A LEARNING PROJECT ORGANIZATION

MASTER'S THESIS – MARCH 2012

Adam Boström
Faculty of Engineering, Lund University

Preface

This Master of Science thesis is the final chapter of my studies at the Industrial Management and Engineering program at Lund University. The work was carried out during the autumn of 2011 and winter of 2012 at Elekta Instrument AB in Stockholm, Sweden. The study is a joint project conducted in collaboration with Alexander Nylén, student at Blekinge Institute of Technology. Thus, all work related to this project is shared between us. We have also done all documentation in this project together, but this Master's thesis is only representing me.

Finishing a thesis of this magnitude would have been impossible without the assistance of my supervisors. Therefore, I would like to thank our supervisor at Elekta, Erik Lindgren, who offered us the opportunity to perform this master thesis at Elekta and also for his invaluable input during the creation of this thesis. And big thanks to Johannes Morelius who also supported and oversaw our work at Elekta. Furthermore, I am grateful to all the project managers at Elekta who participated in the interviews conducted for the purpose of this thesis.

I would also like to thank the people representing the organizations participating in the benchmarking part of this thesis, for sharing their knowledge and thoughts. And finally, to my university supervisor Bertil I Nilsson – thank you for your endless patience, rational wisdom and your true commitment.

I look forward to reading the Master's thesis submitted by Alexander Nylén, hopefully very soon accepted and published.

Adam Boström

Stockholm, March 2012

Abstract

Title

A learning project organization

Author

Adam Boström

Project team

The project team that undertook this thesis work consisted of Adam Boström, Lund University, and Alexander Nylén, Blekinge Institute of Technology.

Supervisors

Erik Lindgren, Process Engineering Manager R&D Neurosurgery, Elekta Instrument AB. Bertil I Nilsson, Department of Industrial Management & Logistics, Faculty of Engineering, Lund University.

(In addition, Alexander's supervisor Ossi Pesämaa at the School of Management, Blekinge Institute of Technology, contributed partly to this project).

Background

Today many organizations convert from being a traditional functional organization to becoming more temporary project-based organizations in order to respond to the changing environment. As a result, project-based organizations have difficulties to learn from within the project and between projects which force project members to "reinvent the wheel" over and over again. If organizations do not reflect and transfer past experiences from past projects, the quality of project learning and the transfer of learning to the surrounding organization will be poor and, as a result, reduce the quality of the project processes and reduce the value for the customers.

Research question

At Elekta they gather lessons from their projects. While lessons are collected and filed in a database, Elekta is still in need of support to learn from them and feed them into new projects. How can Elekta learn from past experiences in order to become a learning project organization?

Delimitations

Elekta requested an implementation plan to be created for their product creation process. The plan explains how the feedback model will be best implemented and within which product

creation activities. Thus, an actual implementation of the process was not conducted within this project.

Purpose

The purpose of this thesis was to develop a feedback model which should help Elekta to learn from past experiences and apply these experiences in future projects. Moreover, the feedback model has to be integrated in Elekta's product creation process. Thus, an implementation plan was created.

Methodology

This master thesis project has been conducted using an explorative and descriptive strategy, where the explorative approach has been used in the first part of the thesis in order to develop the theoretical framework. The second part, which consists of empirical field work, was approached using a descriptive strategy where we describe in detail the current state at Elekta and at four other organizations. Our chosen research method is the case study method where the qualitative data was gathered from in-depth interviews and from internal documentation provided by Elekta. Along the way we have used a deductive approach, which means we first stated our research problem and then investigated secondary sources in order to form our theoretical framework.

Conclusions

With the theoretical framework and the empirical data from the interviews in our backpack, we propose a new lesson design template, a feedback model that takes the new lesson template into consideration, and a plan for the model's implementation including future actions which should guide Elekta towards becoming more matured as a learning organization. The lesson design template we propose makes it easier for Elekta to gather lessons in such way that they can be applied and transferred to future projects which is an essential element in the lessons learned process. The next proposed element in the conclusion is the *feedback model* that will utilize lesson knowledge during process execution (e.g. planning, monitoring) to support decision-making. The feedback model uses a pull approach which means the user can search for lessons that are desirable at the time, using a knowledge repository like Elekta´s current lessons learned database. The suggested implementation plan proposes several features on how and when Elekta should review project activities and how the feedback model is best implemented in Elekta´s product creation process. Finally, a list of suggested future actions prioritized by importance shows, in a simple and lucid way, what measures that need to be taken as Elekta prepares for its first steps towards becoming a learning project organization.

Glossary and keywords

AAR – After Action Review

Best Practices – A best practice is a technique, method, process, activity, incentive, or reward which is regarded as more effective at producing a desirable outcome than any other technique, method, process, etc. when applied to a particular situation.

CBR – Case-Based Reasoning

CMM – Capability Maturity Model

CoPS – Complex Product Systems

KM – Knowledge Management

KMS – Knowledge Management Systems

LL – Lessons Learned

PBO – Project Based Organization

PCP – Product Creation Process

PM – Project Management

PMM – Project Management Maturity

PMMM – Project Management Maturity Model

PMI – Project Management Institute

PMO – Project Management Office

PPA – Post-Project Appraisal

PQ –Project Quarterly

PSG – Project Steering Group

Contents

1. Introduction

The work in this thesis project has been conducted in collaboration with Alexander Nylén, student at Blekinge Institute of Technology. All preparations done previous to the actual project work was carried out by both authors. Through collaboration we gathered the entire data that is presented in this thesis, along with the interviews which were held with both of us present. Also, we have equally contributed to both the analysis and the conclusions of this thesis. Thus, all work related to this project is shared equally. However, comprehensive fine tunings were made to each individual report to comply with university requirements.

The first chapter positions our key concepts; motivate the relevance of our study. As a consequence of this discussion we address a problem and a research question, which guides us throughout the thesis. This chapter also offers some brief details about our case company, Elekta Instrument AB. Finally, we provide a thesis overview.

1.1 Background of the study

This thesis conceptualizes learning and proposes how it can improve project management. In the beginning of 20th century, the concept concerning *learning curve* came up for discussion. Learning curves developed during the 1920´s where it was recognized that the costs of airframe manufacturing, feel with the increase in cumulative volume. Learning curve was adapted by the Boston Consulting Group in the late 1960s for strategic purposes and was explained as the *experience curve.* Conceptually it illustrates that the more often a certain task is performed – whether it is the production of any good or service – the easier and the better can the specific task be performed (Garvin, 1993). Practically, and as consequence the organization will lower costs associated with the specific task (Garvin, 1993).

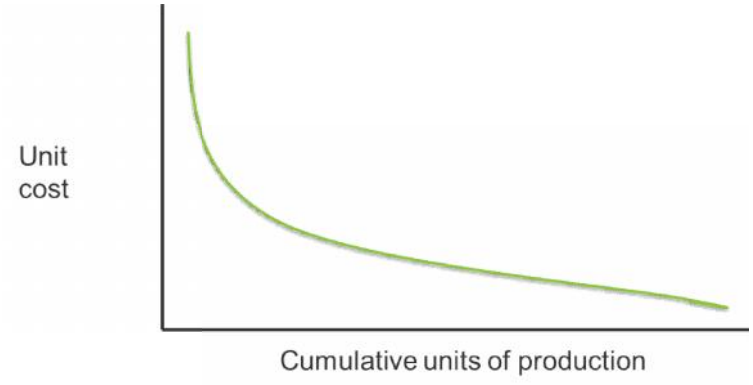


Figure 1: Experience curve. Adapted from Garvin (1993).

The Experience curve is depicted in Figure 1. Such curve can be applied to temporal projects. New projects often have similar components and attributes as previously managed projects. In 1991, the Software Engineering Institute (SEI) developed and published a process maturity

framework for software development, called the Capability Maturity Model (CMM). CMM guide organizations measuring process and practice maturity and ultimately helps to improve project management processes (Wysocki, 2004). Figure 2 illustrates the original CMM, showing that "components and attributes" are equal to the three critical dimensions – "*Procedures and methods", "Skills, training and motivation" and "Tools and equipment"* – that an organization can focus on to improve its business.

