# To Slack or not to Slack; challenges of communication and coordination in distributed software development

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In Partial Fulfillment of the Requirements for the degree of
Master of Science in Informatics: Programming and Networks


UNIVERSITY OF OSLO
Department of Informatics

2018

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# ACKNOWLEDGEMENTS

Writing this thesis was a challenging and interesting journey which became possible by the help and support of several people. I am thankful to the Department of Informatics at the University of Oslo for giving me this opportunity, as well as the company that provided me the Slack chat logs of their software teams, and all those who helped me by distributing or taking my survey. I want also offer my sincere gratitude to my supervisor, Dr. Viktoria Stray, who was always available whenever I was frustrated or needed help. Without her invaluable guidance and recommendations this work could not have been finished. Lastly, I am deeply indebted to the love of my life, Dorna, for all the care and support. With you all the impossibles become possible.

Mehdi Noroozi

Oslo, June 2018

# ABSTRACT

Globalization is affecting our daily life more and more every day. In addition to affecting every and each person, it is also affecting businesses around the globe and to cope with it managers and other decision-makers should think of new and innovative ways to keep their businesses going on. Software development industry is also no exception and was one of the industries that started to merge in the global market. The expansion of access to the internet around the world has evaded the need for co-located software teams and has made it possible to freely collaborate and work on software projects from all around the world.

There are several success stories regarding the distributed and global software development, however, it is not free from mistakes and huge financial losses. Among the several issues that distributed software development is facing, communication and coordination are named in several studies as the prominent cause of failure in distributed projects. In the absence of face-to-face communication which is considered to be the richest form of communication and the presence of cultural and language barriers, misunderstanding is unavoidable and problems can easily escalate.

In this thesis, we are going to take a closer look at communication and coordination issues in distributed software teams through analyzing Slack chat logs of two distributed teams as well as running a survey among software developers. In the end, we are going to give some suggestions for improvement of both theory and practice in communication and coordination of distributed teams.

The results gathered through the analysis of Slack chat logs and results of the survey are in agreement with several other studies and research done on the topic, and based on those results we have come to the conclusion that the right usage of communication tools in distributed teams can significantly improve the coordination and communication between team members which in turn paves the path for more successful software projects.

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## Acronyms

**DM** Direct Message

**DSD** Distributed software development

**DSM** Daily Stand-up Meeting

**DST** Distributed software team

**ESM** Enterprise Social Media

**ESN** Enterprise Social Networking

**GSD** Global software development

**IM** Instant Messaging

**MRT** Media Richness Theory

**MST** Media Synchronicity Theory

**SNP** Social Networking Platforms

**TCP** Team Communication Platforms

# Part I

# Introduction

*1*

# INTRODUCTION

This chapter describes the motivation for the topic of this thesis, states its research questions and sums up the thesis structure. The motivation for the study is based on the globalization of software development, which in turn demands better communication and coordination practices for the distributed software development teams. This type of communication and coordination in distributed software projects involves severe and persistent challenges. This study, therefore, investigates the communication and coordination challenges faced by distributed software projects.

## 1.1 Motivation and background

Globalization has become a fact in recent years, and outsourcing of resources to gain access to cheaper work-force or expert knowledge has never been higher than today in the history (Madon and Krishna, 2017). Statistics show that this trend is just continuing and that the software industry because of its unique characteristics will be affected even more than other industries (Sarfraz et al., 2016).

One of the features that makes global software development (GSD) so interesting and available for outsourcing is the possibility of working on the same software project simultaneously from wherever in the world, given having access to the internet or another type of network which can connect all the people involved in the project to each other (Ferguson et al., 2004). However, at the same time, while this scenario

is so attractive on paper, when it comes to practice there are many obstacles that a distributed software team (DST) might face.

Communication and coordination between team members and other stakeholders turn to become a big challenge in DST (Casey and Richardson, 2005). The author was personally involved in a DST while doing an internship in Toronto and seeing all the challenges faced by the team became motivated to conduct a study in this area to identify the challenges in communication and coordination between DST members and possibly come with some suggestions to improve those practices.

This area is not explored thoroughly and there is just a handful of research available that have looked at new communication and coordination tools used in the enterprises. Stoeckli (2018) looks into the Slack chatbots and integrations from affordance perspective and explores their constraints within enterprises. Lin et al. (2016) through an exploratory study try to find out how developers use Slack and what kind of benefits does it have for them. Feldt (2015) explores the usage of Yammer, an enterprise communication tool, among UX consultants at a Swedish company. Cardon and Marshall (2015) investigate to see if using enterprise communication tools lead to better communication and coordination between teams or not. Gerald C Kane (2015) provides a platform to measure the effects of enterprise social media on enterprises and suggests some design decisions for managers.

## 1.2 Research objective

In the absence of a thorough understanding of communication and coordination challenges in large-scale distributed software development (DSD) projects, this

master thesis will try to contribute to increasing the awareness of such challenges. Thus, this master thesis aims to answer the following research questions:

> **Research question 1:** What are the challenges of communicating and coordinating in distributed teams, and what kind of consequences might it have for distributed software teams?
>
> **Research question 2:** Are the communication and coordination theories, especially the media synchronicity theory still applicable to modern enterprise communication and coordination tools?
>
> **Research question 3:** When considering to introduce communication and coordination tools to teams what factors should be considered to maximize the benefits of using such tools?

The motive for these questions is to look more into the topic of communication and coordination in distributed software development by using both quantitative and qualitative methods. In this regard, we decided to analyze a case and run a survey to achieve a deeper understanding of the topic. Through conducting research with the goals mentioned above in mind, it should be possible to spot practices used to achieve better coordination and communication in distributed software teams, as well as challenges that could be identified through analyzing a real case.

## 1.3 Thesis Structure

Here an overview of all the chapters in this thesis is presented.

Chapter 1: Introduction, outlines the motivation and background behind this thesis. Chapter 2: Communication, contains the theories relevant to this research regarding the communication. Chapter 3: Coordination, discusses the different coordination theories. Chapter 4: Distributed teams, presents the distributed teams and their advantage and disadvantages. Chapter 5: Slack, gives a thorough description of Slack as a communication and coordination tool for teams. Chapter 6: Research methods, describes in detail how the study was conducted. Chapter 7: Results, presents the results achieved through this study. Chapter 8: Discussion, discusses the results presented in chapter seven based on the theories and literature. Chapter 9: Limitations, gives an overview of the limitations of this study. Chapter 10: Conclusion and future work, concludes the findings of the study and suggests the future work.

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# Part II

# Background

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# COMMUNICATION

Distributed software development (DSD) is today practiced commonly in the software industry in both large and small companies and organizations (Shrivastava et al., 2010). This means that software development teams are not physically sitting in the same place and hence do not have the opportunity to meet or speak to other team members in person regularly (Layman et al., 2006). This distribution might mean sitting in two different buildings or sitting on two different continents. Global Software Development (GSD) is a particular form of DSD in which the distribution of teams are across national borderlines (Sahay, 2003).

Communication has an important role in the success of GSD (Carmel and Agarwal, 2001; French and Layzell, 1998), and informal communication in particular plays a crucial role (J. D. Herbsleb and Mockus, 2003). All team members in both co-located and distributed teams communicate with each other using some form of internet-based communication tool (Bradley L. Kirkman and Mathieu, 2005). The processes of communication, coordination, and collaboration are of the utmost importance and key aspects of the software development process (Colomo-Palacios, 2014). Using internet-based communication in teams have several benefits for companies, such as easier access to the global market, preserving the environment, and having team members in different locations around the globe that will enable the companies to work non-stop (Cascio, 2000). Research also shows that distributed teams, that

are inevitably using internet-based communication, perform better than traditional teams in tasks like brainstorming because of the elimination of production blocking effects (Espinosa, Nan, and Carmel, 2015).

However, there are some challenges that threats distributed teams. High pressure in mastering advanced communication technology and lack of nonverbal communication, as well as problems in forming trust are some of them (Jarvenpaa and Leidner, 1998; Kayworth and Leidner, 2002). The misunderstanding might also happen easily in the absence of sentiment and meta-level information, such as body language (Cramton, 2001). Also, the type of communication technology and tools will affect the communication in teams and might lead to limited information sharing between distributed team members (Gilson et al., 2015).

Research shows that distance has a significant impact on the performance of projects (Damian, 2003; J. Herbsleb and Moitra, 2001). Communication is also an essential part of all software development practices (Layman et al., 2006). Empirical research also shows that developers are in need of ad hoc and informal communication (Grinter, 1998; R. E. Kraut and L. A. Streeter, 1995). Therefore any shortcomings in communication between the teams and team members will profoundly impact the success of GSD projects (Layman et al., 2006).

Face-to-face meetings are the most efficient and ideal type of communication (Bradley L Kirkman and Gibson, 2004), but in GSD where teams are spread in different places, often with time zone differences, this is not possible and therefore might be challenging to achieve effective communication between teams and team

members. In the presence of temporal distance between the teams and team members, real-time and synchronous communication by using a phone, text or video chat is challenging to achieve (Holmström et al., 2006; Kommeren and Parviainen, 2007).

Casey and Richardson (2008) have worked on a case in which two distributed teams located in Ireland and Malaysia used just an asynchronous type of communication, e-mail. In that case, using asynchronous communication tools, like e-mail increased the chances of misunderstanding and ambiguity of information. Also, the communication is not adequate if the parties communicating with each other do not understand each other (Kommeren and Parviainen, 2007; Cataldo et al., 2007).

Receiving delayed feedback is also another challenge faced by remotely located teams, which itself is again a side effect of asynchronous communication (Conchúir et al., 2006; Holmström et al., 2006). Research shows that using asynchronous communication tools in remote teams increases dramatically the time it takes to receive a response (Holmstrom et al., 2006).

It is also true that a software engineer usually spends a lot of time searching and exchanging information, rather than doing anything else, and as a result, this can lead to delays in completing the project and increases the cost of the project. One of the ways to mitigate this problem is through proper project coordination (Dumitriu and Mesnita, 2006).

## 2.1 Media Richness and Media Synchronicity Theories

Media Richness Theory (MRT) tries to categorize the communication media based on their effectiveness and "richness" to express the link between communication and technology, and in this regard sees the richest medium in face-to-face encounters that is able of carrying all the verbal and non-verbal messages and minimizes the ambiguity, and sees the written mediums, such as email, as the least rich medium of communication (Daft and Lengel, 1986; Hassell, 2016).

Later, Dennis et al. (2008) proposed the Media Synchronicity Theory (MST) to address the limitations and shortcomings of the other media theories proposed before. MST discusses the different attributes of several types of media and attempts to look at them more precisely.

Dennis et al. (2008) suggest five attributes:

1- Regardless of the medium to be synchronous or asynchronous, immediate feedback is present.

2- Availability and diversity of symbols.

3- Availability of the ability to have several parallel conversations at the same time.

4- The messages can be rehearsed before transmission.

5- The conversations and messages sent and received can be retrieved.

