three factors time, cost and quality. For a successful project, it should accomplish required quality in specified time and cost. If any one of these three features is missing or not meeting, the project might lead towards failure. Organizations have to produce projects in such a way so that it fulfilled above mentioned objectives. However, statistics show that 60% of GSD projects fail [6]; Betz and Makio claim it as 40% [7].

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Moreover, studies show that 2 out of 5 international joint venture projects teams show poor performance [8, 9] and hence it take 2.5 times extra time in distributed environment to complete a project than co-located [8]. Nowadays, competition among organizations has been increased globally and customers want quick projects within specified quality and cost. On time delivery of the project is a burning issue in software development organizations [2]. It becomes more challenging when talking about distributed organizations. If customers are not getting project on time, some other might launch that project before that. In this way, the delayed project will go toward failure. It is very important to fix this issue. Researchers are continuously working on this issue in order to minimize this time delay. They are trying to figure out the problems due to which delay of projects happening in GSD [10]. This research is aimed to figure out those factors through literature survey and industrial case studies. Furthermore, the practices and other tools and techniques to overcome these factors would also be pointed out.

### A. Aims and Objectives

The aim of this research paper is to investigate time delay factors in GSD projects. To achieve this aim, following objectives are considered;

- Identify delay factor in GSD from literature review
- Identify the delay factors which have been reported in GSD industry

Recommendations and suggestion to overcome/minimize these effected factors

### B. Research Questions

Following research questions are answered in this research project;

1. Why GSD projects delay when time zone differs between sites?
2. What practices to overcome time delay factors have already been reported in the literature?
3. What problems GSD organizations face due to which a project delay and which practices have been applied successfully in industry to overcome time delay factors?

### C. Research Methodology

Overall mixed methodology approach is carried out in order to fulfill the aims and objectives of this research. First of all, extensive literature review is conducted to have overall

knowledge of research domain and to understand academia's point of view. Systematic literature review technique is adopted to get maximum knowledge about the research questions of this research study. Case studies are conducted later in GSD organizations, to investigate and align the data extracted during literature study. Moreover, these case studies also helped us to understand what is practically happening in industry. At the end, both literature and organizations' data is analyzed in order to provide recommendations and suggestions regarding this research project.

Following Fig 1 shows the research outline for this study.

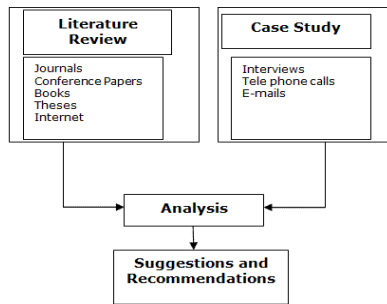


Fig. 1 Research Outline

#### D. Research Outline

This research study consists of three main parts. In next part authors tried to explain how they conducted the research for this project. In third part, answers to research questions are provided using relative research methodologies and at the end, fourth part discusses the recommendations and suggestions based on literature review and industrial case studies.

## II. SYSTEMATIC REVIEW

Systematic review is a scientific technique which is used to identify, evaluate and interpret the available research related to a particular research area of interest [11]. We did perform systematic review into three phases as suggested by [11].

- Planning
- Conducting
- Reporting

#### A. Planning

In first meeting, we selected domain where we will work i.e. investigation of time delay factors in GSD. To achieve the aims and objectives of this research project, we decided to adopt mixed methodology as it looked more suitable. In order to perform qualitative research, we did an extensive literature review followed by systematic review technique. Reason behind choosing systematic review was to get maximum knowledge about the research question of this research project.

#### B. Conducting

Systematic review is conducted to study and compare existing work in the particular selected domain, derive important and trustworthy study results, find gaps in research

within that area and provide a frame work for new research activities in future [11].

By keeping in mind the above purpose, we decided to study at least Abstract, Introduction and Conclusion from each paper, found during systematic review. We adopted this strategy instead of studying a complete research paper due to limitation of time for this research project.

