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Developing a Knowledge Transfer Process for Technology Business R&D

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The combination of work and studies and conducting the thesis research has made this study a tough yet delightful journey. This thesis is authored by me, but I have had the support of many colleagues and academic staff to whom I am extremely grateful. Hence, I would like to use this opportunity to thank all the colleagues at the company who participated in the interviews and the group discussions to help me accomplish this thesis. I am especially thankful to Mr. K.M., R&D manager of the case company who was always available for my questions and patiently supported me through the process of conducting this research. I am thankful to Mr. T.A., my line manager, for his understanding over the course of this study.

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The case company is a multinational telecommunication equipment company which has gone through a recent re-organization. This change has caused a competency gap between different global R&D sites within the company. This thesis focuses on developing a knowledge transfer process for the R&D to close the competency gap and increase the R&D productivity.

This thesis utilizes the qualitative research method through three rounds of data collection with the help of interviews, group discussions, and internal company documents. The thesis is started by first conducting the current state analysis of the knowledge transfer practices between specific R&D sites, and then looking for relevant ideas and knowledge from literature. Subsequently the study continues to the co-creation of a proposal for the knowledge transfer process relying on the collected data and suggestions from the key company stakeholders. Lastly the co-created proposal is validated by presenting the initial proposal and receiving feedback from the company management.

The result of this study indicates that to close the competency gap between the R&D sites a knowledge transfer process can be embedded into project management activities. The components of the knowledge transfer process are “identifying knowledge and participants”, “capture and convert knowledge”, “share or transfer”, “apply and create new knowledge”, and “assess or audit”. Each step needs to be followed with the help of clear definition of roles and responsibilities in addition to relevant use of ICT tools enabling communication and transferring the knowledge among globally distributed R&D sites.

In today’s competitive business environment knowledge intensive organizations need a systematic way to retain and transfer knowledge between different sites, units, and people to increase the overall level of knowledge in the organization. The proposed knowledge transfer process created in this study was approved by the management of the case company and will be implemented in the future projects in the R&D of the case company.

Keywords	Knowledge Sharing, Knowledge Creation, Knowledge Transfer Process

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Acronyms

KT	Knowledge Transfer
PLM	Product Line Management
FE	Feature Engineer
DFO	Development Feature Owner
PRD	Product Requirement Document
SD	Software Developer
LTO	Lead Test Owners
PMI	Project Management Institute

1 Introduction

Knowledge is an important asset in knowledge intensive organizations and the the ability to utilize the knowledge has a significant impact on sustainability and competitiveness of businesses. Knowledge serves as a source of power to those individuals and organizations that possess it (Bundred, 2006). As knowledge is generally distributed among different sites in knowledge intensive global organizations, sharing and transferring knowledge requires knowledge transfer practices meeting specific needs of such organizations.

Organizations lacking an effective knowledge transfer process may face competence imbalance between global units which negatively impacts the productivity of whole organization in the long run. Therefore, the knowledge transfer process does have a strategic significance for management to consider.

In a multinational organization with globally distributed sites, transferring knowledge requires additional attention from company management to facilitate knowledge sharing by embedding knowledge sharing into formal processes and providing the employees with suitable tools to enhance knowledge transfer.

1.1 Business Context

The case company operates in the global telecommunication equipment industry. It is a multinational data networking and telecommunication company developing and delivering end-to-end portfolio of network equipment, software, services, and licensing globally. The target customers are communications service providers, governments, large enterprises and consumers. The case company's net sales were EUR 22.5 billion and the number of employees was 103,083 worldwide in 2018.

The case company is competing with other major players serving communication service providers. Currently the company is facing tough competition with the emergence of latest technology. The R&D of the target business unit in this thesis plays a major role to develop complex customer requests to stand out from the competitors.

1.2 Business Challenge, Objective and Outcome

The R&D of the case company is distributed between 4 different sites globally (Finland, USA, Greece, and India). The company has gone through a recent re-organization. This

change has caused competency gap between different global R&D sites within the company. To meet customer demands and increase feature development throughput, the management has taken baby steps towards transferring some core competencies from other sites to Finland, which has been progressing very slowly compared to knowledge transfer between other sites.

The competency gap in the Finnish site directly impacts the overall R&D efficiency. To improve the competence profile of the engineers in Finland, the current knowledge transfer initiative must be accelerated to enable developing more complex customer requests by Finland R&D.

The objective of this thesis is to develop a knowledge transfer process with the focus on transferring the knowledge to Finland R&D. The outcome of this thesis is a knowledge transfer process and related recommendations.

1.3 Thesis Outline

This study is conducted by investigating the current state of the knowledge transfer practices in the case company. The investigation consists of exploring the internal tools and documents in addition to conducting interviews with various stakeholders in the case company. Based on the findings from the literature and discussions with company stakeholders, a proposal for a knowledge transfer process is created. The proposal for the knowledge transfer process is reviewed and validated by the key decision makers in the case company.

This thesis is divided into 7 sections. Section 1 is an introduction. Section 2 describes the research approach and the data collection methods used in this study. Section 3 describes the current state analysis of the knowledge transfer practices in the R&D of the case company by analyzing the interviews and internal documents. Section 4 continues with exploring the existing knowledge from the literature and creates a conceptual framework for this thesis. Section 5 proposes the first version of the knowledge transfer process and its related recommendations. Section 6 provides the validation stage of the first proposal and presents the final proposal for the knowledge transfer process. Section 7 summarizes this study and provides recommendations for further development in addition to evaluating the credibility of this study.

2 Method and Material

This section describes the research approach, the data collection, and analysis methods used in this study.

2.1 Research Approach

Different approaches to research are known and used in various research studies. Basic research relates to understanding theoretic dimension of business and management process and their outcomes. Such research is mainly intended for academic community with less attention given to the practical implications (Saunders et al (2012:8)). On the other hand, applied research is another approach to research which is more relevant for managers in organizations and helps addressing the practical business issues and finding solutions for business problems (Saunders et al (2012:8)). Table 1 illustrates classification of different approaches and methods including their characteristics.

Table 1. Classification of different approaches and methods including their characteristics (Kananen 2013:29)

Factor	Research Approaches		Researches with Multiple Approaches Researches with Multiple Strategies		
	Qualitative Research	Quantitative Research	Case Research	Design Research	Action Research
Relationship between Theory and Practice	Induction or from practice to theory	Deduction or from theory to practice	Abduction	Abduction	Abduction or interaction between theory and practice
Purpose of Research	Understanding	Generalisation Prediction	Understand-ing	Change	Intervention Change
Researcher's Role	External participant	External observer	External participant	External participant	Active actor
Research Questions	Open questions Theme interview	Structured questions	Mainly open questions	Mainly open questions	Mainly open questions
Responses	Text descriptive	Numbers quantitative	Open	Open	Open

As seen in table 1, a basic division between research approaches are qualitative and quantitative research (Kananen 2013:28). Qualitative research utilizes words and sentences which is intended to help towards a "finding" without statistical methods or other quantitative methods. On the other hand, quantitative research approach is based on numbers and requires theories or models of a phenomenon subject to research (Kananen 2013: 31-33). Design research and action research can utilize both qualitative and quantitative approaches (Kananen 2013:28). The difference between design research and action research is the researcher's role in the research. In action research the researcher is a participant in the development operations, but in the design research the researcher's participation is not required (Kananen 2013: 41-45).

Accordingly, design research is the selected approach for this study. The design research has been chosen because this study addresses a practical business problem in an organization and seeks developing a solution for it. The research method utilized in

this study is qualitative research through multiple data collection techniques, such as documents and interviews.

2.2 Research Design

This section presents the research design of this study. The research design is illustrated in figure 1.

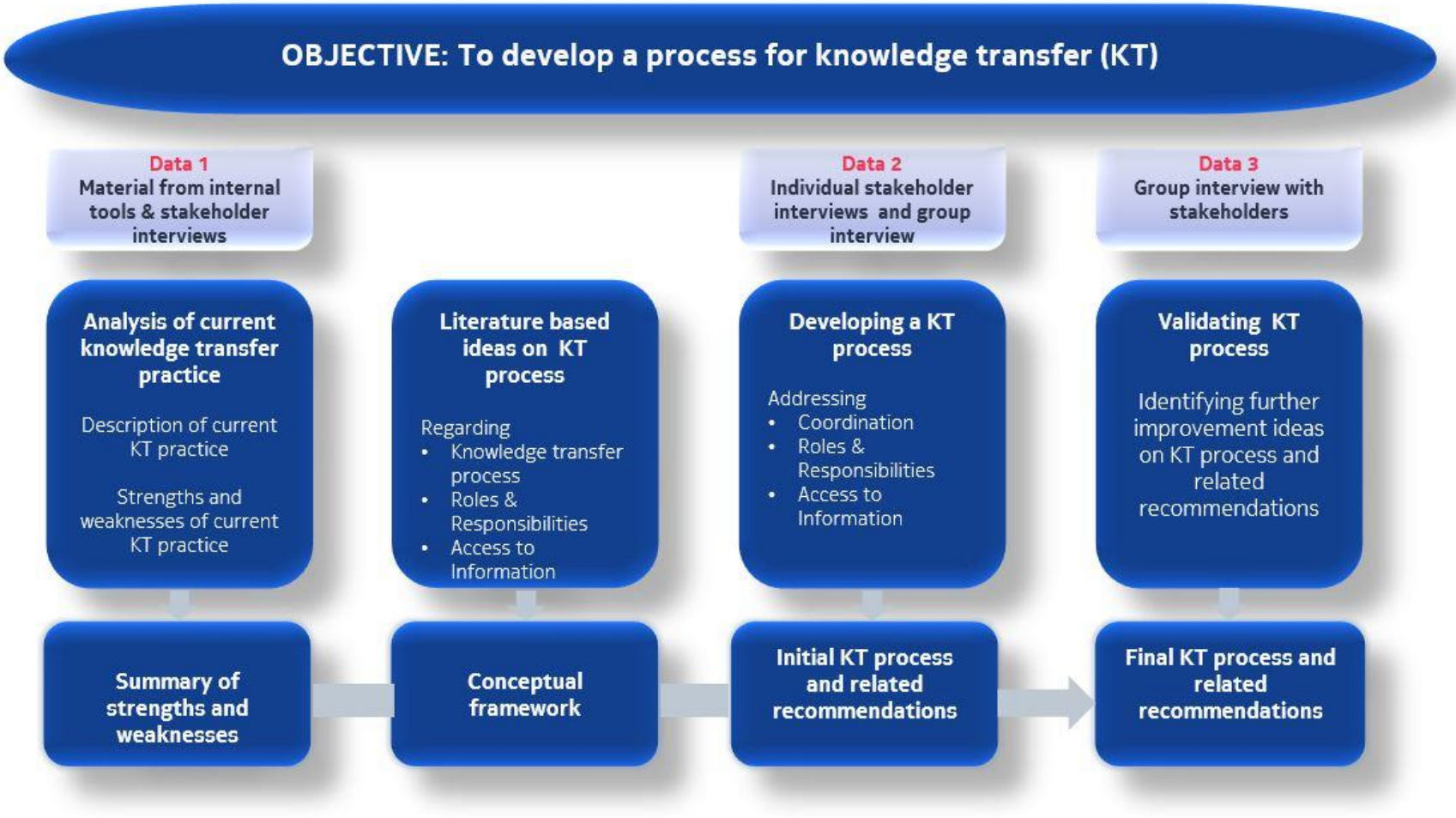

Figure 1. Research design of this study

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As seen in Figure 1, this study is done in multiple stages. Keeping the objective of the study in mind, the study begins with analyzing the current state of knowledge transfer (KT) practices already performed in the case company. Additionally, the strengths and weaknesses of the current knowledge transfer practices are analyzed. Hence, the outcome of the first step is the summary of the strengths and weaknesses of the current knowledge transfer practices. The data collected during the first step is the data 1 of this study which will be discussed in next sections.

The second step is exploring the literature to find ideas from existing knowledge regarding the weaknesses found in the first step. The outcome of this step is a conceptual framework created from best ideas from the literature.

The third step is developing a knowledge transfer process to address the weaknesses found in the current state analysis (step 1). The knowledge transfer process is co-created with the stakeholders in the case company. The outcome of this step is an initial proposal for knowledge transfer process and its related recommendations. The data collected during this step the data 2 of this study which will be discussed in the next sections.

The final step is validating the earlier proposed knowledge transfer process. The draft version of the proposal is presented to the key stakeholders to receive feedback and improvement suggestions. The outcome of this step is the final version of knowledge transfer process and its related recommendations.

2.3 Data Collection and Analysis

This study draws from a variety of data sources including the company documents, interviews and group discussions collected in several data collection rounds. Table 2 below presents the details of the interviews and group discussions.

Table 2. Details of interviews and group discussions in Data1-3

	Participants / role	Data type	Topic, description	Date, length	Documented as
	Data 1, for the Current state analysis (Section 3)				
1	Informant 1: R&D manager 1	Face to face Interview	Identification of the stakeholders and participants in the learning practice	Dec 2019, 2 hours	Field notes
2	Informant 2: Software Developer (trainee) 1 (SD1)	Face to face Interview	Identifying strengths and weaknesses in current knowledge transfer. The knowledge status of the sub-areas	Jan 2019, 90min	Field notes
3	Informant 3: Software Developer (trainee) 2 (SD2)	Face-to-face Interview	Identifying strengths and weaknesses in current knowledge transfer. The knowledge status of the sub-areas	Jan 2019, 90min	Field notes
4	Informant 4: Software Developer (trainee) 3 (SD3)	Face to face Interview	Identifying strengths and weaknesses in current knowledge transfer. The knowledge status of the sub-areas	Jan 2019, 90min	Field notes
5	Informant 5: Software Developer (trainee) 4 (SD4)	Face to face Interview	Identifying strengths and weaknesses in current knowledge transfer. The knowledge status of the sub-areas	Jan 2019, 90min	Field notes
6	Informant 6: R&D manager 2	Face-to-face Interview	Identifying strengths and weaknesses in current knowledge transfer practices	Jan 2019, 60min	Field notes
7	Informant 7-8: Trainers	Teleconference group interview	Identifying strengths and weaknesses in current knowledge transfer practices	Jan 2019, 60min	Field notes
8	Informant 9: R&D manager 3	Teleconference interview	Identifying strengths and weaknesses in current knowledge transfer practices	Jan 2019, 60min	Field notes
	Data 2, for Proposal building (Section 5)				
8	Informant 1: R&D manager 1	Face to Face discussion	Proposal building	March 2020 90min	Field notes
9	Informant 10: PLM (Product Line Manager) Finland	Face to Face discussion	Proposal building	March 2020 75min	Field notes
10	Informant 9: R&D manager 3	Teleconference discussion	Proposal building	March 2020 60 min	Field notes
11	Informant 1,9,10: R&D manager 1, PLM Finland, R&D manager 3	Teleconference group discussion	Proposal building	March 2020 120 min	Field notes

	Data 3, from Validation (Section 6)				
12	Informant 11: Project Manager Informant 1,9,10: R&D manager 1, PLM Finland, R&D manager 3	Group discussion /Final presentation	Validation, evaluation of the Proposal	April 2020 90 min	Field notes

As seen from Table 2, data for this project was collected in three rounds. The first round was collecting Data 1 which was conducted to understand the current knowledge transfer practice between other R&D sites to Finland R&D. The data collection method in Data 1 was face to face and teleconference interviews with the training participants, R&D software developers, and the R&D managers.

In the second round, Data 2 was collected to gather suggestions from the key stakeholders for co-creating the proposal for a knowledge transfer process. The data collection method in Data 2 was firstly conducting face to face discussions with the key stakeholders and a teleconference group discussion to co-create the complete proposal.

In the third round, Data 3 was collected by receiving feedback for the proposal from the decision makers. The data collection method in Data 3 was a group discussion with all the key stakeholders and project manager as the main decision maker.

In this study, the individual interviews and group discussions were the primary method of data collection. The interviews were conducted as semi-structured, face-to-face and teleconference interviews, with a set of questions created in advance and field notes were taken. The questions for Data 1 interviews can be found in Appendix 1. The field notes were taken during the interviews.