Figure 2.1 shows an illustration of MST applied to the functionalities of a variety of communication technologies (Maruping and Agarwal, 2004).

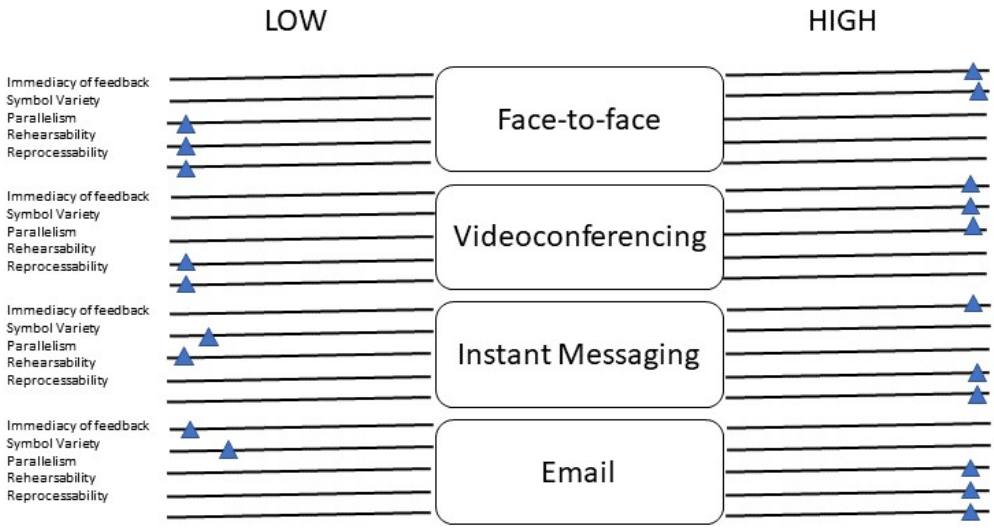


Figure 2.1: MST as illustrated by Maruping and Agarwal (2004)

## 2.2 Enterprise Social Networks

Because of the value that organizations see in using social media at the workplace and high demand for such platforms, during the recent years several companies have started to develop tools such as Slack, HipChat, Yammer, and Workplace by Facebook (Leroy et al., 2013). These applications are known as Social Networking Platforms (SNP) or Team Communication Platforms (TCP) and can be categorized under communication methods that are called Enterprise Social Networking (ESN) or Enterprise Social Media (ESM).

One thing that differentiates usual social media such as Facebook and Twitter from ESN is that social media is open to public and everyone can use them but access to ESN is limited to employees and those with whom the company needs to get in touch regularly (Turban, Bolloju, and Liang, 2011).

Leonardi, Huysman, and Steinfield (2013) describe four attributes which a platform

should provide for its users to be considered as an ESN:

1- The users must be able to send and receive messages to individual members as well as the whole or a group of members.

2- Either explicitly or implicitly should be able to choose and show special coworkers as their communication partners.

3- It must be possible to share files with other users.

4- At any time it must be possible for any user to view all the conversations that are done publicly, consisting of text messages and file shared.

ESN acts as a forum for its members where they are able to communicate with other co-workers in the same organization (Leonardi, 2014) in which business goals, such as enhanced knowledge sharing, easier access to expertise, and innovation can be reached better in a more secure and private environment (Leonardi, Huysman, and Steinfield, 2013).

If the ESN is correctly managed it can boost the productivity and motivation of employees, enhance collaboration between the different actors in the organization, and lead to more learning for team members (Leon et al., 2017). It also enables people in different locations to be able to communicate and become more involved in innovation, revenue creation, and socio-economic growth (Qi and Chau, 2016).

One of the problems that can be associated with the long-term use of ESNs is that employees might feel isolated because of limited face-to-face encounters with other people (Gerald C. Kane et al., 2014), but at the same time ESN is not designed and meant to completely replace personal and physical encounters (Zhang and

Venkatesh, 2013).

Also because of the learning curve associated with any new tool, organizations might have not completely reached their goals of increasing collaboration between their employees (Anderson, 2016). However, developing an open culture among the employees and using an ESN which have similarities to social media that employees use in their private life may help to improve the usage of ESN by employees (Korzynski, 2014).

*3*

# COORDINATION

Scholars have defined coordination in different ways. Malone (1988) defines coordination as for when several actors seek goals together and must do things to organize themselves in order to reach that goal while a single actor seeking the same goals does not have to do the same things. He calls these extra activities needed for organizing, coordination. Later, Malone and Crowston (1994) adjusted the definition of coordination to managing of dependencies. The definition is justified in that there are interdependent associations between activities, and contrive with these relations effectively, coordination mechanisms are needed (Deng, Chen, and Pan, 2007).

Coordination from Osifo's (2012) point of view can be classified as part of an organization. At the same time, Beuselinck, Verhoest, and Bouckaert (2007) and Osifo (2012) confirm Malone and Crowston's (1988) definition which states that there would be no need for coordination if there is no dependency and relation.

There are two aspects of the coordination which are important for organizations, internal and external coordination. Internal coordination is important to achieve cooperation by having support and clarity. Without internal coordination, it would be difficult to achieve satisfactory progress in the projects. It also provides help in setting rules and criteria. External coordination also plays an important role in setting limits so that the project always stays in focus and continues on the right path (Osifo, 2012).

Coordination is part of nearly every single part of a project and is rarely employed alone by only one coordination mechanism (Osifo, 2012). Almost always coordination of a particular project or organization is accomplished by using several coordination mechanisms (Dietrich, Kujala, and Artto, 2013).

## 3.1 Van de Ven model of coordination

Researchers have suggested several coordination mechanisms. Strode et al. (2012) states that synchronization, structure, and boundary spanning are mechanisms which are worthy for efficient coordination. Mintzberg (1980) believes that mechanisms such as mutual adjustment, direct supervision, and standardization are of importance in coordination.

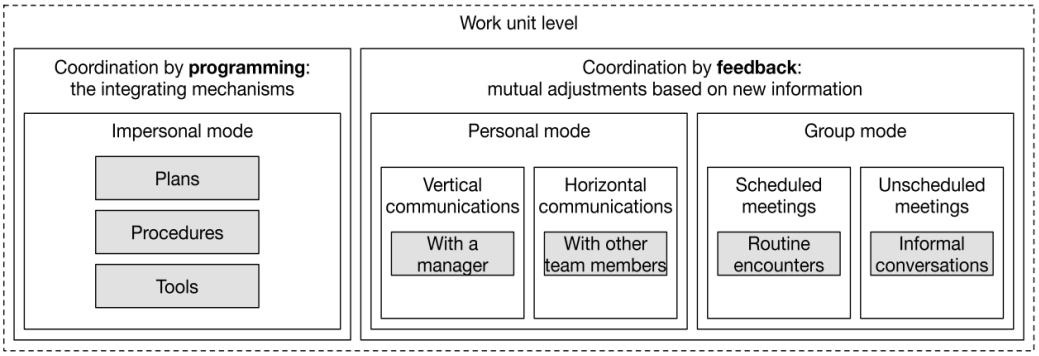


Figure 3.1: Coordination modes according to Van De Ven et al. (Nyrud and Stray, 2017)

Van De Ven et al. (1976) suggest another coordination model which is somehow similar to the models suggested by other scholars but adds the notion of team to the coordination strategy. For example, they believe that mutual adjustment in co-located teams is reached by mutual interactions. Still, in the case of the ways in which coordination can be achieved it is somewhat similar to the theory suggested

by Thompson (1967). According to Van De Ven et al. (1976), there are three modes of coordination of work activities; impersonal, personal, and group mode of coordination (see Figure 3.1).

In Van de Van's model, the focus is on the team and how based on the change of some factors the coordination modes changes. Van De Ven et al. (1976) suggest that coordination mechanisms in every one of those three modes are utilized in different combinations to reach a certain collective goal.

## 3.2 Impersonal mode of coordination

Anything that needs the minimum amount of verbal communication between actors once implemented and in nature is relevant to programming, technical means, and administrative coordination can be correlated with impersonal mode of coordination (Boos, 2011; Van De Ven et al., 1976).

R. Kraut and L. Streeter (1995) suggest some coordination techniques that can reduce some of the coordination challenges when a mixture of large size, intricacy, and interdependence occurs simultaneously; using technical tools, modularization, and formal procedures are some of the suggested techniques.

Keeping large-scale projects coordinated by using tools and having a shared system to keep the record of documents is of utmost importance. Some of the examples of impersonal coordination mechanisms found in large-scale agile are standardization of work process (such as following the Scrum methodology), having rules for QA, and use of tools such as Jira (Nyrud and Stray, 2017).

### 3.3 Personal mode of coordination

In the personal mode, according to Van De Ven et al. (1976), coordination happens through feedback or mutual adjustments on the input information that an actor receives from the other actors. Mutual task adjustments happen either through vertical or horizontal communication channels. Line managers and unit supervisors are often the mechanisms of vertical communication which is hierarchical in nature (Thompson, 1967). But horizontal communication is more about individual people in teams that communicate on a one-to-one basis with other team members, and it is usually non-hierarchical (Van De Ven et al., 1976).

Mintzberg (1980) divides coordination mechanisms to mutual adjustment and direct supervision. These two mechanisms are similar to vertical and horizontal channels of communication in the personal mode of coordination. Mutual adjustment happens when people in the team informally communicate with other teammates to coordinate their tasks. In the direct supervision, a person from a higher level than the others, like the head of a team, gives some instructions that must be followed by other team members who work under her supervision.

Personal mode of coordination consists of both informal and formal communication (R. Kraut and L. Streeter, 1995). Also, it is more valuable in unscheduled and unexpected encounters (Boos, 2011; Dickenson and Mclntyre, 1997). R. Kraut and L. Streeter (1995) suggest that informal communication between team members while discussing work-related matters in front of water or coffee machine forms a large amount of coordination and that coordination does not only happen in formal

meetings.

The success of coordination is dependent on some factors. Trust is one of those factors because organizational performance is realized by the network created by coordination (De Jong, Dirks, and Gillespie, 2016). Reduced coordination is in direct association with trust (Roohullah Jan et al., 2016). And its importance is because it is the central part of decent coordination (Osifo, 2012).

### 3.4 Group mode of coordination

Group mode of coordination, like the personal mode, happens by feedback and mutual adjustments but with the difference that all these happen in the group in unscheduled or scheduled meetings and consists of more planned communication (Van De Ven et al., 1976).

Dietrich, Kujala, and Artto (2013) suggest three other coordination mechanisms that are important in large-scale projects. Those three mechanisms are called centralized, decentralized, and balanced patterns, which respectively are about coordination at the group level that is either scheduled or unscheduled, coordination between teammates which are not scheduled, and at last the combination of the first two ones.

The coordination strategy that Strode et al. (2012) have suggested involves three principal concepts of synchronization, structure, and boundary spanning that assist in managing dependencies. Regarding the group mode of coordination, synchronization has more relevance and importance and is gained within synchronization

activities. These activities are done usually once at the beginning of the project, but also can happen several times during the project so that the team members are aware of the project requirements and maintain this understanding during the whole project (Strode et al., 2012).

