The Impact of "Formal channels" on "Informal Communication" within Distributed Software Development

Submitted by

Shehla Ambreen
Reg. # 157-FBAS/MSSE/F07

Supervised by

Mr. Muhammad Usman
Assistant Professor
International Islamic University, Islamabad

Co- Supervisor

Dr. Naveed Ikram
Associate Professor
Ripha International University, Islamabad

Faculty of Basic and Applied Sciences
Department of Computer Science and Software Engineering
International Islamic University, Islamabad
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In the name of Almighty Allah,

The most Beneficent, the most Merciful.

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Final Approval

It is certified that we have read the thesis, titled **"The impact of Formal channels for informal communication within Distributed Software Development"** submitted by **Miss Shehla Ambreen** Reg. No. **157-FAS/MSSE/F07**. It is our judgment that this thesis is of sufficient standard to warrant its acceptance by the International Islamic University, Islamabad, for the Degree of Master of science of Software Engineering.
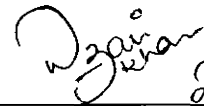
<u>Committee</u>

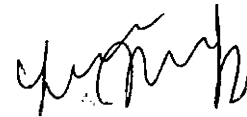**External Examiner**

Dr. Uzair Khan

Assistant Professor

NU-FAST, Islamabad
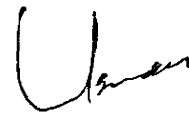
Internal Examiner

MS. Zareen sharaf

Acting chairperson DCS&DSE, IIUI

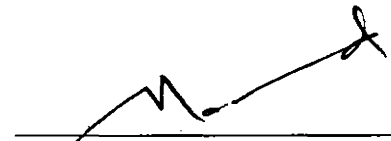**Supervisor**

Mr. Muhammad Usman

Assistant Professor, IIUI

Co- Supervisor

Dr. Naveed Ikram

Associate Professor RIU

i

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Dedicated To

To My Parents

Declaration

I hereby declare that this research, neither in part nor in full, has been copied from any source, except where cited; hence, acknowledged. It is further declared that this research, in its entirety, is a product of my personal efforts, under the sincere guidance of my supervisor. No portion of the work being presented herein, has been submitted to any other university, institute, or seat of learning, in support to any piece of writing for bestowment of any other degree of qualification.

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157/FBAS/MSSE/F07

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Abstract

Distributed software development (DSD), means software is developed in different location of same country but having the distance (difficulty of visiting). The software that is developed outside the country becomes global distributed software development. DSD has many challenges like coordination, communication and control in which communication is the major issue which effects both coordination and control. Informal communication is the main problem of distributed as well as global software development teams. Most of the encountered problems are due to lack of informal communication within DSD/GSD environment. In this research we have analyzed the impact of informal communication by using two Formal communication channels, because the existing Formal channels of communication help teams to communicate formally with each other. The Informal contact between teams is mandatory when teams are far from to one another. A field experiment is conducted within two distributed locations for developing software, by using two formal communication channels Text chat and video conferencing. The development teams have distance problem and they have problems related to visit each other. The experimental results proved that formal channels do not support informal communication within distributed environment.

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Chapter 1: Introduction

This chapter presents the introduction of research, its aim and objectives, expected outcomes and research methodology and thesis organization.

1.1. Distributed software development

Distributed Software Development (DSD) is evolving rapidly now-a-days. DSD means that teams and tasks are distributed across different geographic locations i.e. in different organizations within the same country or across different countries which became global distributed software development, for the development of software [1] [36][43] [44].

Distributed software development teams have become common, located at multiple sites and often in multiple parts of the world [43]. Instead of a team working in the same building, there may be several locations in which the managers, developers and testers operate, potentially separated by hours, miles and cultures from each other and from the customers or end users of the product [36][44].

The attractiveness of the concepts of global software developments are due to bigger markets with reduced development cost in case of low cost skill availability and access, cycle time as in *"follow the sun"* approach, different skill expertise, closeness to the end users [25].

DSD have many challenges like coordination, communication and control in which communication is the major problem which effects both coordination and control [27][28][45] [46].

1.2. Communication

In DSD environment, communication plays a key role for the project success; most of the problems are linked to Communication [48] mainly informal communication [1][6][8].

"Communication is the exchange of complete and unambiguous information— that is, the sender and receiver's a common understanding" [3]. Communication is of two types; *formal communication* and *informal communication* [4][36][49]. Both type of communication is necessary for software project development [15].
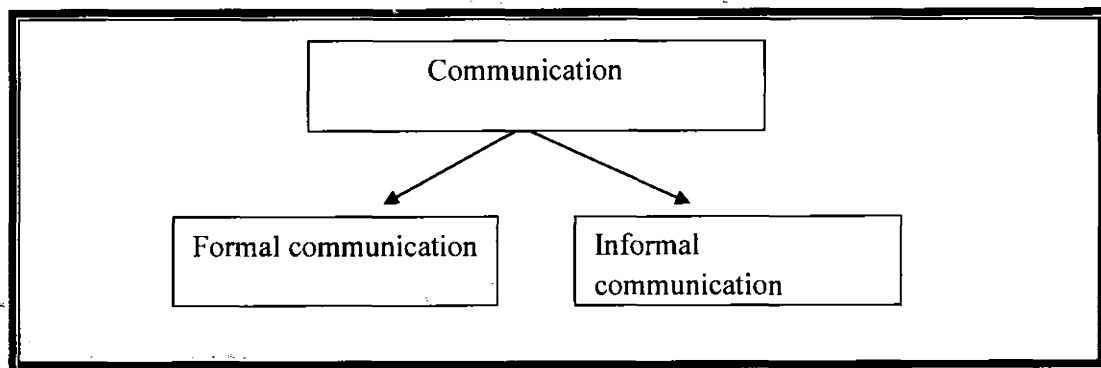
Figure 1.1: Formal and informal communication

1.2.1. Formal communication

Communication that is pre-planned, committed, scheduled by authority, with respect to time, place, and fixed agenda is called the Formal communication[4][12].

1.2.2. Informal communication

Informal communication is the one that is not in arranged. It is done randomly at any topic at any time between team members [4][12]. Following table differentiate between formal and informal communication [5][12].

Formal Communication	Informal Communication
Schaduled in Advance	Unscheduled
Arranged participants	Random participants
Present agenda	Emergent/unarranged agenda
One-way	Interactive
Mandatory	Optional
Authority Organized	Participants organized
Content focus	Experience focus
Impoverished Content	Rich content
Formal Language	Informal language
High cost	Low cost

Table1.1: difference between formal and informal communication

In the context of distributed environment, informal contact improves the relationships among team members. It helps in sharing information, improving coordination, transferring knowledge, identification and selection of particular expertise, problem solving, generation of new concepts, sense of team and trust among team members [9][10][12].

The existing Formal channels facilitate communication within distributed environment, but question arises, at which level these channels facilitate the informal communication among distributed teams.

