BARRIERS OF KNOWLEDGE TRANSFER BETWEEN GLOBALLY DISTRIBUTED TEAMS

A case study of radio PDU in the R&D department of Ericsson

Aicha Togola, Safa Ahmed
Abstract

Today’s increased globalization resulted in a growth of globally distributed teams, which are characterized by geographical distance and used by organizations to promote innovation. However, to be able to collaborate effectively and reach their objectives, these teams must continuously conduct knowledge transfer (KT) between the different geographical locations. The importance of KT has been acknowledged in Information systems (IS) field, but most studies did not focus on the barriers of the KT between globally distributed teams specifically in Information and Communication Technologies (ICT) product development projects. Thus, this thesis was conducted to investigate the main barriers that globally distributed teams face in this area particularly. To do that, we did a qualitative case study of the Product Development Unit (PDU) in the Research and Development (R&D) department of Ericsson. The study has revealed eight main barriers that hinder the KT between globally distributed teams.

Keywords: Knowledge transfer (KT), knowledge, activity context, knowledge context, product development, product development unit, Information and Communication Technologies (ICT), globally distributed teams, barriers.

1. Introduction

In the recent years, companies have become more and more interested and engaged in business globalization (Chevrier, 2003; Kawar, 2012) and R&D business is not an exception. In R&D units, one of the main projects’ types is the new product development (NPD). Cooper (1994) refers to new product development process as a formal and thought process for conducting a new product from the idea stage through market launch and beyond.

Knowledge is recognized as one of the most important resources in an organization which is unique, valuable, and inimitable (Tamer, Calantone & Zhao, 2003; Bresman, Birkinshaw & Nobel, 1999). KT occurs when knowledge is diffused from one entity (e.g., an individual, group, or organization) to other entities (Joshi, Sarker & Sarker, 2007); it can happen between two units of the same firm, or through a market transaction between two separate firms. Effective KT can improve organization’s performance, adaptation, collaboration, innovation (Tamer et al., 2003; Schreiber & Carley, 2003), and provide a competitive advantage (Nonaka & Takeuchi, 1995; Bresman et al., 1999). Reagans & McEvily (2003) also support that the successful KT within an organization is essential for organizational learning, processes, and projects’ outcomes.

Szulanski (2000b) argues that KTIs are often difficult, arduous, and time consuming; he also supports that in order improve the effectiveness of the KT process and outcomes it is crucial to understand the barriers associated with it. Some researchers argue that the challenge of KT grows in complexity if the source and the recipient are located in different geographical location (Oshri, Van Fenema & Kotlarsky, 2008; Gao & Bernard, 2017). Therefore, it is essential to understand that KT can be affected by factors that may hinder a successful KT (Argote & Ingram, 2000).

In this regard, there are multiple studies focusing on KT within organizations (eg. Argote & Ingram, 2000; Bresman et al., 1999; Goh, 2002; 2001; Cumming & Teng, 2003). However,
there are few empirical studies that focused on the barriers of KT in ICT product development projects area, where the type and the content of knowledge is different, as these projects include software, hardware and building practices that make the KT even more complex. Cumming & Teng (2003) conducted a study on key factors affecting R&D KT success. However, they didn’t look into the specific elements of these factors that could be barriers to KT and how they could affect it. Cumming & Teng (2003) suggested that if you look at the KT research from the technology transfer/innovation and strategic management fields, there are four broad contexts that can be studied as areas that affect the KT: knowledge context, relational context, recipient context, and activity context. Another observation is that, Cumming & Teng (2003) study, as well as most of the studies on the factors affecting KT are quantitative studies that used mainly surveys. In addition, these studies were mostly based on respondents from the project management area.

Considering these limitations, this thesis is built upon two of the defined contexts in Cumming & Teng (2003) work to reduce the gap in the research area regarding the barriers of KT between globally distributed teams. The two contexts which this study focused on are the knowledge context and activity context because we believe that compared to relational context which is related to factors such as physical distance, and recipient context which is related to factors such as learning culture, these two contexts (knowledge context and activity context) are the most relevant contexts to study when it comes to KT in ICT product development. We chose Knowledge context because new product development (NPD) is dependent on knowledge (Goffin & Koners, 2011), and there is a significant amount of knowledge that needs to be transferred between team members due to the fact that global product development teams are generally geographically scattered (Gao & Bernard, 2017). On the other hand, the activity context is also relevant because Cumming & Teng (2003) did not elaborate much on the transfer tools & mechanisms and specifically on the role of ICT in KT activities. This is important because the quality of the interactions between different teams can influence whether a new product is launched on time and on budget (Gao & Bernard, 2017).

The aim of this study is to empirically add to the research conducted in KT area by contributing with more knowledge in identifying and analyzing the barriers of KT within organizations for ICT product development teams that are globally distributed. Therefore, our research question is:

“What are the key barriers of knowledge transfer that globally distributed teams in ICT product development projects face, and how are these barriers impending knowledge transfer?”

To investigate this, and in contrast to previous research in this area, we will use a qualitative research method where the data will be collected through semi-structured interviews. In addition, this study will consider respondents from different areas e.g., project management, design and production. By answering this question, more knowledge will be added to the field of KT and specifically in the area of ICT product development. Therefore, this study will benefit both practitioners and researchers because globally distributed teams are becoming more and more prevalent (Karolak, 1999; Sarker, Nicholson & Joshi, 2005), and KT is a quite complex topic that many researchers have interest in (eg. Argote & Ingram, 2000; Szulanski, 2000b; Goh, 2002).
2. Literature Review

2.1 Knowledge, knowledge management, and Knowledge transfer

Many IS researchers acknowledged that knowledge is a fundamental asset for firms in today’s contemporary economy (Schultze & Leidner, 2002; Alavi & Leidner, 2001; Sambamurthy & Subramani, 2005). Davenport & Prusak (1998) define knowledge as information combined with experience, context, interpretation, reflection, intuition and creativity; where information is the base or foundation of knowledge that can be associated with facts about the real world (Karlsen & Gottschalk, 2004). Vance & Eynon (1998) support that knowledge differ across firms; and it is asymmetrical and unequally distributed within firms (Davenport & Prusak, 1998). According to Vance & Eynon (1998), this uneven distribution of knowledge within organizations is the reason why organizations develop knowledge management strategies in an attempt to move knowledge from where it is to where it can be applied to leverage objectives.

Montana (2000) defines knowledge management as a discipline focused on systematic and innovative procedures, and tools for managing the generation, acquisition, sharing, protection, distribution, and utilization of knowledge, intellectual capital and intangible assets. Therefore, the purpose of knowledge management is to support companies create, exchange and use knowledge more effectively. Han & Anantatmula (2007) argue that Knowledge management is a discipline which is usually associated with IT/IS solutions, such as intranets and databases. Effective knowledge management reduces mistakes, increases innovativeness and responsiveness, and results into fewer questions, better decisions, less reinventing of wheels, and improved service and profitability (Vance & Eynon, 1998). An important aspect of knowledge management is the process of KT between different parts of the organization (Bresman et al., 1999; Alavi & Leidner, 2001).

KT in organizations is “the process through which one unit (e.g., individual, group, department, division) is affected by the experience of another” (Argote & Ingram, 2000, p. 151). Ko, Kirsch & King (2005) describe KT as the communication of knowledge from a source so that it is learned and applied by a recipient. Sambamurthy & Subramani (2005) support that the transfer of knowledge resources from source units to destination units where they are needed is essential to extend the range of applicability of the firm’s knowledge resources. However, knowledge is recognized to be sticky and contextualized as a result of which it might not be easily transferable (Szulanski, 2000b). The recipient has to understand the complexities and implications associated with that knowledge so that he or she can apply it (Ko et al., 2005). Boisot (2002) claims that successful KT requires a “degree of resonance” between two or more agents, in the sense that it demands both the transfer (i.e., sending) of knowledge from the source agent, and the assimilation of that knowledge by the recipient agent. Moreover, a successful KT may also depend on the characteristics and attitudes of the human agent sharing that knowledge (Boisot, 2002), and on the transfer channels that are used (Vance & Eynon, 1998). Supporting these views, Sambamurthy & Subramani (2005) conclude that research is still needed to understand what factors will influence the effective KT in organizations.
2.2 Distributed teams and KT in a global setting

Globally distributed and virtual teams have become more and more frequent with the advent of globalization (Kotlarsky & Oshri, 2005), and they have also received significant attention over the past decade from IS and management researchers (Garrison, Wakefield, Xu & Kim, 2010). Such teams are characterized by geographical and time zone distance, and a heavy reliance on ICT tools for collaboration (Marlow & Dabbish, 2012; Gibson & Gibbs, 2006; Kotlarsky & Oshri, 2005). Globally distributed teams are increasingly employed by organizations for the purpose of fostering innovation (Malhotra & Majchrzak, 2005; Gibson & Gibbs, 2006; Garrison et al, 2010); and to achieve this goal, organizations need to exploit the diverse knowledge and expertise available within the distributed teams (Malhotra, Majchrzak & Rosen, 2007). It is essential for organizations to identify and leverage the diverse sets of knowledge resources in global distributed teams (Kanawattanacha & Yoo, 2007). Compared to traditional organizational settings, global distributed teams face major challenges in the coordination and transfer of knowledge across different sites due to the geographically dispersed nature of knowledge and the lack of common knowledge between team members (Griffith, Sawyer & Neale, 2003; Oshri et al., 2008; Kanawattanacha & Yoo, 2007). Therefore, even though KT has been recognized as being essential for organizations and market performance, multiple barriers make it difficult for organizations to reach the promised results (Riege, 2005). Many cases exist where KT activities did not achieve their objectives due to the large diversity of potential barriers Riege (2005).