*4*

# DISTRIBUTED TEAMS

Distributed teams are called by several names, but it is generally agreed that a team is considered as distributed when its members are spread at least in two locations (Hinds, 2005). This physical separation can range between two different offices in the same city or country or people sitting in different countries and continents (Mortensen, 2001). Here I will now discuss some of the advantages and disadvantages of using distributed software teams.

## 4.1 Advantages of using distributed teams

When evaluating distributed teams and discussing the dynamic situation of global business it is essential to know the advantages that this type of team structure offers a company that uses it.

One of the advantages is that the companies can benefit from a much more bigger pool of global experts in different subjects and recruit some of the best talents that might not be available locally or might be expensive to recruit (Snyder, 2003). Relocation is costly and stressful and today most of the workers try to avoid it (Lipnack and Stamps, 1997; Joinson, 2002). Human resources of companies can be increased in this case, because especially skilled members of the company can serve on several teams simultaneously (Hertel, Konradt, and Orlikowski, 2004).

The other advantage is that costs associated with traveling and accommodation will

be reduced drastically or completely eliminated. Baskerville and Nandhakumar (2007) report that IBM by using distributed teams saved $50 million in travel and downtime costs.

It is also an important point that the distributed teams encourage multiculturalism and discourage discrimination by age and race because the members are evaluated mainly by the performance and productivity, not by their appearance. This type of team fosters equality and fairness among the employees (B. Bergiel, E. Bergiel, and P. Balsmeier, 2007).

In addition, because of the heterogeneity of DST, these teams are more effective and creative compared to the more rigid structure of traditional teams which are limited by time and space (B. J. Bergiel, E. B. Bergiel, and P. W. Balsmeier, 2008).

### 4.2 Disadvantages of using distributed teams

These type of teams might also suffer from some challenges. For example managing conflicts between team members in distributed teams is a big challenge (Hinds and Bailey, 2003). Lack of good communication tools and a shared identity in distributed teams lead to conflict (Hinds and Mortensen, 2005).

Also, coordination and cohesion may be reduced in distributed teams which in turn affects work performance (DeRosa et al., 2004). Feeling isolated and lack of face-to-face social interaction is also common among members of distributed teams which do not have the opportunity of meeting their colleagues as often as in traditional teams (Kiesler and Cummings, 2002).

*5*

# SLACK

Since analyzing Slack chat logs constitutes an important part of this thesis and Slack software is more than yet another chat application we will now give a description of this platform and some of its most important functions that makes Slack one of the most popular communication and collaboration systems used in software teams.

In order to describe Slack software both secondary data obtained from its website, as well as my own experience as a Slack user is used. The reader of this introduction will get a sense of what Slack, as a sophisticated enterprise social network, is.

Slack[1] was launched in 2014 and has more than eight million active users every day, three million of which are paid users (Lynley, 2018). It has turned a contemporary form of communication, i.e texting, into a workplace app. Its valuation is $ 5.1 billion. Although lately some big players in the market, like Microsoft, Google, and Facebook, have launched products to compete with Slack, still 43 percent of Fortune 100 companies are using Slack. Its popularity among startup companies is the same, if not more than the big enterprises (Rodriguez, 2018).

Williams (2015) who has created a document on how to use Slack, says that Slack can be seen as a chat room where the whole company and its different teams can be broken into smaller channels for group discussion. Channels are often created to discuss a certain topic and are like the old chat rooms. Like any other communication

[1] https://slack.com

platform, sending direct messages to individuals is also possible in Slack.

Slack is a multi-platform software, meaning that it can be used on all kinds of operating systems on all mobile phones, as well as desktops and laptops. The user can be notified of several things in several ways. Direct messages and mentions usually generate notifications that can both received by email, if the user is not online, or will be shown on the Slack app. These notifications are highly customizable and can be suppressed to avoid being overwhelmed by the number of notifications.

Teams are another feature of Slack. Groups of people who are working together can use it to communicate with each other. It can be created simply by visiting Slack's website. A Slack team must have an owner and can have several admins who will enforce the team rules. Often working in large organizations means being part of several Slack teams. There is also possible to work in several workspaces, as each one works as a separate team that is connected to the Slack's enterprise network. All the teams and workspaces are available on the web, desktop, and mobile version of Slack.

Channels in Slack are used as chat rooms for group conversation. Figure 5.1 shows a screenshot of a conversation going on in a Slack channel. Different channels are usually created to discuss certain topics. These channels can either be public or private. Public channels are visible to the entire team and all the team members can join them. But private channels need an invitation to join and usually admin of the channels adds the other users to the channel.

Everything shared on Slack, including text, image, file, and other types of posts

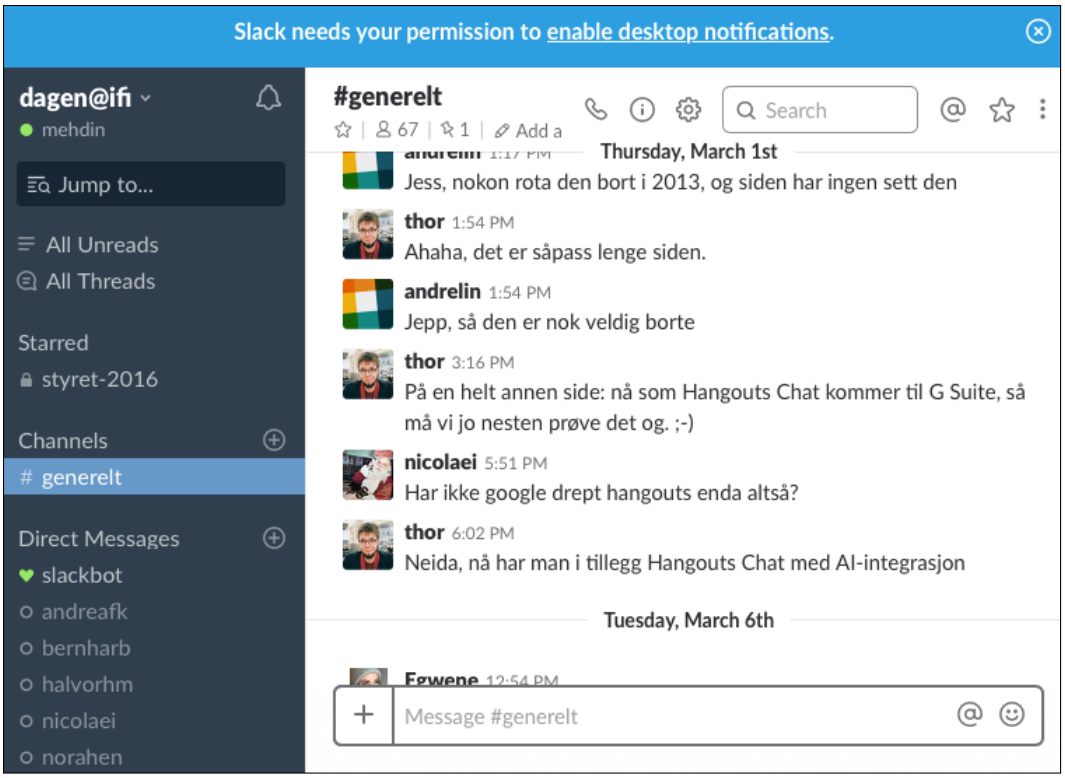


Figure 5.1: A screenshot of Slack's web version

can be searched by users. The information shared in private channels can just be searched and found by the members of the channel. Also paid customers of Slack have the ability to invite external users. In that case, only the information shared in the respective channels can be searched and found by the external member.

The other way that users can communicate in Slack is by direct messages (DM). It is possible to send a DM to up to eight other users simultaneously. Obviously, these messages can be just seen and searched by those who are involved in the messages. It is also possible to call up to fifteen users at the same time if the team is a using the paid service, but in the free version, just one-on-one calls are supported.

Using emoji is another way of communicating in Slack, it can be both used by the

user who is writing the message to communicate her emotions (Figure 5.1), as well as by the readers of the message who can "react" to the message and communicate their emotion with the sender of the message. It is also common to get the attention of someone or the whole members of a channel by putting @ before the username of the users. In this case, users will immediately get a notification if they are online, or will get an email in case they are offline.

Moreover, the notifications that the user receives can be customized to meet the needs of the user. Users, for example, may define certain words that when appeared in chat messages the system will generate a notification. Notification can be manipulated based on several properties, like time and date. For example, one can decide not to receive any notification during weekends. Another capability of Slack is the ability to organize messages by pinning them or starring them, in order to get access to important messages more easily late on. All the sent messages can also be edited after being sent. And the appearance of the Slack can be customized by changing themes and colors to match the taste of every individual user.

One of the reasons of the popularity of Slack in teams is because of its ability to integrate with lots of external services, like Google Calendar, GitHub, IFTTT, etc. (Williams, 2015). Users also have the possibility of sending and sharing files. It is also possible for users to make voice and video calls. All the functions mentioned in this section are provided free of charge but enterprise users can pay to enjoy some extra features like group video chats, more storage, and unlimited availability of past conversations.

# Part III

# Research Methods

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# RESEARCH METHODS

This chapter describes the methodology of the research and the reasons for choosing it for the data analysis used in this thesis. It will provide detailed information about the data, the research design, and how the analysis was conducted.

## 6.1 Research approach

Because of the rather limited number of previous research focused primarily on communication and collaboration on Slack, our research is based on an explorative approach (Paré, 2004). We also decided to use a hybrid approach, i.e. using both a qualitative and a quantitative approach. According to Ghauri and Grønhaug (2010) qualitative research is more suitable when the research is more investigative and not many insights is available from past researches. Stray, Moe, and Aurum (2012) state that in case studies a mixture of qualitative and quantitative approaches can be used in order to ensure the validity of the results.

## 6.2 Quantitative data from the survey

The quantitative data was collected through running a survey among active professional software developers who were working in teams in order to gain more insight about coordination and communication tools, methods, and challenges in software teams.

The survey targeted professional software developers, so a link to the survey was

posted on Reddit [1] in order to recruit active software developers. Reddit is an open social media where everyone, including developers, can share their ideas and interesting links in special groups, which are specified around certain topics, called subreddits. I chose two subreddits that were relevant to programming; r/programming with 1 million subscribers, and r/gamedev with 254000 subscribers.

The other method that I used was snowball sampling. Snowball sampling is a non-probability sampling technique where current study subjects recruit future respondents from the people they already know. Thus the sample group of subjects will grow like a rolling snowball from top of a mountain. Baltar and Brunet (2012) calls the method virtual snowball sampling when the subjects are recruited through social media. It is used when an eligible respondent shares the survey with other subjects who satisfy the criteria defined for the targeted population (Berg, 2006).

In order to recruit respondents with this method, I used a combination of asking people in Facebook groups devoted to programming and software engineering, as well as emailing a group of friends and contact persons who I have in some of the Norwegian IT companies and asking them to share the link in their company's internal social network.