Additionally, Data 1 includes other types of data such as internal tools and databases with the information on software sub areas and their corresponding owner and current knowledge distribution between R&D sites. Table 3 shows the internal documents used in the current state analysis of this study.

Table 3. Internal documents used in the current state analysis, Data 1

	Name of the document	**Number of pages/other content**	**Description**
A	Feature estimation documents	10 pages	Software area and main estimators
B	Feature task list	60 rows	List of feature tasks and task owner
C	Software sub area list	10 rows	List of relevant main software areas to be learned

As seen from Table 3, this study also analyzed several internal documents. The main documents included software sub areas and their main estimators and the full list of the relevant sub areas in addition to the list of the related task. The documents were analyzed for the current state analysis, Data collection 1, to help understanding the level of the tasks Finland R&D software developers have handled so far.

All data were analyzed using Thematic/content analysis. The biggest part of data analysis was done for the current state analysis stage to establish the current state of the knowledge transfer practices. The findings from the current state analysis are discussed in section 3 below.

3 Current State Analysis

This section discusses how the current state analysis of current knowledge transfer practices were conducted in the case company and describes the related findings. The analysis includes the strengths and weaknesses of the current knowledge transfer practice. All data were analyzed using Thematic data/content analysis.

3.1 Overview of the Current State Analysis Stage

The objective of the current state analysis was to find out what the knowledge transfer practices have been in a multi-site software product R&D organization. The focus was mainly on how knowledge has been transferred from other sites to Finland and what have been the barriers for this transfer. The current state analysis was conducted in 6 steps. The first step focused on identifying the important software sub areas to be learned by software developers in Finland. The second step focused on deriving more sub areas and the names of the trainees and their tasks on the corresponding sub areas. The third step was conducting individual interviews with the employees in Finland followed by interviewing R&D manager 2 and the trainers from R&D India and their manager, R&D manager 3. R&D managers from USA and Greece were not interviewed as the knowledge transfer has been mainly from India to Finland. Figure 2 illustrates the global R&D distribution.

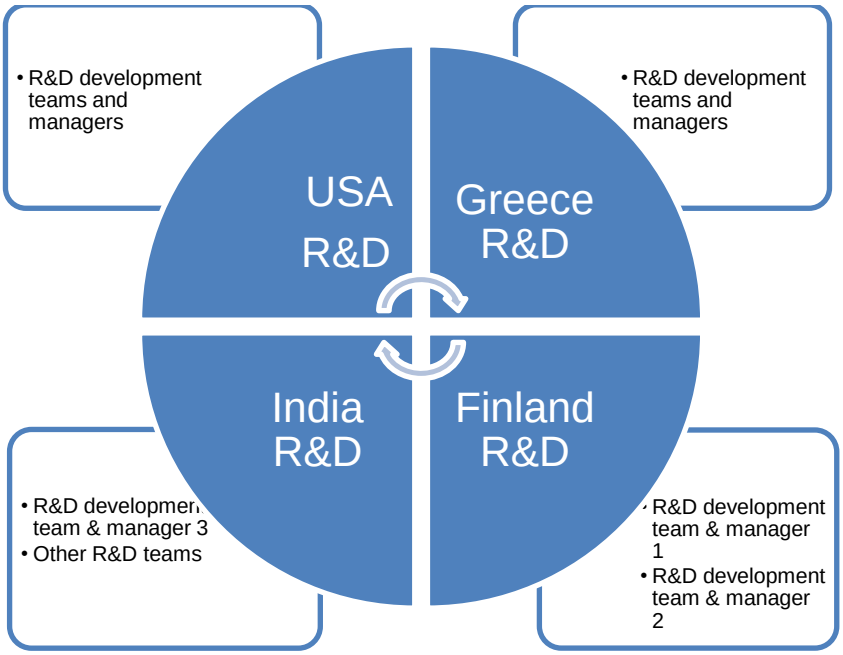


Figure 2. Global R&D distribution

As depicted in Figure 2, global R&D is distributed in 4 different sites and each site has various sub teams with a dedicated manager each. The interviews were conducted as semi-structured face-to-face and teleconference meetings with the stakeholders. Figure 3 presents the order of the interviews.

Figure 3. The order of the interviews

As illustrated in Figure 3, the first step involved an interview with R&D manager 1 in Finland to identify the trainees and the corresponding software areas regarding current knowledge transfer practices. R&D manager 1 is based in Finland and leads one team of software developers in addition to holding some site leading activities in Finland. Therefore, R&D manager 1 was the first person who was interviewed. The first interview led to an overall introduction to the current learning status, the names of the trainees, other stakeholders involved, existing tools and internal documents to be used to extract additional information on the trainee's current tasks and learning status. In the second step, with the information obtained from the first step, the internal tools and databases were explored to find out how each software sub area was linked with a trainee's task and whether they had started applying any of the learned areas so far. The limitation at this step was that the internal tool did not list some of the old tasks anymore. However, to obtain additional information on all the tasks and more details on the learning practice, the third step was conducted.

In the third step, each software developer (trainee) in Finland was individually interviewed. Due to the lack of resources in Finland, the number of trainees is only limited to 4 people currently. However, the objective of the individual interviews was to openly discuss and get familiar with their personal view on the current learning practice. One of the trainees was the subordinate of R&D manager 1 and the remaining 3 trainees were subordinates of R&D manager 2 who was interviewed in the fourth step. In the fourth step, the R&D manager 2 leading three of the trainees was interviewed. The author decided to interview the R&D manager after interviewing the trainees to avoid any biased views induced by the manager when interviewing the trainees. The objective of the interview with the manager was to know his view on the barriers to the current learning practice. Due to the context of the interviews, they were conducted individually to make sure employees would be able to comment freely with less hesitation.

3.2 The Knowledge Distribution in Global R&D

The interviews resulted in obtaining an understanding of the overall competence level of each site and how the knowledge flow to Finland was initiated. To simplify the discussion and for confidentiality reasons, the actual names of the product sections have been re-named for the purpose of this assignment. The product R&D is distributed globally among 4 different sites, i.e. USA, Finland, Greece, and India. The product is a software with two main areas which are named as **O** and **C**. Customer requests can impact area O, C, or O+C and they can be small, medium or large requests. Customer requests reach R&D via PLM (Product Line Management) team who has direct contact with customer teams from different regions globally. The PLM and project management team discuss the requests and create a list of features to be implemented by R&D.

Once the feature candidate list is ready, the project management team contacts the global R&D managers who have the potential to take the responsibility of the feature. The R&D managers initially assign the feature team according to the feature definition and their area of expertise of their teams. At this point the requirement tags in the feature are not so clear initially but the managers make a calculated guess which subsystem it will impact and assign DFO (Development Feature Owner). The next step is conducting a review for product requirement document (PRD). The roles involved in PRD meeting are PLM (Product Line Manager), LT (Lead Tester), FE (Feature Engineer), DFO (Development Feature Owner), and LTO (Lead Test Owners). After the PRD review draft, more information from the feature is known and the feature team may change accordingly depending on which sub area the feature impacts and the availability of the person per their estimated workload in the related release. Figure 4 illustrates the global R&D knowledge areas.

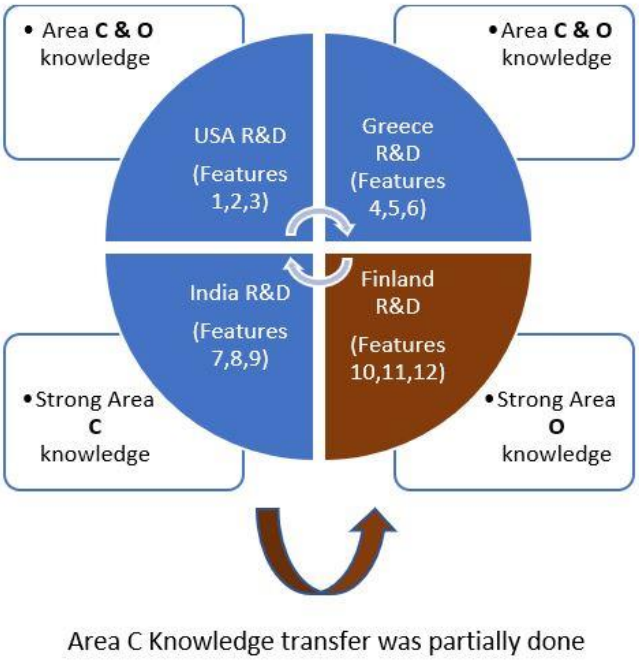


Figure 4. Global R&D knowledge areas

As seen in figure 4, knowledge transfer for the area C of the product has been partially done.

The focus of this study is on Finland R&D as it possesses high level competence in area **O** and very limited competence in area **C**. The goal is to improve the competence in rest of area C in order to increase feature development capacity in Finland by enabling the R&D to implement more O+C features which correspond to a high percentage of customer requests. The area filled with red color indicates the slow progress of knowledge transfer to Finland which will be discussed in detail in next sections.

3.3 Knowledge Transfer Practice Analysis

The interviews for current knowledge transfer practices were analyzed with the help of Thematic content analysis method. Finland R&D is lacking expertise in area C. The learning practice to gain knowledge of area C has been initiated from India R&D but it had a rather slow progress. Figure 5 illustrates the current and target development ability in Finland R&D.

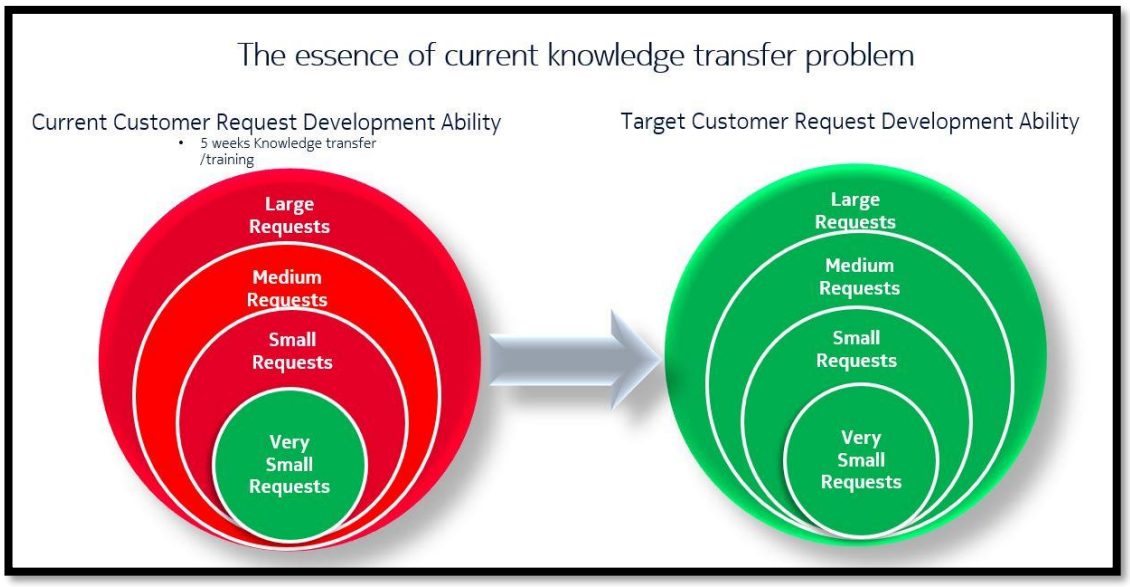


Figure 5. Current and target development ability in Finland R&D

As seen in figure 5, the development ability is limited to very small customer requests concerning area C and O+C. The target is to gain more competence to implement more customer features and gradually handle medium and large customer requests. Table 4-a and 4-b illustrate the learning status of area C in Finland with detailed information about its sub areas.

Table 4-a. Area C sub area knowledge status

C1 - sub area	C1-Train-ees	C2 - sub area	C2-Trainees	C3-sub area	C3-Trainees	C4 - sub area	C4-Trainees	C5 - sub area	C5-Trainees	C6 - sub area	C6-Train-ees
aC1sm	SD1, SD2, SD3	aC2om	x	aC3mm	x	ac4cm	x	aC5mss		aC6rf	SD1
mC1sm	SD1, SD2	aC2nr	x	aC3sm	x	mC4am	x	mC5ms	x	aC6sf	SD1, SD4
mC111		aC2ge	x	mC3mm	SD1					aC6mm	SD4
aC1sm		aC2bc	x	mC3sm	x						

As illustrated in Table 4-a, area C of the product consists of 6 main software groups and various sub areas relatively. The green areas represent the areas for which knowledge transfer has been initiated and the red areas represent the remaining sub areas to be learned. So far 4 software developer trainees (SD) in Finland have been involved in this practice. Table 4-b will illustrate other area C sub area knowledge status.

Table 4-b. Other area C sub area knowledge status

C1 - sub area	C1- Trainees	C2- sub area	C2- Trainees	C3- sub area	C3- Trainees	C4 - sub area	C4- Trainees	C5 - sub area	C5- Trainees	C6 - sub area	C6- Trainees
		mC2om	x	mC3as	x						
		mC2ng	SD4	aC3mm	x						
		mC210	x	aC3sm	x						
		mC2ap	SD3								
		mC2gn	x								

As illustrated in Table 4-b, area C of the product consists of 6 main software groups and various sub areas relatively. The green areas represent the areas for which knowledge transfer has been initiated and the red areas represent the remaining sub areas to be learned. So far 4 software developer trainees (SD) in Finland have been involved in this practice.

3.3.1 Training Method

In November 2018 the knowledge transfer practice was initiated with two software developers traveling from India R&D to Finland to provide training for 5 weeks. The timing

of the training enabled the trainers to introduce the framework for the area C of the product and collaboratively designing a new feature concerning two area C sub areas together with the trainees. The trainers provided classroom training in the first 2 weeks followed by hands on trainings enabling trainees to implement small tasks from the feature under design. During the five weeks, learning time was rather limited as the trainees were simultaneously involved in their other existing feature tasks from other areas (Area O). This was brought up by SD1 who stated as follows:

> *"Daily tasks were together with learning (time was not enough)". (Software developer (SD1))*

The outcome of the face to face trainings in Finland was an overall understanding of the internal functionality of area C framework and some knowledge from some subareas. However, there are many more areas left to be learned and global distribution of R&D does not provide the luxury of having face to face trainings so often. During the training period, the complexity of this new area and lack of prior knowledge made it very intense for trainees and there was not enough time to digest the new information. However, the trainees and the trainers shared the opinion that providing face to face classroom training in addition to browsing the code and over the shoulder code reviews made it easier to transfer the knowledge. It was also beneficial to use the whiteboard to illustrate examples. The effectiveness of face to face training was brought up by software developer 1 (SD1) and the trainers who stated as follows:

> *"Face to face training was effective, we could ask them questions. but it was too intense compare to what we could do at that time when they were here. Because we had other tasks and we did not have prior knowledge from area C. One can only ask questions if you know what to ask".* (Software developer (SD1))

> *"Face to face training and browsing the code, also over the shoulder code reviews and using whiteboard was beneficial, made it faster". (Trainer 1)*

Trainees had a common understanding that once the framework is known, separate training is not needed for each new sub system anymore only if enough remote support is available when the new area is to be learned.

3.3.2 Applying Knowledge

Once the trainers traveled back to India, the trainees in Finland faced a long waiting time before getting new features related to area C to apply the previously learned knowledge. Therefore, they did not immediately get a possibility to learn more by practicing with feature tasks. The delay of area C feature assignment to Finland R&D was partly due to the lack of proper plan and partly due to ongoing release and other existing feature tasks from area O. In the next releases, some R&D development engineers in Finland started to get small feature tasks regarding C sub areas.