Barriers of KT have been investigated in different organizational settings (e.g. Szulanski, 2000b; Cumming & Teng, 2003; Argote & Ingram, 2000; Joshi et al., 2007), and some of these studies divided the KT barriers into different categories. Cumming & Teng (2003) framework (see fig.1) presents the KT from four broad contexts that can be studied as areas that affect the KT: knowledge context, relational context, activity context and recipient context. But as mentioned, this study will focus on the knowledge context and activity context.

![Diagram of Knowledge Context, Relational Context, Activity Context, and Recipient Context](image)

**Figure 1. The study is focusing on two contexts of Cumming and Teng’s Framework**

### 2.2.1 Knowledge context

In the context of global projects, several researchers looked into the knowledge that is required for effective global virtual teams, and product development for global markets; like Subramaniam & Venkatraman (2001) who discussed the impact of tacit overseas knowledge;
or Kogut & Zander (1999) who researched in the area of location specific knowledge. In their framework (see fig.1), Cumming & Teng (2003) also presented their basic argument for the knowledge context in a global setting, which is that KT success requires that both parties develop an understanding of where the desired knowledge resides. Cumming & Teng (2003) refers to (Dixon, 1994) by arguing that it is important that they both (Sender and receiver) participate in the processes by which the knowledge is made accessible. They presented different reasons why both sides involvement in the articulation process is important, and they concluded that it supports the recipient’s later ownership and commitment to the knowledge and also that it enhances the relationship between the source and the recipient (Cumming & Teng, 2003). Furthermore, in his article, Goh (2002) supports that the type of knowledge to be transferred affects the needs and conditions for the KT process. These arguments make the knowledge context an important aspect to study when attempting to understand the KT; especially in new product development (NPD) which is a complex activity that is dependent on both knowledge and learning (Goffin & Koners, 2011).

The process of product development generates a huge amount of knowledge. Cohen & Levinthal (1989) use the term “the dual role of innovation” for the product development, where there is the generation of not only the technical knowledge but also knowledge on organizational processes. Besides the technical knowledge, product development also contributes and enhances a firm’s ability to exploit existing knowledge. In their framework, Cumming & Teng (2003) presented two factors in the knowledge context that are affecting the KT: knowledge articulability & Knowledge embeddedness.

2.2.1.1 Knowledge embeddedness
Cumming & Teng (2003) recognize knowledge embeddedness as an important characteristic of knowledge. When considering the knowledge embeddedness, one needs to think of which elements and related sub-networks will need to be transferred, absorbed, adapted and adopted by the recipient (Cumming & Teng, 2003). Some researchers argue that knowledge can be embedded in individuals, and that whether tacit or explicit, such knowledge can be transferred by transferring individuals (Berry & Broadbent, 1987; Starbuck, 1992). Moreland, Argote & Krishnan (1996) supports that when there are no personnel transfers accompanying KTs, recipients often fail to learn all the different routines. Argote & Ingram (2000) also present a framework which supports that knowledge in organizations can be embedded in three different elements: members, tools and tasks, or the combinations of these.

Knowledge embedded in tools, products or technology has been identified as well as being critical in new product development (Söderquist, 2006). In addition, there is more extensive research on the knowledge that is embedded in products and tools (e.g. Davidson, 1980; Zander, 1991). The research in this area support that product- or technology-embedded knowledge has been found to transfer between units more readily than knowledge embedded in other organizational elements (Zander & Kogut, 1995; Galbraith, 1990). Ward, Duray, Leong & Sum (1995) discussed that Knowledge embedded in a product is more than just the final design. It includes all the changes that led up to the final design, and that all this is useful knowledge that can help future projects. It has been also pointed out that knowledge that is in a more fluid than specific stage of its life cycle can be much harder to transfer, as identification of the appropriate knowledge elements to be shared is difficult (Utterback, 1994).
Knowledge can also be embedded in organizational routines and best practices (Levitt & March, 1988; Szulanski, 1996a). For example, procedures that give directions on the sequences of activities to follow; tools and methods. Kostova (1999, p. 310), argues that since organizational routines may be meaning, value, and knowledge based, “the success of their transfer is determined by the transferability of meaning and value, in addition to the transferability of knowledge”. Gersick & Hackman (1990) added that routines are implicitly embedded with underlying meaning structures, and this makes their transfer even more difficult.

2.2.1.2 Knowledge articulability

KT is affected by its articulability, or the extent to which knowledge can be verbalized, written, drawn or otherwise articulated (Bresman et al., 1999). Articulable knowledge is more easily transferable than less-articulable knowledge (Cumming & Teng, 2003). Hakanson & Nobel (1998, p. 13) also support that “poorly articulated knowledge is difficult to teach and learn” and more difficult to transfer within the firm. The problem of knowledge articulability can be related to the knowledge type. Knowledge could be explicit or tacit; and for understanding organizational knowledge, the distinction between the two is essential (Nonaka & Takeuchi, 1995; Björkman, Barner-Rasmussen & Li, 2004). The nature of the knowledge being transferred, its tacitness versus its articulateness, has an important impact on the ease of transfer (Zander, 1991).

Tacit knowledge is a knowledge that is difficult to communicate and formalize because it is contained within the individual and usually gained through experience or personal skills (Nonaka & Takeuchi, 1995). On the other hand, explicit knowledge is concerned with a knowledge that have a public character and that is easy to be codified and shared; it is based on globally accepted and objective standard (Tamer et al., 2003). Zander & Kogut (1995) found that the transfer of product-based knowledge, that is codifiable and explicit is easier than less articulable knowledge. However, it has been acknowledged that much of the knowledge generated in new product development (NPD) is tacit; which is difficult to express, connected with problem solving, and dependent on the interactions within the team (Goffin & Koners, 2011). Cumming & Teng (2003) support this by arguing that individuals know more than they can explain because individuals possess tacit knowledge that is non-verbalized, intuitive, and unarticulated. In addition, global product development demands dealing with differences in the markets, and much of the location specific knowledge is claimed to have a connection to local market requirements. This location specific knowledge is to a large extent tacit by nature, and therefore difficult to transfer between globally dispersed teams (Subramaniam & Venkatraman, 2001). The ambiguity that is associated with the tacit knowledge is an important barrier to KT (Szulanski, 1996a).

2.2.2 Activity context

In this study, the activity context is mainly concerned with KT mechanisms & tools that are used to transfer knowledge between team members. The study will investigate more in the role of ICT and the barriers in this area in the activity context, because Cumming & Teng (2003) in their study didn’t elaborate on the transfer mechanisms & tools in the activity context and specifically on the role of ICT in KT activities. Many researches have classified KT mechanisms
into formal and informal (Štrach & Everett, 2006; Lawson, Petersen, Cousins & Handfield, 2009). Argote & Ingram (2000) claims that transferring knowledge with a combination of informal and formal mechanisms can be effective. However, it might be easier for close source and recipient to utilize informal procedures, but distant source and recipient may be limited to formal mechanisms through the use of ICT tools for easy transfer to remote locations (Slaughter & Kirsch, 2006).

2.2.2.1 ICT and knowledge transfer
ICTs are usually recognized as the solution to organizational KT for geographically dispersed teams (Tanriverdi, 2005; Griffith et al., 2003; Alavi & Leidner, 2001). Gurteen (1999) supports that it is difficult to transfer knowledge effectively within an organization without the use of information technology. ICTs have helped bridge temporal and spatial barriers by facilitating distributed and virtual communication and coordination of work (Hackney, Desouza & Loebbecke, 2005). Likewise, Goh (2002) argues that computer-aided systems facilitate KT by enabling geographically distributed team members to exchange best practices through these systems. Alavi & Leidner (2001) elaborate on the role of ICT in KT by arguing that it can improve the KT by expanding an individual reach beyond the formal communication lines. ICT can enhance knowledge integration and application by codifying and automating organizational routines and by making organizational directives available on corporate intranets; this will subsequently increase the accessibility and the speed at which they can be applied (Alavi & Leidner, 2001). Supporting this point of view, Tanriverdi (2005) also recognizes the importance of IT in KT by supporting that when business units adopt common IT infrastructure standards, the firm is capable to build IT based cross-unit connectivity and boundary spanning processes and hence facilitate the identification and sharing of related knowledge.

Hendriks (1999) identifies four potential roles of ICT in KT: First, ICT can be helpful in reducing some barriers involved in KT such as temporal, physical, and social distance. Second, ICT can also facilitate the access to information bases that are storing data by the use of tools such as document information system that can allow employees to identify each other’s documents. Third, ICT may be used to enhance KT processes by supporting or directing KT processes. Finally, ICT can be used to find the different elements relevant to the process of KT such as knowledge owners and knowledge reconstructors (Hendriks, 1999). On the other hand, Robey, Khoo & Powers (2000) classified ICTs used by virtual teams into two groups: technology that allows for synchronous (same time, different place) interaction and for asynchronous (different time, different place) interaction. Synchronous ICTs include telephone/audio conferencing, live application sharing, video conferencing, instant messaging, and electronic white boarding; Asynchronous ICTs include email, shared document repositories, and threaded discussions (Montoya, Massey, Hung & Crisp, 2009). Griffith et al. (2003) support that organizations use a large number of ICT tools that range from email and voicemail to broad-based enterprise solutions for KT. Moreover, Jashapara (2004) and Griffith et al. (2003) argued that groupware tools such as Lotus Notes/Domino support long distance collaboration and knowledge exchange. Furthermore, according to Alavi & Leidner (2001), computer networks and electronic bulletin boards and discussion groups
could create a forum to enhance the contact between the individual seeking knowledge and those who hold or have access to the knowledge.

However, even though the emergence of advanced ICT tools for collaboration is known as one of the reasons why globally distributed teams are growing (Vlaar, van Fenema & Tiwari, 2008). Also, that without IT systems, most KT practices would be less effective and applications less timely (Riege, 2005). It is important to understand that IT systems ability to enhance KT practices is not universally applauded (Connelly & Kelloway, 2003). Computerized IT tools allow people to span boundaries of time, space and organization, but their use also introduces new challenges (Chudoba, Wynn, Lu & Watson-Manheim, 2005).