1.3 Channel of communication

Channel is a medium that enable to communicate with each other (e.g. chat, forum, etc.)[11]

1.3.1   Formal communication channel

The formal channel of communication strictly follows the policies which are set by the organization [49] like e.g. different formal reports assignments, task deliverables etc. Due to geographical and physical separation, distributed software projects follow formal communication channels.

Hence, there is a need to explore to what extent the formal channels of communication facilitates informal communication between remote teams. So that communication lapses can be overcome in a situation where teams are geographically scattered.

1.3.2 Informal communication channel

This channel doesn't follow organization rules and policies. Informal channel works like a personal network without any limitations [49]. The informal communication channel exists in collocated software projects.

The existing Formal channel of communication allows teams to communicate with each other in a restricted and a formal way. Informal contact is mandatory when teams are far from one another .This informal contact helps in sharing knowledge/ information and develop trust among the remote teams. The motivation to undertake this research work is to identify which formal channels will support informal communication in DSD environment? And can informal communication be facilitated through formal channel of communication among the remote teams?

1.4. Research Aim

The aim of our research is to evaluate the impact of Formal communication channel in DSD to facilitate the informal communication among remote team's members. The purpose of our research question is to identify what is the Formal channel which would facilitate the informal communication during software development in a distributed setting.

The research question is as follows;

What is the impact of using Formal channels for Informal communication among the team members in DSD?

1.5. Research objectives

Although the significance of informal communication is general but it is not considered within GSD teams [37]. Informal communication is considered a negative activity and its impacts are ignored [34]. Even though informal communication is necessary for project teams,but it is completely absent.[9] viewing the impact of informal communication through formal channels is valuable as informal communication reduce background contextual misunderstanding and cultural language problems which are caused by lack of contact[15].

1.6. Expected outcomes

> ➢   Ambiguities, misunderstanding, risks will be reduced by implementing informal communication among teams.

> ➢   Better performance of teams and success rates will be increased.

> ➢   Strong relations will be developed as a single team which will be helpful for trust and dealing with risks and unplanned events.

> ➢   Satisfied some level communication needs and better coordination activities performance.

> ➢   Also this research will provide future direction; Informal communication will be considered as an important part of communication as well.

> ➢   Distance effect may be reduced at some level to implement the informal communication within distributed remote teams.

1.3. Thesis Outline

The remainder of the thesis is structured as follows;

Chapter 2 presents detail literatures review to the informal communication in Distributed Software development. It reports the analysis of informal communication its drawbacks', hurdles, values in distributed remote teams.

Chapter 3 presents the proposed research methodology of Experiment and its process of complete execution.

Chapter 4 reports an Experiment validation process. The chapter provides introduction to the implementation of experiment, experiment design and results of the experiment.

Chapter 5 provides the analysis of experimental results and their graphical representation.

Chapter 6 provides the conclusion by discussing the contribution of the thesis and how the findings of an experiment answer the research question presented in the first chapter and future work.

Chapter 2: Literature Review

This chapter presents in detail the software distributed environment, communication within Distributed Software Development also in Global Software Development, types of communication and detail literature review about informal communication, its role and importance, barriers within Distributed Software Development, communication channels and their selection for our research.

2.2. Communication in DSD/GSD

Communication should be two way process, needed as for clarity of misunderstandings, ambiguities and building the equal common ground for all. Communication skill can be build and improved[11]. Communication is necessary part of any project development but become critical in distributed development environment due to lack of face to face contact and distance involvement [27].

For any successful software projects development, desire for communication is vital. Both type of communication is necessary among cross teams for developing projects i.e formal and informal. Formal communication is required to maintain management control level, task completion within time period, responsibilities fulfillment, proper flow of work activities [8] and informal communication is required to maintain healthy relations among remote teams, knowledge about each other activities and area of expertise, and background information that tight them as a single team [8] lack of informal contact lead to misalignment and rework[8].

2..1.1. Formal communication

Formal communication is necessary for focusing on work, routine flow of activities, work completion, for making decisions and planning, regular coordinating, Transactions and for control management of completing the projects.[12][15] But using only formal mechanisms such like different specification documents/ artifacts for needed information is not enough because it has some problems with it i.e., which of the documents provides the required information, it may be updated and ambiguous or linked with one another and also time consuming to read and understand documentation.[6] Formal communication cannot update as early as required and have no quick response when change will occur. It fails in novel and/ or uncertain situations [20]

Depending upon only using formal mechanisms such as different specification documents/ artifacts for needed information is not enough because it has troubles like which document is provided the required information, it may be updated and ambiguous or linked with another one and also time consuming to read and understand documentation [6].

Characteristics	Formal communication	Informal communication	Source
Situation	Regimented, deliberate, impersonal	Casual, spontaneous, interpersonally familiar	Morand (1995)
Commitment	Higher for topic then for relationship	Higher for relationship then for topic	Mead (1990)
Credibility of contents	High	Low	Johnson *et al.* (1994)
Style	Reports, briefing etc	Ad Hoc conversations, memos etc	PMI (2000)
Speed	Slow	Fast	Mullins (1999)
Accuracy	High	Low	Mullins (1999)

Table 2.1: Difference between formal informal [53][62]

2..1.2. Informal communication

In distributed software development environment communication becomes challenging within remote teams in general and informal communication in particular [23][6][9][19]. There is no doubt about the key value of informal communication [12]. Everyone considers the essential role of informal communication within distributed environment of software development [13]. The physical distance makes it difficult for distributed team members to communicate informally, but is an integral part of collocated team communication that raises their mutual awareness, while in GSD settings mutual awareness is lacking in developers because of less informal communication and therefore has difficulty in establishing trust [54].

Informal communication is spontaneous, interactive and expressive in nature, it has rich contacts and is more frequent[14][15]. Through the Informal communication the sense of tameness' and trust is developed between teams because when there is direct communication link between remote teams they feel themselves the part of same team and trust each other. They can also share everything with one another which is helpful in the success of the project[1] Casual/informal conversation increases the contacts among people which is the base of knowledge, better and faster information passing and the process of feedback and socializations.[16] Due to the frequent, interactive, and expressive nature, the informal communication is very helpful in novel, uncertain situations.[14][15]Informal contact is necessary between distributed teams because it is an important means of implicit knowledge, shared understanding and good working relationships and quick response feedback within remote teams [12] [15] Informal communication is very helpful in rapidly resolving the conflicts due to strong relationships among distributed remote teams because informality has the awareness of other team's member activities, experiences, expertise's and problems.[13] so conflicts are easily identified and then resolved because of shared contextual information among cross sites teams [13] The speedily evolving information among cross teams are due to strong connection bonds which are build through informal contacts.[13]