According to the interviewees, the code of the area C of the product is complex and the feedback loop from an implemented change is very slow. When a code change is implemented for the area C by a software developer, it takes very long to verify it. The complexity of the code and its slow feedback loop due to the lack of unit testing slows down the progress. This was brought up by software developer 3 who stated as follows:

> *"There is no unit testing possibility in the code, therefore it is slow to make a correction and wait for some hours to check the result." (Software developer (SD3))*

The trainees believe that the best way to learn is to get the task and learn by doing the feature task. The other problem is that they keep getting features/tasks which are related to their expertise in area O, that way there is no room for learning new sub areas from area C. Not getting a task or late assignment of a task related to the new area slows down the learning progress. This was discussed by SD1 and SD4 who stated as follows:

> *"The main problem is that we don't get the tasks ". (Software developer (SD2))*

> *"New C area tasks were assigned very late after training ". (Software developer (SD4))*

However, in the later releases, some small features were assigned to the trainees in Finland but the amount of existing other tasks from other areas and lack of early feature task coordination between sites inhibits learning more new sub areas.

3.3.3 Access to Information

IT systems and existing internal tools and databases have been used for information sharing and collaborating with current geographic distribution of the R&D with location and time zone differences. The PLM (Product Line Management) team members are globally distributed among all R&D sites but system architects are not equally distributed between every site. Finland R&D does not have employees having system architect roles and responsibilities. These types of roles only exist in some other global R&D sites. The lack of this role in Finland has been also isolating the site due to the exclusion from initial important architectural discussions when a large customer feature with architectural change requirements reaches R&D. This was discussed by R&D manager 1 who stated as follows:

> *"We don't have architect type of people here, then there is no reason to talk to us here. We have nothing to give in that early discussions since we would only be listeners." (R&D manager 1)*

Managers and employees sometimes find themselves searching for information which has been discussed between other teams or within another R&D site and has not been visible to everyone for later access. When the project management team sends an inquiry to development managers to assign a feature, prior discussions about that feature have already taken place between some individuals. This information is not necessarily visible to R&D development managers and team members who will be handling the feature in later phases. the outcome of the initial feature discussions does not always move to other sites and information that has been initially discussed with PLM is lost along the way. R&D manager 1 who also has the site leading role, brought up the problem of information flow between R&D sites and stated as follow:

> "*When product requirement reviews are started, project management team sends emails to potential DFOs (development feature owners), and LTO (lead test owners). They send proposals to look at the feature and check if they can be the DFOs then if DFO thinks it can be handled in their site, it is taken there. But when they ask for DFOs, some feature discussions have already been taken place between some people in other sites. So, it is sometimes in very important phases it is forgotten that we are a multisite organization". (R&D manager 1)*

Additionally, based on the current practices, a feature that has primarily been assigned to a team, might be re-assigned to a different team in another location due to the lack of resources at that specific release. Some valuable previous knowledge may also get lost

in this transition due to lack of proper documentation or up to date information about the feature. This was brought up by SD4 who stated as follows:

> "*It is so hard to find information and if I need to ask something they are on other sites and I don't want to call anyone or work after 4. I usually send emails and that takes time. Minimum 1-day delay is caused". (Software developer (SD4))*

For some features, lack of proper notes or documentation about existing knowledge inhibits learning and reduces motivation to be involved in new sub areas. SD3 was one of the interviewees who brought up this problem and stated as follows:

> "*Sometimes design documentation is missing or it is too short. Then it requires many verifications from different places and people, so it takes time." (Software developer (SD3))*

3.4 Key Findings from the Current Knowledge Transfer Practices

The analysis of the interviews and internal documents point to the following strengths and weaknesses grouped into 4 different categories. Table 5 lists the summary of these strengths and weaknesses.

Table 5. Summary of the Strengths and weaknesses

Theme/Category	Strengths	Weaknesses
Coordination	**A good level of coordination within Finland R&D**	**Ad hoc assignment of new tasks based on resource availability**
Roles and responsibilities	**Software developers (trainees) have implemented some tasks with the new framework**	**- Lack of a plan to proceed with learning new sub areas** **- Lack of system architecture role and small number of Feature Engineers (FE) roles in Finland R&D**
Access to information	**Common internal tools used within global R&D**	**-Insufficient design documentation and visibility to interactions between software sub areas** **-Lack of access to initial feature discussion notes**
Framework	**Previous knowledge of similar coding language from different product**	**Complex code with slow feedback loop (out of project scope)**

As illustrated in Table 5, coordination, roles & responsibilities, access to information, and the used framework are all identified as underlying factors impacting the current learning practice. In an attempt to transfer knowledge between other sites to Finland, there has not been any proper coordination nor a process in the project to plan the learning practice. The area C related tasks have so far been assigned to developers mainly based on the remaining tasks from other sites and the resource availability of software developers in Finland. Global project stakeholders have not discussed how to proceed with the remaining software sub area knowledge transfer.

Lack of certain roles in Finland due to the overall resource deficiency has been another reason behind the slow progress of knowledge transfer. Global R&D has access to common repositories for sharing and storing basic project information. However, these are static pages which are not designed for interactive knowledge sharing purposes to be used during planning phase of the customer request (feature) or for knowledge sharing between software developers during implementation phase.

Another weakness is the complexity of the current code with slow feedback (presented at the bottom of the table 2). However, due to its direct relation with the fundamentals of code design, it was excluded from the scope of this study. Hence, the focus of this study is on the remaining weaknesses mentioned above to improve learning practices in Finland R&D.

4 Existing Knowledge on Knowledge Transfer

This section discusses the existing literature related to the objective of this thesis and the weaknesses identified in section 3. Firstly, an overall knowledge transfer lifecycle is discussed. Secondly, the importance of having clear roles and responsibilities is explored. Thirdly, the existing literature on how to access information in the practice of knowledge sharing is discussed. Finally, the conceptual framework of this study is presented.

4.1 Knowledge Transfer Lifecycle

The level of knowledge sharing, and knowledge transfer activities varies between different organization. Scholars have identified that such differences may be due to several types of barriers related to organizational structure, processes, people, or technology (Riege, A. 2005). According to (Komi-Sirviö et al. 2002), in today's competitive business environment managers find it very challenging to cope with daily activities to meet project targets. Therefore, knowledge sharing practices may not get enough attention from management since they are perceived as extra duties.

Knowledge sharing must be integrated into project management processes to provide guidelines for sharing knowledge. These processes will guide the efficient use of knowledge databases and capturing and reusing the knowledge (Komi-Sirviö et al.2002). Langley (2015) also argues that organizations have higher chances to succeed in knowledge transfer if they have realized the value of knowledge and integrated components of the knowledge transfer life cycle which is presented in figure 6 as follows.

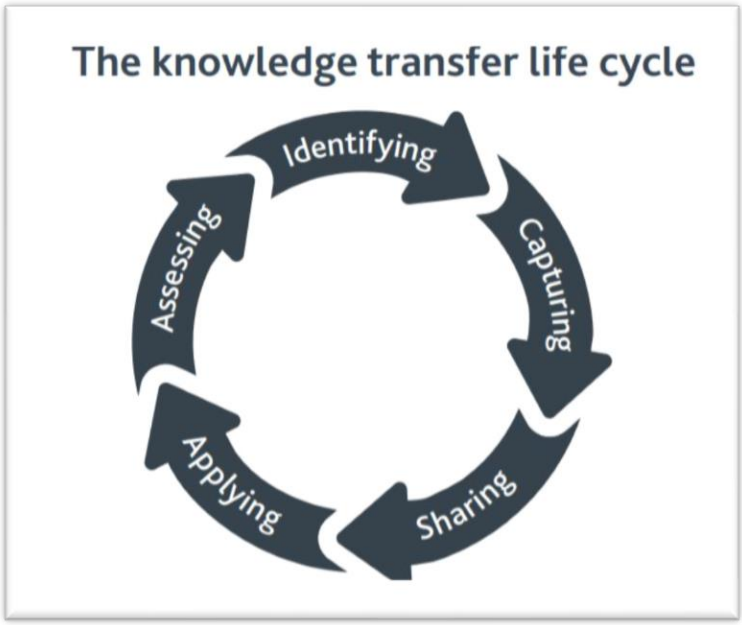


Figure 6. The knowledge transfer life cycle (Langley 2015)

As depicted in figure 6, the knowledge transfer life cycle is an iterative process of identifying, capturing, sharing, applying, and assessing the knowledge. Each element of the cycle will be shortly discussed. The knowledge transfer life cycle is derived from Pulse of the Profession annual 2015 study made by PMI (Project Management Institute).

The first step is identifying relevant and valuable knowledge that needs to be transferred through various techniques. Figure 7 presents the methods organizations use to identify knowledge.

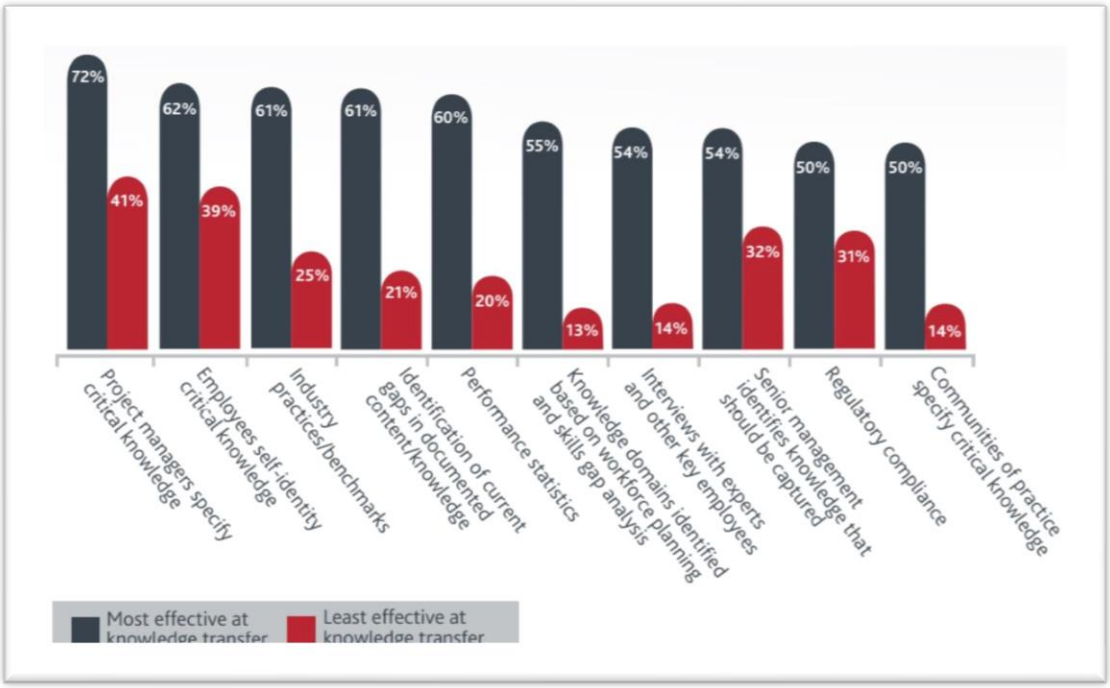


Figure 7. Methods organizations use to identify knowledge (Langley 2015)

As seen in figure 7, usually project managers identify the most relevant knowledge, but other techniques include employee's self-identification of critical knowledge, performance statistics, resource planning, and skill gap analysis. Second step is capturing the identified knowledge which is accumulating the essence of the knowledge that needs to be transferred (Langley, 2015). Organizations have various approaches for capturing and retaining the identified knowledge. Figure 8 illustrates activities and approaches for capturing knowledge.

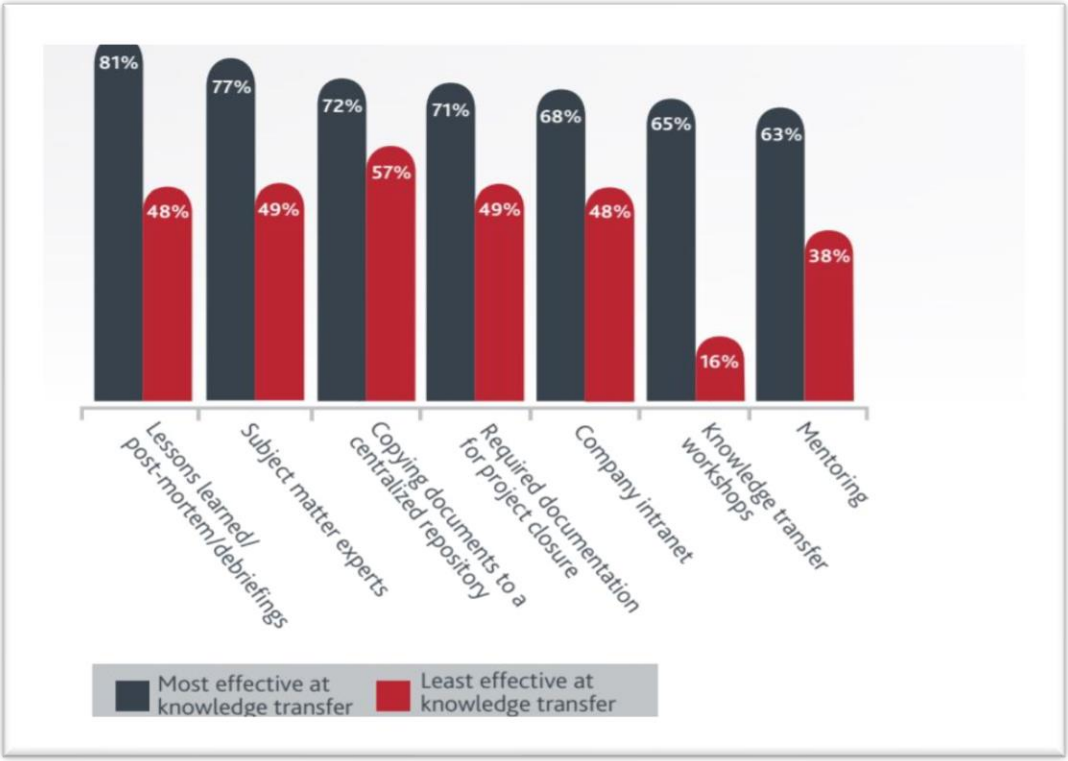


Figure 8. Activities and approaches for capturing knowledge (Langley 2015)

As depicted in figure 8, usually lessons learned, centralized repositories to capture knowledge, and even mentoring and dedicated knowledge transfer teams are the activities and approaches businesses use to capture organizational knowledge (Langley, 2015).

The third step is sharing the knowledge. Like other steps, various methods and resources are used in this step to transfer knowledge. Figure 9 illustrates the most common methods and resources for sharing relevant knowledge.

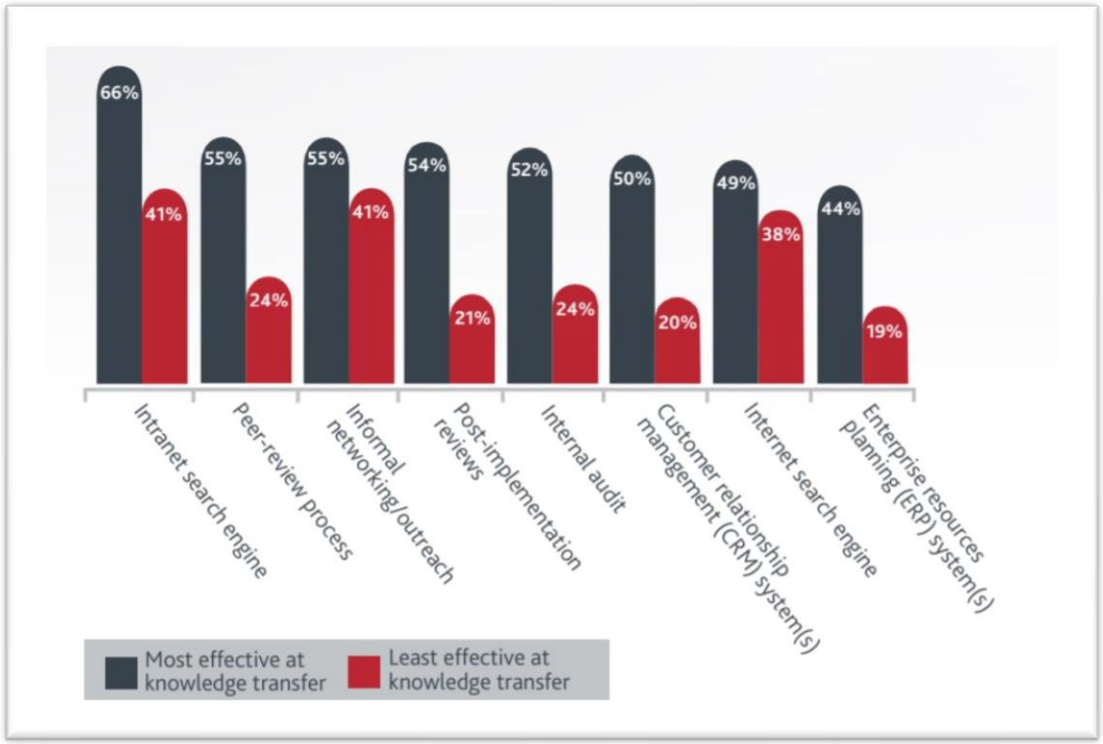


Figure 9. Methods or resources for sharing relevant knowledge (Langley 2015)

As seen in figure 9, the most common ways to share knowledge is through intranet search engines and peer-review processes. However, most of these approaches do not necessarily engage individuals in an effective way. According to Langley (2015), "*Organizations that are effective at knowledge transfer create a more interactive process that facilitates direct, person-to-person knowledge transfer.*"

The next step is applying the knowledge which is mainly using the knowledge that is already transferred. Technology is widely used to support the application of knowledge. Figure 10 lists the technologies used to facilitate applying knowledge.