2.2.2 ICT related barriers
In their study, Han & Anantatmula (2007) found that organizations usually invest in IT/IS tools in the hope to willingly engage employees in KT. However, according to them this has resulted to some disappointments due to the fact that IT couldn’t achieve what they wanted. Organizations understand that overemphasizing on ICT as the full solution to successful KT may introduce some problems because other factors also play a role in the KT practices. The use of ICT for KT can only work if some other organizational factors are well managed (Goh, 2002). Researchers acknowledged this, by arguing that the use of ICT as a means to enhance KT may also introduce ICT specific barriers in KT; and addressing these technology barriers is important for organization KT improvement (Riege, 2005; Hendriks, 1999).

Some scholars found that virtual teams may have a disadvantage because face-to-face meetings is important for some type of KT activities (Cumming & Teng, 2003; Joshi et al., 2007). Face-to-face communication play an important role in the process of KT between intra-firm units such as new product development teams (Joshi et al., 2007). Connelly & Kelloway (2003) argue that it can be difficult for ICT to replace the rich interactivity, and communication that is present in conversation; because sometimes it is easier to get some knowledge through a conversation with the actual expert than from an IT system. Dedrick Carmel & Kraemer (2011) also support that tacit knowledge is usually transferred through face-to-face meetings or other interactive means. In addition, according to Blumenberg, Wagner & Beimborn (2009) since tacit knowledge is hard to be codified and transferred using formal methods, one of the most suitable mechanisms for transferring tacit knowledge will be face-to-face interaction.

On the other hand, according to Riege (2005), organizations need to select and implement the appropriate technology that gives a close fit between people and organization because a technology that is effective in one organization may fail in others. In addition, Bolisani & Scarso (1999) claim that different types of ICT tools might be suitable for generating and transferring different types of knowledge. Supporting this point of view, Daft, Lengel & Trevino (1987) argue that it is important to match ICT tools with the tasks in order to enhance interaction. For example, asynchronous technology (e.g. email) may be appreciated when there is no need for all team members to be present or agree on the meaning; while synchronous ICTs (e.g. video conferencing) will be more appreciated when there is a need for interactivity, and to develop a shared meaning or agreement.

Riege (2005) introduced the following factors that could be potential barriers of KT at a technology level:
- **Lack of integration and compatibility of different IT systems and processes**

Riege (2005) argues that technology is multifaceted, hence it is important for an organization to integrate an infrastructure that supports different types of communication; because a lack of integration of the right IT systems and processes may obstruct KT practices effectiveness. In addition, Han and Anantatmula (2007) also supports that a newly endorsed technology for KT must be compatible with the existing system which has a different purpose of use. According to Riege (2008), this problem arises when the existing system used for one purpose need to be used in conjunction with another system in another location.

- **Mismatch with employees' need requirements**

Technology can also cause a barrier to KT if the provided solution does not fit with employees' need requirements (O'Dell & Grayson, 1998). For example, if an employee need to transfer knowledge, the technology in place should match the employee's need requirements (Riege, 2005). Connelly & Kelloway (2003) support this by arguing that sometimes, an employee may prefer to use phone calls or checking his/her social network to gather relevant knowledge if that is more suitable instead of consulting intranet or database.

- **Reluctance to use IT systems and unrealistic expectations**

Some people can be unwilling to use newly introduced systems because of the complexity of the system (Riege, 2005). Thus, this unfamiliarity and experience with IS/IT systems could be a potential barrier to KT (Connelly & Kelloway, 2003). According to Han & Anantatmula (2007), this problem could arise due to the lack of training and communication regarding new systems and processes. If employees do not possess the required skill to use a technology it is unlikely that they will efficiently interact with each other even if the said technology has the right functionalities (Han & Anantatmula, 2007). In addition, Riege (2005) also supports that some people tend to be confused about what technology can do and not do; and this unrealistic expectation towards the role of IT could also result in a KT barrier.

- **Lack of technical support**

Almost every IT system comes with its drawbacks; and a lack of instant maintenance and technical support of the systems can be annoying and eventually causes a barrier to work routines and KT (Keyes, 2008; Riege, 2005). Therefore, an immediate support function for technical faults is essential to provide timely solutions to system problems and anticipate future potential problems that could be an obstacle to effective KT (Riege, 2005).

### 3. Method

#### 3.1 Choice of Method

To conduct this study, we chose qualitative research method because of its richness. Ritchie & Lewis (2003) support this as they talked about the volume and richness of qualitative data, and its ability to provide an in-depth and interpreted understanding of the social world. Qualitative research methods are appropriate for interpreting and understanding a specific phenomenon under study (Creswell, 2003). This interpretive nature of qualitative research makes it adequate for this study. In addition, Creswell (2003) argues that qualitative research is useful when little research has been done on a concept, where the researcher does not know the important variables to examine, or where the existing theories do not apply with the
population being studied. This also makes qualitative research suitable for this study which is aimed in identifying and analyzing the barriers of KT between globally distributed teams in ICT products development projects. Moreover, we used a case study based on interpretive case study guidelines in IS research of Walsham (1995a) and Walsham (2006b).

Ritchie & Lewis (2003) support that the term “case study” is highly associated with qualitative research and it involves a detailed and rigorous study where a specific context is explored. A case study is useful when there is a need to understand a complex social phenomenon because it allows an investigation to retain the integrated and meaningful characteristics of real-life events (Yin, 1994). In addition, according to Ritchie & Lewis (2003), multiplicity of perspectives is one characteristic of a case study, and this multiplicity of perspectives can be obtained by using multiple data collection methods or by using one method which include people with different perspectives on the study object (Ritchie & Lewis, 2003); in this study, we chose to use a mix of both options.

3.2 Research case

The case study object of this thesis is the R&D department of the Swedish telecommunication vendor Ericsson; and during the study we had the chance to be in the headquarter offices in Kista-Stockholm. The study focuses on the Radio product development unit (PDU) which has sites in three main countries: Sweden, China and Canada. PDU radio has over 3000 employees in total. The organization structure in Ericsson follows a decentralized organization structure where the decision-making powers creep down in the hierarchy pyramid and give more opportunities and focus on team environment at different levels in the business (Lindkvist, Bakka & Fivelsdal, 2014). Individuals at each level in the business may have some autonomy to make business decisions related to their level (Mintzberg, 1992). The meetings and communication between the different sites in PDU radio is mainly done through Skype and other specific ICT tools that are used to exchange specific information.

Some more investigation on the case settings revealed that the radio products are developed in platforms where each platform has a main platform product and following that, frequency variants products are developed as part of the same platform. Each variant product is supporting different frequency range eg. frequency band based on the targeted market and countries. This is because the frequency bands are different in different countries and also each telecom operator usually has specific allocated frequency range within the band to prevent overlapping.

In most of the cases the main platform product is developed in Sweden and the variants are usually developed in China and Canada. However, in the last years some of the platform products are developed in China and Canada while the products variants are developed in Sweden, and this is due to resources availability and cost considerations. So, based on this, usually there is a big amount of knowledge that needs to be transferred between the different sites and this KT is necessary to ensure the continuity and the quality of the radio products development. We also came to know that in each radio product development project, there are three sub-projects: Hardware (HW), Software (SW) and systems. As the names suggest, HW project focuses on the hardware part of the product including design and development, SW project focuses on the software development part of the radio product and system project
focuses on the standardization, systemization, customer requirements’ definition and functionalities definition as an input to the design teams. Surely, all sub-projects have regular meetings together to ensure their alignment.

3.3 Data collection and Sampling

We started the study by engaging with the employees in a more relaxed and informal interviewing way to understand how the radio product development projects are conducted in PDU radio in the company. Informal interviewing can help to build the relationship with the respondents and in gaining their trust, also it gives an understanding of the topic, and the setting (Cohen & Crabtree, 2006). This was mainly for us to have a background that will help us to construct the interview questions in a better way, and also to enable us to choose the participants for our main data collection method which is the semi-structured interviews.

Even though the primary data collection method for the study were the semi-structured interviews, the data collection was actually a mix of the following:

<table>
<thead>
<tr>
<th>Data collection method</th>
<th>Purpose and comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Literature review</td>
<td>Review of the existing literature in the topic to identify the barriers and relate these barriers later with the study results in the discussion section</td>
</tr>
<tr>
<td>Company’s documents review</td>
<td>Mainly organization structure documents to understand the organization better before selecting the participants and constructing the interview questions.</td>
</tr>
<tr>
<td>Informal interviews</td>
<td>To get a preliminary insight of the projects to construct better questions and select the right interviewees</td>
</tr>
<tr>
<td>Semi-structured interviews</td>
<td>The main data collection method</td>
</tr>
</tbody>
</table>

Table 1, Data collection methods of the study

In this thesis, semi-structured interviews were chosen as the main data collection method because it provides the opportunity to gain rich and detailed data. Walsham (1995a) argues that interviews are the primary data source for interpretive case studies as they allow best access the interpretations that participants have regarding the actions and events and also their views and aspirations. We had the main questions prepared beforehand (see Appendix 1), as Bryman (2011) argued that pre-decided questions or themes allow to keep the participants to the topic but at the same time to give them the space to speak freely. However, the order of the questions was flexible, and we let the interview flow and take us to the suitable order.

Twelve interviews were conducted with participants from Sweden, China and Canada. The interviews in Sweden were face to face interviews, the rest of the interviews with participants from China and Canada were done through Skype for business video calls. All these interviews were recorded. We decided to do a pilot interview first to test the timing and to see how long the interview could take. In addition, the aim of the pilot interview was also to see if all the questions were easy to understand by the participant or if we needed to rephrase some of them. For the sampling and the choice of participants, we tried to follow mainly purposive selection.

