How is information and knowledge communicated?

A case study on communication within and across software-provisioning team boundaries

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Abstract

Today it has become standard for organizations to rely on self-serving teams to make decisions since they are believed to provide access to bigger pools of information and knowledge than individual managers. However, while a lot of research has been focusing on how to improve information and knowledge sharing in teams to better promote the making of deliverables, not much has been said about how self-serving teams actually communicate information and knowledge. In this thesis a qualitative study was conducted with seven members of a software-provisioning team to, with particular focus on using IT when communicating, investigate how information and knowledge is communicated within and across team boundaries. Findings in this thesis suggest that there is a tension between information and knowledge sharing in teams. While the formalization of technological channels might facilitate effective information sharing in teams, it could have negative effects on knowledge sharing.

Keywords: Information sharing, Knowledge sharing, Team communication

1. Introduction

Since the very beginning, information management has been a core issue of IS research (Dat & Lengel, 1986; Livari & Lyytinen, 1999). Information sharing in the context of self-served organizational teams is a central process through which team members collectively utilize available information resources. Overtly promoting information sharing amongst team members has shown positive effects on team consensus, team trust and team cohesion (Mesmer-Magnus & DeChurch, 2009; Robert et al., 2008). Improved team performance is strongly related to how well teams can function in many different aspects. Robert et al. (2008) argue that high obligation and identification with team views predict for better information flow and sharing amongst members, increasing the likelihood of improved team performance. Researchers agree that effective information sharing amongst team members lead to better decision-making, which can be related to having members that feel strong obligation and identity with the team (Miranda & Saunders, 2003). Research suggests the same applies to knowledge sharing. Espinosa et al. (2007) mention that team cognition research suggest that when team members interact over time they develop team knowledge that can help them coordinate implicitly where they can anticipate what other members know and can do, making them able to interact more effectively. Research has long recognized the importance of knowledge and information sharing in organizations, mostly because it has been proven to be critical when it comes to maintaining long term organizational competitiveness in the fast changing technological era that we live in (Carlile, 2002; Yang & Maxwell, 2011). In accordance with this having effective knowledge and information sharing in self-serving teams is crucial to team success and team performance.

However, while a lot of the research has focused on how to better optimize and more accurately coordinate team knowledge and information (Prencipe & Tell, 2001), a closer look at the research on knowledge and information sharing in teams suggests that little has been said about how knowledge and information sharing in teams actually is communicated in

practice. Prencipe & Tell (2001) argue that traditionally knowledge codification and integration from project-to-project has only been justified depending on the potential financial outcome it can bring, not considering the future possibilities of constructing formalized ways of mapping how information is communicated in self-directed teams. Furthermore, Hart-Davidson (2003) argues that both the research literature on team-based communication in organizations and the journals of technical communication have little to say about what team communication really looks like in practice. The focus has traditionally been on the outcome of teamwork – the deliverables – not saying much about the day-to-day communication events that precede and facilitate the production of deliverables. Using this as a background I chose to study and map how a self-serving software provisioning team, with a particular focus on the role of IT, communicates knowledge and information within and across team boundaries. The main goal with this thesis is to gain more knowledge on how information and knowledge is practically communicated in self-serving team environments. Following this my research question is therefore: *How is information and knowledge communicated within and across software-provisioning team boundaries?*

1.1 Communicating knowledge

Jasimuddin et al. (2005) mention that knowledge, compared to information, is far more complex and can be both tacit and explicit. Tacit knowledge is knowledge that people develop trough internal processes, which makes it complex to transfer because it is situated within the individual. Explicit knowledge on the other hand represents knowledge that can be codified in a tangible form, making it easier to share with other individuals. Since knowledge is more complex than information it becomes harder to communicate between individuals. Looking at the research on knowledge sharing in teams there are no precise definitions on how knowledge can be communicated, which arguably, could be related to knowledge being complex and situated. However, when it comes to knowledge being communicated there are two ways in which this can be supported. Leonardi (2015) mentions that there are two distinct approaches for the sharing of metaknowledge between individuals. Firstly, a person can learn experientially by directly communicating with other coworkers by asking questions and listening to answers. Secondly, a person can learn vicariously by watching how others communicate and how their communication patterns looks like.

1.2 Positioning of the thesis

The aim of this thesis is to generate and add knowledge to the research on information and knowledge sharing in organizational based self-serving teams. The characteristics of the findings and contributions generated in this thesis provide knowledge to both the theoretical research on information and knowledge sharing in teams, and to the practice research on team communication processes. The below figure displays where this thesis is positioned within the IS field.