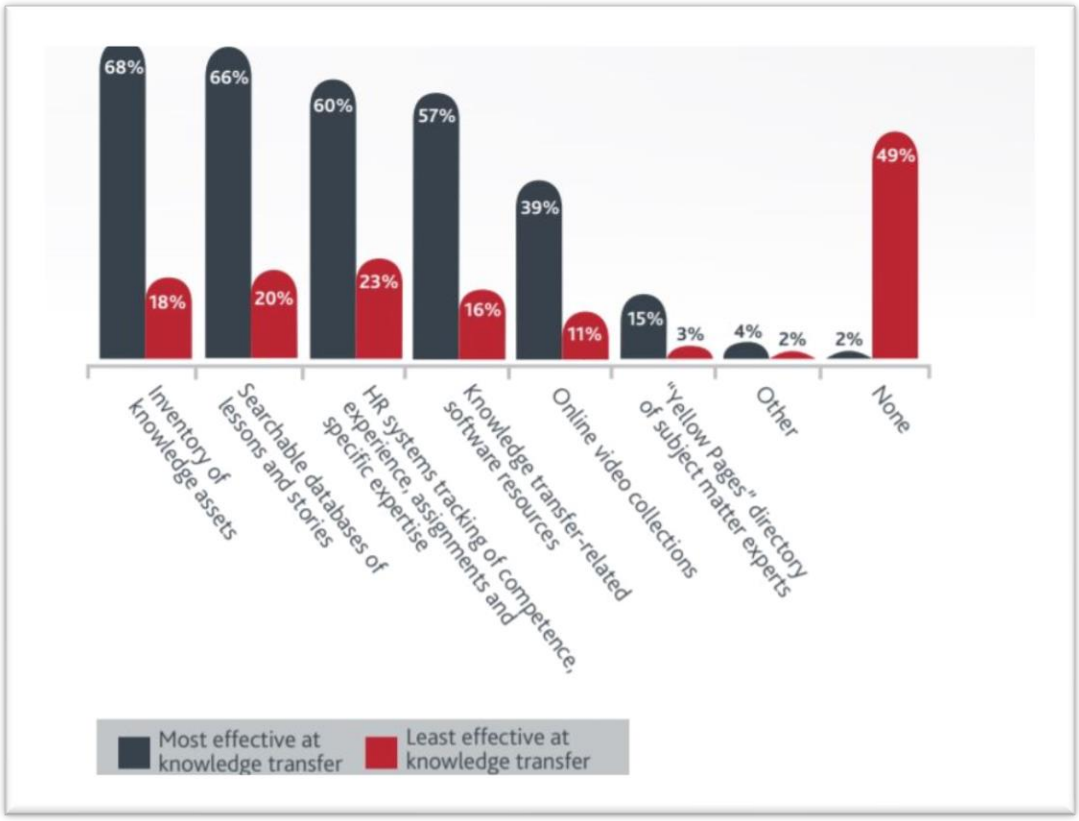


Figure 10. Technologies used to facilitate applying knowledge (Langley 2015)

As depicted in figure 10, technology is a frequently used tool to support applying the transferred knowledge which must be accompanied by individuals in the organizations to be more effective (Langley, 2015). The final step in knowledge transfer life cycle is assessing the benefits of knowledge transfer. Assessing the benefits of the transferred knowledge is one of the most challenging steps yet most beneficial one in the cycle for many organizations (Langley, 2015). Figure 11 illustrates methods for assessing the value or benefits of knowledge transfer.

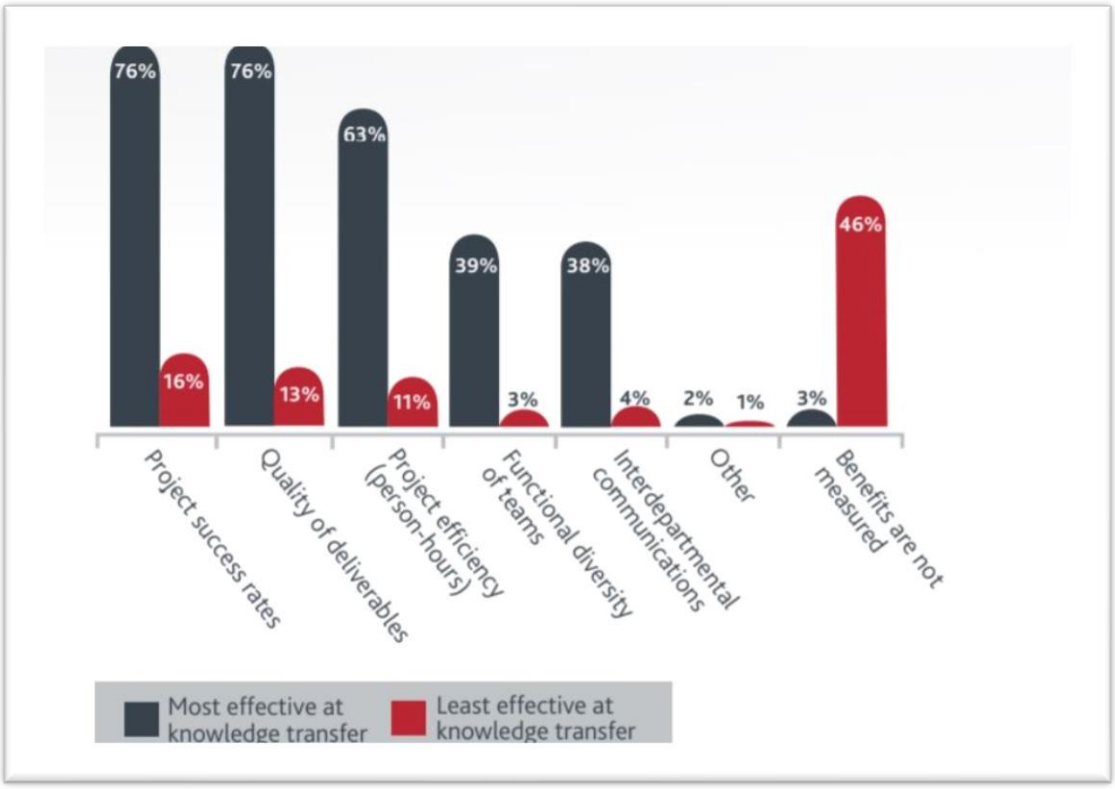


Figure 11. Methods for assessing the value or benefits of knowledge transfer (Langley 2015)

As seen in figure 11, most effective method for assessing the benefits of knowledge transfer is project success rates, quality of deliverables, and project efficiency. However, according to Langley (2015) as this is a challenging step, the benefits of knowledge transfer are not measured in many organizations.

This sub-section identified all the steps of the knowledge transfer Lifecyle which can be utilized by organizations to develop the knowledge base of the employees.

4.2 Roles & Responsibilities

An essential component of any successful project is knowing at every step, exactly who is responsible and accountable, who must be consulted, and who needs to be informed. Various organizations and projects may have different levels of clearly identified definitions of roles and responsibilities. However, introducing a new set of tasks to any project needs clear definition of responsibilities and assignment of those to specific people.

According to Smith & Erwin (2005), there are three assumptions in any role. They are “role conception”, “role expectation”, and “role behavior”. Role conception is a person’s assumption of his or her own job which could be influenced by false assumptions. Role expectation is what others in the organization believe that person is responsible for. These assumptions may also be false. Role behavior is, however, what that person does while performing his job. Smith & Erwin (2015) argue that responsibility charting makes the role conception and expectation consistent which results in predictability of role behavior. They present the “RACI” process as a tool to help define roles and responsibilities and provide a real time clarity to who should be performing what action. Table 6 presents roles and responsibilities charting definitions.

Table 6. Roles and Responsibilities Charting Definitions (Smith & Erwin, 2005)

Responsible	**Accountable**	**Consult**	**Inform**
The individua(s) who perform the task Responsibility is possibly shared if more than one person involved. The responsibility level is determined by Accountable	The individual who delegates the task to the responsible individuals and holds a veto power. Only one person may be assigned to this action	The individual(s) who are subject matter experts whose opinions are asked before making final decisions	The individual(s) who are kept up to date after the decisions are made or actions taken

As depicted in table 6, responsible, consultants, and informed roles can be many individuals. However, the accountable role belongs to one individual only. The charting process is a collaborative process which can be conducted with workshops and group meetings to agree upon the tasks involved for each role. The responsibility chart must be documented and distributed among stakeholders in the organization. It must be kept in mind that follow-ups are needed to ensure the roles are followed and adjusted if significant changes are made (Smith & Erwin, 2005).

4.3 Access to Information and Knowledge

Knowledge is an important asset in any organization and the ability to utilize organization's knowledge has a significant impact on sustainability and competitiveness of any business. Knowledge serves as a source of power to those individuals and organizations that possess it (Bundred, 2006). Therefore, organizations lacking awareness on importance of organizational knowledge and retaining that knowledge are more prone to face fundamental challenges in the long run. Many scholars define knowledge capabilities from the resource-based view. According to Parashar & Singh (2005), knowledge capabilities are the sum of organizational knowledge assets which determine its ability to absorb and create new knowledge. However, (Ning et al. 2006) take a more holistic approach to knowledge capabilities and define organizational knowledge capabilities as the total sum of both knowledge assets and knowledge operating capacities in an organization. The first step in retaining knowledge is capturing existing organizational knowledge. However, many studies have discussed that capturing knowledge is challenging due to complexity of knowledge (Blackler, 1995).

A vast number of scholars have based the organizational knowledge discussions into two forms of "tacit" and "explicit" based on knowledge distinction made by Polanyi (1966). According to Polanyi (1966), explicit or codified knowledge is the information which can be articulated and transmitted in formal and systematic language. However, tacit knowledge cannot be easily articulated as it is more know-how type of knowledge which has a personal quality making it hard to formalize. Polanyi (1966) argues that "we can know more than what we can tell". In knowledge intensive organizations, a big percentage of knowledge is in the form of experiences, ideas, and skills which are mainly in tacit form (Chugh, 2015). Therefore, it is exceptionally difficult to transfer this type of knowledge between organizational members. Tacit knowledge is made sense through active social interactions and networking within the knowledge source and recipients.

As discussed above, tacit knowledge dominates in knowledge intensive organizations. However, explicit knowledge also exists in organizational knowledge, so knowledge creation and transfer are not only limited to tacit form. Depending on the context, to share knowledge, a certain level of knowledge conversion is needed to transfer knowledge within teams and units in the organization and convey the knowledge between sender

and receiver. Nonaka (1994) introduced four modes of knowledge conversion. Figure 12 illustrates modes of knowledge creation.

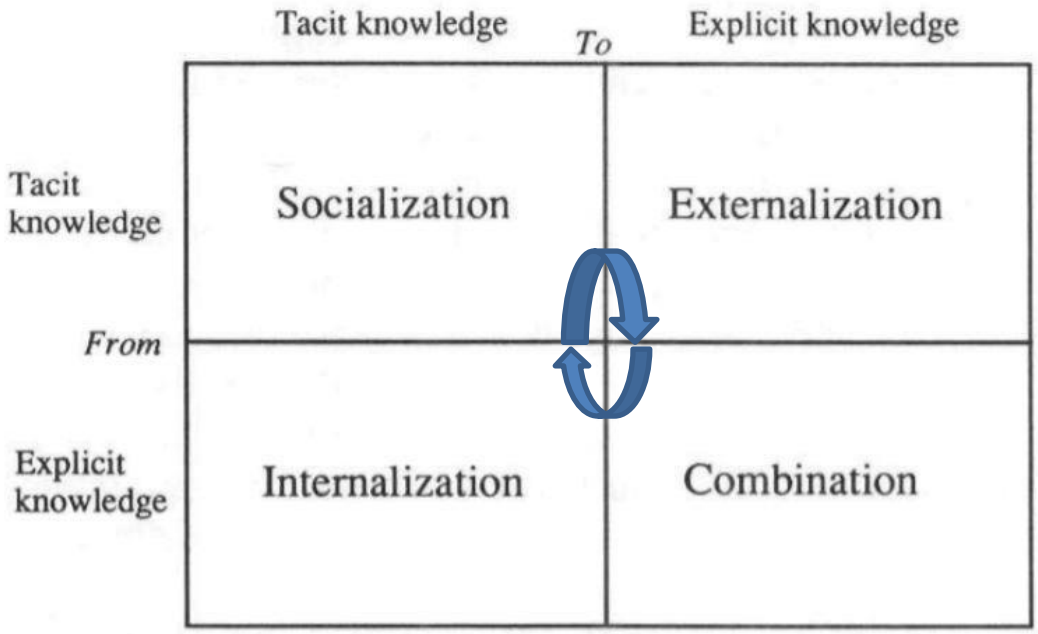


Figure 12. Modes of knowledge creation (Nonaka,1994)

As seen in figure 12 there are 4 modes of knowledge creation according to Nonaka's study. Tacit knowledge can be created through job training, even by observation and imitation without necessarily using language (learning by doing), or through conversations to share experiences, discussion of ideas and opinions. "Socialization" is described as the process of creating tacit knowledge through interactions and sharing experiences.

Individuals holding explicit knowledge can exchange and combine knowledge leading to modifying and improving existing knowledge. It includes a process of converting a system of formalized concept into another one such as (re-modelling the formal models and data, changing code, etc.). This is how new explicit knowledge is created from existing explicit knowledge which is referred to as "combination". New knowledge can also be created from explicit to tacit, and tacit to explicit interactions where the former is referred to as "internalization" and the latter as "externalization". Nonaka (1994), argues that externalization is usually triggered by rounds of meaningful dialogue in an attempt to articulate experiences into formal models or data. Externalization has the potential to reveal hidden tacit knowledge which is usually hard to share. Externalizations is the process of converting models and data into tacit skills (Nonaka, 1994). Nonaka (1994) argues that

managing organizational knowledge requires all four modes of knowledge creation identified above.

4.3.1 ICT Applications and Media for Knowledge Transfer

In today's globalized world, teams and units of an organization may be physically dispersed around the world. Therefore, knowledge intensive organizations who deal with a lot of tacit and explicit knowledge need IT assistance in mechanisms and technologies to share and create the organizational knowledge. Panahi et al. (2013) present a summary of these mechanisms and technologies based on earlier studies of other scholars. Table 7 shows the mechanisms and technologies for knowledge creating and sharing.