11
where we focused on the characteristics of the respondents to make the choice (Richie & Lewis, 2003). Our target was to interview people from the three different sites, and also to interview people with different levels and backgrounds in order to get more insight on the phenomena. After some investigation, we found that there are mainly three sub projects within each radio product development project: HW project, SW project and systems project. So, we decided to go for three main groups:

- Project managers: from all types of sub projects HW, SW and systems.
- Chief engineers: who are usually responsible as technical leads for the overall project.
- Design leaders: who are basically engineers with technical expertise in a sub area, they also manage small teams that consist of designers.

We conducted the interviews as the following:

<table>
<thead>
<tr>
<th>Interview No.</th>
<th>Interviewee Position</th>
<th>Site</th>
<th>Duration (Minutes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Technical Project manager-(Systems)</td>
<td>Sweden</td>
<td>30</td>
</tr>
<tr>
<td>2</td>
<td>Project manager (SW)</td>
<td>Sweden</td>
<td>29</td>
</tr>
<tr>
<td>3</td>
<td>Chief Engineer</td>
<td>Sweden</td>
<td>28</td>
</tr>
<tr>
<td>4</td>
<td>Design leader</td>
<td>China</td>
<td>44</td>
</tr>
<tr>
<td>5</td>
<td>Project manager (HW)</td>
<td>Sweden</td>
<td>50</td>
</tr>
<tr>
<td>6</td>
<td>Project manager (HW)</td>
<td>China</td>
<td>40</td>
</tr>
<tr>
<td>7</td>
<td>Chief Engineer</td>
<td>Canada</td>
<td>45</td>
</tr>
<tr>
<td>8</td>
<td>Design leader</td>
<td>Sweden</td>
<td>45</td>
</tr>
<tr>
<td>9</td>
<td>Design leader</td>
<td>Canada</td>
<td>30</td>
</tr>
<tr>
<td>10</td>
<td>Chief Engineer</td>
<td>China</td>
<td>40</td>
</tr>
<tr>
<td>11</td>
<td>Technical project manager-(Systems)</td>
<td>Canada</td>
<td>26</td>
</tr>
<tr>
<td>12</td>
<td>Technical project manager-(Systems)</td>
<td>Canada</td>
<td>42</td>
</tr>
</tbody>
</table>

Table 2: List of interviewees, respective position, location and interview duration.

### 3.4 Data Analysis

Thematic analysis was used to analyze the collected data material from the interviews. Braun & Clarke (2006, p.06) defines thematic analysis as “a method for identifying, analyzing, and reporting patterns within data”. It provides a flexible and useful method for analyzing qualitative data and can usefully summarize key aspects of a large data material to obtain a rich and detailed account of the dataset (Braun & Clarke, 2006). In this study, we followed Braun & Clarke (2006) six phases guide to conduct thematic analysis. These six phases are described below:
Phase 1: Familiarizing yourself with your data—This phase involves transcribing and reading through the dataset in order to familiarize yourself with all the characteristics of the data and identify the possible patterns and ideas while reading (Braun & Clarke, 2006). Therefore, all the interviews were transcribed and read to get an in-depth understanding of the data collected and to prepare for the next stage of the analysis which is coding.

Phase 2: generating initial codes—In this phase, initial codes are generated from the data (Braun & Clarke, 2006). Instead of just coding to identify limited aspects of the dataset, we gave complete attention to each data item by coding the entire dataset to generate the different categories. In addition, to increase the reliability of the analysis, we cross-coded the collected data. Interpretations can be ‘verified’ through cross-coding by colleagues (Eakin & Mykhalovskiy, 2003).

Phase 3: searching for themes—This phase is about classifying all the codes into potential themes by examining how different codes may form a theme and then gather all the relevant codes to each potential theme (Braun & Clarke, 2006). We started by creating a map (see Appendix 2) for the codes to link them together; then we determined the themes by using a mix of data-driven and theory-driven approaches. This means that we searched for themes based on our literature review but also based on the data itself in order to discover new facts that were not considered in previous researches. In theory-driven approach the themes are identified based on specific questions and ideas that the researcher wants to assess, whereas in data driven approach, the themes depend on the data (Braun & Clarke, 2006).

Phase 4: reviewing themes—This phase is about verifying the appropriateness of the candidate themes and also checking the validity of the themes in relation to the entire dataset (Braun & Clarke, 2006). Considering this, we checked the relevance of the themes and the codes associated to them, and we also re-read our dataset to make sure no data extracts have been missed.

Phase 5: defining and naming themes—The aim of this step is to name the themes and further refine the characteristics of each of them (Braun & Clarke, 2006). We did this by making sure that all our themes are clearly defined and that their names are concise and easy to understand.

Phase 6: producing the report—This phase is about describing your findings by writing a coherent, and interesting report of your results (Braun & Clarke, 2006). This is done in the results section of this thesis, where we present a clear account of our findings.

3.5 Ethical considerations
Richie & Lewis (2003) support that researchers need to negotiate some factors such as the access to participants’ private lives, and participants’ consent by given them accurate and clear information on the study objectives and purposes as well as how the findings will be used. We considered these issues by informing all the respondents about the study objectives and obtaining their consent for recording the interviews. In addition, throughout the study, we ensured the confidentiality and anonymity of the participants. We agreed with the participants to only disclose their job title in this research. Furthermore, we signed a non-disclosure agreement with the company that no technical or product information will be revealed, however Ericsson agreed to have their name disclosed in the thesis.
3.6 Method discussion

We did twelve interviews overall and we were able to obtain sufficient and rich data from them. However, after we investigated the organizational structure for PDU radio, we discovered that it is very complex. So, if we had more time it would have been good to dig more into this and maybe try to interview people from all the different parts of the organization and to see how this structure is affecting the KT. Also, it would have been good to look deeper in each of the sub projects (system, SW, HW) in ICT product development in order to get a wider knowledge of what makes each of these projects different when it comes to KT. In addition, a single case study is often criticized of having limitation in terms of generalizability, depth, and pluralist perspectives (Meyer, 2001). But as mentioned earlier, the method we adopted which is gaining the perspectives of heterogeneous participants is recognized as being one way to handle the issue of multiple perspectives in a single case study (Ritchie & Lewis, 2003).

4. Results

The results are structured based on the two contexts of Cumming and Teng’s (2003) KT framework that we are focusing on: the knowledge context and the activity context.

4.1 Knowledge context

For the knowledge context we have identified four main barriers: Knowledge embeddedness, knowledge complexity, knowledge accessibility & documentation gaps, and knowledge problematic articulability.

4.1.1 Knowledge embeddedness

Knowledge embeddedness was one of the themes that was very common among the respondents. Based on the results from the analysis, two types of knowledge embeddedness have been revealed as barriers to the KT: embeddedness in people and embeddedness in sites. However, embeddedness in people was more common than embeddedness in sites.

- Embeddedness in people

All the respondents have agreed that embeddedness in people exists when it comes to product development knowledge, in addition they all believed that it is considered as one of the main barriers to the KT. Some of the respondents explained some of the aspects that makes embeddedness in people a barrier. Respondent 11 mentioned that dependency on those key people is a barrier because they are usually overloaded with work and they don’t have time to support the KT activities and that can be frustrating for the recipient. Furthermore, respondent 12 pointed out that this dependency on people delays their activities and creates gaps in the design. Respondent 11 and respondent 12 quoted:

“Certain areas there were only one person and that person was swamped towards work and they had to prioritize and sometimes Ottawa would have to wait and wait to get any kind of help from that person; it’s not like we blame the person, but it is really the fact that it can be frustrating and can impact the project quite a bit”. (Respondent 11)
“You don’t have enough people that understand how that block works so when you try to design you have gaps in your knowledge, and then in the back end when you try to do integration and actually do the test you know you put the radio together and get it to work properly you have issues and you don’t understand whether it’s in the design outside that subsystem or if there are issues within that subsystem; and that’s problematic”. (Respondent 12)

In addition, Respondent 7 below highlighted the need to distribute this knowledge that is embedded in people to more teams in the different sites to be able to succeed with the KT and also use these key people’s expertise to have more efficient communication for KT:

“People with broad experience should be put in position of helping communication flows because they are able to, they have enough depth in understanding technology to route information to specific experts or specific team that have the expertise and I think too often we try to have the expertise concentrated in one or two individuals where maybe we should actually have teams of people that are focusing on the routing of that expertise. We tend to reinvent things locally because we don’t have information from the other side”. (Respondent 7)

- Embeddedness in sites

Half of the respondents think that product development knowledge is embedded in sites and within this case mainly in Sweden. This embeddedness in sites creates dependency for the teams in the other sites and can delay KT. Respondent 9 from Canada and respondent 4 from China had this to say:

“Things are located a lot in Kista. well we don’t get any transfer specifically on DPD information for one thing specifically. So that is kept within a very very small group even within Kista I think four people maybe, so that is very small, and we get no.. there is no Information or anything that we can do ourselves we were basically relying on them, So that is one aspect; All the platform leaders were all in Sweden as well, so the downlink, uplink and frequency generation were all in, based in Kista”. (Respondent 9)

“The system becomes more complex, so this kind of system standardization things and system technology is... I think is majorly located in Sweden”. (Respondent 4)

Respondent 10 from China below thinks that knowledge and specially the knowledge that is related to new technologies and new products like 5G for example is centered in Sweden:

“for example, 5G is coming but the knowledge in this area I think we are trying to build the knowledge here in Kista but indeed we don’t just spread the knowledge to the other sites yeah that’s clearly a problem”. (Respondent 10)
4.1.2 knowledge accessibility and documentation gaps