But informal communication is reduced due to some barriers like physical, geographical and culture distances [6][15]The informal communication inserts/puts direct innovation during software development process when there is a need to spread any news/information rapidly between remote members [26] When teams have informal contact with other remote colleagues they are aware of their work and expertise of one another and know about the issues on the daily basis. Little changes are identified and corrected earlier. Without friendly relations between teams, they don't know what has happened at another remote side [15]

During research and software development informal communication has been seen as far more significant because of two reasons [15]

    a)   Research and development is a communicative area where lots of collaboration and coordination is needed.[15]

    b)   Ambiguity and uncertainty level is high.15]

Mode of comunication	Informal ⟶ Semi-formal ⟶ Formal		
Frequency	Daily	weekly	monthly
Media	Personal	personal And email	written
Reasons for communication	Surprise avoidance		
	Trust building	Control enhancement	

Figure 2.1: model for communication migration [33]

The essentiality for informal communication is that the communication through formal channels are time consuming and one way like progress reports to the management and specification documents which does not satisfied communication desires of teams.[7]

Informal communication is required for facing the uncertainty, reduced complexities and misunderstandings, building social relations [7][15] But distance is the main barrier to avoidance of the informal communication[14]

2.2. Communication channels

The main channels that are used for communication are formal channels that are work within the organization policies like structures meetings[[7] and informal channels like personal networks.[7][49][11]

2.3. Communication channels used in DSD&GSD

Globally distributed teams generally and frequently use formal channels for communication such as Specification Documentation, Email and Scheduled meetings, communication during software development due to geographical separation and culture diversity. [2][30][3][35][50] Due to lack of informal communication within distributed teams,

these formal channels are failed to incorporate the happening of unplanned events and unexpected change [7][15][18].

2.4.   Formal communication channel Selection

I have selected two formal communication channels Chat and Scheduled video meeting (Videoconferencing (VC)) [50] As in following table [52]

Name: Brian			Nov 9th
Location: Qttawa			
Work Item	**Contact Person**	**Reason of Communications**	**Media used**
Bug 0001	Trish	Update of the module one development	Email
	Fabio	Coordination of the implementation	Phone
	Chris	AOI issues and semantic Checks	Face to face
Bug 0002	Florian	Discussion and comments about new proposal	Chat

Table 2.2: Excerpt from the interaction log provided by Brian for Nov 9th

2.6.1   Text chat channel

Chat can be used as a formal channel [12] Text chat can support informal conversation [12][51].

Figure 2.2: Emoticons from MSN Messenger

2.4.2   Scheduled Video conferencing

Video communication support face to face contact at a distance and visually oriented to maintain the frequency and interaction.[14] Due to valuable of face to face communication and supporting the informal communication medium.[15] I have selected VC as a formal channel for informal communication for viewing the impact in my experiment.

2.5.   Variable selection

The dependent variables are formal channels and independent variables are frequency of communication [15] which is measure of considering the impact of informal communication [15]

2.5.1   Dependent variable

The dependent variables that I have selected are formal channels like Text chat channel and Videoconferencing channel due to their nature and supporting the formal and informal communication.

2.5.1.1 Text chat channel

Chat is lightweight favorable channel and support formal and informal both type communication [15][47][22].

2.5.1.2 Scheduled video meeting channel

The communication channel have little effects on flowing communication process due to its nature.[15] video channel is face to face, interactive nature and richer in contact.[15][22]

2.5.2   Independent variable

The independent variables are communication frequency [15] and communication openness.

2.5.2.1 Communication Frequency

Frequency of communication is measured by the total interaction of the students within total time. [40]

Physical distance has enormous effect to reduction of communication frequency, when distance involve among development teams they face the lack of frequency communication problems. [9][23]

Frequently communication during the software development is more valuable that it build the strong and healthy relations among peoples, knows and favor about communication styles of each other, trust building and understanding sharing.[55] The awareness is crucial for distributed project development teams, which is produced by communication frequency is the result of informal communication [46]

Formality decreases when frequency of communication increases due to low distance [15][23] and its move to the informal communication as it is greater in frequency.[14][15]

2.5.2.2 Communication openness

Communication openness is the message sending receiving behavior.[42][45]communication openness related to positively exchange information and healthy relations which can be helpful to reduce unexpected bad events and trust building.[41][42] openly sharing of information among teams.[21] it can be measured by following factors[45]

1. Supervisors/leaders of team ask for suggestions

2. Supervisors/leaders of team acts on criticism

3. Supervisors/leaders of team listens to complains

4. people ask Supervisors/leaders of team opinion's

5. Supervisors/leaders of team follow up on people opinion's

6. peoples follow up Supervisors/leaders of team new ideas

7. peoples ask coworkers for suggestions

8. Supervisors/leaders of team listen to bad news

9. people's listen to new ideas from coworker

10. Supervisors/leaders of team listen to new ideas

11.   Supervisors/leaders of team follow up on suggestions

12.   Supervisors/leaders of team ask for personal opinion's

13.   peoples listen to Supervisors/leaders of team suggestions

Reason for why use formal channel for informal communication

As teams in DSD are distributed across the world, it makes informal communication hard to carry out due to distance and different cultures diversity [9]. Most of the organizations when involved in DSD for the first time they often drastically underestimates the impact of using geographically distributed teams. One reason behind this is that the extent to which people in collocated environments rely on informal communications to develop software was un-noticed and now under-recognized. The most noticeable and important reason for the absence of informal ad hoc communication is distance involved amongst the co-workers. Due to this remote co-workers have rarer opportunities to interact. The organizational arrangement in DSD results in sense of isolation, loss and detachment, reduced visibility especially as it relates to promotion opportunities, and compromised feelings of belonging. Despite the need for communication, informal interaction has often been treated as a disruptive and/or negative force, e.g., using organizational e-mail systems for personal messages on company time [38]

The only way to conduct informal communication is to use formal channel for informal communication. That's why I want to facilitate the informal communication through an existing formal channel. To do this I have to find out which formal channels will facilitate informal communication during DSD settings if we use formal channel for informal communication

Chapter 3: Proposed methodology- An Experiment

This chapter presents the proposed research method and its overall process of implementation procedures in detail. A DSD environment is such an environment where there is no direct, face to face communication and physical distance of 30 meters exists between teams location [36][38]. They communicate through web based technology; the work is distributed between different sites of (same country) in DSD environment [36]. The proposed research methodology will be a *Quasi-Experiment*. We selected Quasi-experiment because it's near to field settings having less control over the environment; it has low biasness during sampling and demonstrates the cause-effect relationships. We want to see the impact of using formal communication channels for informal communication during DSD developments so we selected Quasi-experiment due to the reason that case study is not feasible option for the fact that global software development teams are not available. Since case study requires studying phenomena in real world settings but due to lack of resources a real world scenario is not possible to be studied in our context.