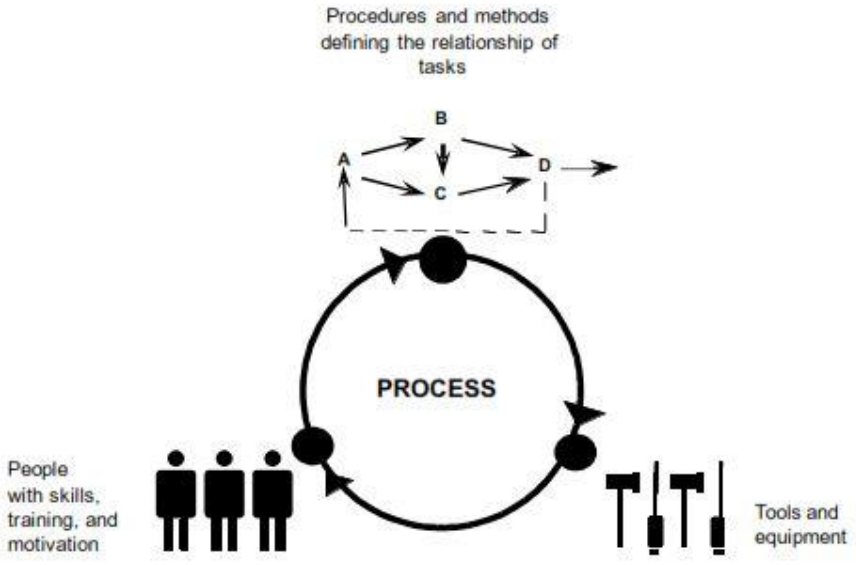


Figure 2: The three critical dimensions (CMM, 2010).

Earlier studies indicate it is important to gain knowledge from past experiences to ensure the same mistakes are not repeated (Bresnen et al., 2006). This is fundamental in project management (Arthur et al., 2001). The Project Management Maturity Model (PMMM), which is patterned after the CMM, is widely used and emphasizes the need for organizations to continuously improve their project management process. Excellence can only be accomplished if the project management methodology operates routinely (Wysocki, 2004.)

1.2 Problem description and research question

Today many organizations convert from being traditional functional organization to becoming more temporary project-based organizations in order to respond to the changing environment (Kerzner, 2009). Practically, this means that each new project needs to set-up some basic organizational principles otherwise found in non-temporary organizations. Some of these temporal principles are recurrent and adopted smoothly whereas other cause several learning loops before everyone involved accepts an agreed fact. The latter means that organizations invent and develop something that could be adopted from past projects. But some principles do not come easily but cost time, effort and resources. Some even tend to cause interpersonal conflicts. Due to different irregularities, organizations have difficulties to learn within the project and between projects (Keegan & Turner, 2001). Some missing principles may even cause failures to projects. Bresnen et al. (2006) came to the conclusion that a project-based

organization faces problems when capturing and transferring knowledge from project to project, forcing project memebers to "reinvent the wheel". This results in higher project costs and even delays.

As stated above, organizations have difficulties to learn from past experiences and apply these experiences to new projects. This is also true for many Swedish high tech firms. Elekta, which is a Swedish medical technology company, develops equipment for cancer treatment and brain disorders in technology-intensive projects. At Elekta they gather lessons from their projects. While lessons are collected and filed in a systematical database, Elekta is still in need of support to learn from past lessons.

Furthermore, Elekta can as an organization become more mature and utilize benefits of being a so called *learning project organization*. Conceptually a learning organization depends upon an environment that supports learning. Garvin (1993) states that a learning organization is "*an organization skilled at creating, acquiring and transferring knowledge, and at modifying its behavior to reflect new knowledge and insights*". This thesis addresses the following research question: *How can Elekta learn from past lessons in order to become a learning project organization?* To approach this question, this thesis will examine processes related to project management and project process improvement. In addition, this thesis will examine processes related to knowledge management, project learning and lessons learned (LL).

1.3 Target group

The main target group for this thesis study is Elekta Instrument AB and its project personnel. The result will address project managers and the project management office in particular because of the importance these functions have regarding a potential implementation of any recommendations we will impose. Since any implementation will affect the whole product creation process (PCP) - which eventually will be adopted globally – the project can be of interest also for other parts of the company.

The thesis project is also intended to be of educational importance for students at the Faculty of Engineering at Lund University and at Blekinge Institute of Technology. The topic of this thesis is indeed relevant for any project-based organization which builds their core business around technology-intensive projects, both large scale and small scale.

1.4 Purpose

To help Elekta learn from past experiences and apply these experiences into future projects, we will develop a **feedback model** for LL to enable systematic feedback of LL in past projects to future projects. With this model, we will minimize uncertainty that occurs when initiating a new project. Through theoretical studies and practical experiences in a real corporate project environment we will gain valuable experience which will contribute to the progression towards our engineering professions. This will be done by studying project management, knowledge management and project learning theories in order to understand the importance of project learning and its implications on project management process improvement. In addition, different kinds of methods to capture, store, transfer and assimilate

LL will be investigated which, in turn, will increase our understanding in the area. By learning about the practical experiences of LL at Elekta Instrument AB, and comparing industry best practices, we will identify strengths and weaknesses with current solutions and identify key parameters that can improve learning from past projects. The outcomes will serve as input for developing a process for how future projects can learn from past projects. The study will result in arrangements for how such a feedback process can be implemented into the Elekta PCP.

1.5 Delimitations

Elekta requests an implementation plan to be created for their Product Creation Process. The plan will explain how the feedback model will be best implemented and within which product creation activities. Thus, an actual implementation of the process will not be conducted within this project.

1.6 Project deliverables

The project's final product will take the form of a comprehensive report including: a description of the chosen research methodology; a theoretical framework; empirical studies of the current situation at Elekta and of best practices in four other companies; and a model for how future projects can learn from past projects derived from knowledge management philosophy. An implementation plan for how the feedback model should be embedded in the Elekta product creation process will also be developed. Finally a presentation of the project will be held at the Elekta offices. Furthermore, a scientific article will be composed and another presentation will be held at university grounds. In addition to the project presentation, an opposition on another project thesis will be conducted.

The work in this thesis project has been conducted in collaboration with Alexander Nylén, student at Blekinge Institute of Technology. All preparations done previous to the actual project work was carried out by both authors. Through collaboration we gathered the entire data that is presented in this thesis, along with the interviews which were held with both of us present. Also, we have equally contributed to both the analysis and the conclusions of this thesis. Thus, all work related to this project is shared equally. However, comprehensive fine tunings were made to each individual report to comply with university requirements.

1.7 Elekta Instrument AB

Elekta is a human care company providing clinical solutions for the treatment of cancer and brain disorders. The corporate mission is to improve, prolong and save lives. Elekta is the world leader in image guided and stereotactic clinical solutions for radiosurgery and radiation therapy. Elekta's solutions in oncology and neurosurgery are used in over 5,000 hospitals around the world. Every day more than 100,000 patients receive diagnosis, treatment or follow-up with the help of a solution from Elekta. The company employs more than 3,000 people globally. Elekta Instrument AB is the Swedish subsidiary, partly located at the Elekta Group headquarters in Stockholm, partly in Linköping. The Elekta stock trades only in Sweden, but their largest sales market is in the United States.

1.8 Chapter overview/Report outline

This thesis consists of nine main chapters. Our recommendation is to read all chapters – from beginning to the end - in order to get the overall picture of the thesis.

- *Chapter 1: Introduction* consists of background information and purpose concerning the research problem. Further, objectives and deliverables are presented and general information about Elekta is provided.

- *Chapter 2: Methodology* is the chapter which aims to provide the reader with our scientific approach to the research problem. In addition, the credibility, validity and objectivity of this thesis will be discussed.

- *Chapter 3: Frame of references* presents the theoretical framework that was used in this thesis. This chapter will act as a foundation for the analysis, from which conclusions will be drawn.

- *Chapter 4: Empirics and analysis* presents our findings at Elekta. The chapter starts with presenting and explaining the Elekta product creation process and LL database. This is followed by the different aspects of project management maturity and the processes used to utilize LL. Furthermore, Elekta's needs and challenges are identified.

- *Chapter 5: Benchmarking* presents findings from the interviews conducted at four different organizations. Through these interviews, current solutions, needs and challenges in these organizations are summarized.

- *Chapter 6: Conclusions* presents our conclusions in form of a feedback model, an implementation model and suggested future actions for Elekta.

- *Chapter 7: Discussion* presents the authors' view on their contribution to science, the chosen methodology and further work recommendations.

- *Chapter 8: References* declares the different sources of data used in this thesis.

- *Chapter 9: Appendices*

2. Methodology

This chapter presents our project work process and the chosen research strategies and methods. Different data collection techniques used in this thesis is then presented followed by an explanation of how the validity, objectivity and credibility of the thesis work is ensured.

2.1 Project work process

The project's problem formulation and expectations were laid down at an early stage by the client, Elekta Instrument AB, and was documented in the project specification together with the project's objective. The first phase of the research explains the choice of methods. Secondly, the researchers immerse in different theories and compile these with the empirical studies for the analysis. Next, the findings will be reviewed with the input from industry best practices. This will form the conclusive chapter presenting the result in the form of a feedback model and an implementation plan.