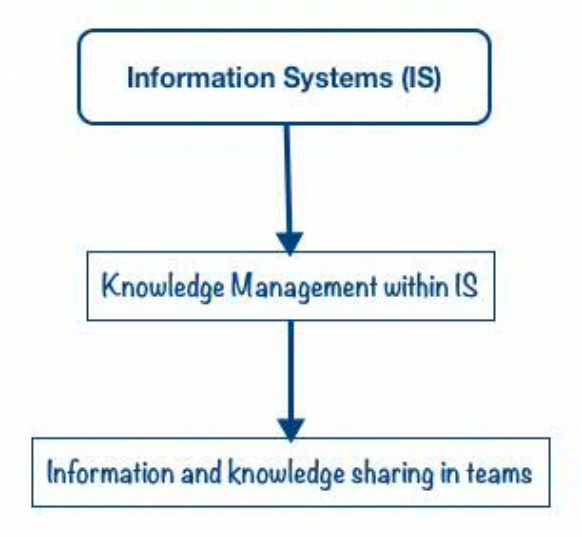

Figure 1: Positioning of the thesis within the IS field.

2. Theoretical background

In this chapter earlier research within the field of information and knowledge sharing in teams will be presented. Firstly, in order to understand the concept of information sharing, the first section reviews research on information sharing related to self-serving teams and sets the parameters for this thesis. Secondly, because this thesis has a particular focus on the role of IT, research on information sharing using IT is accounted for. Thirdly, in order to distinguish between information and knowledge sharing a definition of knowledge is presented. Fourthly, a summary on research concerning information and knowledge sharing in teams is presented. Finally, in order to understand how teams communicate, ways in which to visualize communication in teams are discussed.

2.1 Interpersonal information sharing

Research has long argued that information sharing is an important approach for improving total quality management and to increase organizational efficiency, learning, and innovation (Constant et al., 1994; Miranda & Saunders, 2003; Yang & Maxwell, 2011). Within that approach, interpersonal information sharing where individuals share information in the context of interpersonal relationships becomes important to information management within organizations (Yang & Maxwell, 2011). Yang & Maxwell (2011) further state that information sharing research on the interpersonal level focuses on individual's behaviors, such as their motivation for sharing information, approaches and channels through which they communicate information. Information sharing can be related to both voluntary purposes and also to satisfy the needs of others (Jaarvenpaa & Staples, 2001). Following these parameters, information sharing in this thesis is focused on the context of interpersonal relationships and the channels through which they communicate information.

2.2 Information sharing using IT

The first use of computer-mediated technologies (CMT) increased the potential for information sharing in organizations (Constant et al., 1994). Hinds & Kiesler (1995) highlight that the theoretical literature emphasizes the significant importance of using IT for collaborating and sharing information across organizational boundaries. Miranda & Saunders (2003) further argue that while having an electronic medium in multimedia environments may hamper information sharing, once available, using such media may be more effective than face-to-face conversations. Constant et al. (1994) argue that traditionally the sharing of information was referred to one-to-one exchanges of data between a sender and a receiver. Warkentin et al (1997) further argue that with technology today being more advanced information exchange happens instantly, continually and over different socially enabled technical platforms. However, CMT technologies impose constraints that are likely to affect group performance. People rely on multiple modes of communication in F2F conversations such as facial expressions, hand gestures, eye movement etc. CMT technologies prelude these secondary attributes in conversations thus changing the orderliness and effectiveness of information exchange (Warkentin et al, 1997). Furthermore, if information sharing is not effective teams will not fully capitalize on all the informational resources that are within the team. There is much more to information sharing than

quantitative information transfers. Research shows that members of groups tend to discuss information that is commonly held and known in the whole group, rather than discuss individual unique information known only to each team member (Mesmer-Magnus & DeChurch, 2009; Robert et al., 2008).

2.2 Knowledge definition and knowledge sharing

Schulz (2001) argues that knowledge is a broad concept that usually includes insights, interpretations and information. Knowledge is distinguished from information by its integrations of interpretations, where it is to been seen as something that can be transformed and acquired (Schulz, 2001). Jasimuddin et al (2005) argue that the predominant view on categorization of knowledge is the knowledge-as-a-category viewpoint that is embedded and widely studied in the research on organizational knowledge. This perspective suggests that explicit and tacit knowledge is two different types of knowledge and links back to early attempts on classifying knowledge. Tacit knowledge is constructed from individual's own experiences of the world and forms the basis for explicit knowledge.

> *Knowledge is not only tacit, in the narrow sense of it being that which is not explicit, but also that knowledge and knowing cannot be separated from an individual's engagement in the "practicing" of their practice (Carlile, 2002, p.445)*

Jasimuddin et al. (2005) argue, in contrast, that explicit knowledge represents knowledge that can be codified and transferred in a tangible way. While explicit knowledge generates computable data that in relation to tacit knowledge is easy to manipulate, tacit knowledge is more costly to access and transfer. This view on knowledge as both explicit, where it is tangible and relatively easy to access, and the far more complex situated knowledge can be linked to the earlier studies by Carlile (2002). He proposed "three approaches" in understanding how knowledge is transferred across boundaries. Firstly, the syntactic approach suggests that if a common syntax is established coordination of knowledge becomes easier. Secondly, the semantic approach suggests that while a syntactic understanding is established we still have our own interpretation differences in understanding transmitted messages. Thirdly, the pragmatic approach that highlights the importance of understanding the consequences that exist between things that is different.