The environment of our Research Experiment is real DSD environment as our teams are from two different universities of Pakistan; let's say university A and university B. The teams have difficulty of face-to-face communication as they are physically distributed from one another. They use web based technology for communication e.g. text chat and video-conferencing.

3.1   Proposed Research Methodology

On the basis of existing literature review; the problem which is found is the reduced or lack of informal communication among distributed software development teams. So the research problem arises that what would be the impact of using Formal communication channels for informal communication [10][25]. Due to the significant of informal communication in GSD we want to see that is it possible to facilitate the informal communication through formal communication channels. This question will be answered by conducting a Quasi- experiment. We have selected Quasi-experiment as a research methodology. A case study is not feasible

option for me due to fact that global teams developing software are not available. Since case study requires studying a phenomena in a real world settings due to lack of resources a real world scenario is not possible.

3.2 *Selected formal channels for experiment*

The dependent variables for my experimentation are formal communication channels and independent variables are frequency of communication [9] and communication openness.

1.	Research methodology	Quasi-experiment
2.	Hypothesis	Research hypothesis: Formal communication channel facilitates Informal communication among the DSD remote team members Null hypothesis: Formal communication channels do not facilitate the informal communication within DSD teams.
3.	For testing hypothesis we set	Ho: Average number of conversations for two groups is same. H_1: Average number of conversations for two groups is not same.
4.	Subjects	Undergraduate students
5.	Object	Distributed software development
6.	Dependent variables	Formal communication channels (Chat,VC)
7.	Independent variables	Communication frequency, Communication openness

Table 3.1: Research design

3.3   Experiment Design

The experiment will be conducted in a distributed software development environment setting in Pakistan. We select two universities of Pakistan (university A and university B). The formal channels (which will be used during the experiment) are Chat formal communication channel and video conferencing (VC) formal communication channel. The daily 2 hour distributed meeting time is decided for evaluation of both formal communication channels for informal communication using A&B groups. A web based project called "IIUTUBE" was selected for development during the experiment. Skype tool will be used on both distributed sides for communication and all communication will be through Skype. The independent variable manipulated by this research is formal communication channel o and dependent variable is communication frequency and communication openness.

During the treatment; members of Group-A communicate with each other working on the project "IIUTUBE" using only scheduled video conferencing formal channel. Members of Group B communicate with one another working on the project "IIUTUBE" using only text chat formal communication channel. Results are compared on the basis of treatment.

Teams group	IIU Team	RIU Team	Software Project	Tool	Channels	Time/per day
A group	5	5	IIU website	Skype	VC	1-2 hr
B group	5	5	IIU website	Skype	Chat	1-2 hr
Total	10	10	IIU site	Skype	Chat+VC	

Table 3.2: The design Table

3.4   Sele

3.4.1   Sample selection

For the experiment we randomly select the sample; that were students of software engineering and computer science department of two different universities of Pakistan. They belong to same background and have same knowledge level. Criteria used for sample selection is shown in Table 3.3. The students of BSSE & BSCS were selected based on their knowledge and experience in PHP.

S.N.	Parameter	Criteria
1	Groups	Two A(A1,A2) and B(B1,B2)
2	Status	Undergraduate students
3	Selection	Random selection
4	Semester	7th and/or 8th semester students
5	Experience	PHP, Skype
6	Members	20 members

Table 3.3: Selection Criteria

3.4.2 Introduction of Student Groups

Two main groups (A, B) were formed. Each group was geographically distributed into further two sub teams. Each group consists of 10 members i.e. team leads, developers and testing team. Group members remained same throughout the experiment. The both distributed development teams selected their team leader by themselves.

Group A: Group A has two Teams (A1, A2). Group A have 10 members. Team A1 has 5 members. Team A2 has 5 members too. Each team has the roles of leader,

developer and tester. According to these roles there was 1-leader, 2-developer and a tester.

Group B: Group B also has two Teams (B1, B2). Group B has 10 members. Team B1 has 5 members. Team B2 has 5 members. Each team has the roles of leader, developer and tester. According to these roles there was 1-leader, 2-developer and 2-tester.

Groups	Group A (A1.A2)	Group B(B1.B2)
Leader	2	2
Programmer	4	4
Tester	4	4
Total	10	10

Table 3.4: Composition of distributed groups

Groups	Group A	Group B
Using Video channel	Yes	No
Using text chat channel	No	Yes

Table 3.5: Difference between groups

3.4.3 Role of experimenter

The role of experimenter exists for both the distributed teams. Experimenter will observe the teams during the experimentation. This will also brief the leader about the project and other detail of experiment. Experimenter gives the brief presentation to team including

project detail, execution of experiment, working plan. At the end of experiment results are collected.

Days	Roles	Responsibilities	Members	Working hours
Tuesday	Distributed teams leader	Design the website	Leaders	2 hr
Wednesday	Distributed development team	Coding	developers teams	2 hr
Thursday	Distributed development team	Coding	developers team	2 hr
Friday	Distributed Testing teams	Testing	testers teams	2 hr
Saturday	Distributed teams	Documentation	Teams	2 hr

Table 3.6: Team setup and roles and responsibilities team members (from both universities)

3.5   Introduction to project

Teams develop a website project for IIU. This web development project was carried out by the undergraduate students of two Universities "Group-A" and "Group-B" who are the students of 7th semester of BSSE (software Engineering) and BSCS (computer science). The "IIUTUBE" project is an informatics website. It provides a platform for the user to view, download, upload and share contents to some specific members. Members can upload and share pictures, lectures and different documents related to IIUI.

Name of project	IIUYUBE
Project type	Web development
Project work	Design, implement and test
Duration	Approximately: 1 week

Table 3.7: Following table presents the detail of project.

3.6   *Selected formal channel*

Two channels are used during the experiment text chat[22] and video Confrencing[22]

Text chat: one group participants were told that they would be able to chat with other distributed group participants during the meeting. All participants were aware that their chat was being recorded.

Scheduled video Conferencing: all participants were aware that their comments/conversations were being recorded.

3.7   *Introduction to tool*

During the experiment the tool used for communication purpose from both sides is Skype. Skype is used because of its good features, popularity, usability and ease of use. Students are well familiar with Skype. Skype provides both features which I require for my experiment i.e. group chat and video conference call. Skype provides good quality group audio video and group text chat. Camtesia screen recorder was used for recording purpose.

A Group

B Group
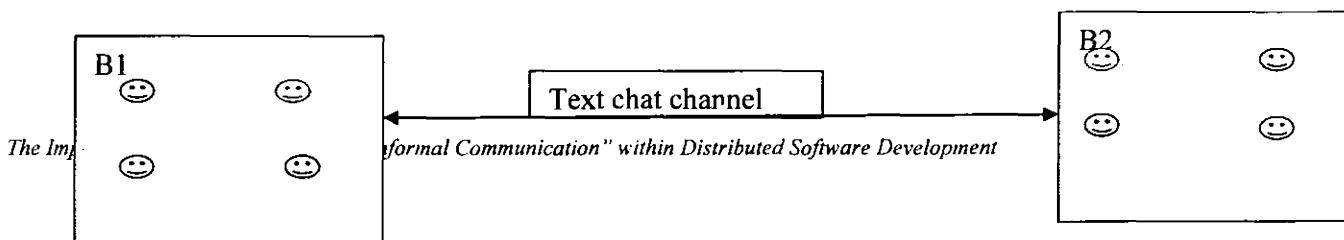
Figure 3.1: Team setup

3.8   Constraints

Following steps are necessary in order to achieve the objectives of the experiment.