Qualtrics [2] survey cloud platform was used to format the survey (see appendix A) and collect the data, and it was designed to be filled just once by every respondent. In order to increase the quality of the data, no incentives or compensation were offered to respondents. The survey took between three to five minutes to complete

[1] https://www.reddit.com
[2] https://www.qualtrics.com

and was open for five days, from March 11, 2018, to March 15, 2018.

The survey flow was dynamic, meaning that not all questions were shown to all the respondents and some questions were skipped automatically based on the previous answers. In addition, some of the questions were voluntary to answer which inevitable led to lack of response and missing data for some questions.

### 6.3 Qualitative data from the case

Qualitative data was collected from Slack chat logs of public and private channels of several software development teams of Datasoft (a pseudonym). Datasoft is an international company headquartered near Oslo, Norway that currently has more than 15,000 employees and 350 offices operating in more than 100 countries having more than 100,000 customers, and provides services for several industries. Its software branch has more than 500 employees that are located in several countries, including Norway, Poland, China, and Germany.

In this thesis, we will analyze conversations between a couple of software development teams of the company. These teams are located in two development centers in Norway and Poland. Conversations are in form of instant messages sent through Slack. Slack is an acronym for "Searchable Log of All Conversation and Knowledge". Slack does not use an IRC backend but offers a lot of IRC-like features, such as public and private channels (IRC chat rooms) organized by topic, as well as private messages. A detailed description of Slack is presented in section 5.

Chat logs, consisting of around 30,000 messages were gathered from Oct. 20, 2014,

to Aug. 25, 2017. The exported chat logs were in the form of a compressed zip file. This is the only format that Slack lets the users export chat data. The zip file contains several folders which represent the channels and inside each folder there are lots of JSON files which each one contains the chat logs of one day. Inside the JSON file every message is coded in a special format (See a sample in Listing 6.1) showing the ID of the sender, the message, timestamp, etc. All the names that are appeared in this thesis are anonymized and a pseudonym is used instead.

In order to analyze the messages, I decided to use QSR NVivo [3] software. NVivo is a software mainly used in qualitative research which helps researchers to analyze the unstructured material. By enabling the researchers to code their collected information into nodes and cases NVivo makes the classifying and sorting of the documents much easier. Another functionality that is very beneficial and we have also used during this research, is the ability to write memos during the research which acts as a log and one can at any time go back and see what was challenging or why a particular decision was made during the research.

Unfortunately, it is not possible to import JSON files into NVivo, so I was obliged to convert the desired JSON was that I wanted to analyze to MS-Excel format. Another challenge was to match all the IDs with usernames and also convert the timestamps which were in Epoch format to a human-readable format.

In order to identify the categories for coding the chat logs a general inductive coding technique was employed (Thomas, 2006). To do this I went through some of the

[3] https://www.qsrinternational.com/nvivo/

chat logs and gathered a preliminary list of suitable categories that could have been relevant to finding patterns of communication and coordination in the chat logs. During the coding process, all the details were discussed with the supervisor and both the categories and subcategories were edited several times.

Table 6.1: Nvivo categories used in coding, with explanation and examples

| **Category** | **Explanation** | **Example** |
|---|---|---|
| General Answer | Answering general questions | OK, great, I didn't know that you visited ECS before. |
| General Question | Asking a question about general topics | Should I also join this meeting today? |
| General Information | Giving general information | Hello all, this is my work schedule created due to my studies. |
| Technical Answer | Answering technical questions | It depends on how much we need to refactor, but there is better support for using a Java framework. |
| Technical Question | Asking question about technical topics | Is it expected that user groups options endpoint returns nothing? |
| Technical Information | Giving technical information | Please ignore notifications from TFKR, I'm just cleaning up. |
| Socializing | Messages used for socializing | I would like to award this week's Commit Name Award to @Viktoria. |
| Emoji | Emojis used by users | :slightly_smiling_face: |

For the code to be validated, at least one person apart from the coder must review it to ensure that the material is free from misinterpretation and researcher bias. But as this research is done by just one person this was not possible, although all the coding scheme and any ambiguity were discussed with the supervisor. Also in order to ensure the validity and consistency of the code, all the codes were always double checked. The end result of the categories used for coding the chat logs is shown in Table 6.1.

```
{
    "type": "message",
    "user": "U3YTI6W97",
    "text": "I don't understand the question :slightly_smiling_face:",
    "ts": "1495181765.592074"
},
{
    "type": "message",
    "user": "U0LDR8UKF",
    "text": "I had a discussion with <@U047LFHAW> on the topic of pulling
   through 'Multiple language support in Web client'. The suggestion is to create
    a separate story for 'cache key' for MVOP3. <@U03SFGREPM> does this sound ok
   for you?",
        "thread_ts": "1503491779.000440",
        "reply_count": 16,
        "replies": [
            {
                "user": "U0J0OU5RB",
                "ts": "1503493553.000496"
            },
            {
                "user": "U0HT9RH7R",
                "ts": "1503493693.000398"
            },
            {
                "user": "U047SU1AW",
                "ts": "1503563956.000351"
            },
        ],
        "unread_count": 16,
        "ts": "1503491779.000440"
    },
```


Listing 6.1: Sample of logs exported from Slack in JSON format

# Part IV

# Results and discussion

*7*

# RESULTS

In this section we will first present the results of the analysis of the chat logs and afterward will report on the results that we have got from the survey.

## 7.1 The case study

After running a word frequency query to gain some general insight about the data, we came to the result that is presented in Figure 7.1, here the results are limited to the first 100 most frequent words. As we see here the word “works”, after omitting irrelevant words like pronouns, etc. is the most used word in the backend, frontend, operations and help channels with a frequency of 2770. Smiling is the second word here which is repeated for more than 1900 times and the reason is that smileys or emoji are shown in logs as “:smile:” or “:smiling_face:”. All in all the list of most frequent words, at least in the backend, frontend, operations and help channels, convey that most of the conversation in those channels were related to some sort of problem and finding ways to solve them. An example is:

> **Ola 2016-12-02 13:01** Does automated database build translate to long-running build? I already find that the pull requests are clashing with branching out for working on a story. Is there something I am missing with regards to basing your next work on a branch other than the master?

**John 2016-12-02 13:02** Database builds are long-running yes. but of course, we will probably have more than one build agent going forward. We used to have 4 (5 if you include Petra).

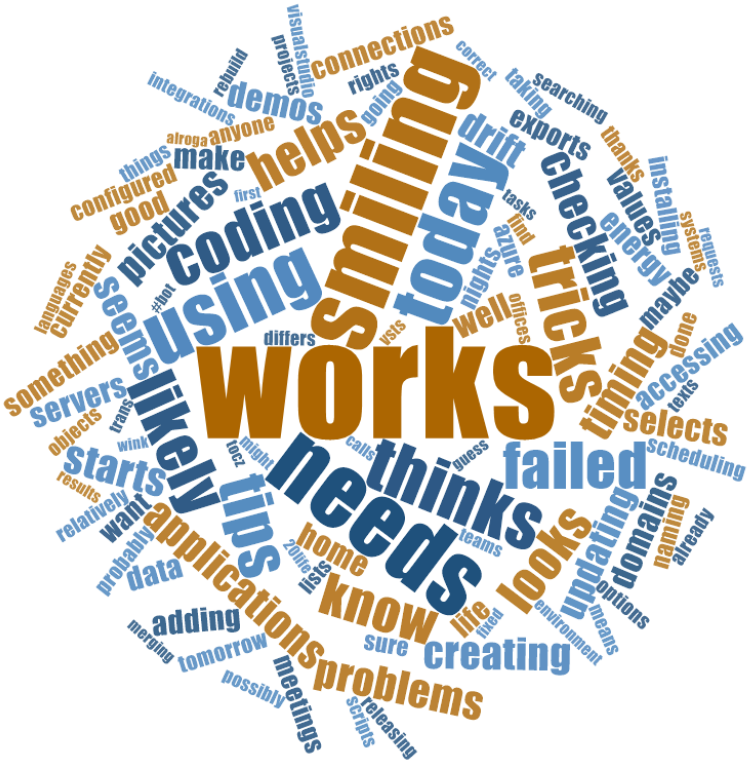


Figure 7.1: Word cloud of the first 100 most used words.

We also did an automatic sentiment analysis of the help, general, and backend channels with NVivo 12 and found the results that are presented in Table 7.1. Generally, the sentiment tends to be neutral, but in the help channel, there are more mixed, negative and positive sentiments found compared to the other channels. This could be linked to people being nervous asking questions, but since we do not have access to the algorithm that NVivo uses to analyze the sentiment it would be difficult

Table 7.1: Sentiment analysis results

| Codes | n |
|---|---|
| Operations - Mixed | 0 |
| Operations - Negative | 6 |
| Operations - Neutral | 292 |
| Operations - Positive | 1 |
| General - Mixed | 2 |
| General - Negative | 6 |
| General - Neutral | 43 |
| General - Positive | 8 |
| Help - Mixed | 107 |
| Help - Negative | 62 |
| Help - Neutral | 354 |
| Help - Positive | 32 |
| Backend - Mixed | 4 |
| Backend - Negative | 8 |
| Backend - Neutral | 79 |
| Backend - Positive | 11 |

to say exactly what causes the difference of sentiment in the help channel.

By the end of the coding process of chat logs in the NVivo we came to the results presented in Table 7.2. The table shows the number of conversations coded in the general, backend, and operations channels.

There are a number of interesting findings coming out of table 7.2. It is obvious for example that the usage of emojis in the general channel is six times more than the

Table 7.2: Number of conversations coded in each category in three channels

| | Backend | General | Operations |
|---|---|---|---|
| **General Answer** | 50 | 50 | 10 |
| **General Informing** | 20 | 5 | 45 |
| **General Question** | 15 | 10 | 15 |
| **Technical Answer** | 110 | 130 | 100 |
| **Technical Informing** | 170 | 25 | 150 |
| **Technical Question** | 125 | 60 | 115 |
| **Socializing** | 5 | 15 | 4 |
| **Emoji** | 15 | 90 | 70 |

backend channel. We infer that it is due to the highly technical nature of the backend channel which inhibits the members from using emojis since it does not give much sense to use them while discussing technical matters. It might also be related to the personality of those team members working with the backend, because it is not only in the general channel that the numbers of emojis are high and team members in the operations channel have also used emojis quite a lot.

At the same time, we see that number of technical questions and informing drop dramatically in the general channel compared to both backend and operations channel which is expected. General questions are asked almost the same in all three channels. General informing which is probably expected to happen more in the general channel has actually happened more in the operations channel.

We also looked at the number of messages sent per hour in backend and frontend channels. Early in the morning, between 8:00 and 9:00 is the busiest time, in which 686 messages are sent. This is due to the fact that the working hour starts from 8:00, and also looking at the chat logs it seems like that the team is running automated tests while leaving their jobs and then the next day in the morning start to look at the errors and try to debug their code. In the following examples two different programmers from the frontend team are reporting on the failures in the tests:

> **Kari 2017-08-21 08:37** @kari commented on file https://slack.com/files/kari/F6S7MN3/past-image-at-2017-08-21-08-34-am.png: UI-tests are failing because of this.