2.3 Information and knowledge sharing within and across teams

Looking at the research on knowledge and information sharing it becomes clear that to stay competitive organizational firms need to have effective knowledge and information sharing within and across their teams (Polyaninova, 2011). However, as mentioned by both researchers in topic of information and knowledge sharing (Mesmer-Magnus & DeChurch, 2009; Robert et al., 2008; Carlile, 2002), information and knowledge can be localized and embedded individually, contextually and socially making it sometimes very complex in nature and hard to codify for transfer. What becomes apparent, though, is the fact that research has focused on the importance of utilizing information and knowledge sharing to better facilitate actual outcome of deliverables, not saying much about the day-to-day

communication events that precede and facilitate the production of deliverables (Hart-Davidson, 2003; Prencipe & Tell, 2001).

A closer look at the research on knowledge and information sharing in teams suggest that little has been said about how knowledge and information sharing in teams actually is communicated in practice. Leonardi (2015) mentions that informal "Coffee break" conversations can facilitate both implicit and explicit information and knowledge sharing, either in direct communication between two co-workers or watching somebody else talking. This, then, suggest multiple ways in which team members can acquire and share information and knowledge within and across boundaries, but how is it actually communicated? This thesis will investigate how this is done and generate insights on the subject of information and knowledge sharing in teams.

2.4 Communication visualization

In order to investigate how knowledge and information is shared within and across team boundaries, this thesis will analyze the ways in which knowledge and information is communicated in the day-to-day activities of the team. Communication can be visualized in a number of different ways. Leonardi (2015) conducts a grounded approach where he uses a comparison method between two departments at an organization, where one department used an Enterprise Social Network for communicating with each other and the other was used as a control group. From this, a theory of communication visibility emerged suggesting that the use of Social Media in organizations enhances metaknowledge on who knows what and whom. Knowing what other co-workers do could lead to more innovative products and services if they can learn to work in new ways. By learning vicariously, rather then through experience they can recombine existing ideas and avoid unrelated information and knowledge exchange with less work duplicate (Leonardi, 2015).

In another research effort Hart-Davidson (2003) uses a diary method to visualize communication patterns in project management activities. The diary method involved participants of two school projects where they wrote down in diary form how they chose to communicate, either using physical or technological means for communicating.

The research question in this thesis is concerned with how knowledge and information is communicated within and across team boundaries, with a particular focus on the role of IT. Therefore, for the purposes of this thesis, the means of communication is of particular interest, and I will draw on the method of visualizing the means of communication, in the form of tables (Hart-Davidson, 2003). These tables represent and show the preferable means communicating information and knowledge in the team studied in this thesis.

3. Research effort

Aiming towards understanding how information and knowledge is communicated, I adopted a qualitative methodology to try and understand the complexity of information and knowledge sharing. In the following sections I will describe the research approach more in detail, the selection process of respondents and the setting in which the data was collected and analyzed.

3.1 Research approach

Carlile (2002) argue that a core issue with managing knowledge is the fact that it can be dynamic, complex, explicit and tacit in nature. Based on this assumption, in order to investigate this, I chose to conduct qualitative interviews to collect my data. Acknowledging the problematic issue with capturing knowledge, this research approach allowed me to get a more accurate understanding of knowledge sharing by intercepting and capturing the respondent's personal experiences and understanding (Bryman, 2011). While the characterization and definition of knowledge is extensively grounded in research, the common-sense definition of knowledge can be related to it being "the same as information". Realizing that the respondents might refer to knowledge being the latter, also highlighting the difficulty in describing your own perception of knowledge (Leonardi, 2015), questions were developed using influences of a semi-structured interview approach. The semi-structured interview form combines the use of structured and unstructured questions and usually begins with an itinerary of questions which depending on the context where it is used can be changed during the interview to better facilitate the research question being answered (Bryman, 2011). Because knowledge is far more complex to understand compared to information, this allowing me to expand my itinerary of questions during the interviews with follow up questions to ensure that the respondents understood and reflected on their own perception of what knowledge is defined to be.

3.2 Data collection and analysis

This section describes how the data was collected trough selected interviews and how the data was analyzed.