2.2 Research strategy

The research strategy in this thesis has been divided into two parts - exploratory and descriptive. According to Höst et al. (2006), is exploratory suitable when the researcher wants to dig deep into the research subject. In the first part of the thesis, we will adopt an exploratory strategy in order to explore and understand the whole process concerning project management, knowledge management, project learning and LL. This forms the theoretical framework. With this theoretical framework, we will have the sufficient knowledge to develop interview questions for the empirical study. It is stated by Höst et al., (2006) that the purpose with a descriptive study is to find out and describe how something works, by portraying a situation or phenomenon. Thus, the second part of this thesis is descriptive, where we portray in detail the current state at Elekta and at four other participating organizations. Moreover, as a result from the interviews we will find new interesting insights concerning needs, challenges and current solutions in benchmarked organizations. These insights will be utilized as we develop the feedback model and implementation plan for Elekta Instrument AB.

2.3 Research method

A case study involves intensive examination of a specific setting (Bryman 2008). Due to the fact that we use an exploratory and descriptive strategy in this thesis, a case study approach is used in order to gain detailed knowledge about issues related to the research problem. It is stated by Höst et al., (2006) that case studies are suitable when the researcher is using an exploratory strategy. We will examine the processes of knowledge management and LL (i.e. capture, analysis, storage, dissemination and re-use) in order to discover how these parts interrelate and also to identify which factors that influence their progress. Another reason why we choose to use a case study method is our need to capture valuable and exclusive insights from the interviewees' which, in turn, help us to discover new ideas and unravel the

complexity around the research topic. Therefore, in-depth interviews will be held in this thesis. This is also in line with the views of Denscombe (2007), who states that case studies can reveal interesting insights that would not come to light if another research method is used.

Survey is a research methodology which is related to case studies. Information is gathered from a specific population or a sample, usually by questionnaires or interviews (Runeson & Höst, 2009). We started the case study by first gathering qualitative data at Elekta in form of interviews and corporate data. From this information we could identify challenges and needs; understand Elekta's current situation; and see problems that need to be addressed. When these were clarified, the next step was to benchmark and find current solutions at four other organizations. The organizations chosen are depicted in Table 1.

The organizations participating were selected based on three criteria. They are (1) project-based organizations, (2) developing high-technology intensive products, (3) located on markets with hard competition and high maturity.

Table 1: Organizations participating in interviews

Company	Country	Industry
Elekta Instrument AB	Sweden	Health
Ericsson	Sweden	Telecommunication
Saab Automobile AB	Sweden	Automotive
Scania	Sweden	Automotive
Volvo Car Corporation	Sweden	Automotive

2.4 Data collection techniques in this project

There are several tools that can be used to collect data for a research study; all with their own feature. There is, however, no general "best practice" in this area. Depending on the context; all these methods have their advantages and disadvantages. Below is our choice of data collection techniques.

2.4.1 Literature review

Literature review is a method to gather other researchers knowledge about a particular field of study. Furthermore, the data that is gathered from literature reviews is secondary, which means it needs to be managed with a critical approach (Denscombe, 2007). According to Creswell (2009), literature reviews provide and share results from previous studies, which makes it easier for a researcher to benchmark and compare the results from his own study. In this thesis we will study literature in the shape of books and articles to investigate current findings. The literature will provide us with the theoretical framework for the analysis.

2.4.2 Corporate data

Company data and documents such as guidelines, reports and database files relating to Elekta's current LL process are obtained. This data is viewed as primary data.

2.4.3 Interviews

Selection of respondents

The selection of respondents was based on the criterion that they either are project managers or have been working as project managers. Based on this criterion, we received a list of ten people from Elekta. From that list, we randomly chose six with various job positions (e.g. R&D, Quality & Regularity affairs) and ranges of experience, and asked them if they would be able to participate in an interview about project learning, lasting for an hour. Time and resources restricted the number of interviewees to six.

Creation of interview questions

When the creation of the interviews started, we had several criteria which were required to be fulfilled. First of all, the questions we selected had to be easy to understand which, in turn, would eliminate any possibility for misunderstanding. Furthermore, the questions had to have an approach which gives the respondent the opportunity to talk freely about the questions and develop ideas around the research topic. During the creation of the interview questions, it was necessary to deliberate about the potential answers we might get from the interviewees, so that questions could be rephrased and improved before the actual interviews took place.

When the interview sheet was ready, a "pilot interview" was carried out with the supervisor at Elekta. The purpose of this interview was to get feedback on the structure of the questions, if they were easy to interpret and understand. Eventually, two questions had to be rephrased or redesigned.

The interview consists of an introduction and 21 questions (see Appendix 1). The introduction is on the front page of the interview sheet. The intention with the introductory text was to provide brief background information about the research topic. The front page further explains that the interview will be confidential and last for approximately an hour. The questions were derived from the frame of reference. In other words, we asked questions concerning; project learning, project management, and the processes of LL, i.e. capture, storage and transfer.

The interviews are divided into five sections:

- Section A – Demographics
- Section B – Introduction
- Section C – Collecting lessons
- Section D – Storing lessons
- Section E – Transfer lessons

Chosen interview method

In order to assess and grasp the interviewees' thoughts and beliefs concerning the research topic, we came to the conclusion that a qualitative approach was most suitable for this thesis.

This is in line with the views of Creswell (2009), who explains that qualitative research is suitable when using an exploratory strategy. It is further stated by Dawson (2002) that a qualitative interview is beneficial because it collects in-depth opinions from the participants and takes attitude, behaviors and experiences into consideration. However, one of the negative aspects of qualitative interviewing is the time-consuming work required to manage the cumbersome amount of data (Bryman 2008). Bryman (2008) further states that it can take around 5-6 hours to analyze 1 hour of interview speech. Nevertheless, a qualitative approach was used due to the fact that we needed to capture the ideas and opinions regarding the capture, storage and transfer of LL. The interviews were of semi-structured, open-ended nature, which means we had a clear list of selected topics and questions that needed to be addressed. Furthermore, a semi-structured approach was helpful to facilitate the steering of the interview.

In connection with the interviews at Elekta Instrument AB, we had the participants answer a few questions of quantitative nature, in addition to the open-ended interview. These questions were answered solely by the interviewees, thus constituting a small sample size. However, by combining the qualitative questions with participants' own thoughts and authentic quotes, any uncertainty that might dispute around the trustworthiness of the data was eliminated.

Preparation of interviews

The interview sheet was sent out in advance to the respondents at Elekta. That way, they got a chance to print it out, read it through, and make any necessary notes before the interview. They were also encouraged to answer the multiple choice questions before coming to the interview.

Confidentiality

All the answers gathered from the interviews were confidential. This was also stated on the front page of the interview sheet. The interviewees got fictitious names and can be quoted in the thesis. In addition, we asked the interviewees if they would accept being recorded during the entire interview.

The interviews

Denscombe (2007) argues that interviews should take place in a quiet setting with no chance for interactions. The interviews were conducted in smaller group rooms in the Elekta office, away from any distraction. Bryman (2008) emphasizes the need to record and transcribe the interviewee's answers. This is of great help for us as researchers, since it ensures that the answers are reliable and that words are not taken out of context. Another positive aspect, which relates to the latter, is the possibility to do an in-depth examination of what the interviewee actually said (Heritage, 1984). However, there are some negative aspects of using a recorder. For example, an interviewee might feel susceptible and insecure (Bryman, 2008). Despite the negative aspect we decided to record. Throughout the interviews one of us was taking notes on the question sheet while the other asked the questions. This method worked

very well. We estimated the interview to last for approximately 40 minutes. The actual time varied between 40 and 60 minutes.

Analysis of interview data

The interviews were transcribed in Swedish. During the analysis it was translated to English. Our expertise in English leaves little risk of misinterpreting the data. As stated earlier, data was transcribed in detail in order to grasp what people actually said which, in turn, helped to catch interesting quotations and insights.

Coding the data

After transcribing the data, it was read through as ideas were noted in the document. It was carefully organized and prepared which, in turn, facilitated the screening process. The screening process reduced the amount of data which were considered as non-value data. The data was broken down into categories which were labeled with a term, which is – according to Creswell (2009) – called *in vivo term*. This facilitated the process to;

- Compare and combine the data
- Find similarities in the data
- Find dissimilarities in the data
- Find interesting quotes in the data

Benchmarking interviews

As we stated earlier, we conducted four interviews at four different organizations to benchmark our findings at Elekta. These interviews had a slightly different approach than the interviews conducted at Elekta. Instead of a semi-structured approach, these were unstructured. This approach was chosen because of our lack of knowledge of any existing knowledge processes at each firm. Hence, we wanted the respondents to talk freely about their own thoughts and beliefs. Depending on the relevance of the issues brought up, the influence from the researcher varied.

2.5 How argumentation is built

There are two main approaches when it comes to argumentation; induction and deduction. With an inductive approach, theory is the product of research. Thus, the researcher first gathers data. A theory is then developed based on findings (Bryman, 2008). Deduction is used to verify and test an already established theory (Denscombe, 2007). In this thesis we will follow a deductive approach. We will present the theory platform before the empirical study is presented. In the empirical study, we will use and test our findings from the theory, in order to explore Elekta's current problems, challenges and needs.