#### 1. Databases

Due to limited time, we selected four database resources:

- IEEE
- ACM
- Springer Link (SpL)
- Google Scholar (GS)

IEEE and ACM are most authenticated database resources with the enormous collection of citations, full text journals, conferences that are scientifically and technically peer reviewed. Springer Link has huge amount of bibliographic citation and abstract of research papers in the field of engineering and technology. Moreover Google scholar also has ability to provide search results in the form of books, journals, theses and articles that are directed to other databases such as IEEE, ACM, Springer link etc.

#### 2. Searching Strategy

In order to search productive material, we made a strategy where we identified keywords (strings) related to our topic domain area and research questions. We also used synonyms, alternative keywords and operators. Moreover, we identified an inclusion and exclusion criteria.

##### Keywords and synonyms used

- Investigation of Time Delay Factors in "Global Software Development"
- "Global software development and delay"
- "Time Delay" Factors in "Global Software Development"
- Challenges in multi-site software development organizations
- GSD projects delay when time zone differs between sites
- Time delay problem in "different time zone" in global software engineering
- Time Delay Factors in Global Software Development with "different time zone"
- "Global software" and delay factors with different time zone
- Tools and techniques for multi-site software development in different time zone

##### Operator used

- AND

##### Inclusion/Exclusion criteria

- Language English
- Published year (2000-2011)
- Addressing at least one research question
- Document type Article (A) Book (B), International Conference (IC), Journal (J) and Thesis (T)

We followed above criteria in order to narrow down our search and focused on that literature which has been done recently. Thereby, we maintained a blog file to present our narrowed search result as shown in Table I.

TABLE I  
BLOG TABLE

KEY WORD(S)	GS	ACM	IEEE	SPL
Investigation of Time Delay Factors in "Global Software Development"	142	24	0	35
"Global software development and delay"	23	3	7	3
"Time Delay" Factors in "Global Software Development"	15	1	0	2
Challenges in multi-site software development organizations	1050	128	4	206
GSD projects delay when time zone differs between sites	218	1	1	1
Time delay problem in "different time zone" in global software engineering	80	4	10	5
Time Delay Factors in Global Software Development with "different time zone"	45	5	1	8
"Global software" and delay factors with different time zone	305	43	0	67
Tools and techniques for multi-site software development in different time zone	301	27	0	19

### C. Reporting

This section includes reporting review of research studies that are gathered from different databases. This process is performed by following above described inclusion and exclusion criteria. During extensive review, the authors selected 27 papers (tabulated in Table II) according to the criteria outlined for paper selection from the selected databases.

TABLE II  
PROCESS OF SELECTING AND REVIEWING BY DEFINED CRITERIA

PAPER ID	Type	Database	Publication Year	Address Questions		English	Inc.
				1	2		
1[1]	A	GS	2003	y	y	y	y
2[10]	IC	IEEE	2008	y	y	y	y
3[12]	IC	IEEE	2004	y	-	y	y
4[8]	A	IEEE	2003	y	y	y	y
5[13]	A	IEEE	2001	y	-	y	y
6[14]	A	SL	2007	y	y	y	y
7[15]	A	GS	2007	y	y	y	y
8[16]	B	SL	2007	y	y	y	y
9[17]	J/A	SL	2005	y	y	y	y
10[18]	IC	ACM	2000	y	y	y	y
11[9]	J	SL	2007	y	y	y	y
12[19]	BA	SL	2008	y	y	y	y
13[20]	IC	SL	2006	-	y	y	y
14[21]	BA	SL	2008	y	y	y	y
15[7]	BA	SL	2007	y	y	y	y
16[22]	IC	GS	2002	y	y	y	y
17[23]	A	GS	2002	-	y	y	y
18[24]	IC	ACM	2006	y	y	y	y
19[25]	IC	GS	2007	y	y	y	y
20[26]	IC	GS	2006	y	y	y	y
21[27]	IC	IEEE	2005	y	y	y	y
22[28]	B/A	SL	2008	y	y	y	y
23[2]	J/A	GS	2008	y	y	y	y
24[6]	IC	IEEE	2009	-	y	y	y
25[3]	J	ACM	2010	y	y	y	y
26[4]	IC	IEEE	2011	y	-	y	y
27[5]	IC	SL	2011	y	-	y	y

E (Excellent): Total score = 2

G (Good): Total score = 1.5

M (Medium): Total score = 1

L (Low): Total score=0.5 clearly state the units for each quantity in an equation.