> **Henry 2017-07-13 08:43** CI builds seem to be failing for PRs today.
>
> I see some error related to handlebars in the logs, but maybe one of you on the frontend team could look into this?

Then between 9:00 and 13:00 the number of messages sent is stable at around 500 messages per hour, and then halves until 14:00. Then suddenly the number of messages drops substantially to around 90 at 15:00 and steadily goes down until 5:00 in the morning that again starts to rise. Here the lower amount of messages after 16:00, which is the official ending of the work day, is understandable but at the same time, it is not completely logical that after 14:00 the number of messages drops so much. One explanation could be that team members become exhausted and either some of them completely stopped working or were just working in a slower pace. The other possible explanation could be that the team members in these teams start to do things that do not need any coordination or communication with other

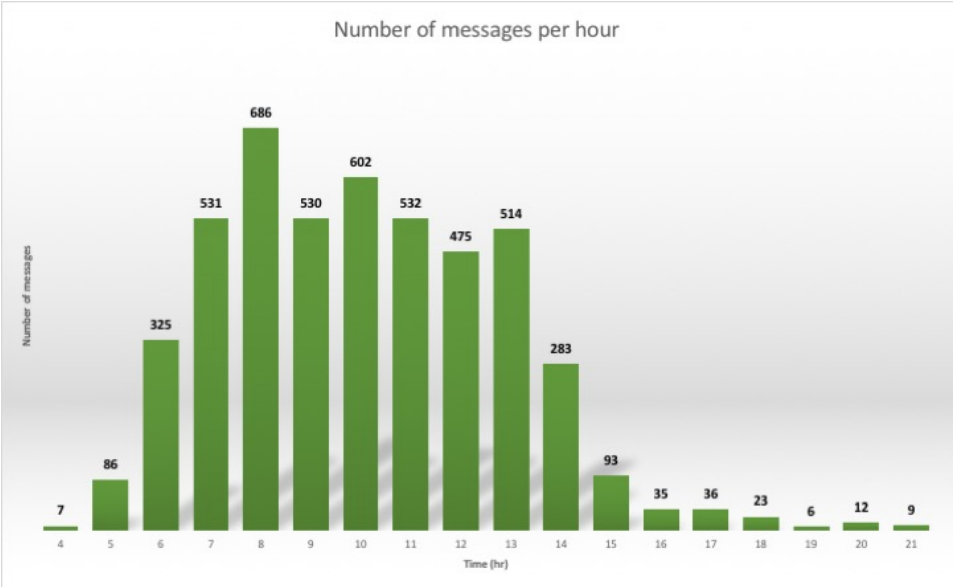


Figure 7.2: Number of messages sent per hour in backend and frontend channels

team members, for example starting to test the code that they have produced during the day, or they might be in the meeting and that the meetings were being held after the lunch.

At the same channels, i.e. the backend and frontend, we also looked at the user activity to see how much each and every user was active in writing messages in the channels (See Figure 7.3). For privacy and security reasons the usernames are not converted to real names. Here we see that there are three users who were extremely active and have written around 500 messages in three weeks, four other users are also identified that were very active and have written more than 200 messages. In total there are 11 users out of 38 who have sent more than 100 messages. Although we expected that there should be fewer barriers for people to communicate virtually, compared to face-to-face encounters, it seems that it is not always true. Here we see that there are nine users who have sent less than 10 messages, and several other with less than fifty messages. There are several reasons which might have caused the users to stop being active. First, these are public channels which every message can be seen by other peers, therefore some people might feel ashamed to ask questions or provide answers that might seem unprofessional or irrelevant for the others. For example in the following quote from the chat logs it seems that a team member is mentioning two others implying that those two need to be more informed regarding the WAPP structure:

**Jakob 2017-05-22 09:48** @rick @harold Did you have specific questions regarding our WAPP structure and practices? We can arrange

an ad-hoc session to discuss issues if you have any.

Second, the language might play an important role and people might not be confident using English or any other language which is not their native tongue. In our study team members are at least from two different nationalities who speak two different languages and the only language which is understood by everyone is English which itself is not the native tongue of most of the team members. The reason we are suspect of this as a barrier to communication is that in many cases team members have suddenly started to write in Norwegian or Polish as if it was difficult for them to communicate their desired message in English.

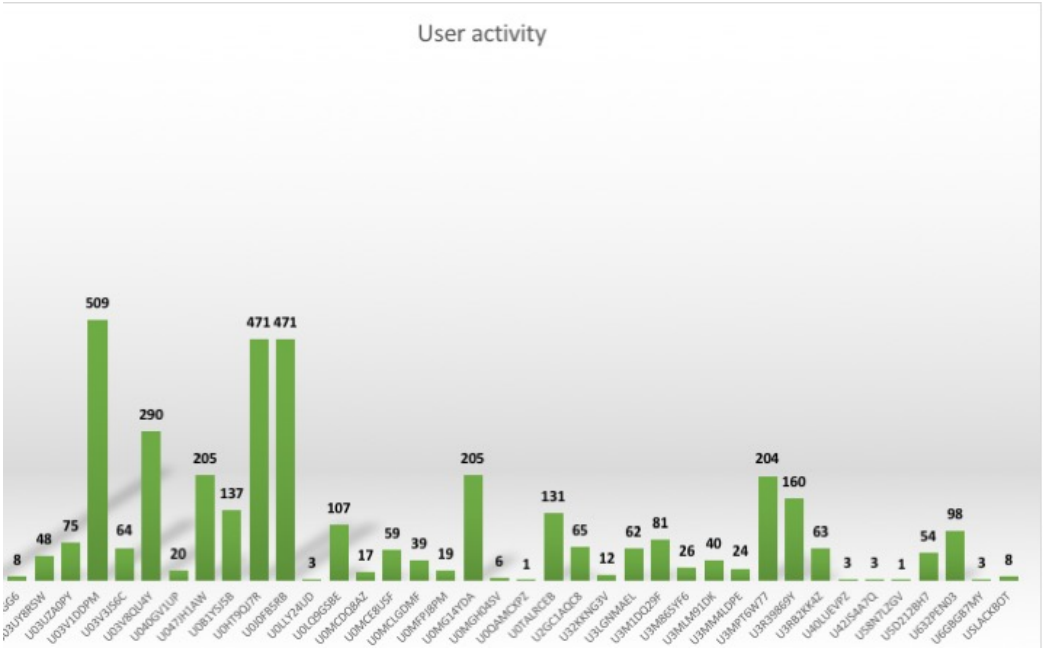


Figure 7.3: User activity in backend and frontend channels

## 7.2 The survey

A total of 112 responses were gathered, of which 95 were completed to the extent that was usable and analyzable. Out of 95 respondents, 87 percent were male (n = 83), and 13 percent female (n = 12) with a mean age of 32 years old (n = 95). Percentage of the respondents who reported that they were working in a team was 96 (n = 91), and the proportion of people working in co-located teams (n = 46, 48%) were slightly less than those who reported working in distributed teams (n = 49, 52%). The proportion of the team size among the respondents was one-third being in teams of two to five members, one-third in teams with six to eight members and one-third in teams with nine or more members. Table 7.3 shows the descriptive statistics. The respondents were mainly located in North America and western Europe, a heat map of the location of the respondents is presented in figure 7.4.

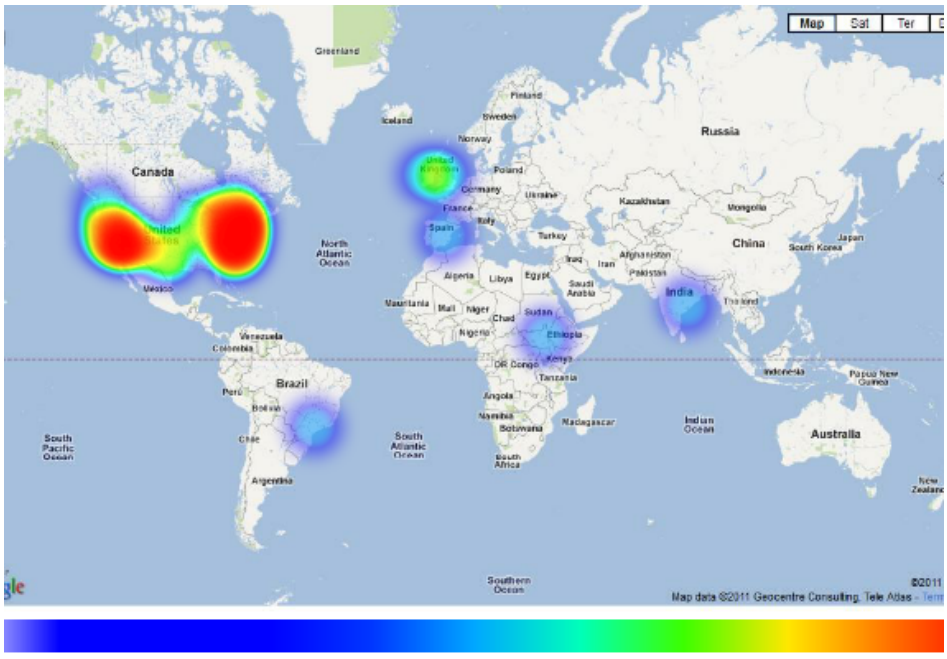


Figure 7.4: A heat map of the respondents location

Table 7.3: Descriptive statistics

| | Unit | n | Mean(M) | Median |
|---|---|---|---|---|
| **Meetings** | Frequency per day | 63 | 2.9 | 3 |
| **Time in meetings** | Hours per day; DSMs included | 48 | 1.4 | 1 |
| **Team size** | Members including self | 87 | 8.1 | 7 |

Among all the respondents, 69% were software developers, and the rest had roles such as designer, software architect, and manager (Table 7.4). The respondents were also asked whether they consider themselves front-end developer, back-end developer or other types of developers. 36% of all respondents considered themselves as other type of the developers, 26% considered themselves as back-end developers and 7% as front-end developers (Table 7.5).

Here there is no meaningful difference between the results gathered through Reddit vs. snowball sampling, except that there were 10% more back-end developers responding to the survey compared to Reddit users. Looking at the other roles we see that none of the respondents considered themselves as pure testers, which was somehow expected, since the survey was posted in developers forums.