This was a main barrier that almost all respondents believe that there are many challenges associated with it. All respondents and specially respondents from recipient’ organizations highlighted that accessing the knowledge is not easy and also that there are some gaps in the documentation. One of the issues that has been emphasized on by the respondents is that some of the documentations are missing. Other than the missing documentation, there are also other issues related to accessibility and documentation gaps that came up from the analysis such as: the inefficient process of updating and reviewing the documents, the questionable quality of the existing documents, the lack of clear database and file structures and the problems associated with access rights to the knowledge. When it comes to the missing documentation, the respondents explained how the missing parts are creating major problems for them to fully understand the knowledge that is being transferred. Respondent 7 quoted:

“The design from CBC came from Kista and parts of this that were evolving; there were actually gaps in the systemization or gaps in the way that the product is working and those gaps were really never resolved and were not documented but they were still not impacting CBC and their project, but when we took the CBC project and started making some changes we realized that those changes were causing us problems now because of the previous gaps and those were never documented, because of the lack of the complete document that describes how and why and how these things were going to evolve it was missed from the first sort of knowledge transfer from Kista to CBC and then it was missed from Ottawa at the start of the project when we took the CBC design and realize quite late in the project that Oh there are things that are not working at all! And it’s a gap so it could have been avoided early”. (Respondent 7)

The quality of the existing documentation is also questioned by the respondents. Specially in the recipient sites, some believe that many documents exist but that some important knowledge are not documented and that there is a lot of redundancy and even contradiction in some documents. Respondent 12, respondent 7, and respondent 11 quoted:

“I think there is a lot of documents but the useful stuff doesn’t get written down, and in my view some of the critical pieces that explain why you did different things, why you have certain requirement numbers, the budgeting of uplink downlink budgeting throughout the radio, we haven’t really written down; why we are doing things properly and the rationale for the things that you have”. (Respondent 12)

“I would say we have a lot of documentation but some of it is redundant and a lot of it can be based and delta of other documents; but there are very rare documents that explain the fundamentals of the design and how you... they interact and why the decisions were made.” (Respondent 7)

“Sometimes the documentation maybe difficult to understand and occasionally it’s contradictory too”. (Respondent 11)
Moreover, related to the quality of the documents, respondents mentioned that some of the documents are also not updated all the time, which can cause a mismatch between the products and its documentation and create confusion and frustration for the recipient of the knowledge. Respondent 9 quoted:

“So that has been a lot of frustration because we are now trying to update the design documents to actually make it match so whatever they are currently building will have the same thing and then going forward we can choose to make design changes if needed”. (Respondent 9)

Furthermore, the process of reviewing and updating the documents is considered slow by some of the respondents, and in some cases the updates of documents that are affecting both source and recipient products are not shared or spread in a good way. Respondent 12 and respondent 10 quoted:

“I don't think we are particularly regulars at reviewing the documents which we do produce, or even realize that we should have some traceability in terms of the design”. (Respondent 12)

“Some general documents are maintained in Sweden, but sometimes, even for the documents update we are not informed, if you find something changed in the document you have to ask the reason why you have changed this? what was the reason behind that? So, this is not active transfer”. (Respondent 10)

Concerning the knowledge accessibility, respondents mentioned that this problem is mainly caused by the lack of clear database and file structure for the knowledge. According to them in some cases, the knowledge is not even stored in a database. Respondent 10 mentioned that sometimes the document location is not known. Respondent 9 also emphasized that it is very difficult to find documents and also that some people just keep the knowledge in their laptops instead of storing it. Respondent 10 and Respondent 9 quoted:

“It's not kind of transparent, the folder where knowledge is stored, where to find, in which document or which folder we don't know”. (Respondent 10)

“Unless you know exactly what you are looking for it is very hard to search for items and find the information. I find too that people will not necessarily submit to documentation, they just keep it in their laptops. And that is again hard to find certain information you want”. (Respondent 9)

Respondent 6 below mentioned that sometimes some documents’ location stays unknown even after the KT meeting, and that they need to ask where they are stored.

“Sometimes we have to say even when we have knowledge transfer session, maybe we cannot get all of the information, all of the documents; we still have some things, we don't know where it is, and we still need to ask”. (Respondent 6)
Regarding the same topic, some respondents emphasized that the knowledge accessibility problem is sometimes due to the lack of access right to the knowledge storage places. If the knowledge stored cannot be accessed by some team members, this causes knowledge gap and makes the KT incomplete. Respondent 4 and respondent 10 below emphasized that some knowledge is stored in only one site’s local disk or in databases that they don’t have access to.

“When we do the transfer for example, there is certain parts evaluated by Kista, but we won’t find the evaluation results. But we find that it is only stored in that computer or in Kista disk, but we cannot access. So, we prefer, we ask it to be stored in Eridoc like that but if we forgot that we will never find that document”. (Respondent 4)

“When some is open to all sites maybe and some are not. When we try to get some access maybe we don’t have the access. And maybe some cases actually even you know who is maintaining this folder, you ask, send a mail to the person to ask for the access, they will not respond you (laughing) yeah”. (Respondent 10)

4.1.3 knowledge complexity
Knowledge complexity was also one of the barriers that all respondents agreed upon, the analysis revealed that PDU knowledge is considered complex and that is due to mainly two reasons: the use of new technologies and the content of the knowledge itself. For the first reason, PDUs in general work with new technologies all the time. These new technologies are sometimes considered not mature enough or even not completely defined from standards perspective; that can hinder the KT process because there is still no mutual understanding or a common ground between the source and the recipient for these new technologies, adding to that, the new terminologies that come with every new technology. Respondent 6 and respondent 1 quoted:

“If the technology part is not clear then I think the knowledge... that will be more difficult for the knowledge transfer itself; it’s hard to describe and hard to transfer, such as 5G. For 4G maybe it is easier because the technology is very mature, so we know what we are doing when we are transferring it, that is easier but for the unclear things, of course the knowledge transfer is not quite clear because I believe there are a lot of open questions, some things are not clear that will impact the knowledge transfer efficiency”. (Respondent 6)

“We are working with 5G and AAS and these are new areas. So, the organization is per knowledge and as way of speaking is for traditional radios, but they miss it for new radios. So yes, we struggle a lot with communication, on just the basic understanding of everyone involved is not there, and that causes a lot of struggle in order to drive discussion in a very good way. it is easy to get confused”. (Respondent 1)

Regarding the same topic, the source team members also highlighted the complexity of new technologies knowledge. Thus, if the source itself does not fully understand all the details of
the new technologies, that will impact the KT quality as well. Respondent 8 and respondent 3 from Sweden quoted:

“The main issue with the new technology would be if we don’t understand then we cannot do this very properly, then we can have some missing parts we don’t understand functions, or we don’t understand the requirements”. (Respondent 8)

“when it comes to what shall we do and all words, it’s a completely new setup of words and I don’t know them all, I have gone on courses, and I will attend even more courses because this radio will be used in another way than the previous. I will explain how the radio is used, will be used in network and this will be another way than the previous way, and I don’t know how to explain that, it’s new so, I probably need to improve that in the few 3 or 4 months”. (Respondent 3)

The second reason that explains why ICT product development knowledge is complex is linked to the content of the knowledge itself: Respondents mentioned that radio knowledge was complex and that it includes many different parts: Hardware (HW), software (SW) and systems that are interacting in a very complex way which can cause challenges for the KT. Furthermore, the uniqueness of each product that is developed is adding to the complexity. Respondent 7, respondent 9 and respondent 2 quoted:

“Most of the time you have a combination of SW and HW that is required as well, because we are delivering products and products are made of systems, HW components and SW components that all need to come together so that, when you have all that, all these different development technologies. we are using complex chips and designs and ASICS and things of that nature”. (Respondent 7)

“Digital design is a little bit easier from the perspective it is 1s and 0s, it is right or wrong, it is a little bit, a little less ambiguous whereas radio design comes down to scales of how good or not so that some things can be good enough”. (Respondent 9)

Respondent 6 quoted below thinks that this knowledge complexity leads to complicating the planning of the KT activities as well:

“The radio is complex, I think for the knowledge transfer... organizing the knowledge transfer or make the plan for the knowledge transfer is complicated”. (Respondent 6)

4.1.4 Knowledge problematic articulability
Half of the respondents think that there is a challenge when it comes to knowledge articulability. The challenges of the articulability have two parts: the tacitness of the knowledge and the problems with the articulation process. From the respondents’ responses it is obvious that PDU knowledge is considered tacit knowledge that is difficult to communicate and transfer. One aspect that explains that tacitness is that some respondents believe that the
majority of PDU knowledge was gained through experience and practice which is hard to articulate or document and as a result leads to harder transfer of this knowledge. Respondent 4 quoted:

“Radio knowledge is analog knowledge, so many of this related to experience, you work for the project, you work in this area for long time you have a lot of experience these experience things is hard to transfer, this is actually extremely important in radio technology the design experience. It’s hard to be verbally crystal clear that everyone who will read it will know it immediately. Also, how we build up the boards the powers what happens in the lab this part of experience is hard to transfer”. (Respondent 4)

For the articulation process, almost all respondents agreed that the articulation is done mainly by the source that is transferring the knowledge. Recipient in some cases came back with some questions but no major feedback on the content of the documentation. Respondent 3 and respondent 8 from Sweden quoted:

“Usually I am doing the work here, but I want them to review all things, maybe they just correct errors not rephrase, maybe they can do it, Ottawa for the correction they maybe rephrase it to better English, I expect china to just do correction not much else more but not in the knowledge itself, I usually write the document completely by myself, if I need assistance I take from the design team here”. (Respondent 3)

“Yeah, they will not tell you that you are missing this part, or we need more that part, and they may just say documentation is not complete, but you will never get like ok I need chapter yeah like content, we will need more, this information or this is missing or we don’t understand this part”. (Respondent 8)

From the data analysis, it came up that the fact that articulation is done by the transferring organization only is a barrier that can affect the sense of engagement that can boost the KT activities’ quality. Respondent 8 from the source site feels that this lack of feedback and engagement from the recipients is frustrating for them; Respondent 8 quoted:

“The first thing that I ah, that pop up to my head is lack of reciprocity there, like feedback sort to say. So I was thinking if you are trying to give information to someone to either teaching someone or ah.. you expect some kind of engagement from the other side, “ok I understood” or “oh it was clear” or, so anything anything and how do we experience that in our work, and then you get frustrated”. (Respondent 8)

4.2 Activity context

For the activity context, we found four main barriers for KT namely: ICT tools reliance vs fact to face, inefficient ICT tools utilization, inefficient IT support, and lack of formal processes and guidelines.
4.2.1 ICT Tools Reliance vs face to face

The reliance on ICT tools for KT implying the lack of face to face interaction can cause some challenges and becomes a barrier for KT. All the respondents emphasized that face to face KT is the best as compared to using ICT tools, especially if the team members have never met before. Respondent 6 below emphasized that for the most important matters, face to face is better to obtain a common understanding and to get more from the KT.