1.   Students will strictly follow only formal channels for communication which are defined initially by the experimenter.

2.   No other means for communication can be used.

3.   All communication will be recorded for analysis and to ensure authenticity of communication results.

4.   The subject's were 18 undergraduate students who volunteered to take part in the experimentation, after giving informed approval.

3.9   Experiment implementation process

This experiment will be conducted using university laboratory machines on a LAN network. For video meeting we will use Skype and camtasia screen server for recording purpose from a server on the LAN network. For text chat Skype will be used.

3.9.1 Briefing session: The Experimenter will brief about the experiment execution plan to leaders. After the briefing session SRS will give the leader and both the groups for web site development. All communication will be through Skype and will be recorded for comparisons of the results. Both the groups will work daily on parallel basis. A brief experiment execution plan and SRS will be provided by the experimenter to both group's team leaders before starting the experiment. After receiving the requirements they will start working on the IIUTUBE project.

3.9.2 Treatment: During the treatment on the 1st day of the experiment there will be meeting between the leaders of distributed teams. Leads of Group A&B will contact to each other and

introduce their teams to one another and plan to divide work among them clearly. Both the leaders will discuss the work and divide according to their own settings. After division of the work both teams will start working on project using formal communication channel for all types of communication. They are only allowed to use Skype for all communications. Their communication will be recorded, saved, retrieved for comparison and analysis of the results. In this experiment both teams will discuss each and everything related to the project. At the end of experiment leader will hand over all recordings to experimenter. Parallel working of both groups should be on the daily basis. During the whole project both distributed teams fully communicate to one another whenever they needed/required. The following tasks will be performed by distributed teams during the experimentation.

Task -1:	Task -2:	Task -3:	Task -4:
Introduction	Analysis,	Coding	Testing
Work division	design	User management	
Design work division	domain model	Document management	Artifacts
Modules division	system sequence diagram	Picture management	
		Notification management	
	sequence diagram		
	class diagram		
	ERD		
	Artifacts		

Table 3.8: Task distribution

3.9.3 Working Process: At the starting of 1st day leaders of both distributed teams meet and introduce their teams to one another, also both discuss with their whole team like developers and

quality team members and finalize IIUTUBE work division of project e.g. design part and modules etc. So then they can design the IIUTUBE at the end of 1st day. At the 3rd and 4th day the developers of both teams (A+B) will code the design and complete the development process. 5th day the testing team of A and B test the IIUTUBE for working and different artifacts. During the whole project both distributed teams fully and openly communicate to one another whenever they need/require using formal channel of VC for any type of communication.

Days	Task assignment	Groups A.B teams	Time
Day 1	Task -1	A+B teams	2 hr
Day 2	Task- 2	A+B teams	2 hr
Day 3	Task- 3	A+B teams	2 hr
Day 5	Task -4	A+B teams	2 hr

Table 3.9: Task assignment table

3.10 *Measurement and Analysis:*

The measurement process will be on the saved Chat history and VC Data Recording. Data Analysis will be on the basis of all saved, recorded data. We examined chat archives and recording for frequency of interaction and communication openness. The data analysis will focus on qualitative aspects of the project team's communication. I will study and evaluate the communicating remote teams all VC and chat sessions in distributed software development. The data sources are used in this research come from VC, Chat sessions from members of communication teams.

Communication Frequency will be measured: Communication frequency is the number of interaction per time. [40] We will measure the frequency of communication of the both groups according to the interaction per hour as per day of meeting.

Frequency is= total no. of students interaction per hr on the daily basis.

Frequency of communication	Day 1	Day 2	Day 3
Total interaction/per hr		.	

Table 3.10: Communication Frequency table

Communication Openness will be measured: Communication Openness is the sending and receiving behaviors' to each other [42][45] we will measure the openness of communication of the both groups according to the defined parameter as both groups per day of meeting. Communication openness factors:

1.   Supervisors/leaders of team ask for suggestions

2.   Supervisors/leaders of team acts on criticism

3.   Supervisors/leaders of team listens to complains

4.   people ask supervisors opinion's

5.   Supervisors/leaders of team follow up on people opinion's

6.   peoples follow up Supervisors/leaders of team new ideas

7.   peoples ask coworkers for suggestions

8.   Supervisors/leaders of team listen to bad news

9.   people's listen to new ideas from coworker

10.   Supervisors/leaders of team listen to new ideas

11.   Supervisors/leaders of team follow up on suggestions

12.   Supervisors/leaders of team ask for personal opinion's

13.   peoples listen to Supervisors/leaders of team suggestions

Communication Openness factor	Day 1	Day 2	Day 3
1. Supervisors/leaders of team ask for suggestions			
2. Supervisors/leaders of team acts on criticism			
3. Supervisors/leaders of team listens to complains			
4. people ask Supervisors/leaders of team opinion's			
5. Supervisors/leaders of team follow up on people opinion's			
6. peoples follow up Supervisors/leaders of team new ideas			
7. peoples ask coworkers for suggestions			
8. Supervisors/leaders of team listen to bad news			
9. people's listen to new ideas from coworker			
10. Supervisors/leaders of team listen to new ideas			

11. Supervisors/leaders of team follow up on suggestions			
12. peoples listen to Supervisors/leaders of team suggestions			
13. Supervisors/leaders of team ask for personal opinion's			

Table 3.11: Expected communication table

Chapter 4: Results

This chapter presents the results reported from experimentation. The proposed method for considering the impact of informal communication within DSD by using formal channels was validated by an experiment. An experiment was selected as a validation method because this method is suitable for considering our research as we want to see the impact of using formal channels of communication for informal communication during DSD developments so we have selected Quasi-experiment.

The results obtained from implementation of field experiment are presented in the following sections.

4.1   Data collection procedures

The data was collected from student groups recorded chat history and recorded videos of the daily meetings of the experimental results.

4.1.1 Analyses Chat history/transcripts

For analyzing purpose we recorded 4 chats sessions from the experiment. All postings (sending and receiving messages) from these chats sessions were collected and analyzed to determine frequency/interaction of distributed student's teams and communication openness. We analyze the chat history of both distributed team student's daily meetings for communication frequency and communication openness results. For analyzing purpose we read all chat as line by line. [32] The data is read and reread several times. And assigns the code to each line for analysis and references purpose.[22][24] we determine whether students were using textual elements to express feelings, akin to nonverbal communication in face-to-face chat, and students expressed their feelings as much as they would in normal conversation by using text chat channel. Of the raw data collected by experiment we used 3 chat sessions, containing 1147 chat messages in total (total participants involved in the text chat range from 1 to 10) who were not collocated.