3.2.1 Data selection and setting

In this thesis I have conducted seven interviews with members of a software provisioning team working at the local offices of a multinational IT-consultancy firm. The roles of the seven members varied and involved members working in managerial positions and in start-up positions, also varying in background and experience. Working in software provisioning teams is hectic and involves tight scheduled workdays, which had to be considered when booking dates for interviews. An effect of this was that, in order to conduct as many interviews as possible and to decrease the workload for the respondents, all interviews had to be done in one day. To make the interviews more efficient and effective I chose to hand out papers where basic information around each respondent could be filled in before the interview started to further save time. Each interview circulated between 15-20 minutes in total recording time making them time efficient and comfortable in length for all the

respondents. No participant in this thesis is mentioned by name and I put a great amount of effort into not asking questions that were to long, diffuse and leading/misleading (Ryen, 2004). Below is a graphical explanation of the background of the seven different respondents.

IR1 Age: 40 Background: Dev., Test, Project Manager Role: Project Manager	IR2 Age: 40 Background: Dev., Project Manager, Sales Role: Solution Architect
IR3 Age: 36 Background: Systems development Role: Developer	IR4 Age: 38 Background: Systems development Role: Consultant
IR5 Age: 35 Background: Systems development Role: Dev./Architect	IR6 Age: 35 Background: Dev., Architect Role: Dev./Architect
IR7 Age: 29 Background: Systems development Role: Developer	

Figure 2: Presentation of the respondents.

The respondents interviewed in this thesis were all based out of the same software team. As mentioned earlier the scope of this thesis is limited to look at one locally based software provisioning team, where all members and stakeholders are locally bound and works closely with each other. All interviews where conducted at the IT-consultancy firm in their natural working environments. This decision was preferable since it makes the respondents more familiar and possible more comfortable when interviewed (Bryman, 2011). Following the choice of doing interviews on location suggested the use of observations at the same time, but due to the time limit of this research thesis this was not conducted.

3.2.2 Analysis

All the data in this thesis was generated from recordings during the interviews. The interviews were done in Swedish and the citations in the findings section is therefore translated to English. When all interviews had been transcribed they were printed out and read trough. The most interesting findings and themes were marked with color markers in order to identify relevant parts. The relevant parts were there after categorized into three categories, which is presented in the findings chapter under subsections. The first category focused on preferable means of communicating within team boundaries. The second category focused on preferable means of communicating across team boundaries with other locally bound teams working at the firm. Finally, the third category focused on analyzing

chosen means of communicating information and knowledge in teams. After that the relevant data was collected and summarized in the tables described below. The first table displays preferable means of communicating within team boundaries and between members of the team only. The second table used the same template and displays means of communicating across team boundaries between internal members and external members of other teams locally. Both tables were graded where grade 1 indicates the most preferable way of communicating and where grade 5, grade 3 in the second table, indicates less preferable ways of communicating. In this thesis I have not looked for any link or correlation between the uses of physical or digital ways of communicating, the grade scale only show preferable ways of communication. The example below displays a table example.

Grade 1	F2F meetings & E-mail
Grade 2	MS Communicator
Grade 3	Skype & Live Meeting
Grade 4	Telephone
Grade 5	Coffee break conversations

Table 1: Table example of different means for communicating.

3.3 Method choice and source criticism

Sources used in this thesis are mostly collected from Google Scholar and Informs. I have tried to use sources that are of concern to my research area, the IS field, and also to critically review them by thoroughly making sure that the sources are within the IS field and using sources that have been published in relevant journals (Bell, 2006). Furthermore, as communication of knowledge and information can both be facilitated using technical and psychical means, as well as being transferred tacitly and explicitly, this qualitative approach could have been complimented with observations in an effort to more effectively cover how different sets of knowledge and information is being communicated within and across teams. All interviews in this thesis were conducted during one day, an approach that is not recommended because interviews are highly demanding and tiring on the person doing the interviews (Bryman, 2011, Kvale & Brinkmann, 2009). This was considered and notified but could not be avoided. Moreover, since this thesis is written in English all interviews should have been done in English to avoid translate related issues when coding and transcribing. Finally, after analyzing all the data I can confirm that some of it was not usable in this thesis, suggesting that more interviews with follow-questions could have been done to gain more empirical data to support the conclusions.

4. Findings

In this chapter I will present and analyze the findings of the thesis using the two tables found below. Firstly, table 2 will be presented and analyzed, which show a summarized display of how team members preferably communicate within team boundaries. Each table row will be accounted for in descending order, where I will present and analyze around each mean of communication within the table row. Secondly, table 2 will be analyzed in the same way, which displays how team members preferably communicate across team boundaries. Thirdly, the respondent's perception of information and knowledge sharing will be analyzed in conjunction with their preferred ways of communicating.