Later on, benchmarking interviews is conducted to find current solutions, needs and challenges at four other organizations. From this, we derive our conclusions, present recommendations and lastly discuss our contribution to science, the credibility and further

work. Moreover, triangulation is also an ingredient in this study – two researchers have collected data from a variety of sources steering the conclusion in a joint direction which is in line with what the literature states. According to Dencombe (2007), triangulation is important to get a better knowledge and understanding of the subject.

2.6 Credibility

In order to ensure the credibility in this project, we are using multiple data collection methods and sources of data, which in turn, enable an extensive triangulation of data, ensuring the validity of the research. Six interviews with six project managers at Elekta were carried out. Beyond this, four additional interviews at four different organizations were conducted. Anything included from the interviews with the external organizations was sent to the interviewees for validation. The literature review was conducted by collecting information from multiple sources, each providing their view on the given topics, ensuring validity. The semi-structured interview form was handed out to the interviewees prior to the interview to eliminate risk for misunderstanding. Further, the analysis was reviewed by members of Elekta to ensure that conclusions were based on facts and not biased by the researchers' valuations. The analysis was carried out with an open mind to ensure that the research findings were objectively obtained. Nothing that could misfit the analysis was overlooked and left behind. Due to the qualitative approach of this research, in-depth descriptions of situations have been provided, enabling the reader to better understand the phenomena that is investigated. Much of the problems, challenges and needs that are addressed in this thesis exist in other project-based organizations. Therefore, the findings and the recommendations that were compiled for Elekta Instrument AB can be generalized and transferred, and thus be of interest for other organizations.

More in-depth discussion regarding the credibility of this thesis project takes place in chapter 7.2, which reflects on the chosen methodology and contains more explicit examples of our work to ensure that the interviews came out reliable.

3. Frame of reference

The purpose of this chapter is to present the theoretical framework that was used in this project. First, the theory behind project, project management and project process improvement is presented. This is followed by the theory behind knowledge management and the different features of knowledge e.g. knowledge creation and transfer. Furthermore, the researchers conclude this chapter by discussing the different aspects of project learning and LL. All in all, this chapter is fundamental for data gathering and will serve as ground for developing questions. Further the literature study will act as foundation for the analysis, enabling the researchers to draw conclusions and define recommendations.

3.1 Theory behind project and project management

In response to the uncertainty and environmental pressure in today´s market, companies need to act quickly and be competitive in order to hold their position in the market. Since the second half of the 20th century, many organizations have converted from the traditional functional organization to a more temporary *project-based organization* (PBO) (Wiewiora et al., 2009; Kerzner, 2009).

The literature supports the opinion that a PBO have several benefits compared to a functional organization. A PBO can quickly respond to upcoming changes in the environment e.g. increasing competition and technology changes (Kerzner, 2009). Other strengths with a PBO are fast delivery of a product with a limited amount of resources and implementation of new business processes (Wiewiora et al., 2009).

A *project* is a temporary and unique organization which has a limited life cycle. Its mission is to create a unique company objective e.g. a product or service. The length of a project is limited and a project is usually terminated either when the outcome is reached or when the predefined objectives cannot be reached. Moreover, projects are also multifunctional, which means they can involve a single organizational unit or a multiple organizational unit. A project has, traditionally, a predefined procedure with specific components, but these may vary depending on the organization. Even though there is a predefined procedure in projects, uncertainty can always arise due to its uniqueness (PMBOK™ Guide 2008; Kerzner 2009).

Turner et al. (2000) define a project-based organization as "an organization in which the majority of products made or services supplied are against bespoke designs for customers." A project-based organization can be a separate firm, making products for external customers, or a subsidiary of a larger firm, making products for internal or external customers. In Table 2, shown below, there is a comparison between a project based organization and a functional organization.

Table 2: Comparison between project-based organization and functional organization (Wiewiora et al., 2009)

Characteristics	Project-based organization	Functional organization
Organizational structure	Main unit – Project Project: Unique, novel and transient Project Manager is a chief executive of a temporary organization Lack or weakness of formal links across projects	Main unit – Function, Department, Division Activity: Repetitive, routine and ongoing Manager of the function reports to senior manager who further reports to executive manager in a chain of command. Easy co-ordination between departments as activities are related
Viewpoint on TIME	Time is existence Time oriented Finite character – the end date of the project is known from the outset	Time is money Survival (continue existence) oriented Future is perceived as eternal with no end time identified priori
Process(es) and people	Flexible, staged People come from several areas of organization; are formed around the project.	Stable, continuous People remain on their positions and stay within the function.
Geographical Location	Co-located and geographically dispersed projects	Co-located functions

Further, a *matrix organization* is a combination of functional and projectized characteristics, in which a project manager is more or less responsible for the progress of the project (PMBOK™ Guide, 2008). A project involves most functions in the organization and thus constitute a cross-functional team. The employees in a matrix organization are accountable to both the line management and the project management, and therefore a conflict of loyalty can arise between line managers and project managers over the allocation of resources.

3.1.1 Project management process groups

PMBOK™ Guide (2008) defines project management as the "application of knowledge, skills, tools and techniques to project activities to meet the project requirements". In project

management, there are nine different knowledge areas comprised in five different interrelated processes, or phases (see Figure 2), that are followed to ensure the project meets the stakeholder's predefined deliverables. Moreover, these five related processes guide the project team and ensure that the project has an effective flow throughout the whole project life cycle. The predefined process groups are the following:

- *Initiating process* – In order to initiate a new project or new phase, authorization is needed. In order to obtain this, the project or the phase needs to be clearly defined. The initial scope, financial resources and the stakeholders are defined. All the material is then gathered in a project charter and stakeholder register.

- *Planning process* – The planning process helps to reach the predefined goal, and consists of a number of processes where the project team pinpoints the project scope, enhances the objectives, develops the work breakdown structure (WBS) and defines which actions it needs to take. However, the planning and documenting processes are ongoing processes during the whole project life cycle due to a continuous supply of project information, insights and experience.

- *Executing process* – The executing stage is a set of processes in which all the resources in the project team execute the predefined objectives.

- *Monitoring and controlling process* – Monitoring and controlling the project performance is essential because it supports the project manager to; collect progress status, analyze and observe variances, communicate project status and take actions if necessary.

- *Closing process* – The last process group contains a set of processes to formally close or phase out the project. During this process, the project management team verifies that all previous processes are completed. In addition, post-project reviews are conducted and LL should be documented.

All processes which are presented above are divided into nine different knowledge areas which are defined in the PMBOK™ Guide. A full picture of the whole system is displayed below.

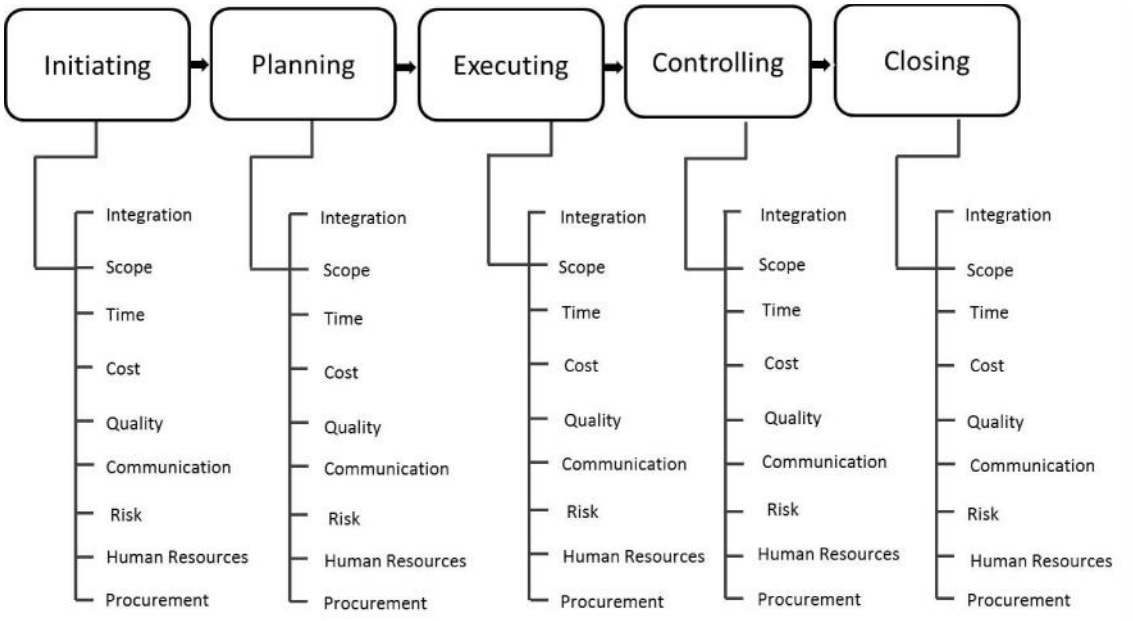


Figure 3: The five process groups integrated with the nine knowledge areas (PMBOK™ Guide, 2008)

Table 3, which is presented below, provides a brief definition of all nine knowledge areas that were lined up in figure 3.