Table 7. Mechanisms and technologies for knowledge creating and sharing (Panahi et al. 2013)

Face to Face		**IT assisted**	
Socialization *(tacit to tacit)*	**Externalization** *(tacit to explicit)*	**Socialization** *(tacit to tacit)*	**Externalization** *(tacit to explicit)*
- Team meetings *- Discussions* *- Interpersonal interactions* *- Apprenticeship* *- Participation* *- Observation*	*- Dialog with team* *- Answering questions* *- Story-telling* *- Metaphors/analogies*	*- Online real-time meetings* *- Synchronous communication (Chat)* *- Online community of practice* *- Groupware systems* *- Social media*	*- Answering questions* *- Annotations* *- Blogs/Wikis* *- Discussion forums* *- Collaborative systems* *- Groupware systems* *- Phone/video conferencing*
Combination *(explicit to explicit)*	**Internalization** *(explicit to tacit)*	**Combination** *(explicit to explicit)*	**Internalization** *(explicit to tacit)*
- Books *- Papers* *- Reports* *- Presentations* *- Indexes, etc.*	*- Learning by doing* *- Learning from books, reports, presentations, lectures, etc.*	*- All forms of technologies* *- Text search* *- Document categorization* *- Podcast/Vodcast* *- Blogs/Wikis* *- RSS* *- Mashups*	*- Visualization* *- Video/Audio presentations* *- Online learning* *- E-mail* *- Webpage*

As depicted in table 7, IT can assist organizations in four dimensions of knowledge conversion, socialization, combination, externalization, and internalization. A set of mechanisms and technologies are listed which could be used by organizations to support effective knowledge transfer. Wikis are one of the most useful ICT tools which can be incorporated into knowledge management and knowledge transfer systems. Wikis can be used for both externalization and internalization and can assist tacit knowledge sharing by providing a field for collaboration and knowledge capturing and sharing. This also increases social interactions between individuals, making it a great tool for knowledge sharing (Panahi et al. 2013).

In order to utilize existing knowledge and improve organizational outcomes, knowledge must be effectively transferred within the teams and units. Correct choice of media to transfer knowledge has an essential role in facilitating the information or knowledge transfer from a source to the intended receivers. Bolisani and Scarso (1999), have studied how ICT can be exploited for more effective knowledge management and emphasize that the application of ICT should be suitable for the knowledge management activity in any given context. Figure 13 illustrates knowledge transmission through ICT applications.

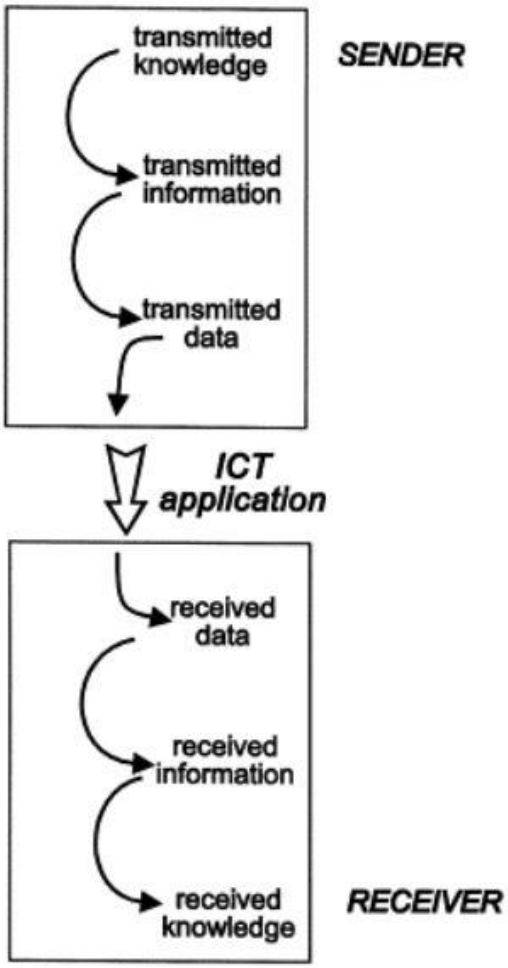


Figure 13. Knowledge transmission through ICT applications (Bolsiani & Scarso, 1999)

As depicted in Figure 13, ICT can be used to transfer data between sender and receivers. This is how information and knowledge are exchanged between senders and receivers through the usage of ICT. Sender's knowledge is changed to information (interpreted data) and then to data (language or scientific structure) which is again converted back to

information and new knowledge which makes it a double transformation process to transmit knowledge (Bolsiani & Scarso, 1999). In this double transformation process usually the role of human interaction is significant. Therefore, the choice of media in ICT must vary depending on the type of knowledge and the source and recipient of the knowledge. Media richness theory (MRT) by Daft & Lengel (1984) is a prominent theory on the choice of communication media in knowledge management and knowledge transfer which suggests the usage of most appropriate communication medium to reduce uncertainty. Richness in this context implies the capacity to convey information. The knowledge being transferred on a suitable media should convey appropriate content which can be both reachable and accessible.

The right communication media must be chosen to facilitate better accessibility of knowledge depending on the type of knowledge being sought, whether it is explicit or tacit knowledge. MRT theory suggests that having low media richness is more suitable for sharing explicit knowledge, whereas high media richness is more suitable for sharing tacit knowledge. Figure 14 illustrates the relation between communication channel richness and communication effectiveness.

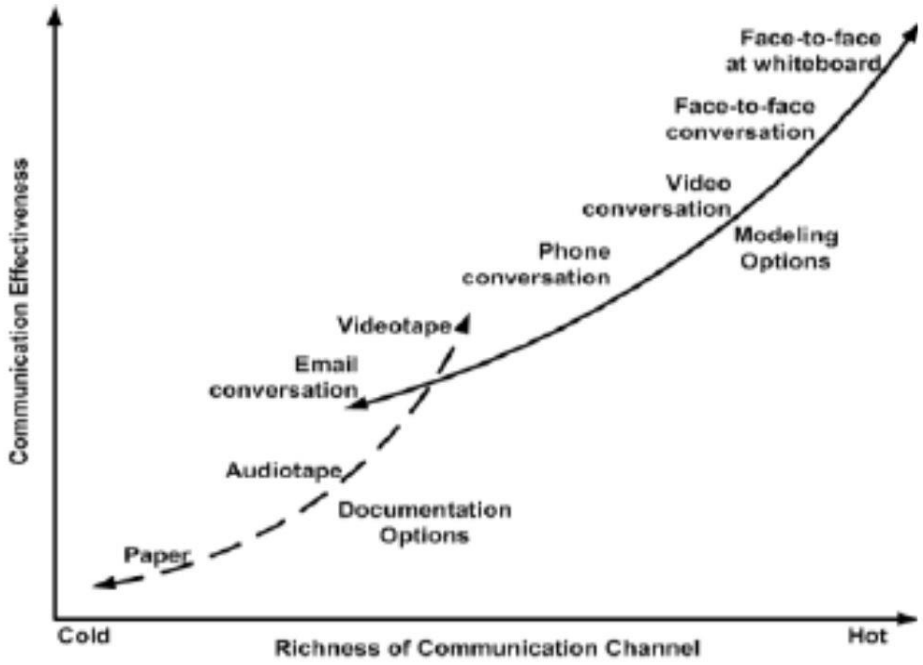


Figure 14. The relation between communication channel richness and communication effectiveness (Ambler 2002)

As seen in figure 14, communication effectiveness increases with higher channel richness. The most effective way to communicate is known as face-to-face communications.

However, in globally distributed organizations, individuals tend to often rely on documentations and email conversations. Additionally, possible time zone differences between organizational units or teams may inhibit frequency of phone conversations.

In addition to type of knowledge and ICT tools to share knowledge in organizations, organizational structure, relationships, collaboration and communication are also important factors contributing to the success of knowledge sharing in organizations. However, simply making more information available in an organization is not enough for managing knowledge sharing problems. Organizational social factors play a big role in creation and communication of knowledge in organizations. Szulanski (2000) argues that the effectiveness of knowledge transfer between sender and receiver is highly dependent on the strength of the relationship or the "tie" between them.

Knowledge workers involved in software development projects rely on effective communication and collaboration between participants (Cockburn, 2004). Hansen (1999) discusses the negative impacts of lacking direct relations and extensive communication within organizational units. He emphasizes that the absence of relationship inhibits knowledge transfer within the organization. According to Hansen (1999), strong personal ties are necessary to transfer tacit knowledge between units. Also, Epstein (2000) argues that personal relationship plays a big role in the effectiveness of tacit knowledge sharing between individuals in product development projects.

In globally dispersed organizations, establishing strong relationships gets rather challenging due to the physical distance and time zone differences among units and teams. Therefore, collaborative relationship with a clear purpose and goal is essential for any knowledge to be successfully shared within organizations (Ylitalo, et al., 2006). Managers have an important role to facilitate communication and collaboration between teams as communication and interactions between individuals are needed to build relationship and foster knowledge sharing.

One way to facilitate communication is setting task-oriented work groups among individuals from different teams to share responsibilities and share knowledge and skills while working towards a common goal. Some examples of these groups include research and development teams, product development teams, and project teams (Lewis et al.2005). On the other hand, Olson & Olson (2000) argue that long distance communication lacks the richness of face to face information exchange. They claim that, due to the difficulty

of performing tightly coupled work remotely, work can be re-organized to fit the geography (Olson&Olson,2000) so that tightly coupled work is collocated which decreases the need for cross-site communication.

4.4 Conceptual Framework of This Thesis

The conceptual framework is the summary of theories and guidelines in existing literature. The conceptual framework of this study is constructed through a process of studying existing research on knowledge transfer. This conceptual framework provides a theoretical and systematic approach to knowledge transfer in knowledge intensive global organizations. Figure 15 presents the conceptual framework for knowledge transfer process.

Modified from "The knowledge transfer life cycle process"(Langley, M.A, 2015)(PMI)

	Identify knowledge and participants	Capture and Convert knowledge	Share / transfer	Apply / create new knowledge	Assessing / Auditing
Roles & Responsibilities	Roles&Responsibilities charging (RACI) (Smith & Erwin, 2005)	Roles&Responsibilities charging (RACI) (Smith & Erwin, 2005)	Roles&Responsibilities charging (RACI) (Smith & Erwin, 2005)	Roles&Responsibilities charging (RACI) (Smith & Erwin, 2005)	Roles&Responsibilities charging (RACI) (Smith & Erwin, 2005)
Access to Information and knowledge		Tacit/Explicit -> Explicit/Tacit conversion (Nonaka 1994)	Communicating channel effectiveness (Ambler, 2002)	Tacit/Explicit -> Explicit/Tacit conversion (Nonaka 1994)	

Figure 15. Conceptual framework for the knowledge transfer process

As seen in figure 15, the conceptual framework consists of three main elements. First element of the conceptual framework is a knowledge transfer life cycle with five steps of identifying, capturing, sharing, applying and assessing the knowledge. This process is the core element of the conceptual framework which guides the main steps of an attempt to implement a knowledge transfer process.

The second element of the conceptual framework is concerning roles and responsibilities. Having clear roles and responsibility definitions and assignments ensures that everyone involved in a knowledge transfer process are clear about their role expectations. For each step of the knowledge transfer process, it is necessary to know who is responsible, accountable, consulted, or informed to achieve the best results.

The third element of the conceptual framework is regarding having access to information and knowledge by using relevant ICT tools and means of communication depending on the type of knowledge to be captured, converted, and shared within the organization.

The combination of these three elements provide a framework which is an iterative process of identifying knowledge and its type, identifying participants and defining their roles and responsibilities. Subsequently by choosing a suitable medium and using proper ICT tools knowledge can be captured, converted and shared which is then followed up by application and eventually evaluating the knowledge by the assigned responsible people.

In the next section, section 5, this conceptual framework is utilized to build the proposal of this study.

5 Building Proposal for Improving Knowledge Transfer Practices

This section introduces a draft proposal by combining the results of the current state analysis (section 3), conceptual framework (section 4), and the input received from the stakeholders presented as data 2 in section 5 below. The outcome of this section is a draft proposal of a knowledge transfer process for intra R&D knowledge transfer activities between globally dispersed R&D sites.

5.1 Overview of the Proposal Building Stage

The draft proposal of this study is co-created with the stakeholders based on the suggestions from theory and the weaknesses of the current state of the current knowledge transfer practices as illustrated in figure 16.

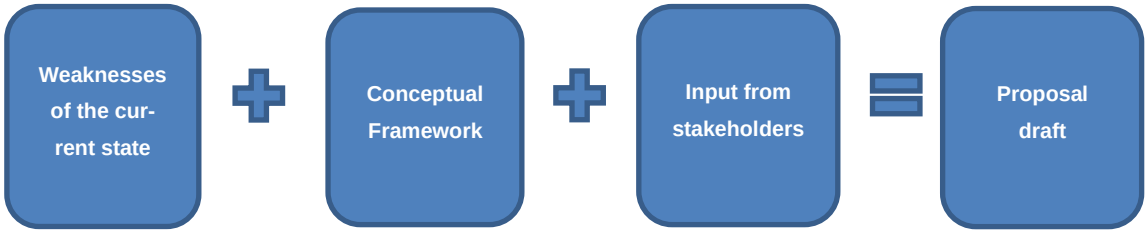


Figure 16. Building stages of draft proposal

As seen in figure 16, building the draft proposal was done in three stages. The proposal building was conducted in multiple steps. The first step was reviewing and analyzing the summary of the weaknesses of the current state. The second step was reviewing the summary of the existing knowledge from literature. The third step was collecting the input from the stakeholders (data 2). The draft proposal is the combination of the key points from all these steps which is an integration of existing theoretic ideas and current practices of the case company.

5.2 Findings of Data Collection 2

The input from stakeholders was collected in 4 phases. With the current state analysis and ideas generated from existing theory, the first interview was conducted with the R&D manager 1. R&D manager 1 was the first person to be interviewed as he is the key person in Finland R&D who has been involved in arranging knowledge transfer practices so far. It was previously discussed that the lack of system architecture role in Finland R&D and the lack of coordination between the sites in pre-PRD phase was one of the major drawbacks for knowledge transfer practices in Finland R&D inhibiting early involvement in feature discussions. However, according to R&D manager 1, there is no plan to employ a software architect role in Finland. R&D manager 1 suggested that the local product manager (PLM) can play an important role and act as the key person to help Finland R&D be involved in pre-PRD discussions with other R&D sites. To mitigate the communication problem and have access to knowledge, the benefits and possibility of having all responsible roles in the feature team in the local site was discussed. However, as the R&D manager was not informed about the local product manager expertise details, an additional interview with the product manager in Finland was conducted.

Secondly, the interview with the local product manager, PLM, was conducted and revealed a high potential for the local PLM to act as the link between Finland R&D and other sites to have access to pre-PRD information, facilitating feature planning to support learning new software areas in Finland.

Thirdly, a teleconference interview with R&D manager 3 was conducted. The reason for interviewing R&D manager 3 was because the trainers visiting Finland R&D two years ago were his subordinates and he is still leading a large R&D software development team with good knowledge on area C who have high potential to be involved in future knowledge transfer practices. The summary of the weaknesses and the hints from the theory were discussed in the interview and his ideas on improving the knowledge transfer from India to Finland was sought.

Finally, R&D manager 1, Finland PLM, R&D manager 2, and R&D manager 3 were invited to a group discussion to build the proposal based on the suggestions received earlier and to create the process of knowledge transfer based on the conceptual framework. Table 8 presents the summary of stakeholder suggestions.