Grade 1	F2F meetings & E-mail
Grade 2	MS Communicator
Grade 3	Skype & Live Meeting
Grade 4	Telephone
Grade 5	Coffee break conversations

Table 2. Communicating within team boundaries

Grade 1	F2F meetings & E-mail
Grade 2	MS Communicator, Collaborative Management Systems, Buzz- Talk, Developer blog
Grade 3	Social Media

Table 3. Communicating across team boundaries

4.1 Communication within team boundaries

The first row in table 2 show that internal team communication is primarily focused around the use of E-mail and meeting F2F. The F2F encounters could for example be, as explained by some of the respondents, a quick walk by the room where a member is sitting and just have a chat about something. Another encounter could be when team members bump into each other in the hallway where they have a conversation about something that occurred on the spot. The preferred digital mean of communicating is primarily E-mail and one re-occurring reason for this is explained by IR3*:* "E-mail is the primary source when we communicate… it is the most formal mean of communicating and also somewhat binding". All respondents highlighted the importance of having E-mail conversations and that E-mail is essentially the primary way of communicating digitally within the team. One reason for this is because it is considered to be formal and that it becomes more binding than F2F

discussions. Another reason for this, as explained by IR4, is because E-mail makes for better a platform when discussing technical solutions, avoiding stuff being lost in translation when talking F2F. “IR4: I like to handle my technical conversations over mail, since informal F2F conversations risk stuff being lost in translation (…)”.

The next row in table 2 show that most of the team members also use the communication software tool Microsoft Communicator in situations where instant messaging is required. Almost all respondents mention that if they have something they want to discuss with multiple members at the same time, or if they just want to have a chat with a specific member, they use MS communicator because it makes for a better platform then mail if you want faster response time. This is highlighted by IR1 who talks about one team member not being there in presence:

> *“There is one person who I never meet so with him we are using the fast chat (Communicator). There we can have talk and we have quite good communication. (…) It is a little up and down with using E-mail, you get better answers if you use the Communicator.”*

The third row of the table 2 show that digital meeting software such as Skype and Live Meeting can be used for communicating within the team. There were some differences between respondents on the perceived use of Skype and LM. One respondent mentioned that Skype was primarily used when talking to individual people, while other respondents argued that Skype is appropriate when communicating with many people at the same time allowing them to have conference type communication. Row four displays the use of telephone. The analysis of the data shows low use of telephone as a mean for communicating within the team. However it was mentioned to be an important tool for communicating with members or customers not physically there in person. When asked with the question “How do you communicate with others in your team in informal situations?” IR2 says:

> *“It is a combination, we rarely work with a customer here, so, we often work distributed. (…) Usually we are using some kind of digital platform, however, at this company we do not have the most modern solution. The use of telephone and telephone conference is the most common way.”*

The last row in the table 2 displays the least favorable setting for communicating within the team, confirmed by many of the respondents. These settings are Informal settings such as coffee breaks; couch discussions and overall “fika” discussions. Some respondents mentioned that while these settings are good for just having a chat about something they are not the most likely places for knowledge sharing. However, as mentioned by two respondents, there are more formal gatherings called “developers fika” where they have conversations about technical issues and interesting techniques. As IR3 points out: “On Wednesdays we have a developers “fika” which is largely formalized where we discuss developer-related topics”.

4.2 Communication across team boundaries

When it comes to communicating with other members of teams working locally table 3 show similarities in how it is done. Firstly, summarized in table 3 on the first row data show that the primary way of communicating across boundaries is done via E-mail and F2F meetings. Looking back at communication within team boundaries the some respondents argue that communication across boundaries is done pretty much in the same way. One respondent mentioned that when you want to know what members of other teams are doing you usually end up discussing how they are preceding F2F. IR4 argue that the use of E-mail for communicating across boundaries usually happen when the physical meetings is not possible, when a member for example is not available or away for work.

> *"Well, absolutely, but I would say that about 99 % of the times I would just physically go by someone and then have a chat. It happens sometimes that I use the mail but that it is if someone that I am looking for is not here"*

However, one respondent did have a slightly different view when it came to having physical meetings with members of other teams. While it could be possible to walk past the offices of members working in other teams, IR5 argued that a lot of the conversations happening across team boundaries are done via E-mail. In contrary to what some members stated IR5 suggested that physical meetings or conversations across team boundaries are rare.

> *"Usually it is mail, and if someone is sitting here I could walk past there office. It is pretty similar the way we communicate inside the team, but would say a lot of mail (…) rarely physical meetings"*

While IR5 was the only person that explicitly stated that E-mail is the primary approach when communicating across boundaries, almost all respondents argued in similar fashion acknowledging the importance of having E-mail conversations. The same argument on why E-mail is important when communicating within team boundaries is also applicable when communicating across boundaries. There is a unanimous agreement among the respondents that the use of E-mail is more effective when communicating across boundaries because you get notes on what the conversation was about for future references. This is explained by IR6:

> *IR6: "I would probably walk past their office, or just send them an email. E-mail is good in the way that you get "free notes" on everything (…) so it depends on how advanced the things your talking about could be (…) if you have something that you want to remember it is nice to send an E-mail because then you have it written down and you can go back and look at it."*

However, analysis of the data showed that there are different arguments among the respondents for why the use of E-mail is important when communicating across boundaries. As the analysis above show one argument for using E-mail to communicate is because of the free notes that can be looked at later if needed. Another reason for using E-mail is because it does not interrupt other members in the way that physical meetings or conversations might do. IR1 highlights that while sending E-mails could mean slower response time than just

walking past the office of another team, it is important to not disturb members of other teams in their work.