#### 1. Quality Assessment of Selected Literature

This section describes the quality assessment of selected literature. This quality assessment is based on the quality contained by each collected research study with respect to the area of all research questions. The quality assessment is based on the following rules.

**QA1:** The study should address the reasons of globally distributed project delayed factors when participant sites have different time zones.

**QA2:** The study should address the practices that are used to overcome time delay factors.

On the basis of above defined quality assessment rules, the quality assessment of each research paper is performed and evaluated through quality points as shown in Table III. The quality points are also given by the following rules.

1. If the research study has ability to detailed answer to any one quality question then it is pointed as 1.
2. If the research study has ability to partially answer to any one quality question then it is pointed as 0.5.

#### 2. Results and Synthesis of Findings

This section contains the rationale behind the above defined criteria about accessed literature in the context of research questions. The main purpose behind all defined criterion is to gather detailed quality material from authenticated and available databases with respect to the research questions of this research project. We classified our gathered search material into two categories with defined criterion given below and result is tabulated in Table IV.

**C1:** Studies that addresses delays factors of distributed project with sites having different time zone.

**C2:** Studies that addresses the practice that is used to overcome these delays factors.

TABLE III  
THE SCORES OBTAINED BY EACH SEARCHED STUDY ACCORDING TO ABOVE DEFINED CRITERIA

PAPER ID	QA1	QA2	Total Score	Assessed Quality
1[1]	0.5	0.5	1	M
2[10]	1	1	2	E
3[12]	1	0	1	M
4[8]	1	1	2	E
5[13]	0.5	0	0.5	L
6[14]	1	1	2	E
7[15]	0.5	1	1.5	G
8[16]	0.5	0.5	1	M
9[17]	0.5	1	1.5	G
10[18]	1	1	2	E
11[9]	1	1	2	E
12[19]	1	0.5	1.5	G
13[20]	0	0.5	0.5	L
14[21]	0.5	1	1.5	G
15[7]	0.5	0.5	1	M
16[22]	0.5	0.5	1	M
17[23]	0	0.5	0.5	L
18[24]	0.5	0.5	1	M
19[25]	0.5	0.5	1	M
20[26]	0.5	0.5	1	M
21[27]	1	0.5	1.5	G
22[28]	1	1	2	E
23[2]	0.5	0.5	1	M
24[6]	0	0.5	0.5	L
25[3]	1	1	2	E
26[4]	0.5	0	0.5	L
27[5]	1	0	1	M

TABLE IV  
CATEGORIZATION OF GATHERED STUDIES THROUGH ABOVE DEFINED  
CRITERIA

Paper ID	C1	C2	Fully Covered	Partial Covered
1[1]	y	y		C1,C2
2[10]	y	y	C1,C2	
3[12]	y	-	C1	
4[8]	y	y	C1,C2	
5[13]	y	-		C1
6[14]	y	y	C1,C2	
7[15]	y	y	C2	C1
8[16]	y	y		C1,C2
9[17]	y	y	C2	C1
10[18]	y	y	C1,C2	
11[9]	y	y	C1,C2	
12[19]	y	y	C1	C2
13[20]	-	y		C2
14[21]	y	y	C2	C1
15[7]	y	y		C1,C2
16[22]	y	y		C1,C2
17[23]	-	y		C2
18[24]	y	y		C1,C2
19[25]	y	y		C1,C2
20[26]	y	y		C1,C2
21[27]	y	y	C1	C2
22[28]	y	y	C1,C2	
23[2]	y	y		C1,C2
24[6]	-	y		C2
25[3]	y	y	C1,C2	
26[4]	y	-		C1
27[5]	y	-	C1	

### III. ANSWERING TO RESEARCH QUESTIONS

#### A. Why GSD Projects Delay When Time Zone Differs Between Sites?

According to Carmel [29] different time zone between two different sites of an organization is called temporal difference [8], [13], and [28].