“You know, I think for the most important things, face to face communication will make you understand more about what people want or know. For the language it can help you; and if we just use the conference call or we use email, yes, we can get specific things we want to know, we ask questions they give answer but if we have some face to face communication, face to face knowledge transfer, I think that we can get more compared with other tools”. (Respondent 6)

Respondent 11 also mentioned that face to face is particularly important for the language barrier and that it also help to build personal relationship with team members from other countries. He also supports that with face to face, more information and better understanding can be gained because people are busy, and you might not get the help you want with the use of ICT tools; respondent 11 quoted:

“I find that it's really valuable once you get that F2F contact with people then, specially I find with China actually, when we are transferring something from China to Ottawa it really helps when you have the engineers go there because people are so busy and the language, you know they are not; English obviously isn’t their first language but when you are there you tend to get more information from people when you are actually there and you get much better sense of what is really going on and you also develop the relationship which can help you when people are really busy they might ignore you your email but if you met them in person they are more likely to help you out”. (Respondent 11)

Moreover, some respondents mentioned that in a KT through ICT tools, some information can be lost due to the lack of face to face interaction which causes challenges in KT process. Respondent 6 below mentioned that sometimes, lots of information is lost during KT through ICT tools.

“Sometimes when we communicate, we miss a lot of information in our communication especially for knowledge transfer; that is maybe they give you 5 points, but you only get 2 or 3 points at that meeting”. (Respondent 6)

Concerning the same topic, some respondents highlighted that the use of ICT tools result to a much longer response time as compared to face to face. Below, respondent 2 underlined that, with face to face you can get a response at the same moment whereas with ICT tools the same response can take many days.

“I think if you are on another site then you are forced to use mail or the phone and you talk to people that maybe you have never met before and it takes much
longer time; if you talk to someone face to face you can ask questions you get answers in 10 minutes you can ask 10 questions; if you handle the same via mail worst case it takes 10 days, you send the mail then the next day you have an answer, so then you send the questions back and then the next day, so it's so much slower”. (Respondent 2)

4.2.2 Inefficient ICT tools utilization
The efficient utilization of ICT tools by the team members is important for the success of KT in a distributes team setting. Team members must find the most appropriate ways to transfer knowledge using ICT tools. But this requires team members to have the necessary skills and exploit ICT tools in the best way in order to increase KT effectiveness. Our findings show that employees awareness of the functionalities and capabilities of ICT tools is important for the effective utilization of ICT tools for the purpose of KT. All the respondents emphasized that they are not aware of all the capabilities of the tools they use. Respondent 9 mentioned that the basic functions of some tools are OK but that there may be other features that could improve things. Respondent 10 also claimed that SharePoint have been used for a while but that they still do not have the full knowledge of how to use it; respondent 9 and respondent 10 quoted:

“There may be other features that we don't necessarily realize, that may improve things. So, some of the them, the basic functions are fine no problem but some of the other...I think there was ways of doing new reviews with actually office 360, which I am not actually sure about. So, we have started using PDF reviews but there may be other ways of doing, sharing reviews differently as well”. (Respondent 9)

“SharePoint, we used it for a while, but we still need to figure out how to use it and what is different. So maybe it is powerful, but we need time to figure out how it works”. (Respondent 10)

Our results reveal that the challenge of the employees’ awareness of the capabilities of ICT tools may be related to the complexity of the tools. Most respondents claimed that some tools are complex to use. Respondent 7 mentioned that some tools are not used effectively because they are difficult to set-up. Respondent 2 also acknowledged that the tools they use have more capabilities but that they are quite complex to use; respondent 7 and respondent 2 quoted:

“We are using complex chips and designs and ASICs and things of that nature so, we don't use the tools effectively I think there are tools for that and we don't use them effectively because we feel they are complex sometimes, they are difficult to set-up”. (Respondent 7)

“I understand that there are so much more you could do with the tools especially SharePoint but also like hansoft. You can create very good reports and data and follow-ups, but they are quite complex to use”. (Respondent 2)
Regarding the same topic, respondent 6 below mentioned that sometimes there is a reluctance to use the tools due to the complexity; but they still use these tools because they aid in KT.

“Sometimes I don’t want to use it because of the complexity but we still use it because that can help us to share information, but to be honest I have to say sometimes it is a little bit complex and people need to take time to study how to use it”. (Respondent 6)

The challenge of team members awareness about the tools functionalities and capabilities is also due to the lack of training. Training sessions on ICT tools are essential for the suitable use of ICT tools for KT. Most respondents claimed that they received no formal training on the ICT tools they use for KT. Below, respondent 12 emphasized that the fact that people do not use some tools may be due to the complexity and claimed that a training could help in facilitating the utilization of these tools.

“I think there is couple of smart boards maybe in different sites but I don’t see people using that, maybe there is a kind of maybe too much of; right now there is too much activation troubles for people to get used to using them, so if we are thinking about something that we could propose maybe that will be some, you know improving some of the, adding some of the white boards but actually showing people how to use them effectively so that they are easy and there is no activation troubles if you learn how to use it so”. (Respondent 12)

Respondent 1 below recognized that training will be useful to improve the communication efficiency and also that it will enable to transfer knowledge and work in a better way.

“It is very important that we communicate in a very good way, so I think, I mean that one note is very good compared to what whatever we had before. But I think it is a quite good tool if we see it, and that gains a lot on how we can communicate, so it worth... I think at least for some people to have some training, I think that it is, and also for your own efficiency to I mean to be able to do things in a smart way and a fast way and not to work too much on writing and minutes of meetings and etc. that you can do it in a good smart way from beginning and share the information”. (Respondent 1)

Our findings also prove that the efficient utilization of ICT tools is related to how well the tools are exploited by team members. Most respondents emphasized that video calls are rarely used. Respondent 4 below mentioned that this causes some information to be lost during the meeting.

“Actually, it is not often that we use video, video conference call. We just use voice and a lot of information is lost by the conference call if it is only with the voice”. (Respondent 4)

Respondent 11 below had the same thought and claimed that there is a reluctance to use video at meetings. According to him, using more video could help team members to develop
personal relationships and that it could also be useful when explaining technical problems to team members in other countries by showing the hardware instead of explaining with only the audio.

“I think we should use more video, for some reasons we don’t, there is a reluctance to do that at meetings, I think it enhances the relationship that you develop with people if you have video not just the audio. So, I have seen people using it a bit, but I don’t think we are using it nearly enough, I think it needs to be really encouraged with management too, perhaps the managers and project managers can show, start using it and then others like the working engineers will begin to use it more. And a lot of technical problems you actually could really benefit from the video like if you are working on a circuit board for example you can hold it up and show like you see this part here that is where the transistor is blowing up in production that is where it is happening right there you know, rather than you know... trying to explain that”. (Respondent 11)

4.2.3 Inefficient IT Support

Inefficient IT support can be a barrier to a successful KT in a product development project by affecting the effective collaboration between geographically separated team members. Most respondents claimed that IT support takes time to solve issues, and this can impact KT process across the different development sites; respondent 5 quoted:

“I mean this whole SharePoint business that we were doing, this migration; the project sites were down for 2 weeks. Something that people are used to help over the night, or even you know, you shouldn’t be able to notice it. If you have an apple iPhone, you get update overnight and you don’t even know it, it just tells you, you have a new update. Here they shut down the project websites for two weeks and then when it comes back up it is so slow that you can’t do work anymore and then we engaged with the IT crew in Ericsson, we got some managers and explain that you are sort of sinking the business for radio right now we can’t work here, what are you doing?”. (Respondent 5)

Respondents emphasized that the lack of competence of IT support is another challenge. This lack of competence caused an avoidance towards IT support where many people try to solve some of the issues themselves instead of requesting the support of IT. According to respondent 8 below, people usually prefer to solve some of the issues themselves or to ask the help of their colleagues because sometimes IT support cannot solve the problem.

“I usually avoid it, I mean I go to my colleagues and ask. So, yeah and it is not sure that you are going to get the help you want (laughing), yes umm... so if Skype cannot start I usually do something, I go in the task manager and kill these two processes like yeah, and it is easier like to call in, but in general people avoid calling if they are not forced to and for the non-urgent purposes you can send a mail or setup the service request but if you really need help then you usually need to call and then....... sometimes they can help you, sometimes, they cannot help you. I am not sure that it is the best”. (Respondent 8)
In addition to the above challenges, some respondents also mentioned that sometimes there is a misunderstanding when trying to explain the problem to the support because of the language barrier. Respondent 10 claimed that IT support is usually outsourced; which means that people usually get a support with a different native language and this complicates the description of the problem and makes the process even longer; respondent 10 quoted:

“As a company I think we also want to cost down everything; specially IT, I think we also have cost down. So sometimes you need to find some local support that is not easy; you, some of the case then you get someone from India or Russia, or somewhere else to help you, yeah that’s not very good, yeah........ Maybe some has the competence but sometimes it is a communication problem”. (Respondent 10)

Respondent 2 below shared this point of view by adding that the complexity of some of the issues makes it even harder to describe it, especially to a person with a different native language.