Table 3: All knowledge areas and their definitions (PMBOK™ Guide, 2008)

Knowledge Area	Definition
Integration management	A set of processes that coordinates the project management processes and activities throughout the project life cycle.
Scope management	A set of processes used to control and limit the project requirements.
Time Management	A set of processes used to ensure that the project is completed on time.
Cost Management	A set of processes that ensures the project is within budget and completed on time.
Quality Management	A set of processes that ensures the project meets its requirements, objectives and guidelines.
Human Resource Management	A set of processes used to acquire, develop, and manage the project team.
Communication Management	A set of processes that determine which information is needed, how that information is transferred to all stakeholders and how to report the project performance.
Risk Management	A set of processes used to identify, manage and control the project risks.
Procurement Management	A group of processes used to acquire products, services or results needed to accomplish the project.

3.1.2 Environmental factors and organizational process assets

Different tools and techniques can be applied to the project management processes which shape the outcome. For every project, however, there are always two aspects that influence the project process; enterprise *environmental factors* and *organizational process assets*. An enterprise environmental factor can either be internal (e.g. organizational culture) or external (e.g. marketplace conditions). Organizational process assets include all process related assets that can be used to influence a project's success, e.g. plans, policies, procedures, guidelines, and templates. Process assets also include the corporate knowledge bases such as LL and historical information. As stated above, every project is unique which in turn demands

specific needs. As a result, the project team needs to take the organizational process assets into account because it supports the decision to shape the correct organizational processes to successfully deliver the project requirements. Additionally, all processes can be flowcharted measured and improved (PMBOK™ Guide, 2008).

3.2 Project process improvement

The challenge for organizations is to keep the project management processes as efficient as possible to maintain its competitive advantage. If the project management processes operates the similar way year after year and is not continuously improved, the processes will be misused or not used at all. In order to be an effective organization and deliver high quality products or services, organizations need to reach maturity to encounter its goals effectively. The definition of project maturity is highlighted in the next section (Wysocki, 2004).

3.2.1 Project management maturity

The term *Project management maturity* (PMM), is widely used in Project Management (PM) literature to understand how well an organization is performing its current PM practices and processes. If the organization is improving its PMM, it will increase its project performance in all knowledge areas. Additionally, if the PMM is on a high level, the organization is more efficient and has better capabilities to continually deliver successful projects (Practices, 2012).

3.2.2 Project management maturity model (PMMM)

A widely used model to examine an organization's project maturity is the Project Management Maturity Model (PMMM). Over the years, several models from different authors and organizations have been introduced in the literature to capture a variety of views on the PMMM. In fact, an estimation which was made ten years ago identified over 30 different models that were out on the market (Pennypacker & Grant, 2003).
Moreover, most of the PMMM's are patterned after the CMM (see Chapter 1.1) due to a widespread acceptance of this model (Crawford, 2006). The PMMM is composed by five different levels or phases. Each of them represents a certain project maturity condition. Further, the PMMM's found in the literature incorporates the nine different knowledge areas described in PMI´s PMBOK™ Guide.

3.2.3 Assess the Project Management Maturity level

Before an organization tackles its weak areas, it needs to identify its current project management maturity level. This can be achieved through a comprehensive assessment where all the nine knowledge areas are evaluated. If the assessment is done correctly, the organization will identify the areas which make up the weakest links in the organization. It is appropriate for an organization to; first take action on their weakest areas which provide low return on investment rather than improve the areas the organization is already good at. For example, an organization performs well and achieves level 5 in one knowledge area, but in the

same time continues to perform at level 2 in other areas. As a result, the potential benefit the level 5 knowledge area may have on the organization could be erased (Crawford, 2006).

Crawford (2006) states in his article four different elements a project management maturity assessment should contain:

- Personal and/or group interviews
- Collection of knowledge artifacts (documentation, notes etc.) and evaluation
- Widespread survey input
- Benchmark comparison to established standards

3.2.4 Benefits of the Project Management Maturity Model

As a result of the comprehensive assessment an organization does to evaluate its project management maturity, several benefits appear:

Framework for continuous improvement

In order to achieve project success continuously, organizations need to have a dedicated strategy to improve their capabilities. The PMMM is a framework for continuous improvement. It has a simple designed structure which is easy to grasp and assess (Pennypacker & Grant, 2003).

Localize and identify strengths

Judgev & Thomas (2002) explain that the PMMM maps out ways to localize and identify strengths and weaknesses in the project organization. In addition, the model helps organizations to find particular key points where they need to take actions to improve their project and process practices and, in turn, set the direction and move the organization forward (Fincher & Levin, 1997).

Benchmarking information

The literature supports the standpoint that the PMMM provide useful benchmarking information. In turn, this leads to several benefits for the organization. With project management maturity benchmarking, a company can – according to Pennypacker & Grant (2003) – compare its project deliverables with other similar companies. This may lead to improved project delivery capabilities. Furthermore, it can also provide the company with an enhanced opportunity to succeed in the marketplace.

Cultural change

Another benefit organizations may gain from a structured assessment of the PMMM is the start of a cultural change among the employees. Employees may gain new insights and understanding how the project processes are performed (Crawford, 2006).

3.2.5 Explanation of the five different levels of PMMM

As mentioned earlier, there are five different levels or phases in the PMMM. Each of these levels is integrated with the nine – well known – knowledge areas from PMI. Each level can be read up on below.

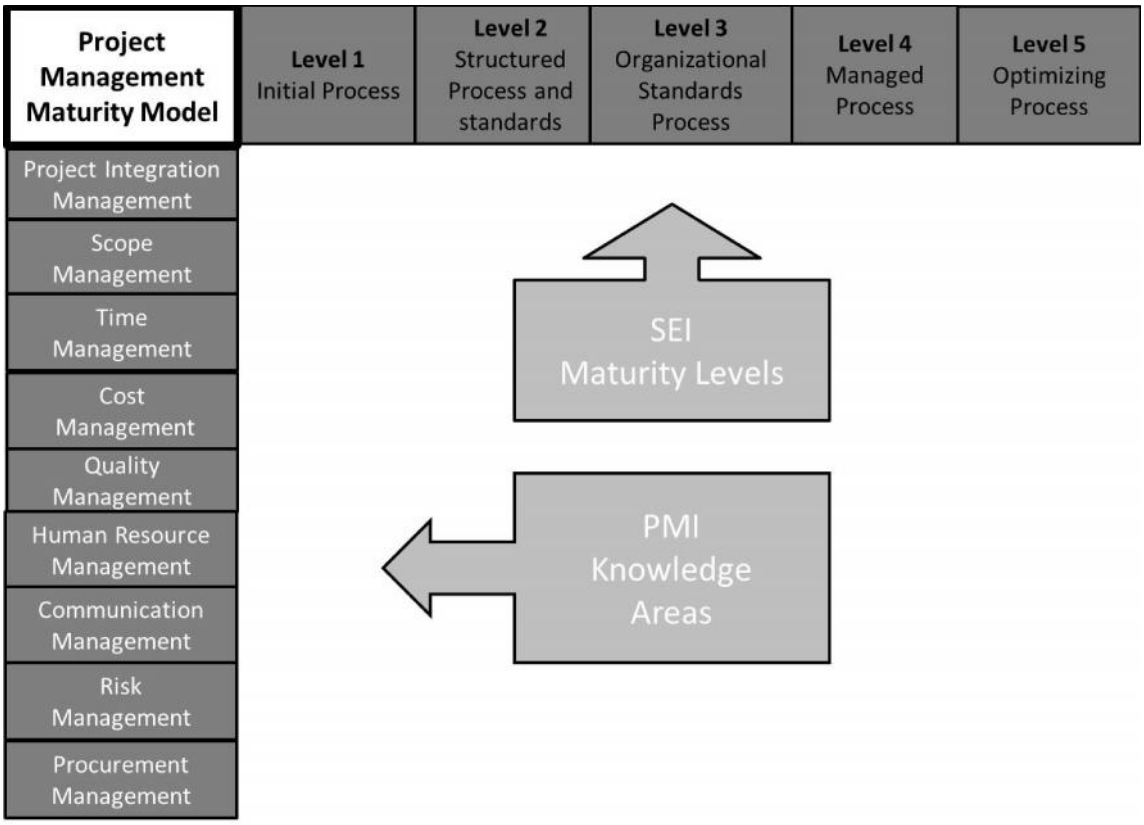


Figure 4: PMMM adapted from Crawford (2006)

Level 1: Initial process

On this level, all project management processes and routines are carried out on *ad hoc* basis, which means the processes are not standardized and the project manager acts in an ad hoc manner when conducting a new project process or activity. The documentation's routines are *not* defined and there is no procedure to share knowledge, experiences and best practices outside the project team. Hence, the project team is largely dependent on their own expertise (Wysocki, 2004). Despite the lack of routines and processes, some projects can be successful due to individual and "heroic" efforts. Furthermore, there is no existing project processes in this stage and project members have a tendency to invent their own process that suits them well (Fincher & Levin, 1997).