Table 8. Summary of stakeholder's suggestions

	Key focus area	*Suggestions from stakeholders*	*Description of the suggestion*
1	Coordination	Early involvement of Finland R&D in the phase of selecting the features concerning new software sub areas is necessary with the help of PLM Finland	R&D manager 1 suggested to learn new software sub areas, Finland R&D should get the opportunity to handle more small and medium features related to area C. PLM Finland has knowledge on some future customer requests. R&D team in Finland can go through the list of future features with PLM and pick a feature where Finland PLM will be responsible for. R&D manager 2 brought up the importance of having the Feature Engineer (FE) role for area C related features in Finland to get more area C features done in Finland. Another alternative is to implement tasks concerning area C subsystems from various features so the software developers in Finland would learn new areas
2	Roles & Responsibilities	Collaborative software development and task assignment between Finland and India R&D to offload some area O related task from Finland developers while supporting the learning of area C.	R&D manager 3 suggested that pair programming could be applied by having 50% of the features in the release would be fine in Finland and 50% of Finland features (area O) would be done by India R&D. This will eventually enable Finland R&D to release some (area O) related tasks from software developers in Finland leaving more time and resources for handling area C features and sub areas.
3	Access to Information	Interactive tool as a central place for updating feature notes from day 1	R&D manager 1 suggested that when we start discussing about a new feature, we should immediately open a page for that feature in company's collaborative software program and record everything that has been discussed and decided there. Company already has a tool which is designed for group working which is a real-time tool that can be used for this knowledge sharing purpose. This tool must be utilized.

As seen in table 8, the proposal draft building phase provided multiple suggestions regarding feature assignment coordination and the sub elements of the knowledge transfer process.

5.3 Proposal Draft

The summary of the proposal draft is illustrated in figure 17. Each step of the process is discussed in the following sections.

Proposal Draft	Identify sub areas to be learned + Participants	Capture and convert knowledge	Share and transfer	Apply and create new Knowledge	Assess /Audit
Responsible (Those who do the work)	R&D managers Finalnd & PLM (Product Line Management) Finland identify subs areas to be learned in Finland and decide which features will be selected	Identified Trainers make sure previous existing knowledge is captured (articulated and accessible to trainees)	Trainers share their knowledge with trainees during joint task (pair work) implementation phase.	Trainees help trainers in implementing joint feature tasks (learn by doing)	Project management assesses the effectiveness of knowledge transfer via the selected method such as project success rate and number of new features or tasks handled in Finland.
Accountable (who delegates the work to those responsible). Only one person accountable	Project management to delegate identification of task to R&D managers	R&D manager India to ensure trainers articulate the needed knowledge	R&D manager India delegates the tasks to trainers	R&D managers in Finland delegate the tasks to trainees	
Consulted (subject matter experts) those whose opinions are asked		Sub area experts, Owner of design documentations, flowcharts for internal code interactions, etc.	Sub area experts, Feature engineer, etc.	Trainers, sub area experts, Feature engineers.	R&D development managers in Finland
Informed (those to be kept up to date on the progress after the decisions are made or actions taken)	Project management and all participants	R&D manager India & Finland, trainees	R&D manager India & Finland, Project management	R&D manager India & Finland, Project management	R&D managers in Finland and India, trainers, and trainees.
Access to information and knowledge	Update internal tools to make the selected features and participants (trainers & trainees) visible to all stakeholders.	Depending on knowledge type convert the knowledge (as much as possible) from ideas and experiences to codified presentable format and store it in common repository/ interactive tool. Make it visible for everyone for future use.	Share via verbal (teleconference meetings) and email communication. Store the newly created knowledge in common repository /interactive tool (continuous conversion of knowledge)	Tools and databases updated by trainees based on the newly created knowledge	Store the measured benefits to the internal tool which is visible to everyone and keep it up to date

Figure 17. Summary of proposal draft

As seen in Figure 17, the proposal draft is a new process for knowledge transfer. The issue of coordination was primarily addressed by suggestions provided by the stakeholders building on top of the initial suggestion from R&D manager 1 noted in section 5.2. To address the ad-hoc assignment of the tasks related to area C sub areas, Finland R&D needs to be involved in the process of reviewing and selecting future customer features which impact the area C sub areas. PLM Finland has knowledge of some future customer requests. It was proposed by R&D manager 1 that R&D team in Finland can go through the list of future features with PLM and pick a feature for which Finland PLM will be responsible. Increasing the chance of having more features in Finland enables software developers to learn new software sub areas and deepen current expertise on already learned areas. R&D manager 2 brought up the importance of having the Feature Engineer (FE) role for area C related features in Finland to get more area C features done in Finland. Another alternative is to implement tasks concerning area C subsystems from various features so the software developers in Finland would learn new areas.

The process of knowledge transfer from the conceptual framework is the second step which completes the coordination proposals in addition to addressing other problems found in the current state analysis of this study. In the proposal building workshop, the boundary elements of the process matrix for knowledge transfer drawn from the conceptual framework were presented and the remaining elements were decided with the participants according to the suggestions from the stakeholders and sub elements of the conceptual framework. The assumption of the proposal draft is that the trainers are in India and trainees are in Finland.

5.3.1 Identify Sub Areas

In the current state analysis, it was found that management did not follow a plan for tasks assignment and knowledge transfer of area C sub areas. At the beginning of each project or software release, it must be decided which sub areas will be learned by Finland R&D. R&D managers Finland & PLM (Product Line Management) Finland identify subsystems to be learned in Finland and decide which features will be selected. This was brought up based on coordination comments provided by R&D manager 1 which is as follows:

"PLM Finland has knowledge on some future customer requests. R&D team in Finland can go through the list of future features with PLM and pick a feature where Finland PLM will be responsible for." (R&D manager 1)

Figure 18 illustrates the first step of the proposal draft for the knowledge transfer process.

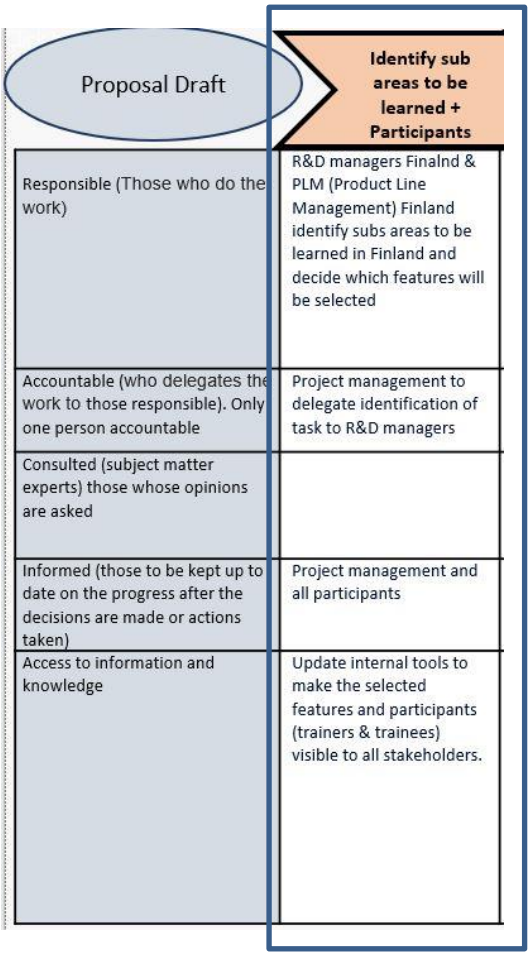


Figure 18. The first step of the proposal draft for knowledge transfer process

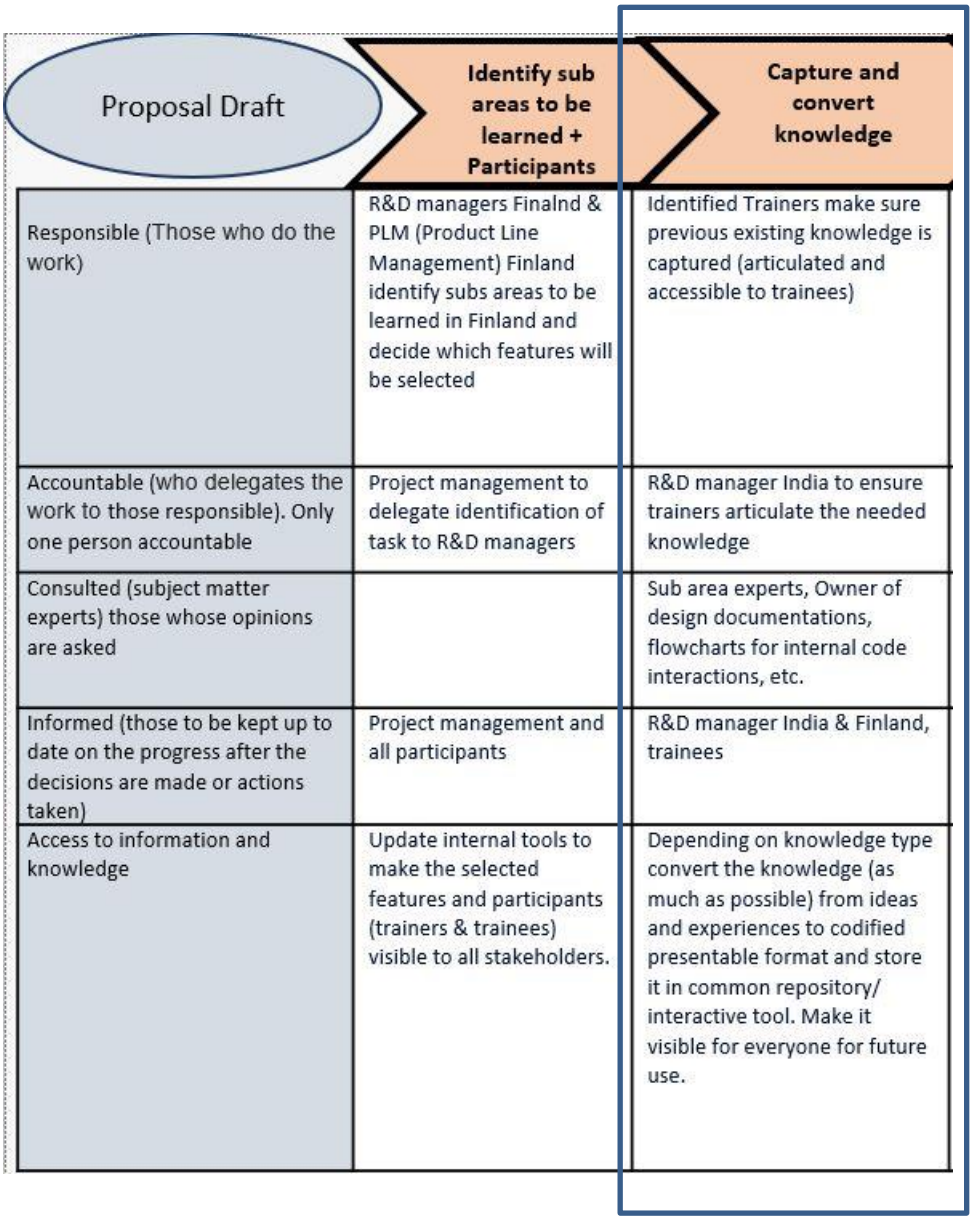
As seen in figure 18, identifying the sub areas to be learned by Finland R&D is the first step of the knowledge transfer process. In addition to the sub area identification, the participants (trainees and trainers) need to be identified. For this to be an official step in the future projects and to ensure the knowledge transfer will be planned and followed, project management in Finland must assign the area C sub area identification task to R&D management. To have transparency, the identified sub areas will be updated in internal tools to be visible and accessible by all software developers who will participate in the knowledge transfer

5.3.2 Capture and Convert Knowledge

In the current state analysis, it was found that there is not enough documentation in place. The lack of documentation is both at the feature design documentation level and in initial feature discussion between PLM and project management in R&D level. To address this, once the prospective features and subsystems are identified and the participants are selected, trainers will make sure previous existing knowledge is captured (articulated and accessible to trainees). This was mentioned by R&D manager 3, who is leading the trainers in India.

> *"If a new trainee joins, we don't have anything prepared to share. We must follow the same procedure for each trainee each time. We should have sequence diagrams for basic procedures, how they interact." (R&D manager 3)*

The R&D manager India would be accountable to delegate the articulating and documenting the relevant knowledge. The trainers are not necessarily always the sub area experts. Therefore, in the process of documentation and codification of knowledge, the sub area experts and the owner of design documentation must be consulted whenever necessary. Depending on knowledge type, from ideas and experiences to codified presentable format, it must be converted and stored in a common repository or an interactive tool (internal Wiki page) which is visible for everyone for future use. Figure 19 illustrates the second step of the proposal draft for the knowledge transfer process.



Responsible (Those who do the work)	R&D managers Finalnd & PLM (Product Line Management) Finland identify subs areas to be learned in Finland and decide which features will be selected	Identified Trainers make sure previous existing knowledge is captured (articulated and accessible to trainees)
Accountable (who delegates the work to those responsible). Only one person accountable	Project management to delegate identification of task to R&D managers	R&D manager India to ensure trainers articulate the needed knowledge
Consulted (subject matter experts) those whose opinions are asked		Sub area experts, Owner of design documentations, flowcharts for internal code interactions, etc.
Informed (those to be kept up to date on the progress after the decisions are made or actions taken)	Project management and all participants	R&D manager India & Finland, trainees
Access to information and knowledge	Update internal tools to make the selected features and participants (trainers & trainees) visible to all stakeholders.	Depending on knowledge type convert the knowledge (as much as possible) from ideas and experiences to codified presentable format and store it in common repository/ interactive tool. Make it visible for everyone for future use.

Figure 19. The second step of the proposal draft for knowledge transfer process

As seen in figure 19, capturing and converting the knowledge is the second step of the proposal draft for knowledge transfer. The outcome of the initial feature discussions among the PLM and project management must also be articulated in a common repository for all prospective stakeholders who will be selected to handle the feature. This was brought up by R&D manager 1 as follows:

> *"When we start discussing about a new feature, we should immediately open a page for that feature in company's collaborative software program and record everything that has been discussed and decided there. Company already has a tool which is designed for group working which is a real-time tool that can be used for this knowledge sharing purpose. This tool must be utilized." (R&D manager 1)*

Once the knowledge is codified into an articulable format, the R&D managers in India and Finland, in addition to trainees will be informed.

5.3.3 Share and Transfer & Apply and Create New Knowledge

In this proposal the process of sharing and applying the knowledge are closely related. Therefore, they are jointly discussed in this sub-chapter. In the current state analysis, it was found that the amount of other responsibility areas inhibits handling new features to Finland R&D. To accelerate learning new subsystems, R&D manager 3 suggested a certain number of features must be picked to be implemented collaboratively. It was stated as follows:

> *"We should do pair programming that 50 % of some feature in India would be done in Finland and 50% of Finland features (O area) will be done by India R&D." (R&D manager 3)*

For a couple of projects this could be done to get two sets of people from Finland and India learning area C and O respectively. Initially feature productivity stays the same so from the project perspective nothing changes while this peer programming is happening. However, this way more people will learn new areas which will improve future feature development capacity. It is possible to have a primary owner for each task and add the other person who is learning in the team. Additionally, learning area O in India will enable moving some tasks from Finland to India to free more developers to learn area C related sub areas in Finland.

This suggestion supports cooperation by having task-oriented workgroups which allow trainers sharing their knowledge with trainees during joint task (pair work) implementation phase. The knowledge being transferred is highly tacit because the software developers share their understanding of specific product feature along with the hints to develop new features with each other during the pair work. The geographical location of teams of trainees and trainers does not allow having face to face communication. However, due to the nature of the knowledge being shared, strong communication channels using ICT tools such as teleconference or video conference must be used to enable verbal discussion. In the process of sharing the knowledge, sub area experts and the feature engineers may be consulted if needed. As the assumption is that trainers are in India, the R&D manager 3 will be responsible to delegate the knowledge sharing task to

Indian software developers (trainers). It is very important to store the newly created knowledge in the process of sharing in the selected common repository or the interactive tool for future access and use.

Figure 20 illustrates sharing, transferring, and applying the knowledge as the upcoming steps after capturing the knowledge.