There are a plenty of factors found in the literature which usually affects a project when it is distributed between different time zone sites. However, if we deeply study them, we might divide and manage them in a couple of factors. There would be more factors/reasons behind delaying in a GSD project. However, we are going to explain which are found during systematic literature review.

##### 1. Inadequate Overlap With Colleagues: [15],[18], [19],[28], [3]

Among the sites where overlap time with other sites is low, it becomes difficult to know completely about colleagues, working at other sites. It might not allow them to be enough social with each other. It means they will hesitate to share their ideas and problems if they exist. Furthermore, there will be less time for them to discuss about the project and there may remain some ambiguities. These ambiguities would be a cause of delaying project.

##### 2. Delay of Responses: [8],[ 13], [18], [19], [28], [2]

As the time difference between sites increases, it becomes more difficult to communicate with each other synchronously. It is because; one office is open while other site has sleeping time then. So, these offices communicate with each other asynchronously which will definitely cause delay in getting response.

##### 3. People Lose Track of the Overall Work Process: [18], [28]

Sometimes, in asynchronous way of communication, other might not understand the ones of view. So, it would require one more e-mail to explain it i.e. one more day delay for that part of work. Furthermore, if someone misunderstood, it may lead the project towards wrong direction.

##### 4. In the Long Run Make People Frustrated: [18]

Delay in response might make onsite/offsite employees frustrated and they might think they are being behind or missing their deadlines. This situation does not allow them to work with full concentration and delay in response has already stopped them to work for the specific project. So, it will definitely affect the overall time of project.

##### 5. Working Very Late or Very Early: [18], [21]

To compensate with issues mentioned above related to different time zones, some of the sites require their employees to stay late at work, until the other office does not start working. On the same scenario, some sites are required to start work early than usual to catch other office before closing. It might be fine with some regions but would not be with the most. Furthermore, it would not be good in long run and make people frustrated.

##### 6. Difficulty in Finding Concerned Person: [14],[9], [19], [6], [3]

Sometimes, organizations have customers with different time zones and it creates difficulty in finding required person for clarification. It may frustrate one, because (s)he did not find a person when required. Definitely it is also frustrating and causing delay of different phases of a project.

##### 7. Co-ordination Problem: [14], [9], [19], [3], [4], [5]

Due to ineffective communication sessions among different sites, co-ordination problems occur. This poor co-ordination will lead towards negative effect while integrating distributed work of different sites.

##### 8. Extensive Monitoring of Offshore Sites: [21]

When time difference between sites is bigger in hours and manager at onshore site is not able to communicate offshore site synchronously. This might cause losing trust in offshore site. One might install some monitoring tools at offshore site. This would affect negatively at offshore site and may lead to less productivity in result.

#### B. What Practices to Overcome Time Delay Factors Have Already Been Reported in the Literature?

There are a lot of techniques and suggestions found from literature. Some of them are mentioned as below;

1. By increasing awareness in remote participants reduces communication problems such as misunderstandings and trust deficit across sites and contributes to a denser social network in the project [10].
2. The presence of particular team members acting as point people through whom much of the team communication flows to distanced teams was found to ensure that efficiency of the coordination across teams [10].
3. Having multiple members of each team in the central point, helps to connect their team to others, reduces possible communication blockage problems and