For example

56. Ali raza: we both design all five and chose one of best

57. Ali raza: for example

58. hafiz umer: yes ali its good option

59 Ali raza: tomorrow we both will design domain model

Recorded Chat transcripts on the daily basis of both groups teams are showed at the end of thesis.

4.1.2 Analyses Video meetings recordings

To analyze the video data first of all I transcribe it into written form. After carefully listening and viewing the students meeting recordings are transcribing into written form for analysis purpose. Video transcription is a time consuming and difficult process.[29] and then apply the above chat analysis process. All recorded video data presents at the end of thesis. This experiment was conducted using university laboratory machines on a LAN network. We will use VLC Player to play stream videos. All participants were aware that their comments were being recorded.

4.1.2.1 Manual transcribing process

The process for transcription is manual. Watch and Listen videos carefully to transcript data and this process repeat again and again. The videos transcripts data is showed at the end of thesis

4.2   Validation Results

We can see the distributed team's communication frequency and openness experimental results in the following table's results.

- Communication Frequency results of Group A&B form experiment
- Communication openness results of Group A&B from experiment

4.2.1 Communication Frequency of group A&B

The communication frequency is measured from students chat and video transcripts of both groups according to the formula *"total interaction of students per hour"* and results are shown in the following table

Frequency of communication of group A&B	Day 1	Day 2	Day 3
Total interaction/per hr Group B	80.5	295	122.5
Total interaction/per hr Group A	81	102	74

Table 4.1: Frequency of both groups

4.2.2 Communication Openness of group A&B

The communication openness is measured from students chat and video transcripts of both groups according to the factors as mentioned in chapter 3 and results are shown in the following table

Openness factor of A group	Day 1	Day 2	Day 3	Day 4
1. Supervisors/leaders of team ask for suggestions	6	3	6	0
2. Supervisors/leaders of team s acts on criticism	4	3	3	
3. Supervisors/leaders of team listens to complains	4	5	0	0
4. people ask Supervisors/leaders of team opinion's	13	2	4	0
5. Supervisors/leaders of team follow up on people opinion's	6	3	2	0
6. peoples follow up Supervisors/leaders of team new ideas	0	0	0	0
7. peoples ask coworkers for suggestions	3	11	2	0
8. Supervisors/leaders of team listen to bad news	0	0	3	0
9. people's listen to new ideas from coworker	0	3	0	0
10. Supervisors/leaders of team listen to new ideas	0	0	2	0
11. Supervisors/leaders of team follow up on suggestions	3	3	4	0
12. peoples listen to Supervisors/leaders of team suggestions	6	5	9	0
13. Supervisors/leaders of team ask for personal opinion's	10	12	17	0

Total	55	50	52	

Table 4.2: Openness of communication for video group A

Openness factor of B group	Day 1	Day 2	Day 3	Day 4
1. Supervisors/leaders of team ask for suggestions	5	2	6	1
2. Supervisors/leaders of team acts on criticism	4	4	10	1
3. Supervisors/leaders of team listens to complains	1	1	3	0
4. people ask Supervisors/leaders of team opinion's	0	3	2	5
5. Supervisors/leaders of team follow up on people opinion'	1	6	5	15
6. peoples follow up Supervisors/leaders of team new ideas	0	0	1	0
7. peoples ask coworkers for suggestions	4	14	7	6
8. Supervisors/leaders of team listen to bad news	1	0	0	0
9. people's listen to new ideas from coworker	4	4	3	1
10. Supervisors/leaders of team listen to new ideas	2	0	1	0
11. Supervisors/leaders of team follow	5	2	10	2

up on suggestions				
12. peoples listen to Supervisors/leaders of team suggestions	6	8	10	2
13. Supervisors/leaders of team ask for personal opinion's	4	7	12	5
Total	37	51	70	

Table 4.3: Openness of communication for text chat group B

Chapter 5: Results Analysis

This chapter presents the graphical representation of experiment results and statistical analysis for validation. In order to determine the difference between two formal channels Chat and videoconferencing, we have applied a statistical Student "T-test" on the results data. The T-test is used for comparison between two groups or things. The graphical representations of results are shows as following:

5.1   *Graphical Representation of Experiment Results:*

The frequency of communication and communication openness comparison of both groups are graphically presented[22] below

5.1.1 Communication Frequency of teams

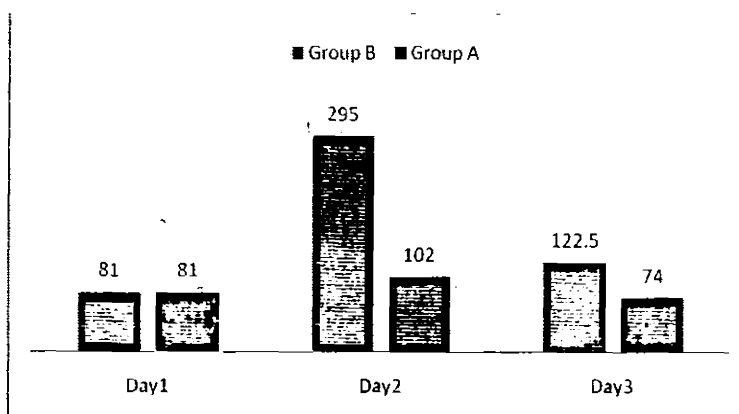| Frequency of group A&B	Day1	Day2	Day3
Group B	81	295	122.5
Group A	81	102	74

Table 5.1: Frequency table

Figure 5.1: Communication frequency per hour

5.1.2 Communication openness of distributed teams:

Total Openness of groups A&B	Day1	Day2	Day3
Group B	37	51	70
Group A	55	50	52

Table 5.2: Communication Openness table
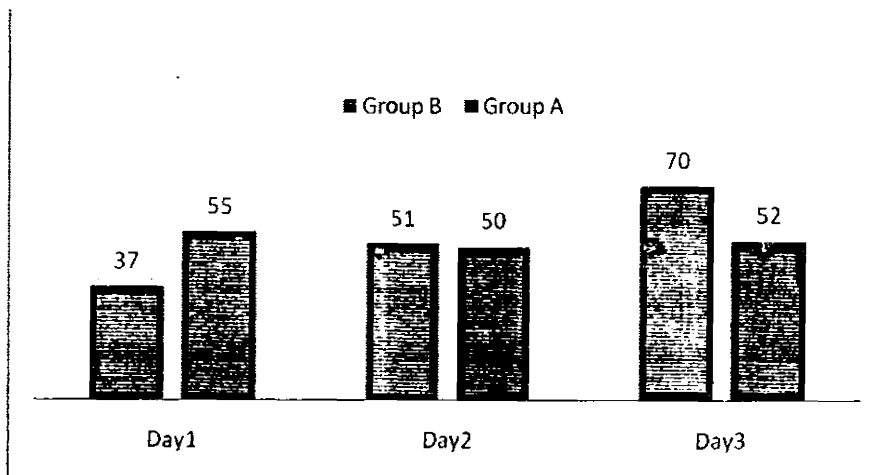
Figure 5.2: Communication Openness per day