Proposal Draft	Identify sub areas to be learned + Participants	Capture and convert knowledge	Share and transfer	Apply and create new Knowledge
Responsible (Those who do the work)	R&D managers FinaInd & PLM (Product Line Management) Finland identify subs areas to be learned in Finland and decide which features will be selected	Identified Trainers make sure previous existing knowledge is captured (articulated and accessible to trainees)	Trainers share their knowledge with trainees during joint task (pair work) implementation phase.	Trainees help trainers in implementing joint feature tasks (learn by doing)
Accountable (who delegates the work to those responsible). Only one person accountable	Project management to delegate identification of task to R&D managers	R&D manager India to ensure trainers articulate the needed knowledge	R&D manager India delegates the tasks to trainers	R&D managers in Finland delegate the tasks to trainees
Consulted (subject matter experts) those whose opinions are asked		Sub area experts, Owner of design documentations, flowcharts for internal code interactions, etc.	Sub area experts, Feature engineer, etc.	Trainers, sub area experts, Feature engineers.
Informed (those to be kept up to date on the progress after the decisions are made or actions taken)	Project management and all participants	R&D manager India & Finland, trainees	R&D manager India & Finland, Project management	R&D manager India & Finland, Project management
Access to information and knowledge	Update internal tools to make the selected features and participants (trainers & trainees) visible to all stakeholders.	Depending on knowledge type convert the knowledge (as much as possible) from ideas and experiences to codified presentable format and store it in common repository/ interactive tool. Make it visible for everyone for future use.	Share via verbal (teleconference meetings) and email communication. Store the newly created knowledge in common repository /interactive tool (continuous conversion of knowledge)	Tools and databases updated by trainees based on the newly created knowledge

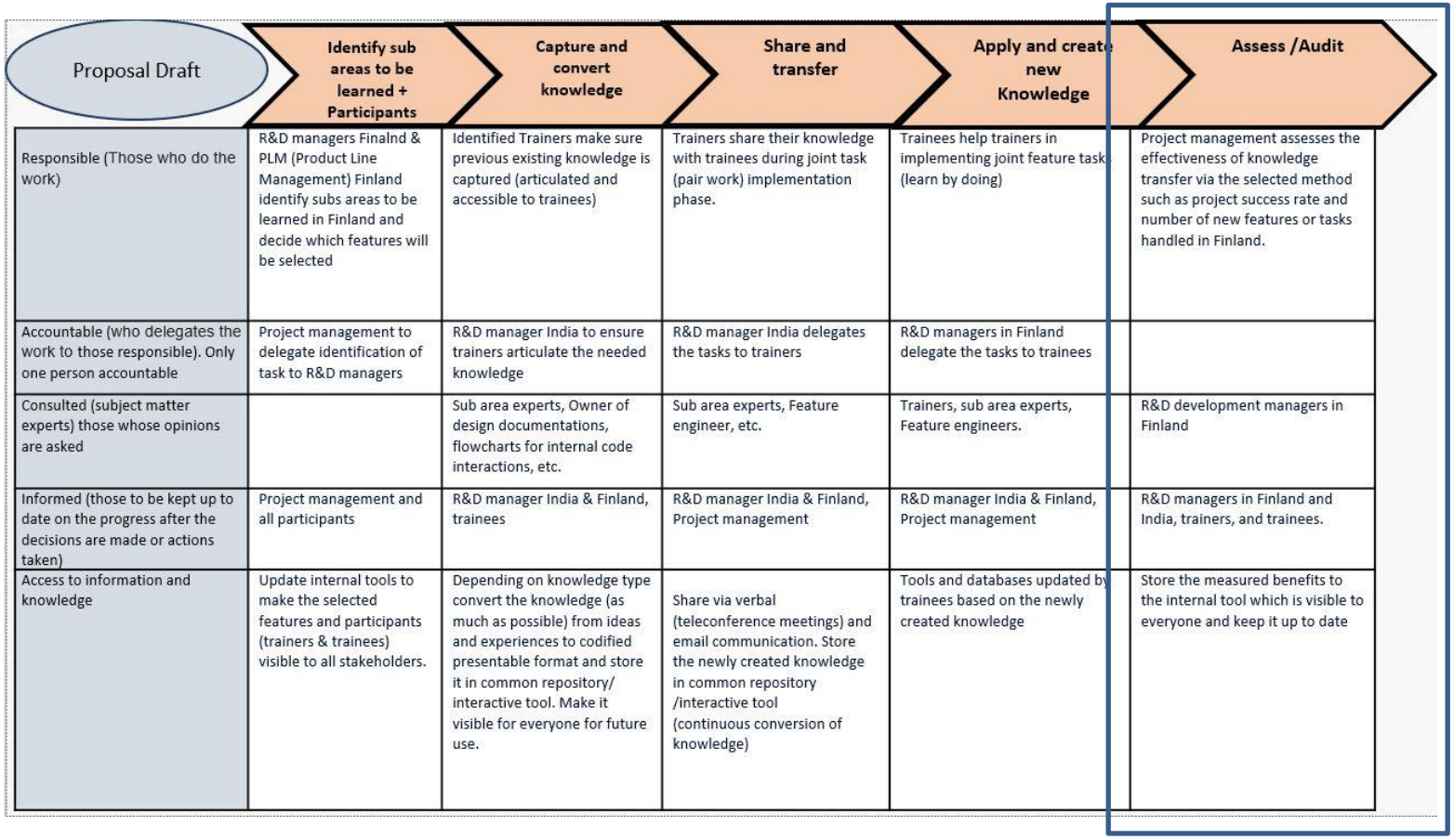
Figure 20. The sharing, transferring, and applying knowledge

As seen in figure 20, sharing, transferring, and applying knowledge are closely related and jointly presented in figure 20. As the plan for trainees and trainers is to work with the same feature, R&D managers in Finland will assign the new tasks to trainees while trainers provide the support in implementing those tasks. Applying the learned knowledge and implementing new tasks along with creation of new product functionalities, creates a continuous knowledge conversion from skills and product knowledge and experiences to codified knowledge which should be captured and stored in tools and databases. These steps must be repeated until most sub areas are covered and some trainees have independently implemented some tasks from each sub area. As new projects with new

area C related features are handled in Finland, the capacity to handle more medium and large features will gradually increase.

5.3.4 Assess and Audit

At the end of the project and after all other knowledge transfer process steps are followed, project management must assess the effectiveness and value of knowledge transfer. This assessment can be done through various methods, but it was discussed with the stakeholders that in this case it can be done via project success rate and number of new features or tasks handled in Finland. Assessing the benefits of knowledge transfer introduces additional tasks for the project manager. In the assessment process, the project manager will consult R&D managers in Finland and will inform the outcome of the audit to all stakeholders including R&D manager India, the trainees, and the trainers. The results of the audit and the measured benefits will be stored in the internal tool which is visible to everyone. The internal tool or database will be kept up to date as the knowledge transfer process continues in the next projects. Figure 21 illustrates the final step of the proposal draft for knowledge transfer process.



Proposal Draft	Identify sub areas to be learned + Participants	Capture and convert knowledge	Share and transfer	Apply and create new Knowledge	Assess /Audit
Responsible (Those who do the work)	R&D managers Finalnd & PLM (Product Line Management) Finland identify subs areas to be learned in Finland and decide which features will be selected	Identified Trainers make sure previous existing knowledge is captured (articulated and accessible to trainees)	Trainers share their knowledge with trainees during joint task (pair work) implementation phase.	Trainees help trainers in implementing joint feature task (learn by doing)	Project management assesses the effectiveness of knowledge transfer via the selected method such as project success rate and number of new features or tasks handled in Finland.
Accountable (who delegates the work to those responsible). Only one person accountable	Project management to delegate identification of task to R&D managers	R&D manager India to ensure trainers articulate the needed knowledge	R&D manager India delegates the tasks to trainers	R&D managers in Finland delegate the tasks to trainees	
Consulted (subject matter experts) those whose opinions are asked		Sub area experts, Owner of design documentations, flowcharts for internal code interactions, etc.	Sub area experts, Feature engineer, etc.	Trainers, sub area experts, Feature engineers.	R&D development managers in Finland
Informed (those to be kept up to date on the progress after the decisions are made or actions taken)	Project management and all participants	R&D manager India & Finland, trainees	R&D manager India & Finland, Project management	R&D manager India & Finland, Project management	R&D managers in Finland and India, trainers, and trainees.
Access to information and knowledge	Update internal tools to make the selected features and participants (trainers & trainees) visible to all stakeholders.	Depending on knowledge type convert the knowledge (as much as possible) from ideas and experiences to codified presentable format and store it in common repository/ interactive tool. Make it visible for everyone for future use.	Share via verbal (teleconference meetings) and email communication. Store the newly created knowledge in common repository /interactive tool (continuous conversion of knowledge)	Tools and databases updated by trainees based on the newly created knowledge	Store the measured benefits to the internal tool which is visible to everyone and keep it up to date

Figure 21. The final step of the proposal draft for knowledge transfer process

As seen in figure 21, assessing the benefits of the knowledge transfer is the final step in the process. Assessment of the benefits is one of the key enablers in the knowledge transfer process. Measuring the benefits of the knowledge transfer simplifies the identification of the knowledge gap in the next project.

In the next chapter, the proposal for the knowledge transfer process is presented to the stakeholders and the project manager for validating the proposal draft prepared in this section.

6 Validation of the Proposal

This section reports the results of the validation stage presented in section 5 and points to further development of the initial proposal based on the feedback received from key stakeholders and decision makers. At the end of this section, the final proposal on the knowledge transfer process and related recommendations are presented.

6.1 Overview of the Validation Stage

The final proposal of this study is created based on the feedback received on the co-created proposal draft which was created with the stakeholders based on the suggestions from theory and the weaknesses of the current state of the current knowledge transfer practices.

All stakeholders involved in building the proposal draft (R&D manager 1, Finland PLM, R&D manager 2, and R&D manager 3) in addition to project manager were invited to a teleconference group discussion to validate the proposal draft built earlier to come up with the final proposal. The proposal draft was a proposal for introduction of a totally new knowledge transfer process. The proposed process needs the project manager's feedback and approval before implementation. Additionally, the proposal introduces suggestions of the new tasks to be performed by the project manager. Therefore, the project manager was invited to provide feedback as the key person to approve the overall process.

6.2 Findings of Data Collection 3

During the group discussion with all the stakeholders the proposal draft was presented, and each step of the process was re-evaluated. Table 9 lists the summary of stakeholder suggestions in this step.

Table 9. Summary of stakeholder suggestions (Data 3)

	Key focus area	*Suggestions from stake-holders*	*Description of the suggestion*
1	Coordination	Early involvement of Finland R&D in the phase of selecting the features concerning new software sub areas was approved.	Project manager agreed that it makes more sense for all R&D managers to select the features to be implemented in each site as new features reach R&D. R&D managers 1&2 proposed to schedule a meeting with all R&D managers at the beginning of each project release when the release list for all of features is ready and go through the list to agree on the development feature owners (DFO). Project manager agreed with the proposal of handling the features in Finland with the local PLM whenever possible.
1	Identify sub areas and participants	Identification of sub-areas must be done after PRD meeting is held.	Project manager noted that first PRD must be done, then features where PLM Finland is responsible for are selected and then subsystems are identified by R&D manager.
2	Share and Transfer and Apply knowledge	Pair programming will not be followed.	Project manager suggested that the task-oriented workgroups are feasible but the joint task implementation with pair work is not necessary. Instead the trainee implements the task and trainer must be assigned as the consult and vice versa.
3	Assess / Audit method	The selected assessment method is measuring the number of area C related tasks and features in Finland.	Project manager found the method of following the number of features and tasks which Finland implements in each Project, a more suitable option to assess the effectiveness of knowledge transfer.

As seen in table 9, the validation phase provided multiple suggestions regarding the sub elements of the knowledge transfer process. These are explained in more detail below.

6.3 Developments to the Proposal Based on Findings of Data Collection 3

The people who know how each R&D site will evolve are the R&D managers, therefore they are in the best position to select the features for the capability growth of the R&D site. Based on the initial proposal and the comments received from the project manager, it was agreed that in the early phase of any project R&D managers will be informed about the future features to select the features to be implemented by their teams. It was also agreed that due to the need for close communication and collaboration between FE and PLM, the features in Finland with the local PLM will be selected whenever possible. The project manager commented as follows:

> *"I definitely agree that co-located assignments should be made whenever possible. For PLM, we can certainly take that into account when we go through the release list at the start of the release." (Project manager)*

The elements of the validated proposal are discussed in the following sub-sections.

6.3.1 Validated proposal on identifying sub areas and participants

After validation of the proposal draft, the identification of subsystems remains as the first step in knowledge transfer process, but the responsible and informed roles are modified. Figure 22 illustrates the validated proposal for identification of sub areas and the participants. The modified items are shown in blue text.

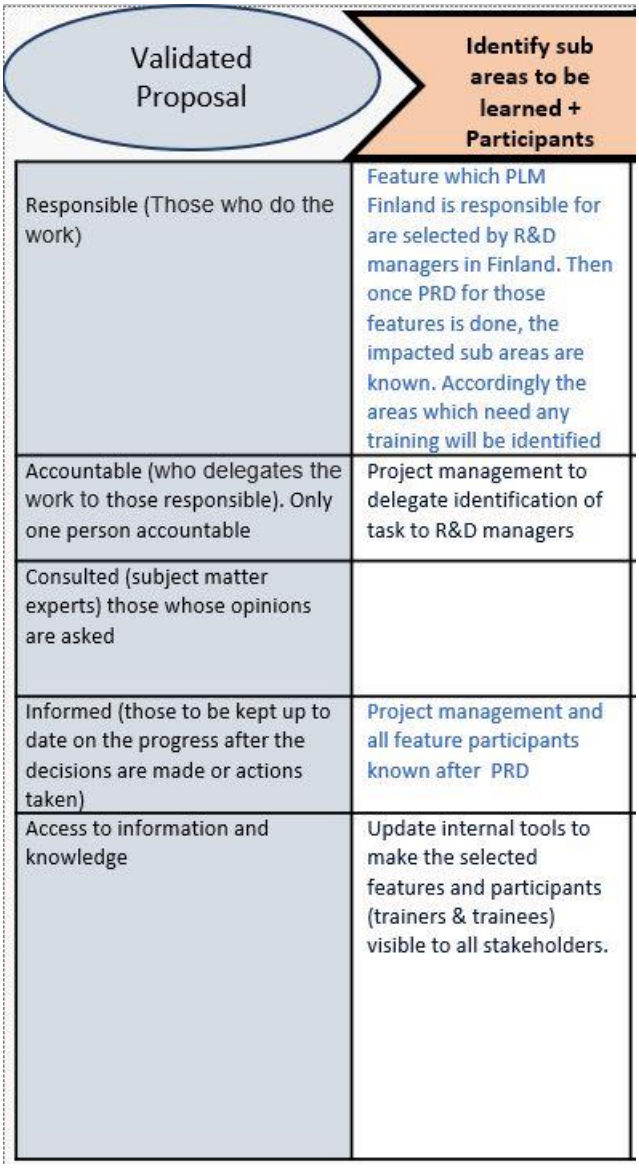


Figure 22. Validated proposal for identification of sub areas and the participants

As seen in figure 22, in the proposal draft building phase, it was proposed that at the beginning of each project or software release, the sub areas to be learned by Finland R&D needs to be chosen. The selected responsible people for identification of these sub areas were R&D managers & PLM Finland. However, in the proposal validation meeting it was agreed that the sub area selection must be done after the PRD for the features belonging to PLM Finland is arranged. That is because in the general PRD phase, all release features are discussed in the high level and the impacted sub areas in every feature is identified. Therefore, once the impacted sub areas are known, R&D managers will focus on the areas which need attention due to the lack of knowledge. That leaves the responsibility of selecting the sub areas to be learned to R&D managers in Finland.

Additionally, as the final feature team is known after the PRD, management needs to make sure that every participant in the feature is informed about the identified sub areas to be learned.

6.3.2 Validated Proposal on Share and Transfer and Applying Knowledge

After validation of the proposal draft, share, transfer, and applying knowledge will follow the same order in the knowledge transfer process. However, the roles are slightly modified. Figure 23 illustrates the validated proposal for share, transfer, and applying knowledge.