“Yeah but then you have to create an IT ticket, and you have to explain the problem, and those kind of crashes is very difficult to explain to someone. so, if you create an online ticket, and you get an IT support in Malaysia and you are supposed to explain the problem to them. So, most people don’t think it’s worth the effort..., you just restart your computer and hope it works better next time...(laughing)”. (Respondents 2)

Respondent 5 supports that the problems related to IT support are caused by the fact that IT support do not have a clear knowledge of how ICT tools affect the product development process and the organization business as a whole; respondent 5 quoted:

“I think that the support is probably lacking, and I think their understanding of how the tools in Ericsson impact the daily work going on in the different development areas is not clear. I have the impression that they are sitting over there in their silo just trying to get update from Microsoft or what is the next thing that we should introduce in Ericsson, and they don’t sort of go around and understand, Ok! How are people using our tools, what is working, what is not working, is it efficient, is it impacting the business and how is it impacting the business, I think there is more to be done by the IT part of Ericsson there”. (Respondent 5)

4.2.4 Lack of formal Processes and guidelines
One important aspect of processes and guidelines is a formal communication plan including the list of people team members need to contact to seek knowledge. This formal communication plan is essential to ensure that team members receive all the knowledge they need for a successful KT. Without formal guidelines, there could be knowledge gap in the product development because team members might not know the right persons to contact or the right tools to use to get the required knowledge. All the respondents agreed that there is no formal processes and guidance for the KT. Respondent 11 below emphasized that
sometimes it is difficult to get the knowledge you need because you don’t know who to contact to get this knowledge.

“Well one thing that comes up to my mind is you don’t always know where to find the information in or who to contact to find the information, especially when it comes to really detailed technical things that are may be not documented that well; so that’s seems to be... well that was my experience, and also people that I work with as well, they often struggle trying to find the information......and you also get a situation where you talk to one engineer and then they refer you to another one and then that person refers you to somebody and you end up talking to the same person again and you go around it in circle”. (Respondent 11)

Respondent 5 below mentioned that KT processes and communication plan is usually experience based and also that many people succeed in their designs just because they have the right contact network. This means that the management does not give any guidance or direction and team members are responsible for searching the right contacts for the knowledge they need.

“I would say it is a lot experience based on starting up and having a contact network as well. So, you work with the board you know which one to contact, it’s just individual base really. And I think many people are successful with their designs because they have their correct contacts, Unfortunately”. (Respondent 5)

Our findings prove that the communication plan must also include a guidance and direction on which ICT tools to use for the KT in order to make sure the most appropriate tools are used for a specific KT. All the respondents mentioned that there is no guidance on which tools to use for the KT; respondent 3 quoted:

“There are tools but no general agreement on what to use, no direction”. (Respondent 3)

Respondent 7 below also noted that there is no guidance on which tools to use. According to them, the choice of the tools for KT is random and individual based:

“I think people are using more and more OneNote and SharePoint, creating their own private channel for sharing information within project and it is too very random. There is no guideline and there is no model”. (Respondent 7)

Concerning the lack of formal processes and guidelines, Respondent 1 below emphasized that it could help improve things if the line management shows more interest in the communication plans by asking project managers about their plans:

“I think it will be valuable if I got questions more about my communication plan, I think that would be something that the line also, for example like OK! you are running a project for all the sites what is your communication plan, I mean if I was forced to answer that in a clear way I will find improvements; maybe I
would see that there is a gap here and maybe I would ask my colleagues more in Ottawa and CBC so maybe they will propose”. (Respondent 1)

5. Discussion

5.1 Knowledge context

5.1.1 Knowledge embeddedness
Knowledge embeddedness remains as one of the most mentioned challenges and a main barrier for the KT. In the specific case of ICT product development knowledge, our results revealed that embeddedness in people was the most common embeddedness theme, how dependency on these experts that are always busy with other tasks can hinder the KT activities as well as the quality of KT. This is in line with what Moreland et al. (1996) mentioned, that when there are no personnel transfers accompanying KT, recipients often failed to learn all the different tools and routines. Other researchers also highlighted that tacit knowledge is usually embedded in people (Berry & Broadbent, 1987; Starbuck, 1992). Respondents also mentioned that some knowledge is embedded in sites and that this embeddedness in sites can also affect KT. Previous literature support this by acknowledging that knowledge can be embedded in sites and that this location specific knowledge is to a large extent tacit, and therefore difficult to transfer between globally dispersed teams (Subramaniam & Venkatraman, 2001), and specially with the lack of face to face interaction that will be discussed later in the activity context.

In the results, the aspect of embeddedness in people was also linked to another barrier that the previous literature and specially Cumming & Teng (2003) didn’t really pay much attention to which is the gaps in KT documentation, the fact that those key people who are the only people knowing all the detailed technical knowledge in some key areas do not have the time or the capacity to focus on documentation.

5.1.2 Knowledge accessibility and documentation gaps
This barrier is a new barrier that came up from the analysis and a one that previous literature didn’t really reflect on. Cumming & Teng (2003) only touched this area very briefly by mentioning that KT success requires that both parties develop an understanding of where the desired knowledge resides. The barrier includes different challenges and issues such as: the missing documentation, the bad quality of the existing documents, the slow and inefficient process of reviewing and updating the documents, the unclarity associated with who maintain access to the knowledge databases and also the unclear database and files structure. In addition, respondents mentioned that instead of storing documents in the central databases, some knowledge are kept in local computers or sites’ local servers. This causes recipient team members to spend lots of time and efforts searching for some documents containing the knowledge they need for the product development. All this leads to highlighting the great importance of having well documented and easily accessible knowledge for having a smooth and efficient KT, especially with the complex nature of the knowledge for PDU that will be explained next.
5.1.3 Knowledge complexity
Another main barrier that the previous literature including Cumming & Teng’s study didn’t focus on was the knowledge complexity which is a barrier that is linked to ICT product development knowledge specifically. Two aspects that again were not discussed in the related research for KT in ICT product development context were linked to this barrier: the use of new technologies in ICT product development and also the type of the knowledge and the uniqueness of each product developed. As emphasized by the respondents, the new technologies lack maturity and clear definitions, terminologies, and standards and it was agreed that these make the KT harder in terms of knowledge and also complicate the planning for the transfer activities as opposed to industries that do not involve new product development. The second aspect was the type of the knowledge and the uniqueness of each product. The fact the ICT development requires HW, SW and systems that makes it more complex than other types of product developments that include only HW or only SW. The complex way that those parts are interacting creates challenges for transferring such knowledge. In addition, the unique characteristics for each product makes product development knowledge harder to transfer compared to other industries like service providing for example. Goh (2002) touched this area and mentioned that the type of knowledge to be transferred affects the needs and conditions for the KT process.

5.1.4 Knowledge problematic articulability
Knowledge articulability was already highlighted in the related research as a barrier. However, the previous three barriers identified in this study in the knowledge context were more common and agreed upon by the respondents than the knowledge articulability. Half of the respondents believed that knowledge articulability is a major barrier. Zander (1991) shares this point of view as he highlighted that the nature of the knowledge being transferred, its tacitness versus its articulateness, has an important impact on the ease of transfer. Bresman et al. (1999) and Hakanson & Nobel (1998) also argued that KT is affected by its articulability, also that poorly articulated knowledge is more difficult to transfer within the firm. Cumming & Teng (2003) agreed to that as they conclude that articulable knowledge is more easily transferable than less-articulable knowledge. Respondents mentioned that the difficulty with knowledge articulability is related to the tacitness of ICT product development knowledge. Goffin & Koners (2011) acknowledged this, that much of the knowledge generated in new product development (NPD) is tacit; which is difficult to express, connected with problem solving, and dependent on the interactions within the team that in this case is mainly through the ICT tools that have their limitations. The study results are also aligned with another aspect of the articulability which is the knowledge articulation process. The study results show that the articulation is mainly done by the source, which can be a barrier that hinders the KT. This lack of engagement from recipient was brought up by the participants as a cause frustration. Dixon (1994) argued that it is important that both the source and recipient participate in the processes by which the knowledge is made accessible. Cumming & Teng (2003) also concluded that both sides involvement in the articulation process supports the recipient’s ownership of and commitment to the knowledge and also that it enhances the relationship between the source and the recipient, which was also evident from this study result.
5.2 Activity Context

5.2.1 ICT tools reliance vs face to face
The participants of this study stated that 90 percent of KT is done through ICT tools. The results of this study show that this lack of face to face interaction is one of the main barriers for KT between geographically separated teams in ICT product development. Cumming & Teng (2003) share this point of view by arguing that geographically separated teams may have a disadvantage because face-to-face meetings is important for some types of KT activities. Participants emphasized that some information can be missed if KT is done with the use of ICT tools. This is because the use of ICT tools can cause misunderstanding due to the lack of body languages and gestures. In addition, according to them, language barrier can be attenuated with face to face and it can also help to build personal relationship with team members. In the knowledge context, we argued that the knowledge involved in ICT product development is complex and that some of it is experience based and tacit knowledge. The use of ICT tools to transfer such knowledge is not very efficient. Participants stressed that compared to KT through ICT tools, face to face KT is better to get more understanding and more information. Connelly & Kelloway (2003) support this point of view as they stated that it can be difficult for IT to replace the rich interactivity, and communication that is present in conversation because sometimes it is easier to get some knowledge through a conversation with the actual expert than from an IT system. Supporting this opinion, Dedrick et al. (2011) and Alavi & Leidner (2001) also argues that know-how and tacit knowledge is best transferred through interactive means such as travel for face-to-face meetings. Furthermore, participants also reported the difficulty in documenting such complex and experience-based knowledge. Blumenberg et al. (2009) confirmed this, as they mention that since tacit knowledge is hard to be codified and transferred using formal methods, one of the most suitable mechanisms for transferring tacit knowledge will be face-to-face interaction. Moreover, as compared to face to face, participants also stated that ICT tools have a slow response time, and this also create some challenges for KT activities. This is one aspect that prior research did not consider much. In a team setting involving team members from different countries, remote KT can take much longer time because there is no instantaneous feedback. This slow response time with ICT tools increase with time zones differences and may affect KT activities.