5.1.3 Communication openness factor between groups A&B

Openness factors for 3 days	Group B	Group A
Supervisors/leaders of team ask for suggestions	14	15
Supervisors/leaders of team acts on criticism	19	10
Supervisors/leaders of team listens to complains	5	9
people ask Supervisors/leaders of team opinion's	10	19
Supervisors/leaders of team follow up on people opinion's	27	11
peoples follow up Supervisors/leaders of team new ideas	1	0
peoples ask coworkers for suggestions	31	16
Supervisors/leaders of team listen to bad news	1	3
people's listen to new ideas from coworker	12	3
Supervisors/leaders of team listen to new ideas	3	2
Supervisors/leaders of team follow up on suggestions	19	10
peoples listen to supervisors suggestions	26	20
Supervisors/leaders of team ask	28	39

for personal opinion's		

Table 5.3: Communication openness factor between A & B
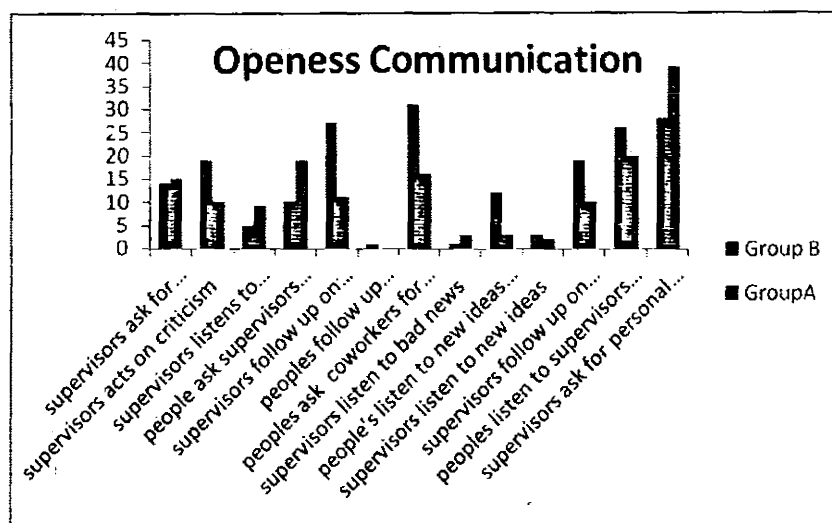
Figure 5.3: Openness communication

5.1.4 Communication Frequency and Openness's of groups
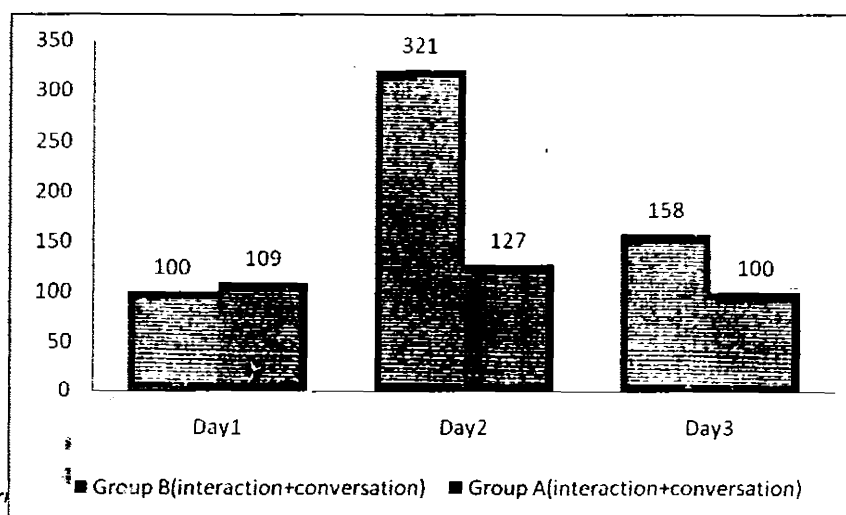
Figure 5.4: communication frequency and openness of groups

5.1.5 Comparison between groups A&B
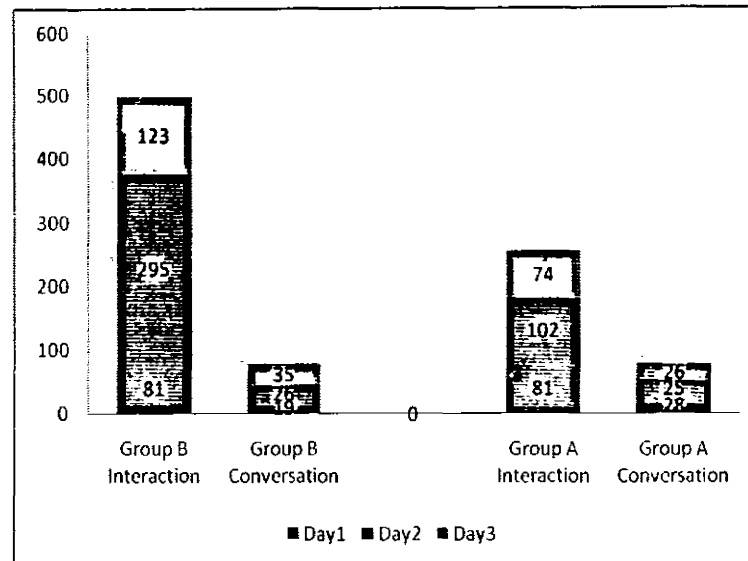
Figure 5.5: Comparison between A & B

5.2   Hypothesis Testing

5.2.1 Students T-test

In order to determine the difference between two formal channels Chat and video conferencing, we have applied a statistical student "T-test" on the results data. The T-test is used for comparison between two groups or things. After the experiment result data is collected from group A&B as shows in tables 4.2 and 4.3, is used for t-test to obtain the mean, variance, size, degree of freedom and P-value for validating the hypothesis. We use only 3 days data for testing because some data are missing and not correct so will not be considered.

For successful comparisons from student t-test application we have establish the following hypothesis.

Null Hypothesis: Ho: Average number of conversations for two groups is same.

Alternate hypothesis: H_1: Average number of conversations for two groups is not same.

The Level of significance: $\alpha = 0.05$ is used.

Critical region: If p-value $\leq \alpha$ (=0.05) then we reject the null hypothesis H_o, and accept the alternative hypothesis H_1.