Table 7.4: Respondents roles in teams

| | n | % |
|---|---|---|
| **Developer** | 66 | 69 |
| **Tester** | 2 | 2 |
| **Software Architect** | 7 | 7 |
| **Designer** | 9 | 10 |
| **Manager** | 2 | 2 |
| **Other** | 9 | 10 |
| Total | 95 | 100 |

Table 7.5: Respondent's roles in detail

| | n(Total) | %(Total) | %Reddit | %Snowballing |
|---|---|---|---|---|
| **Front End Developer** | 7 | 7 | 8 | 6 |
| **Back End Developer** | 25 | 26 | 23 | 33 |
| **Developer** | 34 | 36 | 35 | 37 |
| **Tester** | 2 | 2 | 0 | 6 |
| **Software Architect** | 7 | 7 | 8 | 6 |
| **Designer** | 9 | 10 | 13 | 3 |
| **Manager** | 2 | 2 | 2 | 3 |
| **Other** | 9 | 10 | 11 | 6 |
| Total | 95 | 100 | 100 | 100 |

Scrum was the most used development method among the respondents, with almost half of the respondents using it, followed by Kanban which is reported to be used by a quarter of the respondents (Table 7.6). The most popular communication media in teams, according to the respondents, were instant messaging (IM). It is used by more than 90 percent of the respondents. Email follows closely the IM and is reported to be used by almost 80 percent of the respondents. Face-to-face meetings is the least used communication media by teams, and just 17 percent of our respondents use it (Figure 7.5).

When focusing on specific communication tools, we see that Slack is the biggest winner here, with 59 percent of the respondents using it as their number one means of communication with other team members (Figure 7.6). Skype follows Slack by a

Table 7.6: Development methods used in teams

| | n | % |
|---|---|---|
| **Scrum** | 31 | 47 |
| **Kanban** | 16 | 24 |
| **Scrumban** | 8 | 12 |
| **XP** | 5 | 8 |
| **Waterfall** | 6 | 9 |
| Total | 66 | 100 |

good margin, and only 38 percent of the respondents use as a communication tool. The third place is occupied by Google Hangout. It is worth mentioning here that Skype and Hangout are more famous for their video calling abilities, while Slack is more text-based, so there would be difficult to compare these tools with each other. In this list Webex, Google Hangout and Skype can be grouped with each other and Slack, HipChat and MS-Teams can be compared to each other (Figure 7.6).

The respondents were also asked what was their biggest challenge while working distributed and almost half of them chose time-zone difference as their biggest challenge. There is no surprise that coordination comes as the second challenge, being chosen by 43 percent of the respondents. Being in different time-zones will immediately affect the coordination between team members. Also, one-third chose communication and trust as one of their challenges in their teams (Figure 7.7).

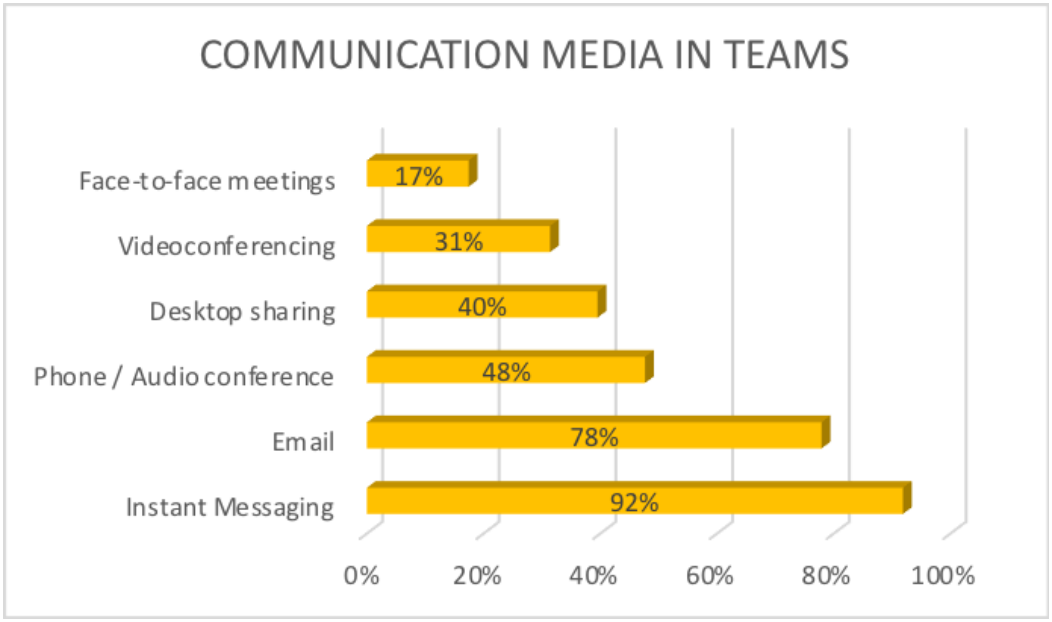


Figure 7.5: Communication media used in teams

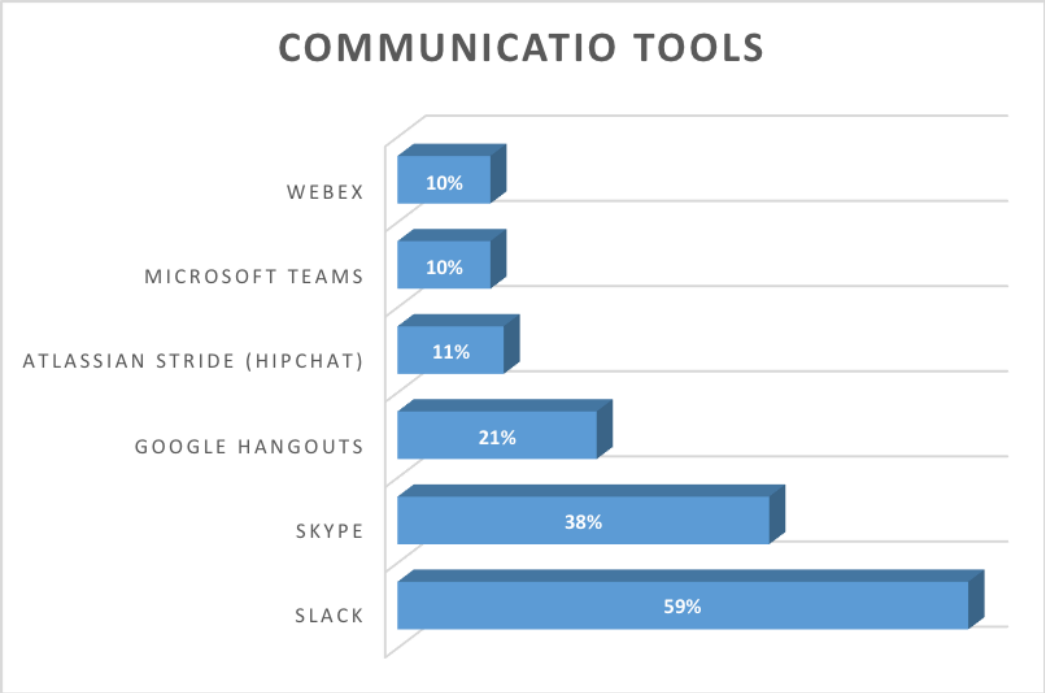


Figure 7.6: Communication tools used in teams

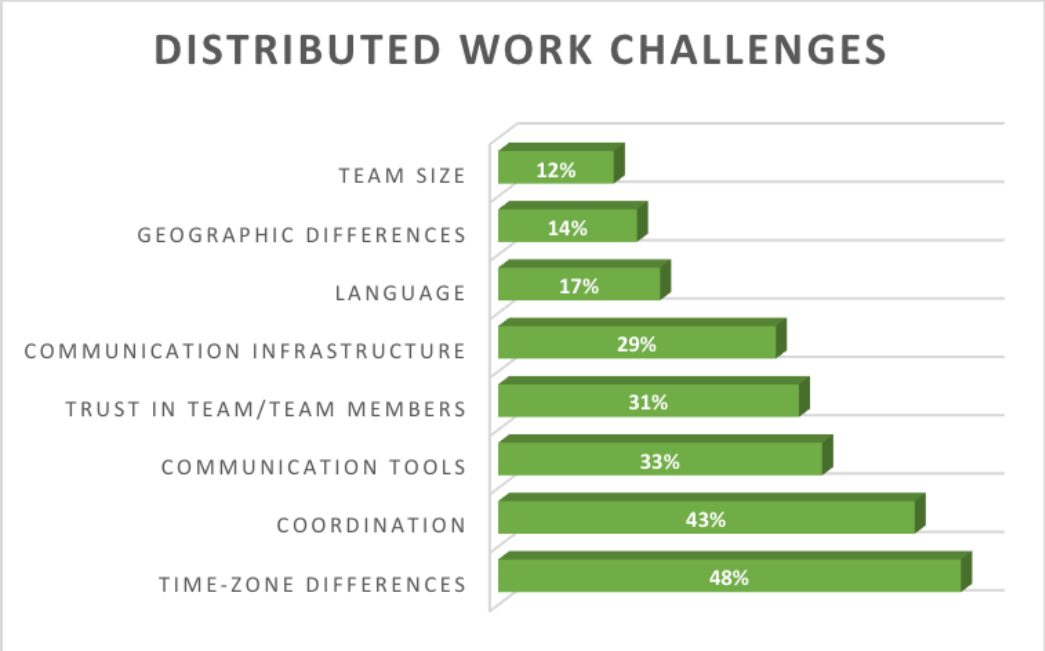


Figure 7.7: Challenges often confronted in distributed teams

Table 7.7: Frequency of face-to-face team meetings

| | n | % |
|---|---|---|
| **Never** | 15 | 34 |
| **At project kick-off only** | 0 | 0 |
| **Monthly** | 9 | 20 |
| **Every 6 months** | 5 | 11 |
| **Yearly** | 2 | 5 |
| **Other** | 13 | 30 |
| Total | 44 | 100 |

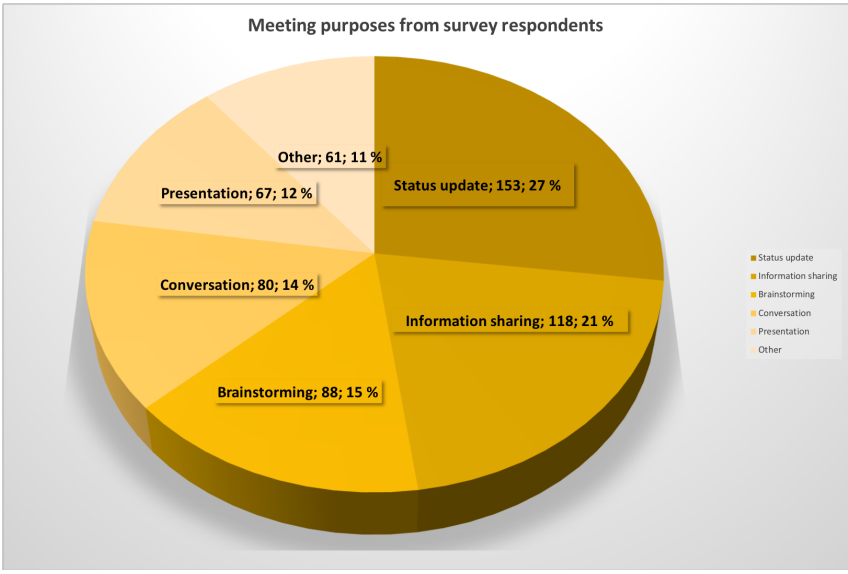


Figure 7.8: Purposes of team meetings

When asked about the frequency of their face-to-face and in-person meetings, one-third of the respondents reported that they never met other team members. 20 percent reported meeting every month, and about one-third chose "other" as the answer to the question (Table 7.7). I also asked the respondents about the purpose of such meetings, and the prominent answer was "status update", chosen by 27 percent of the respondents. Information sharing and brainstorming were ranked as the second and third purpose of the meetings, chosen respectively by 21 and 15 percent of the respondents (Figure 7.8).