- introduce redundant communication channels, enabling fast communication [10].
4. The mechanism of contributing to a shared repository containing work items and associated comments from members that contributed to their implementation facilities knowledge exchange and aids expertise seeking that enables effective cross site collaboration [10, 18, 3].
  5. One way to speed global collaboration is to locate all development resources at one site, but this will often not be applicable because various market requirements make it impossible, or because there is insufficient technical staff available [8, 13].
  6. Second way and more suitable way when it is difficult to keep development recourse at the one site. We can use such technology and practice that facilitate communication across site in order to approximate the properties of same site social networks [8].
  7. For those many organizations that divide the work along lines of product structure, consideration of modular design are extremely important. In addition it is also very important in order to isolate the effects of changes [8].
  8. Instant messaging and MUD rooms play a very important role in order to do effective communication in scientific and business settings [8]. The instant messaging technique is also less intrusive than a telephone because it does not create such a jarring interruption, and answering can be deferred to a convenient time [8, 3].
  9. Using change history data to identify how much work has been done on what kinds of things, who has the needed expertise. To do this practice in an effective way the study [8] developed and deployed a tool called "Experience Browser". This tool provides a visualization of the CM (change management) system and is designed to make it easy to find and contact an appropriate expert [8].
  10. Another advantage of instant messaging application is to give a user an indication of whether a person is available [8, 3].
  11. Shared calendar also plays an important role by letting people at other sites to know where someone is, means when the concerning persons might be free and even with those people they are doing meeting [8].
  12. Efficient use of existence awareness technology has potential to significantly lower the difficulty and frustration associated with contacting a remote colleague [8] e.g. when someone is able to reply.
  13. The "bridge" is one of the tactics that is used to make GSD work better [14]. In this technique temporal bridging is an organizational technique that is actively used to facilitate global development processes. In this bridging technique all team members from different locations have facility to use it for critical and synchronous information seeking. Moreover bridge makes global development more practical than it otherwise would be [14].
  14. A lateral communication is an appropriate coordination mechanism in order to increase the level of interdependency between remote teams. Moreover lateral communication is also beneficial even in cases where low interdependency level existed between remote teams [15].
  15. Site visits and face-to-face meetings are very successful mechanisms for developing and enduring relationships and also facilitate exchange of information, knowledge and collaboration [15].
  16. The GSD organization should take benefit from such mechanisms that allow the identification of the changes in dependencies [15]. So that the manager and developers could be acknowledged and notified of those changes and as a result they could be able to react accordingly [15].
  17. Documentation is a useful coordination mechanism in geographically distributed software development organization [15]. However, in this mechanism, it should be ensured that the gap between the contents of documentation and the actual source code implementation is close.
  18. According to Jae-Nam Lee, partnership between the clients and the service providers is a key predictor in order to obtain outsourcing success. This will make the parties work more efficient by effectively improving mutual relationship [17].
  19. Outsourcing software functions to a remote developer is always depending on trust [17, 3]. Therefore, need of process transparency is very important in global projects. With the help of joint repository it is possible to get control over developer's activities. Joint repository also provides effective configuration management, helps to reduce misunderstanding related to difference document versions usage by the parties. It also provides a tool in order to better progress control for remote partner [17].
  20. There are some other specialized tools exist in software development domain that are designed to help team members effectively to perform asynchronous communication [18]. The example of these effective tools are configuration management system and error logs. Such systems generally used to help developers in order to manage simultaneous software changes, but on the other hand many developers used the comments field to exchange asynchronous notes and messages about the code [18].
  21. If there is some time overlap available, time can be utilized by synchronous technologies to maximize synchronous exchange e.g. telephone, instant messaging, and video conferencing [18]. Thus work that has to be done independently is conducted during non-overlap time so that overlap time can be utilized in