Level 2: Structured process and standards

In contrast with the first level, where all processes are managed in an ad hoc manner, in the second level there is an implemented – although basic – project process methodology. The management team encourages and supports the team to use the predefined practices but there are *no* requirements to do it systematically. Occasions when project management processes are followed in a structural routine are when projects are; critical, large and visible (Wysocki, 2004). Tracking project performance status like costs is on a basic level. In general, there is *no* standardized way to write information documents. The documents are, in general, a mixture between detailed and summary documents (Pennypacker & Grant, 2003).

Level 3: Organization standards and institutionalized process

At the third level – organization standards and institutionalized process – project management processes are established as organization standards i.e. all project teams are required to follow a certain standard. Likewise, the management team has institutionalized processes. Regardless how important or large the project is, the management team is integrated in the project process and provide essential support e.g. approval of key decisions (Pennypacker & Grant, 2003). Furthermore, monitoring and controlling functions are integrated into the organization, but project performance is only on an informal level (Crawford, 2006).

Level 4: Managed process

In the fourth level – managed process – organizations have integrated the project management processes with other corporate processes (Pennypacker & Grant, 2003). When managing on this level, managers adapt their decisions based on two elements; how projects were performed in the past and the potential expectations on future projects. In addition, changes that occur are coordinated across the project team. As a result, managers have the ability to anticipate difficulties in an early stage and determine suitable solutions (Fincher & Levin, 1997). Another vital difference compared to the third level is the capturing of LL and best practices. These LL and best practices are also accessible for other projects (Wysocki, 2004).

Level 5: Optimizing process

The last level – *optimizing process* – differs from the fourth level in multiple ways, both in terms of project management processes, LL, best practices, management commitment and project data. The lead word in this level is continuous improvement. LL and best practices are in this stage incorporated in the organization and are used to improve the project documentation and processes. Hence, the whole organization is absorbing and using the LL and best practices (Wysocki, 2004).

3.3 Knowledge management

The emphasis in research about project management throughout the years has gone from focusing on the management of the individual project, to focusing on creating an environment

in which projects can thrive. In the 1970s, the focus on project management research was on developing tools and techniques. In the 1980s, it was to everyone's understanding that before you can choose appropriate tools to manage a project, you need to know what factors will influence the success of a project. Thus, the focus was on success factors. In the 1990s, however, the focus changed to success criteria. In other words, before you can do all of the above, you need to know how the project will be judged successful at the end, and have the entire team – including all stakeholders – focusing on the same end objectives. The research of the last three decades of the 20th century has inevitably made improvements to project performance (Turner, 2005).

In more recent years the focus has changed to emphasize the creation of a project environment where projects can flourish. Many high-tech and engineering project-based organizations recognize that delivering projects successfully results in competitive advantage. Thus, it is key for an organization to remember how to deliver projects successfully and to improve that knowledge continuously. A functional organization follows a classic three-step process of knowledge management; variation, selection, and retention (Turner, 2005).

Variation leads to changes in organizational practices. And variations in task performance that prove successful will be selected and preserved. Thus, a mechanism exists for retaining the process and it will be facilitated if there are people in the organization who are able to remember the winning activities, or if the organization's files allow easy review of past actions (Aldrich, 2007). A project-based organization, however, is more complex. Turner (2005) explains: *"[In functional organizations] new ideas are created in a function, successful ideas are chosen for reuse, and the knowledge stored within the function where it can be reused. In project-based organizations, new ideas are created on temporary projects, but the project cannot select and retain new ideas. Further, wherever those new ideas are stored, they are not immediately available to new projects."*

For that reason the project-based organization needs to reflect on how to select new knowledge, where to store it, and it needs to add a fourth step of knowledge management; transfer of knowledge to new projects (Turner, 2005).

Knowledge management needs to be embedded throughout everyone's job. By sharing of LL, mentoring, applying knowledge capture/retention activities, exchanging stories and experiences, knowledge management can be part of the everyday organization (Liebowitz, 2005).

Alavi & Leidner (2001) explains that knowledge management refers to identifying and disseminating the collective knowledge in an organization to increase the innovativeness and help it compete. Even though discrepancies exist in the literature, most authors refer to knowledge management as a process involving a variety of activities. The most fundamental KM processes are those of *creating*, *storing/retrieving*, *transferring*, and *applying* knowledge. Further, these processes can be broken up in sub-activities, such as creating internal knowledge, obtaining external knowledge, storing knowledge in documents as opposed to routines, and updating and sharing knowledge both internally and externally.

3.3.1 The definition of knowledge

Knowledge is information held in the mind of individuals: it is personalized information in the form of facts, procedures, concepts, interpretations, ideas, observations, and judgments. Thus, once information is processed in the mind of individuals it is transformed into knowledge. Furthermore, knowledge becomes information once it is expressed and presented in the form of text, graphics, or other symbolic forms (Alavi & Leidner, 2001).

There is a clear difference between information and knowledge. Ikujiro Nonaka (1994) expressed that "information is a flow of messages, while knowledge is created and organized by the very flow of information, anchored on the commitment and beliefs of its holder." Knowledge is from this standpoint directly associated with human action.

There are many views of knowledge described in the literature and these views understandably lead to different perceptions of knowledge management. Alavi & Leidner (2001) summarize different perspectives found in the literature and explain their implication for knowledge management. Knowledge can be viewed as; a *state of mind*, an *object*, a *process*, a condition of having *access to information*, or a *capacity*. The perspective on knowledge as a state of mind focuses on enabling individuals to extend their personal knowledge and apply it to their organization's needs. Another view is that of knowledge as an object, a thing to be stored and manipulated. The process perspective views knowledge as a process of simultaneously knowing and acting, and emphasizes expertise. The fourth view entails that knowledge must be organized to facilitate access to and retrieval of content. Lastly, knowledge can be viewed as an ability with the potential to influence future action. Table 4 summarizes these views and their implications for knowledge management.

Table 4: Summary of knowledge views (Alavi & Leidner, 2001)

Knowledge Perspectives and Their Implications		
Perspectives		**Implications for Knowledge Management (KM)**
Knowledge vis-à-vis data and information	Data is facts, raw numbers. Information is processed/ interpreted data. Knowledge is personalized information	KM focuses on exposing individuals to potentially useful information and facilitating assimilation of information
State of mind	Knowledge is the state of knowing and understanding	KM involves enhancing individuals learning and understanding through provision of information
Object	Knowledge is an object to be stored and manipulated.	Key KM issue is building and managing knowledge stocks.
Process	Knowledge is a process of applying expertise.	KM focus is on knowledge flows and the process of creation, sharing, and distributing knowledge
Access to information	Knowledge is a condition of access to information	KM focus is organized access to and retrieval of content
Capability	Knowledge is the potential to influence action	KM is about building core competencies and understanding strategic know-how

3.3.2 Knowledge types

Nonaka (1994) insinuates that knowledge in organizations exists in two dimensions; *tacit* and *explicit*. Through interplay between explicit and tacit knowledge new ideas and concepts are created. Tacit knowledge is rooted in actions and experience and consists of both cognitive and technical elements. The cognitive element refers to mental models consisting of beliefs, paradigms and viewpoints which form an individual's perspective. In contrast, the technical element of tacit knowledge consists of know-how, crafts, and skills that apply to a specific context. Explicit knowledge, on the other hand, is codified and stored in repositories such as libraries, archives and databases.

Schindler & Eppler (2003) explain that explicit knowledge answers the *what*, *where* and *how many* questions, while tacit knowledge is difficult to express and refers to the *know-how* and *know-why* questions. Furthermore, these questions edify a classification into *declarative*, *procedural*, *casual*, *conditional* and *relational* knowledge (Alavi & Leidner, 2001).

There is also a distinction between *individual* and *social* knowledge. Individual knowledge is created by the individual and thus solely exists in the individual. Social knowledge is formed by a collective of people and embedded in their joint actions. A *pragmatic* view of knowledge also exists and refers to knowledge valuable to organizations, i.e. knowledge about customers, competitors, products, processes, project experiences etc. (Alavi & Leidner, 2001). Table 5 summarizes and clarifies the different types of knowledge raised in this section.