Validated Proposal	Identify sub areas to be learned + Participants	Capture and convert knowledge	Share and transfer	Apply and create new Knowledge
Responsible (Those who do the work)	Feature which PLM Finland is responsible for are selected by R&D managers in Finland. Then once PRD for those features is done, the impacted sub areas are known. Accordingly the areas which need any training will be identified	Identified Trainers make sure previous existing knowledge is captured (articulated and accessible to trainees)	Trainers share their knowledge with trainees by presenting in formal training before feature implementation. Also during the feature implementation provide support whenever needed.	Trainees implement the feature related task independently and deepen expertise by handling new tasks
Accountable (who delegates the work to those responsible). Only one person accountable	Project management to delegate identification of task to R&D managers	R&D manager India to ensure trainers articulate the needed knowledge	R&D manager India delegates the tasks to trainers	R&D managers in Finland delegate the tasks to trainees
Consulted (subject matter experts) those whose opinions are asked		Sub area experts, Owner of design documentations, flowcharts for internal code interactions, etc.	Sub area experts, Feature engineer, etc.	Trainers
Informed (those to be kept up to date on the progress after the decisions are made or actions taken)	Project management and all feature participants known after PRD	R&D manager India & Finland, trainees	R&D manager India & Finland, Project management	R&D manager India & Finland, Project management
Access to information and knowledge	Update internal tools to make the selected features and participants (trainers & trainees) visible to all stakeholders.	Depending on knowledge type convert the knowledge (as much as possible) from ideas and experiences to codified presentable format and store it in common repository/ interactive tool. Make it visible for everyone for future use.	Share via verbal (teleconference meetings) and email communication. Store the newly created knowledge in common repository /interactive tool (continuous conversion of knowledge)	Tools and databases updated by trainees based on the newly created knowledge

Figure 23. The validated proposal for share, transfer, and applying knowledge

As seen in figure 23, in the proposal draft building phase, joint-task (pair programming) and work groups were proposed but in the validation meeting the project manager commented that pair programming is not necessary. It was stated as follows:

> *"Task-oriented workgroups are feasible but the joint task implementation with pair work is not necessary. Instead the trainee implements the task and trainer must be assigned as the consult and vice versa." (Project manager)*

Therefore, the trainers will share their knowledge with trainees by presenting in a formal training before feature implementation. Additionally, during the feature implementation, the trainers provide support whenever needed.

Consequently, at the phase of applying the knowledge, the trainees will independently implement the feature tasks relying on the previously shared knowledge and available support provided by trainers who are assigned as consultants in case of any needed support and consultation during the implementation phase.

6.3.3 Validated Proposal on Assess or Audit Method

After validation of the proposal draft, the assessment step in the draft proposal remains as the last step of the knowledge transfer process with minor modifications to the selected method for the assessment. Figure 24 illustrates the validated proposal for assess/audit.

Validated Proposal	Identify sub areas to be learned + Participants	Capture and convert knowledge	Share and transfer	Apply and create new Knowledge	Assess /Audit
Responsible (Those who do the work)	Feature which PLM Finland is responsible for are selected by R&D managers in Finland. Then once PRD for those features is done, the impacted sub areas are known. Accordingly the areas which need any training will be identified	Identified Trainers make sure previous existing knowledge is captured (articulated and accessible to trainees)	Trainers share their knowledge with trainees by presenting in formal training before feature implementation. Also during the feature implementation provide support whenever needed.	Trainees implement the feature related task independently and deepen expertise by handling new tasks	At the end of each project release, project management assesses the effectiveness of knowledge transfer by following the number of new features or tasks handled in Finland during the project.
Accountable (who delegates the work to those responsible). Only one person accountable	Project management to delegate identification of task to R&D managers	R&D manager India to ensure trainers articulate the needed knowledge	R&D manager India delegates the tasks to trainers	R&D managers in Finland delegate the tasks to trainees	
Consulted (subject matter experts) those whose opinions are asked		Sub area experts, Owner of design documentations, flowcharts for internal code interactions, etc.	Sub area experts, Feature engineer, etc.	Trainers	R&D development managers in Finland
Informed (those to be kept up to date on the progress after the decisions are made or actions taken)	Project management and all feature participants known after PRD	R&D manager India & Finland, trainees	R&D manager India & Finland, Project management	R&D manager India & Finland, Project management	R&D managers in Finland and India, trainers, and trainees.
Access to information and knowledge	Update internal tools to make the selected features and participants (trainers & trainees) visible to all stakeholders.	Depending on knowledge type convert the knowledge (as much as possible) from ideas and experiences to codified presentable format and store it in common repository/ interactive tool. Make it visible for everyone for future use.	Share via verbal (teleconference meetings) and email communication. Store the newly created knowledge in common repository /interactive tool (continuous conversion of knowledge)	Tools and databases updated by trainees based on the newly created knowledge	Store the measured benefits to the internal tool which is visible to everyone and keep it up to date

Figure 24. The validated proposal for assess/audit

As seen in figure 24, the selected assessment method for the knowledge transfer is measuring the number of area C related tasks and features in Finland at the end of each project. This method was selected by the project manager as stated below:

> "*Project success rate does not reveal the real rate for area C tasks because the whole project is a combination of area O and area C. Measuring the number of new area C related tasks during the project would reveal what we are looking for." (Project manager)*

This step completes the validation of the proposed knowledge transfer process.

6.4 Final Proposal

The final proposal for knowledge transfer process is presented in this section. The knowledge transfer process and related recommendations were well received. The final proposal of this study is a knowledge transfer process and related recommendations. The case company will use this process as a guide to transfer knowledge from other R&D sites to Finland to increase the feature development capacity of the global R&D. The complete process as the final proposal is illustrated in figure 25 below.

Final Proposal	Identify sub areas to be learned + Participants	Capture and convert knowledge	Share and transfer	Apply and create new Knowledge	Assess /Audit
Responsible (Those who do the work)	Feature which PLM Finland is responsible for are selected by R&D managers in Finland. Then once PRD for those features is done, the impacted sub areas are known. Accordingly the areas which need any training will be identified	Identified Trainers make sure previous existing knowledge is captured (articulated and accessible to trainees)	Trainers share their knowledge with trainees by presenting in formal training before feature implementation. Also during the feature implementation provide support whenever needed.	Trainees implement the feature related task independently and deepen expertise by handling new tasks	At the end of each project release, project management assesses the effectiveness of knowledge transfer by following the number of new features or tasks handled in Finland during the project.
Accountable (who delegates the work to those responsible). Only one person accountable	Project management to delegate identification of task to R&D managers	R&D manager India to ensure trainers articulate the needed knowledge	R&D manager India delegates the tasks to trainers	R&D managers in Finland delegate the tasks to trainees	
Consulted (subject matter experts) those whose opinions are asked		Sub area experts, Owner of design documentations, flowcharts for internal code interactions, etc.	Sub area experts, Feature engineer, etc.	Trainers	R&D development managers in Finland
Informed (those to be kept up to date on the progress after the decisions are made or actions taken)	Project management and all feature participants known after PRD	R&D manager India & Finland, trainees	R&D manager India & Finland, Project management	R&D manager India & Finland, Project management	R&D managers in Finland and India, trainers, and trainees.
Access to information and knowledge	Update internal tools to make the selected features and participants (trainers & trainees) visible to all stakeholders.	Depending on knowledge type convert the knowledge (as much as possible) from ideas and experiences to codified presentable format and store it in common repository/ interactive tool. Make it visible for everyone for future use.	Share via verbal (teleconference meetings) and email communication. Store the newly created knowledge in common repository /interactive tool (continuous conversion of knowledge)	Tools and databases updated by trainees based on the newly created knowledge	Store the measured benefits to the internal tool which is visible to everyone and keep it up to date

Figure 25. The final proposal

As seen in figure 25, The final proposal of this study is a knowledge transfer process and related recommendations utilizing suitable ICT tools to communicate, share and capture knowledge from India to Finland. The final proposal is the combination of the validated steps described in section 6.3.

In the next chapter, this study is concluded with an executive summary and the next steps and recommendation towards implementation of the final proposal.

7 Conclusions

This section summarizes and concludes this thesis. This section starts with the executive summary of this thesis and continues with the next steps and recommendations towards implementation. Finally, this section ends with thesis evaluation and closing words.

7.1 Executive Summary

The objective of this thesis was to develop a process for knowledge transfer for the R&D of the case company in telecommunication technology business. The case company has gone through merger and acquisition resulting in product architecture changes with the division of knowledge between various global R&D sites. The knowledge transfer process is needed to help address the slow progress of knowledge transfer among global R&D sites. Transferring knowledge between the R&D sites increases the throughput for developing and delivering customer requests in the sites which have been underperforming due to the lack of certain knowledge from the recently modified product.

The qualitative research method was used through three rounds of data collection with the help of interviews, group discussions, and internal company documents. The study was started by first conducting the current state analysis of the knowledge transfer practices between R&D sites, then looking for relevant ideas and knowledge from literature. Subsequently the study continued to the co-creation of a proposal for knowledge transfer process relying on the collected data and suggestions from the key company stakeholders. Lastly the co-created proposal was validated by presenting the initial proposal and receiving feedback from the company management.

The analysis of the current state of knowledge transfer practices between the R&D sites revealed three main findings: the lack of coordination for transferring knowledge across the sites, the lack of definition of clear roles and responsibilities to perform knowledge transfer activities, and the lack of access to essential information to support knowledge transfer. Based on the literature research, the relevant existing knowledge was used to address the findings from the current state analysis by building a conceptual framework combined from the most suitable existing knowledge. The conceptual framework was built to assist in building the proposal for the case company.

The initial proposal was co-created in four steps including three individual and one group discussion to receive the key stakeholder input. The initial proposal of this study is a knowledge transfer process and the related recommendations which is built based on the conceptual framework and the input received from the key stakeholders from the case company. The components of the knowledge transfer process are “identifying knowledge and participants”, “capture and convert knowledge”, “share or transfer”, “apply and create new knowledge”, and “assess or audit”. Each step needs to be followed with the help of clear definition of roles and responsibilities in addition to relevant use of ICT tools enabling communication and transferring the knowledge among globally distributed R&D sites.

The initial proposal was presented to the key decision makers during a group discussion. The overall process proposed in the initial proposal was well received and some constructive feedback was provided which resulted in minor modifications to the initial recommendations in every phase of the process except to the “capture and convert knowledge” step.

The business impact of implementing the knowledge transfer process to manage and transfer knowledge is fundamental. The knowledge transfer process serves as a systematic way to manage and balance the knowledge in a complex, knowledge intensive global R&D organization. Implementing the proposed knowledge transfer process increases the overall knowledge of the R&D site which in turn increases the capacity of developing more complex customer request addressing customer needs to achieve better business outcomes in the long run.

7.2 Next Steps and Recommendations toward Implementation

The validated proposal of this thesis provided the company management with a process with exhaustive overall descriptions for each step to follow when transferring knowledge between one R&D site to another. The proposal was built during an ongoing project. The timing of the project did not allow the author and the stakeholders to put the process into practice by building a complete action plan according to the proposed knowledge transfer process. That is because implementing this process requires the planning at the beginning of any given project.

Therefore, the next step towards implementing the proposal is a targeted action plan for specific customer requests at the planning phase of the next project after the next PRD is done.

The first step to build the targeted action plan is to choose a couple of medium to large features for trials once the global PLM team provides R&D with the list of customer requests.

Later, when R&D Finland selects specific features with a co-located PLM, as the impacted sub areas of each features are known, it is possible for R&D managers in Finland to choose the features by comparing the impacted sub areas with the content of table 4-a and 4-b in this study which maps the details of the remaining sub areas to be learned in Finland.

The second step in building the action plan is selecting the people and the resources needed to complete the tasks according to the guidance provided in the proposed knowledge transfer process. Having a clear process with a specific action plan at the beginning of each project identifies “what”, “when”, and “by whom” tasks need to be done. This increases the chances of success in the knowledge transfer initiatives for the R&D site.

7.3 Thesis Evaluation

The objective of this thesis was to develop a process for knowledge transfer which was addressed in this study and a knowledge transfer process and related recommendations is its outcome. The focus of the proposal in this study was based on the findings from the knowledge transfer practices which were already performed between two R&D sites (India to Finland). This was a suitable choice as R&D India remains to be the site with the highest potential to transfer knowledge to Finland in near future projects. However, in the proposal building phase R&D USA managers could additionally be involved. This could prepare R&D Finland in case of any possibility of having potential areas to be learned from R&D USA in the future. However, focusing on the R&D India served the objective of this study and the problem at hand. Also, the same process has the potential to be used as a model for other knowledge transfer practices between other R&D sites in the future.

Research validity and credibility are important notions which are required by research practice. The validity of this study was ensured through research design and data collection by keeping the objective of the study in mind to address the business challenge of the case company. In this study the literature research from business and knowledge management studies was conducted in addition to the data collection from best available

data sources (interviews and internal documents) from the case company to develop a solution to the business challenge and meet the objective of this study.

In this study the researcher co-operated with the key stakeholders in the company to develop a solution to a business problem with exercising design research approach. The researcher aimed to increase the credibility of this study by studying multiple sources of data and involving various informants from the case company representing different perspectives to the existing problem in addition to studying various relevant sources from literature and existing knowledge. Another step taken to increase the validity of this study and minimizing bias was analyzing the current state analysis with the stakeholders and co-creating the solution for the business problem in multiple rounds of proposal building.

7.4 Closing Words

In today's competitive business environment, it is in the interest of any knowledge intensive organization to capture and retain the existing knowledge within the organization in order to utilize it to gain competitive advantage. Organizations need a systematic way to transfer knowledge between different sites, units, and people to increase the overall level of knowledge in the organization. This is even more significant for the globally distributed organization. In this context, the case company needed to increase productivity of one of its global sites by enhancing its knowledge level in certain areas. This research provided a knowledge transfer process and related recommendations to guide the case company to reach the desired knowledge level to increase the overall R&D productivity.

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Data 1 Interview Questions

Date	21.12.2019
Role	R&D manager 1 (Informant 1)
Duration	120 min

Main themes	Sub questions	Field Notes
Role identification	• What is your role in current knowledge transfer practice? • How have you supported the subordinates learning?	
Identification of the stakeholders	• Who are the participants in the knowledge transfer practices so far?	
Identification of the sub-systems	• What is the current plan for the area C sub-system learning in Finland R&D?	
Identification of tools and databases	• What are the organizational databases to search additional information on tasks and their owners	
Knowledge distribution between R&D sites	• How is the knowledge division between R&D sites? • How do customer request reach R&D?	

Date	03.01.2020, 07.01.2020, 08.01.2020, 09.01.2020
Role	Software Developers 1-4 (Informants 2-5)
Duration	90 min for each interview

Main themes	Sub questions	Field Notes
Training Method	• What is your current role and what was your role in this knowledge transfer? • When and how did the area C learning start? which subsystem you have learned so far?	
Applying Knowledge	• When and how did you apply the received knowledge • What were the barriers to learning and applying the knowledge	
Access to Information	• During the learning phase and implementing tasks did you have access to all needed data? • What was the level of support received from organization and trainers	

Date	**15.01.2020**
Role	**R&D manager 2 (Informant 6)**
Duration	**60 min**

Main themes	Sub questions	Field Notes
Role identification	• What is your role in current knowledge transfer practice? • How have you supported the subordinates learning?	
Identification of the stakeholders	• Who are the participants in the knowledge transfer practices so far?	
Identification of the sub-systems	• What is the current plan for the area C sub-system learning for your subordinates?	
Barriers to knowledge transfer	• What are the barriers which have slowed down the learning in Finland R&D?	

Date	21.01.2020
Role	Trainers (Infromant 7-8)
Duration	60 min

Main themes	Sub questions	Field Notes
Training	• When and how did the training start? • What is your opinion about the practice? • What happened after the training? • What tools did you use during and after training? • What were the barriers during and after the training (if Any)?	

Date	24.01.2020
Role	R&D manager 3 (Informant 9)
Duration	60 min

Main themes	Sub questions	Field Notes
Role identification	• What is your role in current knowledge transfer practice? • How have you supported the subordinates in knowledge transfer practice	
Level of Knowledge in India R&D	What is the current status of the area C sub-system knowledge in India?	
Barriers to knowledge transfer	• What are the barriers which have slowed down the knowledge transfer to Finland?	