- meetings, telephone conversations, problem resolutions, adjustments, and other actions [18].
22. Study in [18] also advise that it is very important to shift more work to non-overlap time so that synchronous meetings become more productive , and question for overlap time are prepared before that time [18].
  23. Team can also enlarge the overlap time by shifting and expanding work hours, like European staff may start late and work late so as to expand the overlapping period with their American counterparts [18]. On the other hand the American staff may start early in order to expand their overlapping period with their European counterparts [18].
  24. Some software organizations create a special character called liaison in their team members that helps to team member interact across sites [18]. To develop this character the organizations send its liaison member to particular sites for 2 to 3 month periods. There (s)he trained according to that particular sites environment than sent back to its own environment [18]. Now (s)he would serve as point of contacts for that particular site's developer [18].
  25. A set of practices that can help to create a common work environment for every team involved in the project shall structure a shared domain in order to perform successful collaboration [21]. We can achieve this goal by implementing adequate technological infrastructure (fast connection channels, modern communication tools, etc.) and achieving common understanding of goals, methods, tasks, moral and cultural expectations, by arranging socialization workshops [21].
  26. By using synchronous and asynchronous communication the temporal difference can be reduced [28, 3]. In case of greater temporal distance asynchronous technology is more supportive than synchronous technology [28]. On the other hand in some instance asynchronous communication is not as beneficial as synchronous communication it has not ability to convey information such as tone and speed of voice, body language facial information, pauses [28].

*Thus synchronous communication is more efficient and also helps to solve conflicts faster [28].*

#### 1. Results from Literature Review and Synthesis of Findings

Table V shows the obtained possible solutions against each related “delay factor”, gathered from research studies in order to answer research question 2 and also numbered above.

TABLE V  
RECOMMENDED SOLUTIONS FOR DELAY FACTORS GATHERED FROM

DELAY FACTORS	Solution provided by Research Studies	
	Fully Recommended	Partially Recommended
Inadequate overlap with	20,22,23	2,3,4,5,7

colleagues		
Delay of responses	4,10,11,22,23	2,3,7,8,9
People lose track of the overall work process	1,3,15	2,12,14,20,24,25
In the long run make people frustrated	4,6,8,9,10,11,12,15,20,25	2,3,7,26
Working very late or very early	4,7,9,20,22,25	2,3,11,26
Difficulty in finding concerned person	2,3,6,9,10,11	4,7,8,25
Co-ordination problem	1,2,3,14,17	4,8,12,13,25
Extensive monitoring of offshore sites	2,3,9,16	4,13,19,25

Note: Digits presented in Table V is not referring to the reference papers, it refers to bulleted numbers mentioned in above section from 1-26.

#### C. What Problems GSD Organizations Face Due to Which a Project Delay and Which Practices Have Been Applied Successfully in Industry to Overcome Time Delay Factors?

After the literature survey of peer reviewed articles, we conducted two case studies in pre-selected organizations to answer research question 3. Online interviews, exchange of emails and telephonic calls ensured the data collection process. All of the parameters are considered during interviews to get maximum data regarding our research project.

##### 1. Project: Workforce Evaluation Tool

The Workforce Evaluation Tool offers an online balance scorecard, helping users to assess changes in workforce practice. It enables organizations to calculate performance in four key perspectives—workforce, customer, service, and finance. The tool offers a visual representation of the performance in the aforementioned perspectives, and alerts best and the worst performance indicators.

Although, we were already in contact with organization, however, data collection process was not so easy since time was short and concerned person was unavailable. There was also a problem of lack of documentation. Although, the studied organization is ISO 9001:2008 and ISO 20000 certified, and also a Microsoft Gold Certified partner, it was observed that the organization is lacking to follow formal steps of software life cycle e.g. documentation and record keeping. An online interview was conducted in order to discuss the questionnaire and elicit some required information related to the delayed project. Interview session was of one hour long. Emails were exchanged later to remove any ambiguity from collected data. This information is then documented and arranged in a readable and understandable form.

Studied project was initially estimated for three calendar months to finish, but it delayed and actual time was four calendar months.

Organizational setting for this project was in such a way so that it was distributed between two locations (see Fig 2). The project activity distribution was organized as follows. Requirement engineering and deployment was performed in the onshore (UK) office, whereas designing, coding, technical writing and testing performed in the offshore (PAK) office. There was no specific designation for project manager explicitly in this project, and requirement analyst worked for project management activities as well. Fig 2 shows the pictorial representation of phases of the project.