Table 5: Knowledge categories and examples (Alavi & Leidner, 2001)

Knowledge types	Definitions	Examples
Tacit	Knowledge is rooted in actions, experience, and involvement in specific context	Best means of dealing with specific customer
Cognitive tacit:	Mental models	Individual's belief on cause-effect relationships
Technical tacit:	Know-how applicable to specific work	Surgery skills
Explicit	Articulated, generalized knowledge	Knowledge of major customers in a region
Individual	Created by and inherent in the individual	Insights gained from completed project
Social	Created by and inherent in collective actions of a group	Norms for inter-group communication
Declarative	Know-about	What drug is appropriate for an illness
Procedural	Know-how	How to administer a particular drug
Causal	Know-why	Understanding why the drug works
Conditional	Know-when	Understanding when to prescribe the drug
Relational	Know-with	Understanding how the drug interacts with other drugs
Pragmatic	Useful knowledge for an organization	Best practices, business frameworks, project experiences, engineering drawings, market reports

3.3.3 Knowledge creation

How is knowledge created? Ikujiro Nonaka (1994) explains that knowledge is created through conversion between "tacit knowledge" and "explicit knowledge". Again, explicit knowledge is codified and transmittable in formal, systematic language. By contrast, tacit knowledge is hard to communicate and is embedded in action, dedication and involvement in a specific context.

Nonaka (1994) has identified four modes of knowledge creation. These modes are illustrated in Figure 4.

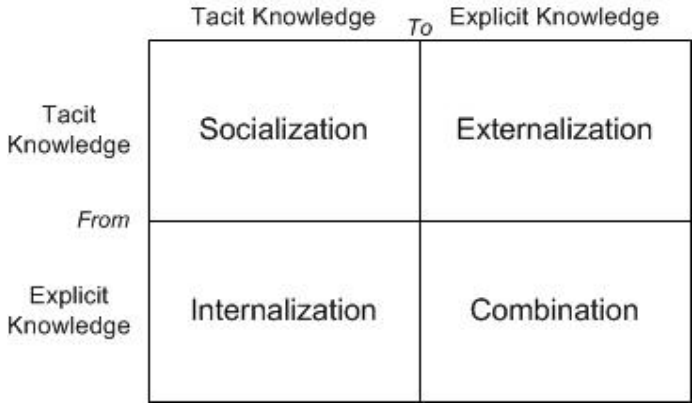


Figure 5: The four modes of knowledge creation (Nonaka, 1994)

1. *Socialization* (tacit-tacit): The socialization mode refers to the translation of tacit knowledge to new tacit knowledge through shared experience and social interactions.

2. *Externalization* (tacit-explicit): Externalization involves the conversion of tacit knowledge into explicit knowledge. In other words, it means translating tacit knowledge into comprehensible forms (e.g. articulation of LL).

3. *Combination* (explicit-explicit): The combination mode refers to the creation of new explicit knowledge by merging, categorizing and contextualizing existing explicit knowledge

4. *Internalization* (explicit-tacit): Internalization is the creation of new tacit knowledge from explicit knowledge, which is similar to traditional learning that results from reading and discussion.

The knowledge management cycle describes the flow of knowledge and consists of four stages. First, knowledge has to be identified and collected. Then knowledge can be shared with others, and in combination with existing knowledge it is applied and subsequently formed into new knowledge, which is captured again and the cycle continues (Liebowitz, 2005).

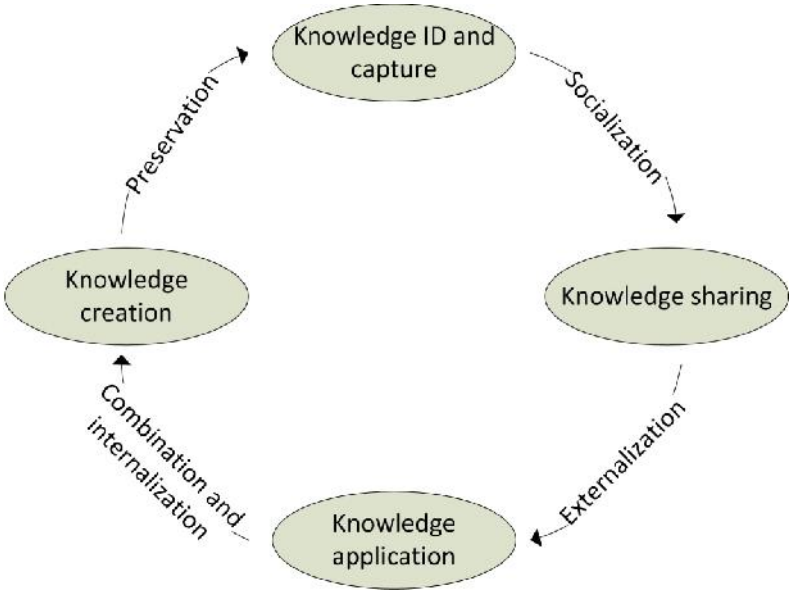


Figure 6: Knowledge management cycle (Liebowitz, 2005)

Nonaka's four knowledge modes can be integrated in the knowledge management cycle as shown in Figure 6. Once knowledge has been identified, socialization takes place and as a result knowledge is shared. This sharing of knowledge results in knowledge externalization – from tacit to explicit – and knowledge application. The explicit knowledge is then converted into new knowledge when combined with other knowledge that is stored in individuals, and it is also internalized affected by individual worldviews and values. The new knowledge needs to be captured and the cycle starts over again (Liebowitz, 2005).

Certain tools can be used to facilitate and enhance knowledge creation. For example, IT tools may be of great value in several knowledge modes. Data storing and data mining could be of great value in the combination mode. An intranet can enhance the internalization in an organization by supporting individual learning and providing a forum where organizational members can interact and share ideas and perspectives (Alavi & Leidner, 2001).

3.3.4 Knowledge storage

An important part of effective organizational knowledge management, resides in the storage and retrieval of *organizational memory*. In contrast to *individual memory*, which is based on a person's observations, experiences and actions, organizational memory also includes other elements such as organizational culture, production processes and work procedures as well as internal and external information archives (e.g. written documentation, structured information stored in electronic databases). Further, organizational memory is classified into *semantic* or *episodic* knowledge. Semantic knowledge refers to general, explicit and articulated knowledge such as archives of annual reports. Episodic knowledge, on the other hand, is context-specific and involves specific organizational decisions and their outcomes, place, and time. Advanced computer storage technology, such as different types of databases, are tools that can enable access to and enhance organizational memory (Alavi & Leidner, 2001).

The benefit of having a knowledge repository to improve knowledge transfer depends on the nature and structure of an organization. Weber and Aha (2003) states that all organizations that fit into one or more of the following cases would profit from using a knowledge repository to support sharing and leveraging of experimental knowledge.

- Large hierarchical organizations where members cannot easily interact.
- Organizations that cannot use automatic methods to incorporate new and experimental knowledge into their system of beliefs (e.g. military).
- Organizations in rapidly changing industries (e.g. innovative high technology firms).
- Organizations whose knowledge is used seldom or is extremely variable (e.g. military operations repeated in different countries and conditions).
- Organizations in which sharing a single experience can save lives (e.g. the Department of Defense).

Great effort is needed in the process of storing organizational memory. Once being stored it is important that the data is not taken out of context. It needs to be analyzed and processed in such a manner that it can be understood and easily applied. Davenport and Prusak (1998) shares an example about how Chrysler stores knowledge for new car development in a series of repositories called "Engineering Books of Knowledge", which act as electronic memory in the form of computer files stored with knowledge from automotive platform teams. When a series of crash test results was to be included in a book, the manager of that book saw it as raw data and encouraged the submitter to add value to the figures. The results needed to be put in contexts – why were the crash tests performed? Comparing results of other models, previous years, and competitors' cars could add understanding and quality to the facts. What redesigns to bumper and chassis did the results imply?

Alavi & Leidner's (2001) view also implicates the importance of having collected data go through a process of refining so that it can be communicated in the most worthy manner; *"Hoards of information are of little value; only that information which is actively processed in the mind of an individual through a process of reflection, enlightenment, or learning can be useful."*

3.3.5 Knowledge transfer

The transfer of knowledge concerns an organizations struggle to maintain its knowledge base as employees come and go. However, organizations most often do not know what they know and have no profound ways for finding and retrieving knowledge located in them (Alavi & Leidner, 2001). According to Diedrich (2004), individuals are in possession of knowledge gained through learning, which emphasizes the need for the organization to transfer as much knowledge as possible from the individual to all other employees in the organization. Only then the organization "will know what it knows", and when that happens employees can concentrate on being innovative instead of spending time solving reoccurring problems, i.e. they do not have to "reinvent the wheel".

Throughout the literature, several authors have tried to capture what lies beneath knowledge transfer and the processes involved. One of the most popular process models for shaping knowledge transfer is called *case-based reasoning* and can be read upon below.

Case-based reasoning

The case-based reasoning (CBR) process is much similar to general knowledge management processes. The CBR cycle is strongly correlated to the KM cycle and is divided into for sub-processes: retrieve, reuse, revise, and retain. A problem is solved by *retrieving* one or more cases from a case-base, *reusing* the case in some way, *revising* the solution based on reusing the previous case, and *retaining* the experience by integrating it into the existing case-base (Aamodt, 1989). The CBR cycle is shown below in Figure 7.