> *IR1: "Well… I would probably use E-mail if I were to contact someone working in some other team here. (…) It feels like, if they are sitting in some other team then you do not want to disturb them by walking over there. Instead they can take their time and answer when they think it is important. So, the lead-time in that instead of just going over there could be longer (…) but if I do not get any answers in a couple of days I usually go there in person, that happens sometimes."*

The second row in table 3 displays the secondly most used ways of communicating across team boundaries. In similarity with communication happening within team boundaries the respondents also use the software MS communicator when communicating with members of other teams. However, when communicating across boundaries team members are relying on several digital mediums. Firstly, when communicating across boundaries with members that are part of other teams, but not necessarily available physically at the moment, Collaborative Managements Systems (CMS) are used to have joint discussions around system updates, change requests or other primarily technical related topics. Secondly, once a week a joint session called Buzz-Talk is arranged where teams have the opportunity to show where they are in their projects and how there are proceeding. The concept of Buzz-Talk is explained by IR2:

> *"Buzz-Talk is, well, it is co-workers that is talking about some interesting project or interesting technique that could be interesting to others. (…) It is a form of lecture where you stand on a podium and talk a little bit about what your are doing, what you want to do or something like that.*

Thirdly, a development blog is available for everyone working at the office where members of different teams can chat and discuss different technical topics related to software-development using an open chat channel. IR3 mentions that the developer blog gives them the opportunity to share everything with everyone at the office. As a complement to this they have a Developer Buzz once a month where members have the opportunity to talk about their areas of expertise and what they are specialized in. Examples of topics could be specific programming languages such C#, Java, other .Net Framework based languages or test related topics such as Unit Testing. While the blog is available for everyone at the office one respondent highlights that is not used as much nowadays and argues that it is better to just ask people questions in person. This is explained by IR4:

> *"We have a chat channel for the whole office that is used by the developers. I don't know how much it is used nowadays but there you could encourage a lot of work related talk. I find it is better to just go to people and have talk instead."*

The third row in table 3 displays the use of Social Media when communicating across team boundaries. When asked with questions surrounding different digital mediums for communicating within team boundaries no respondent mentioned the use of Social Media

software for communicating. However, one respondent highlighted that over the years different SMS have been used to communicate both across and within team boundaries. IR3 elaborates on the use of different Social Media software for communicating across boundaries:

> *"Facebook, Skype (…) Messenger before but mainly Skype now. We did have Pidgeon before and then Jabber XMPP, and then we have mail of course which would be the most preferable way of communicating."*

In summary, when looking at both tables there are distinct similarities in the way in which the respondents communicate within and across boundaries. The analysis show that regardless of whom someone is contacting, within or across boundaries, the preferred way of communicating is either by using E-mail or by having F2F meetings. Some slight differences can be found between communicating within and across boundaries, where the respondents tend to use more variations of CMT for communicating across boundaries then within.

4.3 Information and knowledge sharing

Looking closer at both physical, sometimes more informal conversations, and written communication in the form of using E-mail or other IT the respondents argue that using both is essential for communicating information within and across team boundaries. As shown in the earlier analysis a lot of the information sharing both within and across team boundaries happens trough F2F encounters. However, while these conversations were essential to all respondents when the subject of topic were of non-complex characteristics, for example just having a quick chat with someone down the hall, conversations that hade more complex, often technical related topics, E-mail were more preferable. IR4 and IR5 argue the importance of using both for effective information sharing in the team.

> *"IR4: The formal needs to be the backbone for communication. Otherwise it would be very hard to remember everything that is being said, if I i.e. am working with a customer I might need to look trough my E-mail history to reach something."*

> *"IR5: Both of them are important… the informal communication is faster, just asking someone… but at the same time the formal meetings is needed to avoid stuff being lost in translation."*

However, when asked questions around the technical solutions available to them for communicating with others the respondents highlighted that there is a wish for more formalized technical solutions for communicating information. Respondents suggested that when using formalized channels for communicating it is important that everyone agrees on the chosen solution/s. One respondent specifically emphasized this and argued the need for more formalized ways of communicating.

> *IR3: "The communication inside the team is not that good (…) we have not really formalized the way we communicate, so that is really a big problem. It works since we are talking a lot with each other but if someone is on parental leave for example they could miss things. (…) It would be better if it would be more structured, maybe with*

some kind of chat channel. So there are huge improvements that can be done when it comes to how we communicate, and then we compensate by having more informal F2F conversations."