*8*

# DISCUSSION

In this part, the results of our study, including their limitations are discussed in relation to research and theories and we try to give an answer to our research questions.

## 8.1 Communication and coordination in DSTs

Our first research question was "What are the challenges of communicating and coordinating in distributed teams, and what kind of consequences might it have for distributed software teams?"

Karis, Wildman, and Mané (2016) ran a survey among Google developers and out of 501 responses they received, 6.6 percent stated that they were collaborating nearly all the time while in our case (n = 44), nobody was claiming to collaborate that much. This might be due to the participation of some Google employees in the survey who were working either remotely or participating in activities such as pair programming which needs collaboration all the time. However, when it comes to time spent on active remote collaboration; there is not that much of a difference between our findings with Karis, Wildman, and Mané (2016). Table 8.1 compares the results. It is interesting to see here that 11% of the respondents believed that they were not collaborating at all. This only can be true if the developers were working alone or if they had a different understanding of collaboration since it is not possible

Table 8.1: Time spent on active remote collaboration

| The frequency of active collaboration | Our results (n=44) | Google (n=501) |
|---|---|---|
| None or nearly none of my time | 11% | 10.8% |
| Less than 1/4 of my time | 64% | 53.1% |
| Up to 1/2 of my time | 20% | 22.8% |
| More than half my time | 5% | 6.8% |
| Nearly all my time | 0% | 6.6% |
| | Total 100% | Total 100% |

to work in a team and not to collaborate with other team members in some way.

If we consider a typical workweek as forty hours, then this amount of remote collaboration counts as around 14% of the whole people engaged in distributed teams spending at least 21 hours per week in active collaboration with distributed team members. Also, 24% spend some time between 10 to 20 hours a week on remote collaboration.

These numbers become even more meaningful if we look at the responses we have got about the challenges in the distributed work, where around half of the respondents have stated that time-zone differences and coordination are the biggest challenges in distributed work. If the task or the project that the team members are working on can be divided into parts that can partly be done and worked on individually and independent from other team members then it would be easier to collaborate remotely with other team members, since the time needed to work on a given task simultaneously is minimal or non-existent.

The problem arises when two team members must work on the same task remotely; then it could be a huge challenge if the time difference is so much that at one place the sun is shining at the middle of the day while in the other part of the world it

has past a few hours after midnight. Here there is a dilemma between having a development team that can work around the clock, 24 hours a day or a development team that are far less separated, both physically and by time. The choice might be dependent on kind of the project and tasks, but our research shows that there would be unexpected challenges in coordination and collaboration between team members that can affect the results gained by distributed team heavily.

Findings of Ibrahim, Qumer, and Al-ani (2015) also shows that temporal and geographical distance is the biggest challenge of distributed software development. More than 75 percent of the literature reported it as the number one challenge among the distributed teams. Distance differences also affect communication negatively in teams; it reduces the efficiency of communication between remote teams (Dorairaj, Noble, and Malik, 2011).

Marlow et al. (2016) in their survey asked a question about the purpose of remote meetings. We did the same and Table 8.2 compares the results. According to the results of our survey, almost half of the respondents reported use scrum as their development method. So it is considered that the most stated reason for remote meetings is "status update." "Information sharing" follows closely status update, while the status update is obviously about updating the whole team, information sharing might refer to meeting and collaboration with two team members.

Looking at the communication media used in distributed teams we see that just 17% have stated that they use face-to-face meetings as a communication media, and later in another question when asked about the frequency of face-to-face meetings we

Table 8.2: The purpose of remote meetings

| | **Our results** | **Marlow 2016** |
|---|---|---|
| Status update | 27% | 33% |
| Information sharing | 21% | 18% |
| Brainstorming | 15% | 13% |
| Conversation | 14% | 12% |
| Presentation | 12% | 9% |
| Other | 11% | 14% |

see that 34% of respondents have stated that they never meet face-to-face with other team members. This can be problematic and increases misunderstanding among the team (Curtis, Krasner, and Iscoe, 1988).

So we see that according to our survey and case results, team members are putting a lot of their work time in communication and coordination with other team members. This highlights the importance of using tools that can help teams to do such activities in the best and most efficient way possible. Our study suggests that it is very important for the team members to be comfortable with the tools they are using and that there should be clear guidelines for usage of such tools so that everyone can benefit from them. According to our results, Slack if used properly can be considered as an efficient modern communication and collaboration tool which can help the organizations to have better communication and coordination in their teams.

## 8.2 Application of theories to current communication tools

Our second research question was "Are the communication and coordination theories, specially the media synchronicity theory still applicable to modern enterprise communication and coordination tools?"

We discussed media synchronicity theory as an extension of media richness theory in

Section 2.1, and presented figure 2.1 which was an illustration of media synchronicity theory based on Maruping and Agarwal (2004). After going through the results of our survey and our case and examining Slack as a modern ESN we came to Figure 8.2 which reflects the changes that we have made to the Maruping and Agarwal's (2004) illustration. Here the stars represent our suggestions for change. As it is clear in the Figure 8.2, Maruping and Agarwal (2004) have given a very low grade to the instant messaging regarding symbol variety and parallelism, but fourteen years later we see that modern IM's are quite rich in symbols and parallelism is easy to achieve. Another important point here is that Slack has also another feature which was not present in previous communication applications and that is the ability to edit the messages even after the message is sent.

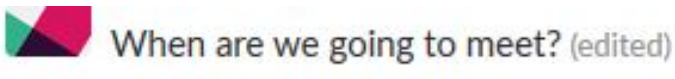


Figure 8.1: An edited message in Slack

This "editability" feature is unique to modern ESNs such as Slack and cannot be found in other ways of communication. In case of Slack, a user can edit his or her own posts without any time limitation and a small (edited) sign will be shown after the message so that the others will know that the message is changed (See Figure 8.1).


Figure 8.2: Suggested update to MST, inspired by Maruping and Agarwal (2004).

Our study also bolds out some of the limitations of the media richness theory applied to digital communication in teams. The theory argues that communication performance is dependent on the richness of media (Daft and Lengel, 1986). The richer the media, the better communication. In this regard, face-to-face encounters are considered as being the richest medium of communication because of availability of facial expressions and non-verbal cues. But our study shows that this does not always apply and in the case of software teams actually the communication in modern enterprise communication tools like Slack is more effective than other types of communication. This is because in these tools lots of functionalities are implemented that helps the users to communicate what they mean easily.

Another point is the Van de Ven model of coordination (Van De Ven et al., 1976) that defines three modes of coordination. But by studying of Slack as a coordination and communication tool and trying to apply those modes of coordination we came to some other findings that challenge the application of this theory to modern communication tools used in teams. Coordination mode in Slack channels can be categorized as both personal and group mode because everyone is talking to a group and also in many circumstances they are talking to other individual users but the group is also able to follow the conversation. It also can be seen as a coordination tool used in personal mode since it is possible for the team members to receive feedback and mutual adjustment from other peers personally through DM. It is even interesting to see that it can be used in both horizontal and vertical channels, though it does not give that much meaning in this context since it is not possible to enforce

some kind of hierarchy in the virtual space. Also, Slack's integration abilities with other systems as well as its bots can put it under the category of impersonal coordination mode. Slack, as a representative of modern communication tools built for teams, in this manner completely challenges this theory and provides us with new insight about coordination modes in distributed software teams.

So we see that these theories can be only applied partially to the modern communication and coordination tools like Slack and they needed to be updated in order to cover the changes that has happened to the way we communicate and coordinate in recent years.

### 8.3 Dos and do nots in introduction of communication tools

Our second research question was "When considering to introduce communication and coordination tools to teams what factors should be considered to maximize the benefits of using such tools?"

Based on our research we suggest the managers to try to understand what exactly their teams need before thinking about introduction of a certain tool to their teams. Are they going to have simple conversations or do they need to communicate and coordinate complicated matters that needs having a communication medium which provides a richer type of communication? Any answer to these questions will show if you need a complicated solution such as Slack or just a simpler IM or a video conferencing tool. If you are already using some kind of tools for coordination and communication then you must be sure that the new tool either has the same functionalities or those functions can be integrated into the new tool, or else your

team members can easily get frustrated and will not use the tool in the desired way.

Before introducing any new tool the managers must become familiar with the tool and based on the functions that the tool provides the teams write down some clear guidelines on how to use and not to use the tool. Relying on norms cannot be a good idea since the team members might not be aware of the norms or have not the same understanding of the norms based on their cultural background (Stray, Fægri, and Moe, 2016). A good example here is to strictly ask all the team members to use just one language in their communication, English for example. In our study we have seen that in many cases people have started to write in Norwegian or Polish, although it seems to be easier for the other Norwegian or Polish team members to understand and communicate in their native language but this could easily be misunderstood by the other team members who do not understand that language, and also prevents them from participating in the discussions.

The organizations should continuously observe their teams and see how they use the tools. There are some team members that might not be familiar with the tools or because some other obstacles might not be using the tools at all or use it minimally, this could be a threat for the team and needs to be resolved.

Even after the introduction of a new communication tool, some team members might still continue to use the older tools that they are accustomed to, like email. Not all the team members are developers or people with lots of technical knowledge and experience, and most possibly there are people in business, design or marketing teams that lack the necessary knowledge to start to use these complicated tools. This

can make inconsistency in communication and coordination of the team and make documentation and tracing the actions to specific team members difficult and should be acted upon. A good sign that helps to identify such users is the users that use the current tool rarely but because of the nature of their job should be communicating a lot with other team members.

It is also a good idea to check the trends by analyzing the data provided by the communication and coordination tool your organization is using. A good example could be looking at the number of messages sent and received by teams during a week or month and see the trends in the number of messages in different hours during working hours. Our study shows that although a normal working hour is from 8:00 to 16:00, in reality, the activity in Slack was reduced substantially after 14:00. Now we can not say for sure that team members were not working during those hours but it could be worth to have a deeper look at that.

*9*

# LIMITATIONS

Notwithstanding using a reliable research method, consisting of cutting the edge research and data collection and analysis schemes I am aware of the several limitations of my research.

We were at first concerned about the reliability of the results of our survey since in our opinion gathering just 95 answers were not enough to reflect the opinions and situation of all or at least a large number of other developers. Thus, to verify that the results of our survey are a good representative of the active programmers we compared our results with the Stack Overflow's 2018 developer survey results[1]. Stack Overflow is a question and answer forum dedicated to computer programming and every year runs a survey among its users and shares it openly with the community. This year more than 100,000 developers participated in the survey, and its results were published shortly after our survey and could be considered as a good reference. Looking at the heat map of the location of the subjects, we see that there are similarities between the two surveys. Most of the respondents are from northern America, Europe, and India. Regarding gender, there were slightly more female participants in our study. There were almost double as much backend developers in Stack Overflow's survey than ours.