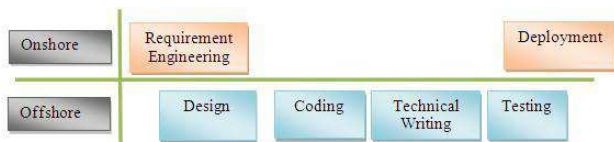


Fig. 2 Phase distribution – Project A

Following are the factors that might cause deviation for project A;

- Different time zones between on-shore and off-shore offices
- Delays in confirmations from the client's end. This was the biggest problem observed that might be a cause for delay in project. There were different issues related to this, such as;
  - o It was difficult to identify a single source of requirements. Since many people were involved on client's end, it causes problems to gather all of them for a requirement analysis session.
  - o Lack of cooperation and hesitation in sharing details from client's end was another issue in this regards. They usually found it difficult to spare sufficient time for requirement analysis phase.
  - o From Client side, no availability of alternate person in the absence of concern person
  - o Hesitation and resistance in signing off SRS documents.
  - o Client usually did not have clarity about their requirements hence they mostly liked to build the project incrementally, each release/version of the software was followed by the change request from Client. Clients liked to refine their requirements having seen something in operations (i.e. demo of the software).
    - Another factor was shared resource's availability issue in their PAK office. Such resources include DBAs, technical writers, graphic designer, test engineer etc.
    - Unrealistic project deadlines dictated by clients- Work pressure caused many mistakes, which took lot of time for corrections.
    - Unavailability of the concern person in a desired time.

#### Practices to overcome these time delay factors

During the interviews following practices were found which they are using to overcome time delays in projects.

- Teleconferencing
- Video Conferencing
- Awareness in remote participants and create a structured way to communicate
- Manager travels to offshore site
- Regular updates/feedback about the understanding of project
- Started documenting each process
- Late hours Working or come early

According to project manager, there were more practices than these, however, when we summarize we can manage them into above mentioned.

## 2. Project: Computerized account system

Computerized account system was an application for accounts system. It facilitated the organization in multi dimensional ways, such as record keeping, inventory, sales, reports etc. This project was built to convert the organizational manual account system into computerize. The client was using a manual record keeping procedure. The client decided to convert their manual record into computerized account system to get benefits from the modern technology.

This project was supposed to complete in four calendar months, but it delayed one and half calendar months. Therefore, the total development period of this project was five and half calendar months. We used same strategy as for project A for the data collection process. Experience from first interview helped us, so it took less time to elicit data from manager. According to manager, the team of this project consisted on six persons. During the interview, different issues and delay factors and how they overcome, were discussed. Data was collected according to the requirements of this research project. The authors then organized data and discussed all the ambiguities with concerned person through emails. This data was used for further process. Fig 3 shows the pictorial representation of phases of the project.

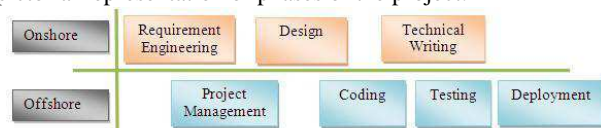


Fig. 3 Phase distribution – Project B

Following are the factors that might cause deviation for project B;

- Since the Requirements Engineering (RE), design and technical writing activities were at onshore site and project management, testing, coding and deployment were on the offshore site, so there were lot of communication tradeoffs between two teams. They consumed much of the scheduled time and communication cost.
- We also observed that the cohesion between the offshore team was high but there was lack of co-ordination with onshore team.
- Time zone difference was one of the reasons behind lack of co-ordination.
- No rich contact with the client.
- Large amount of time wasted on RE process because activities were divided in different locations.
- Unavailability of the concern person in a desired time.
- Delay in response between two sites.