As explained by some of the respondents, becoming fully integrated in how a project works when it comes to the technical infrastructures could take long time and therefore effective knowledge sharing is essential to integrate i.e. new members into the team. One respondent replied, "It could take up to a year for a member to fully become integrated in how our technical infrastructures work, it is that complex." This is also explained by IR6 who agrees on the fact that effective knowledge sharing using formalized channels is important to sustain "know-how" about what others do and where they are in the project. When asked with the question "How important is formalized channels for communicating knowledge or information?" he responded:

"Well, within the project I would say so. It is crucial that we have these meetings to know where we are. (…) Once again, it is about the "know-how", that everyone on some basic level knows what we are doing. In big projects it becomes hard to transfer all knowledge just because it is so big, so it becomes vital with "know-how knowledge" about what everyone is doing."

The analysis show that preferable means of communicating information and knowledge is somewhat related to the character and complexity of the content being shared. While the informality of having F2F discussions and meetings is highlighted by the respondents as particularly important in their daily communication, they argued that formalized features using IT is essential for traceability when the conversations become more complex in nature. Some respondents argue that the current technologies used do not suffice when managing information sharing within the team, and that there is a wish for improvement. Finally, the analysis show that the complexity of working in some of the projects inherently makes knowledge sharing a difficult task where members need to have a basic "know-how" understanding of what is happening and what people are doing.

5. Discussion

In this thesis I have studied how information and knowledge is communicated within and across software-provisioning team boundaries. Two contributions were found which is presented and discussed below. The first contribution generates knowledge to the theoretical research on information and knowledge sharing in teams suggesting that; (1) there is a tension between information and knowledge sharing in software-provisioning teams, where the formalization of IT to better facilitate information sharing might be counter-productive in the sense that it could have negative effects on knowledge sharing within and across team boundaries. The second contribution generates knowledge on the practice of team communication in the context of how software-provisioning teams actually communicate information and knowledge, discussing the question; (2) how can we solve the tension between information and knowledge sharing in software-provisioning teams?

5.1 The tension between information and knowledge sharing

Looking at both how information and knowledge is communicated within and across team boundaries the findings suggest that there is a tension between the two. Some respondents argued that there is a wish for more formalized communication channels to avoid information being lost in translation and that effective knowledge sharing is important to facilitate the integration of new members to the team. However, my analysis showed that team members, regardless of communicating within or across team boundaries, rely heavily on non-formalized means of communication, e.g. F2F, Skype etc., in their everyday communication. Looking at the most common means of communication, F2F and E-mail are at the top of both tables. The findings show how E-mail is preferred when the content is primarily information and when there is a need for traceability. E-mail, then, essentially in itself becomes a formalized way of communicating. Meanwhile, F2F communication is preferred in situations when the topic of conversation and the character of the content being discussed are less complex, also highlighting that almost all subjects of topics were initially held trough the use of F2F communications. Naturally, this is related to the fact that team members working in close proximity to each other are more likely to just walk past the offices of another colleague to retrieve the information needed. Moreover, in contrary to what Miranda & Saunders (2003) argue that while having an electronic medium in multimedia environments may hamper information sharing, once available, using such media may be more effective than face-to-face conversations, these findings suggest that F2F communications are equally important to CMT when communicating information. One explanation for this could be the fact that when we communicate in person we rely on much more underlying expressions, which is hard to mimic using CMT. This conclusion could be related to the fact that in F2F conversations we rely on multiple modes to understand information exchange, which can be mediated implicitly via hand gestures and facial expressions (Warkentin et al., 1997). This, then, suggests that there is more than one variable to be considered when formalizing communication. This implies that when the respondents ask for increased formalization of communications channels, they focus only on increased traceability, subconsciously neglecting the underlying complexity of formalizing the situated expressions that we use in our daily F2F conversations. This is completely rational in the

sense that we use a common sense understanding of what this "knowledge" is. However, referring to the research on knowledge and knowledge management we can clearly state that knowledge is much more than just information. Jasimuddin et al, (2005) argue that the explicit and tacit nature of knowledge makes it hard to codify and transfer. One could then imply that the situated expressions that we subsequently use in our F2F conversations might be complex to communicate through formalized channels. Furthermore, by applying the three approaches to knowledge transfer by Carlile (2002) we can clearly see that despite a common syntax, there are differences in how we interpret knowledge and how we understand transmitted messages. Therefore, while the formalization of communication channels using IT could facilitate effective information sharing, there is a high probability and an overwhelming risk that this solution might implicate negative aspects on knowledge sharing. This, then, is the tension between information and knowledge sharing.