5.2.2 Hypothesis T-Test of Day1

For successful comparisons form T-test application we have establish the following hypothesis.

Null Hypothesis: Ho: Average number of conversations for two groups is same.

Alternate hypothesis: H_1: Average number of conversations for two groups is not same.

The Level of significance: $\alpha = 0.05$ is used.

Critical region: If p-value $\leq \alpha$ (=0.05) then we reject the null hypothesis H_o, and accept the alternative hypothesis H_1.

Test: Two-Sample Assuming Equal Variances		
Day1	*Group B*	*Group A*
Mean	2.846154	4.230769
Variance	4.307692	16.19231
Observations	13	13
Pooled Variance	10.25	
Hypothesized Mean Difference	0	
DF	24	
t Stat	-1.10262	

P(T<=t) one-tail	0.140564	
t Critical one-tail	1.710882	
P(T<=t) two-tail	0.281129	
t Critical two-tail	2.063899	

Table 5.4: T-Test of Day1

'A two tailed t-test was performed for two independent samples with equal variance to test the difference in means. For computing the P-value, excel formula of t-test used, which calculate the mean, variance, degree of freedom value and p value. The p-value of day 1 is (0.0.281129) ≥ 0.05. So we accept the Ho. This shows that the average conversations for both groups are equal. The overall test for differences in means was not significant at any level of significant as p-value ≥ 0.05

5.2.3 Hypothesis T-Test of Day 2

For successful comparisons form T-test application we have establish the following hypothesis.

Null Hypothesis: Ho: Average number of conversations for two groups is same.

Alternate hypothesis: H_1: Average number of conversations for two groups is not same.

The Level of significance: $\alpha = 0.05$ is used.

Critical region: If p-value $\leq \alpha$ (=0.05) then we reject the null hypothesis H_o, and accept the alternative hypothesis H_1.

t-Test: Two-Sample Assuming Equal Variances		
Day 2	*Group B*	*Group A*
Mean	3.923077	3.846154
Variance	16.24359	14.30769

Observations	13	13
Pooled Variance	15.27564	
Hypothesized Mean Difference	0	
Df	24	
t Stat	0.050178	
P(T<=t) one-tail	0.480198	
t Critical one-tail	1.710882	
P(T<=t) two-tail	0.960396	
t Critical two-tail	2.063899	

Table 5.5: T-Test of Day2

A two tailed t-test was performed for two independent samples with equal variance to test the difference in means. The p-value of day 2 is (0.960396) $\geq$0.05. So we accept the Ho. This shows that the average conversations for both groups are equal. The overall test for differences in means was not significant at any level of significant as p-value $\geq$0.05

5.2.4 Hypothesis T-Test of Day3

For successful comparisons form T-test application we have establish the following hypothesis.

Null Hypothesis: Ho: Average number of conversations for two groups is same.

Alternate hypothesis: H_1: Average number of conversations for two groups is not same.

The Level of significance: α = 0.05 is used.

Critical region: If p-value $\leq \alpha$ (=0.05) then we reject the null hypothesis H_o, and accept the alternative hypothesis H_1.

t-Test: Two-Sample Assuming Equal Variances		
Day3	*Group B*	*Group A*
Mean	5.384615	4
Variance	16.75641	21.66667
Observations	13	13
Pooled Variance	19.21154	
Hypothesized Mean Difference	0	
Df	24	
t Stat	0.805387	
P(T<=t) one-tail	0.214252	
t Critical one-tail	1.710882	
P(T<=t) two-tail	0.428504	
t Critical two-tail	2.063899	

Table 5.6: T-Test of Day3

A two tailed t-test was performed for two independent samples with equal variance to test the difference in means. The p-value of day 3 is (0.42850) ≥ 0.05. So we accept the Ho. This shows that the average conversations for both groups are equal. The overall test for differences in means was not significant at any level of significant as p-value ≥ 0.05

Chapter 6: Conclusion and Future Work

This chapter presents the detail conclusion, major contributions, limitations of the research and future research directions are highlighted on the basis of research findings.

6.1 Conclusion and contributions

The detail analyses of literature review shows that informal communication is not considered properly in DSD&GSD regardless of its known worth within collocated projects environments. When software development teams are collocated the whole team knows about background and contextual information of other team mates. They seldom encounter any difficulty in knowing about other team member's areas of expertise, misunderstandings, ambiguities and response delays. Team working as a unit is necessary for project successfulness. So everyone enjoy the fruitfulness of informal communication which is great fascination of collocation projects without any worth.

There is no meaning effort to keep or maintain informal communication for distributed and globally distributed software teams as it has the significance for projects development. The purpose of this research is to analyze the use of different formal communication channels to facilitate the informal communication in distributed projects. To address this, a field experiment is conducted within two distributed locations using two formal communication channels, text chat and scheduled video meeting. During the experiment, distributed teams communicate to one another through these formal communication channels.

Our research study has addressed the research question *what is impact by using formal channels for informal communication in DSD?*

The experimental results shows that distributed teams using formal communication channels for informal communication don't facilitate it. Although Video teams faced some connectivity problems due to internet speed and there were some communication disruption problems with distributed teams during video conferencing. It can be also tested that what would be if we do this with a high speed internet connation. Another thing which affects my research is the studies activities (like assignments, exams) of students, which take away their focus on development project. If we use faster internet connection, then results may be different and better. In this way we can easily analyze and differentiate the results between different channels.

Also give the reasoning of channels failed to facilitating the no informal communication. The results of experiment demonstrated that there was no informal communication among distributed teams using both formal channels. The Statistical analysis based upon the experiment results of Chat and video conferencing formal communication channels failed to prove the research hypothesis. The p-value for 3 days is ≥ 0.05. So we accept the null hypothesis. This research failed to validate the research hypothesis and proved that formal channels don't facilitate the informal communication during distributed setting of software development.

6.2   Limitations

Along with benefits, our study has some limitations as in following;

It can be validated through case study because through an experiment project environment is some level control so not big issues arise.

Due to the fact that this project only simulates the distributed development environment within same country so the issues of cultural, language are minimal. The internet connectivity issues may also affect my research work. During the experiment video Teams faces connectivity problems so results are disrupted due to bandwidth speed. Team size was small and it did not fully represent large global software development teams which face communication problems.

6.3   Future work

Our research provides a baseline to consider the significance of informal communication within distributed and global teams as well. Therefore there is an enormous need to put value on informal communication for global teams as a primary requirement of distributed and global software development. For achieving the success in research objectives the mainly focus should be on internet speed and access of distributed teams for getting better results. Network connectivity issues for distributed develompmnt projects are another direction. In this dimension future work can be done.

Keeping in view, an effort may be appreciated for development and improvement of informal communication for globally distributed projects that have no collocation feasibilities. This research place future direction for informal communication; whose are interested in distributed software developing.

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