#### Practices to overcome these time delay factors

- Teleconferencing
- Video Conferencing (Not that much)
- Manager travels to offshore site

## IV. STUDY RESULTS

### 1. Validity of Time Delay Factors

Table VI shows the validity of time delay factors gathered from literature with case organizations.

TABLE VI  
VALIDITY OF TIME DELAY FACTORS

Time delay factors when time zone is different	Literature	Case Industries
Inadequate overlap with colleagues	Yes	Yes
Delay of responses	Yes	Yes
Misunderstandings	Yes	Yes
Frustration	Yes	Yes
Working very late or very early	Yes	Yes
Difficulty in finding concerned person	Yes	Yes
Co-ordination problems	Yes	Yes
Extensive monitoring	Yes	No

## 2. Validity of Practices to Overcome Time Delay Factors

Table VII shows the relation of “practices to overcome delay factors” gathered from peer reviewed literature and case organizations. Manager travels to offshore site.

TABLE VII  
VALIDITY OF PRACTICES TO OVERCOME TIME DELAY FACTORS

Practices to overcome time delay factors	Literature	Case Industries
Awareness in remote participants	Yes	Yes
Appearance of member at centralized and using shared resources	No	Yes
Change management with proper documentation	Yes	No
Use of latest technologies	Yes	Yes
Create organization's own framework according to their needs	Yes	No
Face to face meetings onshore and offshore employees	Yes	No
Manager travels to other sites	Yes	Yes
“Bridge” communication	Yes	Not applicable
Tele and Video Conferencing	Yes	No

## V. VALIDITY THREATS

The case studies selected for this research project were distributed in Pakistan and England, where time difference between sites is not too much. Whereas, for the study of literature it did not consider, and time zone with large difference is also discussed. So, it would affect the validity of results and may vary when overlap timing between sites is low or none. So, for future studies, we recommend to select some GSD project organizations which are located in larger time zone difference. Moreover, the case organizations presented in this research study are consisted in two locations, whereas in literature review, problems related to multi site organizations is also discussed. So, it would also be another validity threat to our results. The studied projects in this study are related to web. So, another validity threat would be the nature of studied projects.

## VI. DISCUSSION (RECOMMENDATIONS AND SUGGESTIONS)

Analyzing the results gain in above research questions, this part will discuss the recommendations and suggestions. Be remembering that these recommendations and suggestions are based on above literature review and case studies. The time zone difference between different sites or organizations working on same project, cause delays in project. These delays might not be overcome completely. However, organizations should adopt such practices which reduce these delays. Such as;

- Organizations should create an awareness of working together with remote teams.
- Organizations need to use latest digital technologies to reduce communication problems. Although, these technologies would be expensive to use, however, on the other hand these would save a lot of over cost due to delays in projects.
- Managers should visit at least once to offshore sites, let say for project kick-off meetings at start.
- In this way, employees working at offshore sites would be more social with onshore.
- Tele conferencing is also to be very good in synchronous communication. So, it should be used if possible
- Video conferencing is supposed to be very good after face to face meetings. However, it has some negative impact such as one have to sacrifice his time for video conferencing and cannot do anything else while video conferencing.

## VII. CONCLUSION AND FUTURE WORK

The nature of GSD work is already make complex a project to complete. Furthermore, time zone difference increases the probability of delaying project from its due time. Studies in this research project have been explored that organizations are required to adopt and utilize some practices that are successfully working to overcome time delay factors. Some organizations should consider their global setting and design a central framework in order to reduce these delays. During this research project, it is also found that the problems which are reported in literature review are still lies in organizations practically. Whereas, all organizations are not using tools and techniques available to reduce these delay factors.

Studying the organizations with more than two sites with different time zones would be a future work for this topic. For example considering a project which is being executed between (Pakistan, Sweden and New Zealand) would be different than our results in this research paper or may lead these results towards more power. These three sites are temporally in different zones and some of them even do not have any overlap time with each other such as Sweden and New Zealand. The results gathered from this project would be interesting.



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