5.2 How can we solve the tension between information and knowledge sharing in software-provisioning teams?

Highlighted in the discussion above, some respondents argued the importance of having formalized communication channels to more effectively share information within and across team boundaries. Since there is a tension between information and knowledge sharing, subsequently, the next question to ask is how can that tension be solved? An apparent backside of communicating F2F, as explained by all respondents, is the lack of traceability and persistency in physical conversations. Taking these constructs into account there are different technical solutions that could facilitate data to be reexamined and used for future references. One example is the use of Wikis, a database template with the possibilities to store information, which can be retrieved and edited instantly. However, arguably the reason why the primary digital mean of communication is E-mail is because there is a need to ask questions, suggesting that the use of Wikis might only be useful when the receiver of the information knows how to interpret that information into the requested knowledge. I argue that, while suited for informative transmissions only, traditional computer-mediated technologies does not suffice when it comes to facilitating the transferring of knowledge. Treem & Leonardi (2012) argue that communication is persistent if it remains in the same form as the original display after the actor is finished with his or her presentation. When using telephone-conferencing, PowerPoint presentations or video-conferencing the conversation is normally bound in time and the information does not exist beyond the participants, however, a poster to a blog or a Social Network site remains available to users after the conversation is over (Treem & Leonardi, 2012). Could the solution, then, lie in using Social Media? Leonardi (2015) present an emerging theory of communication visibility. This emerging theory suggest once invisible information becomes visible for third-party members they can improve their metaknowledge on (who knows what and whom). Communication visibility can improve metaknowledge trough two interrelated mechanisms; message transparence and network translucence. Watching coworkers messages helps third-party members make inference in others knowledge. Watching the structure of coworkers communication networks helps third-party members make inference with whom coworkers interact and communicate with more regularly. The use of Social Media technologies plays a

central part in this theory since it simplifies communication visibility. Findings from this thesis showed that the use of Social Media to interact within and across team boundaries were low but with Social Media technologies entering the business atmosphere and solutions such as Yammer, an Enterprise Social Media technology, becomes available as a substitute for more unsecure solutions such as Facebook this might be one solution that could somewhat formalize communication in software-provisioning teams. The theory of communication visibility also show that using a Social Media software makes co-workers more aware of what information they need in order to avoid duplicated. (Leonardi, 2015). Furthermore, the use of Social Media in organizations could enhance persistency in the communication.

From this standpoint the use of a Social Network, such as Yammer, could enhance and better streamline both information and knowledge sharing. As the data of this thesis suggest there is a need for both F2F encounters and the use of technological means for communicating within and across local team boundaries, which, arguably, works fine when members are available to have physical conversations with each other. However, with teams becoming more and more distributed and working with members all around the world, one could argue that there is a need to get away from primarily relying on physical F2F conversations when communicating information and knowledge and more towards using IT. One solution for overcoming the tension between the sharing of information and the more complex sharing of knowledge could be to use an Enterprise Social Network in which knowledge and information sharing in teams can be visualized using the same solution within the organization. As mentioned by many of the respondents there is a need for everyone to have a basic "know-how" understanding of what a specific project is about, where they are in the project and what others are doing in the project. If, then, i.e. new team members have more insight on who knows what and who the tension between information and knowledge sharing might be less apparent.

6. Conclusion

This thesis started out with the research question: *How is information and knowledge communicated within and across software-provisioning team boundaries?* This was examined and explored by interviewing seven members of a local software-provisioning team through seven interviews. My analysis of the findings suggests that; firstly, looking closer at how information and knowledge is communicated within and across software-provisioning team boundaries it becomes apparent that there is a tension between information and knowledge sharing. Formalizing how we communicate using IT could facilitate and make information sharing in teams more effectively. However, the formalization of information sharing could have negative effects on knowledge sharing, since knowledge is far more complex in nature than information. Secondly, looking closer at how to ease the tension, thinking in conceptual terms of how to improve knowledge sharing, I conduct a discussion around the concept of communication visibility (Leonardi, 2015) by which the use of an Enterprise Social Network could enhance metaknowledge sharing where team members are more aware of what others are doing and when they are doing it. This, then, suggest on possible solution to ease the tension between information and knowledge sharing.

6.1 Limitations

Before the data was collected the research question and the proposed character of the knowledge to be generated suggested the use of qualitative interviews for collecting the data. However, in hindsight, to more effectively gather insight on how team members communicate information and knowledge longer interviews could have been done accompanied by the use of observations. Also, by acknowledging the fact that little has been said about how software-provisioning teams actually communicate information and knowledge the contributions from this thesis should be confirmed in other studies to validate these findings. Finally, since software-provisioning teams are working more and more distributed these findings might not relate to how communication of information and knowledge is done within and across teams working in geographically different locations.

6.2 Future research

Suggestions for future research could be to conduct a similar study that Leonardi (2015) did in the context of software-provisioning teams, where a comparison study is done using two test teams where one is given the opportunity to use an ESN and the other is the control group, to see if the integration of an ESN can make information and knowledge sharing more effective in software-provisioning teams. Looking beyond the scope of locally bound software-provisioning teams, another suggestion for future research would be to compare if the contributions from this study is applicable and re-occurring in other organizational self-serving teams.

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