Stray, Moe, and Bergersen (2017) also did a survey of distributed teams and found

[1] https://insights.stackoverflow.com/survey/2018/

almost identical demographic results as our survey, which combined with the Stack Overflow results suggests us that our results are reliable.

Although by comparing the results of our study with other similar studies we are convinced that our results are reliable, there are still some other limitations in our study.

First, the lack of access to other means of communication used by team members in the case study, other than conversations in Slack channels. Other means of communication that could have been interesting to get access to were emails and private messages sent on Slack. The company was not able to retrieve private messages due to the type of Slack subscription they have which just allows for exporting of conversations in channels.

Second, due to the enormous amount of Slack chat logs and the fact that all of these conversations needed to be coded manually, just a handful of chat logs from the backend, frontend, and operations channels were coded. Although we tried to choose the channels that are common to other software teams as well, it would have been better to code more data from more Slack channels.

Third, the case study was limited just to one company and the findings might have been under the influence of the culture and other circumstances unique to that company. Also, the fact that the teams were located in the same time-zone and have somehow near European culture and background might also affect the results and make it harder to generalize.

And finally, all the analysis of the data is done just by one researcher, although

that researcher is not biased toward the results gathered through the study. This can reduce the reliability of the research because the gathering of results and their interpretation is dependent on the knowledge and experience of the researcher. But I have tried to describe all the steps taken in detail so that the future researchers can follow the same steps and compare their results with mine.

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# CONCLUSION AND FUTURE WORK

This thesis aims to shed light on communication and coordination in distributed teams. By analyzing conversations traded in Slack channels between two teams located in Norway and Poland, as well as running a survey among professional software developers working in teams we tried to get to know the whereabouts of communication and coordination in distributed teams. According to the results of our study ESNs are becoming the number one way of communication in software teams and there is a demand in organizations to grasp this opportunity to maximize the benefits of such systems.

Our research shows that there are signs that not everyone in software teams is still on-board when talking about communication and coordination in DST. Managers and other influential people in companies have a job to apply the practices suggested by our research to be sure that the transition from older means of communication and coordination to new ones goes smoothly for everyone in the teams.

The recommendations for the future work listed here are mainly based on the limitations of this study. The first possibility for other researchers is to compare the conversations between team members in both an ESN and a traditional method of communication, like email. If possible, it would also be interesting to look at the private messages of the team members in an ESN and contrast it with the messages published in public channels.

Second, researchers who have enough time can code more amount of chat logs or chats from more channels to get a better understanding of the communication patterns in different teams within an organization.

Finally, looking into the communication and coordination in two different companies, preferably one small and one big company and contrasting the results gained through this should reveal interesting information that can help organizations with different sizes to make better decisions regarding the choice of appropriate communication tools for their teams and its implementation.

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*Appendix A*

# SURVEY QUESTIONS

Start of Block: PreQuestionnaire

**What is your age?**

| | |
|---|---|
| Years () |  |

**What is your gender?**

- Female (2)
- Male (1)
- Other (5)

**Do you work in a team?**

- Yes (1)
- No (2)

**What is your main role?**

- ○ Front-end developer (1)
- ○ Back-end developer (2)
- ○ Developer (3)
- ○ Tester (4)
- ○ Software architect (5)
- ○ Designer (7)
- ○ Manager (team leader, technical leader, etc.) (6)
- ○ Other (9)

---

**What development methods do you use?**

- ○ Only Agile (1)
- ○ Agile and Lean (2)
- ○ Only lean (3)
- ○ Neither agile nor lean (4)

---

**In my opinion, we follow:**

- [ ] Scrum (1)
- [ ] Kanban (2)
- [ ] Scrumban (3)
- [ ] XP (4)
- [ ] Waterfall (5)

---

**The length of our sprints are usually:**

- ○ 1-2 weeks (1)
- ○ 3-4 weeks (2)
- ○ 5-6 weeks (3)
- ○ 7 or more weeks (4)

---

**How many meetings do you attend during a typical work day (including daily stand-up meetings)?**

- 0 (1)
- 1 (2)
- 2 (3)
- 3 (4)
- 4 (5)
- 5 (6)
- 6 (7)
- 7 (8)
- 8 (9)

---

**How many hours do you work per day during a typical work day?**

- 4 (1)
- 5 (2)
- 6 (3)
- 7 (4)
- 8 (5)
- 9 (6)
- 10 (7)
- 11 (8)
- 12 (9)

End of Block: PreQuestionnaire

Start of Block: Team questions: location and size

**Considering the team you spend the most time in, your team is:**

- ○ Co-located. (1)
- ○ Distributed across sites. (2)

**Team size?**

| | 2 | 5 | 7 | 10 | 12 | 15 | 17 | 20 |
|---|---|---|---|---|---|---|---|---|
| Number of people in my team including myself () | | | | | | | | |

End of Block: Team questions: location and size

Start of Block: Communication & Tools

**Which communication tools do you use in your team?**

- ☐ Email (1)
- ☐ Videoconferencing (3)
- ☐ Instant Messaging (Slack, etc.) (2)
- ☐ Phone / Audio conference (4)
- ☐ Desktop sharing (5)

**Which one of these tools do you use in your team?**

- [ ] Slack (1)
- [ ] Microsoft Teams (2)
- [ ] Mattermost (4)
- [ ] Atlassian Stride (HipChat) (3)
- [ ] Google Hangouts (5)
- [ ] Skype (6)
- [ ] Zoom (7)
- [ ] Appear.in (8)
- [ ] Trello (9)
- [ ] Kanbanize (13)
- [ ] Jell (10)
- [ ] Asana (12)

---

**How often do all the team members meet face to face, in person?**

- ○ Never (1)
- ○ At project kick-off only (4)
- ○ Monthly (5)
- ○ Every 6 months (3)
- ○ Yearly (6)
- ○ Other (7)

---

**Which of the following do you find challenging while working distributed?**

- ☐ Communication tools (1)
- ☐ Time-zone differences (2)
- ☐ Geographic differences (3)
- ☐ Communication infrastructure (4)
- ☐ Coordination (6)
- ☐ Language (7)
- ☐ Team size (8)
- ☐ Trust in team or team members (9)

---

**How much of your time do you spend actively collaborating with remote colleagues?**

- ○ None or nearly none of my time (1)
- ○ Less than 1/4 of my time (2)
- ○ Up to 1/2 of my time (3)
- ○ More than half my time (4)
- ○ Nearly all my time (5)

End of Block: Communication & Tools

Start of Block: Testing questions

**Please rate from your personal point of view:**

| | Strongly disagree 1 | 2 | 4 | Strongly agree 5 |
|---|---|---|---|---|
| Team members proactively provide relevant information to other team members without being asked () | | | | |
| All demands of the customers are satisfied () | | | | |
| The team members are happy with the timeliness in which they receive information from other team members () | | | | |

End of Block: Testing questions

Start of Block: Stand-up meetings How often and rating

**Do you attend stand-up meetings (aka Daily Scrums?)**

- ○ Yes, local stand-up meetings (1)
- ○ Yes, distributed stand-up meetings (2)
- ○ Yes, both local and distributed stand-up meetings (3)
- ○ No (4)

---

**How valuable do you think the local daily stand-up meetings are?**

1 - Not valuable
5 - Very valuable

| | | | | | |
|---|---|---|---|---|---|
| For you personally (1) | ☆ | ☆ | ☆ | ☆ | ☆ |
| For the team as a whole (2) | ☆ | ☆ | ☆ | ☆ | ☆ |

---

**How valuable do you think the distributed daily stand-up meetings are?**

1 - Not valuable
5 - Very valuable

| | | | | | |
|---|---|---|---|---|---|
| For you personally (1) | ☆ | ☆ | ☆ | ☆ | ☆ |
| For the team as a whole (2) | ☆ | ☆ | ☆ | ☆ | ☆ |

**End of Block: Stand-up meetings How often and rating**

---

**Start of Block: Standup equipment**

What type of equipment do you use in your **local** daily stand-up meeting?

- [ ] Phone (1)
- [ ] Video (2)
- [ ] Electronic board (4)
- [ ] Physical board (5)
- [ ] None (6)

What type of equipment do you use in **distributed** daily stand-up meeting?

- [ ] Phone (1)
- [ ] Video (2)
- [ ] Electronic board (3)
- [ ] Physical board (4)
- [ ] None (5)

**End of Block: Standup equipment**

**Start of Block: Time spent**

**Roughly how many hours do you spend on the following activities during a typical work day?**

| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|---|
| Time in scheduled meetings (including daily stand-up meetings) () | | | | | | | | | |
| Time in unscheduled meetings and ad hoc conversations with 2 or more people () | | | | | | | | | |
| Time in ad hoc conversations with one other person () | | | | | | | | | |
| Time doing testing () | | | | | | | | | |
| Time doing programming () | | | | | | | | | |

End of Block: Time spent

Start of Block: Skills

**Programming skills**

(1 = Novice, 5 = Expert).

| | | | | | |
|---|---|---|---|---|---|
| How do you rate your programming skills? (1) | ☆ | ☆ | ☆ | ☆ | ☆ |
| How do you rate the programming skills of your peers? (2) | ☆ | ☆ | ☆ | ☆ | ☆ |
| How do your peers rate your programming skills? (3) | ☆ | ☆ | ☆ | ☆ | ☆ |

**Testing skills**

(1 = Novice, 5 = Expert).

| | | | | | |
|---|---|---|---|---|---|
| How do you rate your testing skills? (1) | ☆ | ☆ | ☆ | ☆ | ☆ |
| How do you rate the testing skills of your peers? (2) | ☆ | ☆ | ☆ | ☆ | ☆ |
| How do your peers rate your testing_skills? (3) | ☆ | ☆ | ☆ | ☆ | ☆ |

End of Block: Skills

Start of Block: TWQ

***Last question...***

Please rate from your personal point of view:

| | (Strongly disagree) | | | (Strongly agree) |
|---|---|---|---|---|
| | 1 | 2 | 4 | 5 |

| | |
|---|---|
| Going by the results, this teamwork can be regarded as successful. () |  |
| The product proves to be stable in operation. () |  |
| The customer is satisfied with the quality of the teamwork result. () |  |
| The teamwork result is of high quality. () |  |
| The company is satisfied with how the teamwork progresses. () |  |
| Overall, the team works in a cost-efficient way. () |  |
| Overall, the team works in a time-efficient way. () |  |
| The team is within schedule. () |  |
| The team is within budget. () |  |

**Please rank the most common purpose of your remote meetings.** (Drag and drop to arrange)

_____ Status update (1)
_____ Information sharing (2)
_____ Brainstorming (3)
_____ Conversation (4)
_____ Presentation (5)
_____ Other (social, demo, planning, training) (6)

**End of Block: TWQ**