5.2.2 Inefficient ICT tools utilization
When there is reliance on ICT tools for KT, a poor utilization of these tools becomes a barrier for a successful KT. The results of this study prove that team members awareness of the functionalities and capabilities of the tools is one of the most important things necessary for the efficient utilization of ICT tools for the purpose of KT. Connelly & Kelloway (2003) confirmed this by arguing that unfamiliarity and experience with ICT tools could be a potential barrier to KT. In addition of not being aware of all the capabilities of the tools, participants also mentioned that there is a reluctance to use some ICT tools due to their complexity. Riege (2005) share this opinion as he stated that people can be unwilling to use newly introduced systems because of the complexity of the system. Han & Anantatmula (2007) support that the problem related to tools complexity and team members unfamiliarity with ICT tools could arise due to the lack of training and communication regarding new systems and processes.
Participants had the same thought as they mentioned that the company does not usually organize trainings concerning the tools they use for KT. If team members do not have the skills required to use ICT tools, it is unlikely that they will efficiently accomplish KT even if the said ICT tools have the right functionalities. Therefore, for team members to be able to effectively exploit ICT tools for the purpose of KT, it is essential that the organization organize formal and mandatory trainings on these tools. However, one big challenge that previous research did not pay much attention concerning the utilization of ICT tools for remote KT is team members’ neglectance towards visual channels such as video calls. When KT is done through ICT tools, overlooking visual channels increases the challenges because the use of visual channels can increase team members understanding as they see each other, and they can explain some complex things by doing some drawings or showing some hardware as mentioned by some participants.

5.2.3 Inefficient IT support
For the effective KT between globally distributed teams, good IT support is important to ensure that team members receive all the necessary support to facilitate remote KT. Riege (2005) shared this opinion as he claimed that an immediate support function for technical faults is essential to provide timely solutions to system problems. Inefficient IT support can delay KT meetings or make some team members miss important KT meetings. In addition, it can also affect the daily and continuous KT and prevent team members to access the knowledge they need in time and hence delay the whole product development process. Participants emphasized that the process for getting an IT support is long and also that IT support takes time to solve issues and this create challenges for KT. Supporting this opinion, Keyes (2008) and Riege (2005) argue that a lack of instant maintenance and technical support of the systems can be frustrating and eventually cause a barrier to work routines and KT. In addition to the lack of instant support, participants also complained about IT support competence and inability to solve some issues. This detail is not reflected much in prior literature. Instant availability of IT support is important, but it also has to be competent to solve all the problems that users face. Another aspect that previous research did not focus on is the language barrier between the users and IT support. When users and IT support do not share the same native language, this can cause communication problems and misinterpretation of the problem by IT support. In such cases, even if the support is competent, it will still take time to solve the issues. In order to be more efficient and not affect KT across different countries, we believe that it is important for IT support to continuously investigate the problematic areas in the network, and the infrastructure to prevent or reduce tools crashes. They should also be more interested in the way ICT tools are exploited and continuously try to improve things instead of only waiting for users’ request before acting.

5.2.4 Lack of formal processes and guidelines
In an ICT product development project involving team members of different countries, having a formal processes and guidelines for KT activities is important for the outcome of the KT. Goh (2002) referring to KT activities, argues that the use of ICT tools for KT can only work if some other organizational factors are well managed. However, previous literature did not reflect much upon these organizational factors that could be a barrier to remote KT. The results of
this study show that the lack of formal guidelines about the communication plan is one of these factors. All the respondents stressed that the lack of formal communication plan is a major barrier to KT. The communication plan need to include many elements such as the list of contacts necessary for the KT and a direction on which ICT tools to use for the KT. A formal list of contact will facilitate KT by allowing team members to contact the right people who hold the knowledge, and the direction on which ICT tools to use is important because different types of tools may be suitable to transfer different types of knowledge. The lack of consistency and formal guidance in the choice of the tools for KT can lead to the use of less appropriate tools for a specific KT and can also create confusion on the knowledge accessibility. Daft et al. (1987) shared this point of view as he argues that it is important to match ICT tools with the tasks in order to enhance interaction. For example, email may be suitable for one case, and totally inappropriate for another case. Therefore, formal processes and guidelines are essential to give direction to team members concerning KT and facilitate KT activities.

6. Research Limitation

Few limitations need to be considered while evaluating this study. One limitation is that due to the time constraint, we only concentrated on two contexts of Cumming & Teng’s framework which are the activity and knowledge context. This can be a restraint as there might be important barriers in the other contexts that may affect the KT even more than what we have identified. Furthermore, as this is a single case study, and it looks into a specific company in a specific industry that can be considered as a limitation and one can question the generalizability of the results.

7. Conclusion and further research

The objective of this thesis was to investigate the barriers of KT between globally distributed teams in ICT product development projects and how these barriers affect KT. To answer the research question, a case study was conducted with twelve semi-structured interviews including respondents located in three different countries and with different perspectives and positions. The study focused on the main barriers of KT and specifically concentrated on the barriers related to the knowledge context and activity context of Cumming & Teng (2003) KT framework.

Looking at the study results, it can be seen that this thesis managed to deliver the following:

- In the knowledge context, the main barriers that have been found are knowledge embeddedness, knowledge complexity, knowledge problematic accessibility & documentation gaps and finally knowledge problematic articulability. In the activity context, the main barriers that have been identified are ICT tools reliance vs face to face, Inefficient ICT tools utilization, inefficient IT support, and lack of formal processes and guidelines.
- The thesis contributes to both research and practice as follows: New barriers were identified, and they were not mentioned in previous literature while they were
highlighted and emphasized on by all respondents in this study results as main barriers; these barriers are: knowledge complexity, knowledge problematic accessibility & documentation gaps, and the lack of formal processes and guidelines. As opposed to previous literature, this thesis also describes how the identified barriers affect KT between global distributed teams; for example, how the neglectance of video calls can hinder remote KT or how the different aspects of knowledge complexity like the use of new technologies and new terminologies can complicate the KT. These findings can help practitioners as well with more understanding on the challenges of remote KT that enables them to tackle and find solutions to these barriers.

Further research can investigate the barriers of KT in other organizational contexts, they can also look into the barriers related to the other two contexts in Cumming & Teng’s framework. Lastly, there is also a need for further research with the aim of investigating how these barriers can be mitigated and overcome.

**Acknowledgment**

We would like to give our sincere thanks to our supervisor Taline Jadaan for her valuable feedback and guidance, we thank you for that. We also give our thanks to all the participants for their time and their valued insights. Moreover, we thank the Swedish institute (SI) for giving us the opportunity to be part of their scholars and pursue our master studies in Sweden. Finally, we thank our families for always been there for us.
References


Appendix 1: The interview questions

1. How the projects are set-up between the different sites? How the responsibilities are divided and based on what?

2. In which cases the knowledge transfer is conducted? (for example, when there are different variances)? Different platforms?

3. In your opinion, and on a high level what do you think are the main barriers of knowledge transfer between the different countries in radio products development context?

4. How the transfer activities are organized (meetings: video calls, voice calls, F2F, workshops (all day?), percentage of each?)

5. What do you think about the amount of time that is usually planned for such activities? Do you feel the management is aware and considering these aspects?

6. In your opinion, what makes radio product development knowledge different? How do you think this could affect the knowledge transfer?

7. Do you think that this product development knowledge is easily articulable, or Do you think it is somehow non-verbalized and hard to formulate? To what extent do you think it is articulable?

8. When it comes to new technologies like 5G, do you feel difficulty with the articulation?

9. Do you articulate the knowledge here in your site only and then use it in the transfer activities? Or do the recipient organizations usually also engage in articulating the knowledge for a mutual understanding?

10. Do you think that radio product development knowledge is embedded in something? For example: specific sites, physical assets, people, or tools. How this affect the knowledge transfer?

11. Do both sides usually know where the knowledge can be accessed?

12. Which tools are you using for the transfer activities? (documents archiving, collaboration tools, emails, etc...)

13. How do you compare communicating via IT tools Vs face to face meetings?

14. Do you use skype chat and normal phone calls? Do you think these are frequent?

15. How do you perceive the use of technology for KT? Is the organization exploiting that in a good way?
16. Do you think the used tools match the work need and employees’ requirements? Would you prefer another tool? Why?

17. Do you use video calls for the knowledge transfer?

18. Do you think you are aware about all the functionalities and capabilities of the technology tools you use? What it can and can’t do? How are these functionalities affecting KT?

19. What about the complexity of the tools? Have you always feel comfortable in using the technology for KT?

20. Did you receive any training about the IT tools used for knowledge transfer? If no, do you think that a training would have helped to use the technology better for KT?

21. Do the tools go down frequently? If yes, does that affect the knowledge transfer?

22. Do you have good technical support always available in case the technology has a crash?

23. Did you experience the case where the tool for KT were not integrated in a good way? (For example, where you cannot import the data from one tool to the other)? Explain how.

24. Do you feel any difference when you work with teams in different countries, in the WoW for example?

25. Are there any directions from the lines or the project manager on how to setup the communication plans or which tools to use?
Appendix 2: Data analysis Mindmap

Link to the data analysis mindmap: https://drive.google.com/file/d/1mYvY4gL3HhAOEZ5BZTsVgRKX28aoBmBo/view?usp=sharing