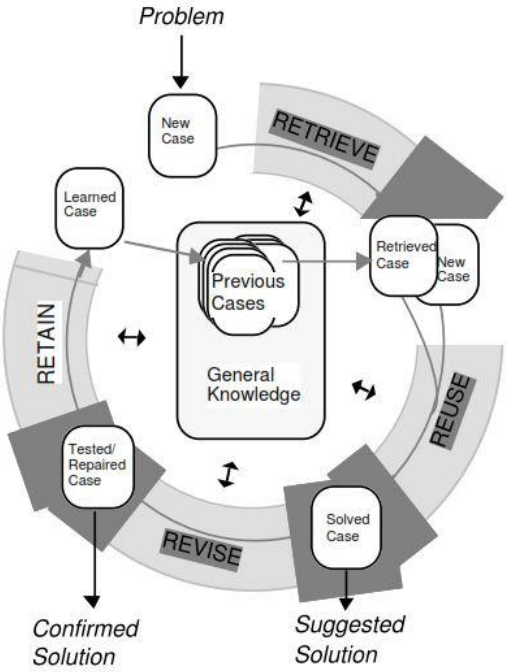


Figure 7: CBR cycle (Aamodt, 1989)

3.3.6 Knowledge management systems

Knowledge exchange has seen new opportunities with the low cost of computers and networks. People with knowledge can easily be found and communicated with through sound, video and text (Davenport & Prusak, 1998). These IT-based systems that support and improve the organizational processes of knowledge creation, storage, retrieval, transfer, and application, is referred to as Knowledge Management Systems (KMS). KMS allows one to search through recorded sources of knowledge using online directories and databases. For example, it supports knowledge sharing and collaboration in virtual teams; learning about customer needs and behavior by analyzing transaction data; gives access to information on

past projects etc. (Alavi & Leidner, 2001). However, KMS do not create knowledge and do not guarantee that knowledge will be generated or shared in an organization without a knowledge sharing corporate culture (Davenport & Prusak, 1998). We will add to Table 4 (p. 24) – which summarizes the various views of knowledge and their meaning for knowledge management – the different implications for Knowledge Management Systems (see Table 6).

Table 6: Knowledge perspectives and their implications (Alavi & Leidner, 2001)

Knowledge Perspectives and Their Implications			
Perspectives		**Implications for Knowledge Management (KM)**	**Implications for Knowledge Management Systems (KMS)**
Knowledge vis-à-vis data and information	Data is facts, raw numbers. Information is processed/ interpreted data. Knowledge is personalized information	KM focuses on exposing individuals to potentially useful information and facilitating assimilation of information	KMS will not appear radically different from existing IS, but will be extended toward helping in user assimilation of information
State of mind	Knowledge is the state of knowing and understanding	KM involves enhancing individuals learning and understanding through provision of information	Role of IT is to provide access to sources of knowledge rather than knowledge itself
Object	Knowledge is an object to be stored and manipulated.	Key KM issue is building and managing knowledge stocks.	Role of IT involves gathering, storing, and transferring knowledge
Process	Knowledge is a process of applying expertise.	KM focus is on knowledge flows and the process of creation, sharing, and distributing knowledge	Role of IT is to provide link among sources of knowledge to create wider breadth and depth of knowledge flows
Access to information	Knowledge is a condition of access to information	KM focus is organized access to and retrieval of content	Role of IT is to provide effective search and retrieval mechanisms for locating relevant information
Capability	Knowledge is the potential to influence action	KM is about building core competencies and understanding strategic know-how	Role of IT is to enhance intellectual capital by supporting development of individual and organizational competencies

3.4 Project learning

As stated earlier in the thesis, projects can be considered successful when they deliver a product or service on time, with the correct quality and with the right amount of resources. However, projects should also generate learning for the organization and incorporate learning objectives besides the traditional objectives (Arthur et al., 2001; Koners & Goffin, 2007) Arthur et al., (2001) further states that project success, in terms of learning, "*depends upon the exploration of new learning avenues for both the company and its project participants. Exploration emphasizes themes of search, experimentation, discovery and innovation*".

When a project is nearing its completion and project team members return back to their functional or line duties, the accumulated knowledge gained from working on a specific project is seldom shared or documented (Trevino & Anantmula, 2008). This also tends to happen when project members are working on several projects simultaneously – once a project is completed, the main focus moves to a different project, and they do not stop and reflect on past experiences.

A very important first step to create a learning environment is to make sure that the individuals making up the organization are aware of that knowledge adds value. This is coherent with acknowledging that valuable knowledge gained during projects tends to get lost. Knowledge sharing is not completed once the project team members complete their tasks on projects, and this must be recognized by project managers (Trevino & Anantmula, 2008).

PBOs often face problems with capturing and transferring knowledge from project to project, which results in "reinventing the wheel" (Wiewiora et al., 2009; Bresnen et al., 2006). However, many projects have overlapping components (see Figure 2, p 2). By learning from experience, these components can improve in performance, and the wheel does not have to be reinvented every time a new project is started. Thus, money can be saved (Trevino & Anantmula, 2008).

It is therefore essential to absorb knowledge and experience and, in turn, learn from them (Ayas, 1996). Further, project knowledge and experiences set the foundation for the organization's knowledge base. To be able to gain this knowledge, the organization needs to capture and transfer all knowledge effectively (Schindler & Damm 2002).

Furthermore, learning needs to be a standard practice in project management. It is only then PBOs get the ability to continually improve their project processes and practices (Ayas, 1996; Anbari et al,,2008). However, companies are facing great difficulties to integrate knowledge and experience into the organization. According to a study by Schindler & Eppler (2003), companies usually do not systematically integrate project experience and knowledge into the organization. Hence, the organization is not retaining project insights.

Both tacit and explicit knowledge make up the overall knowledge possessed by project managers, and they are both essential when it comes to the training and education of project managers. In fact, research has shown that 85% of project personnel have gained their knowledge – both explicit and tacit – through experiential learning (Turner et al., 2000). Kolb

(1984) further defines learning as "*the process whereby knowledge is created through transformation of experience."* Kolb's experiential learning cycle explains that experience is constructed in a social setting and shaped by a specific firm or culture. Thus, experience needs to be reflected on and observed from different perspectives in order to be formed into abstract concepts and generalizations, which, in turn, the learner can use to establish theories for performance improvement. Since projects are unique in their nature, competence can be seen as the ability to test the implications of concepts in new situations (Turner et al., 2000).

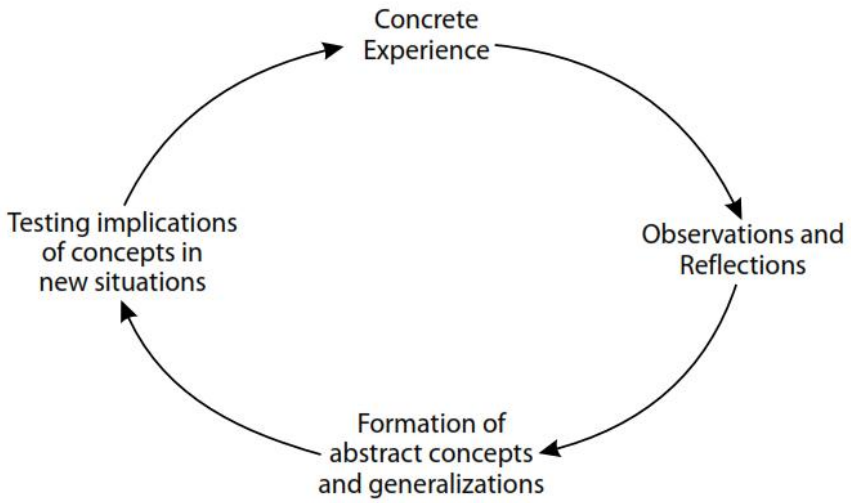


Figure 8: The experiential learning cycle (Turner et al., 2000)

3.4.1 Barriers to project learning

An organization which systematically conserves and uses project experiences effectively, will gain several benefits. Organizations will become more *efficient* to; solve problems, reduce project risks and reduce potential project pitfalls. As a result, organizations will increase their project competencies and in the long-term gain *competitive advantage* (Anbari et al., 2008). However, a PBO has a number of different characteristics – listed below – which makes it hostile to effective learning.

Lack of time to develop trust

Developing trust among people requires a long period of time. In a project, however, there is a limited time frame. Thus, the time to develop trust among project members is limited. As stated by Koskinen et al,. (2003) trust has an indirect effect on how effectively project members share tacit knowledge. Consequently, in a project the tacit knowledge transfer is limited as opposed to in a permanent organization.

Temporary organization

A PBO's operation is by nature temporary, which makes it difficult to learn effectively. Furthermore, a PBO's approach is often action or task- oriented. The people involved in the

project (e.g. project members from within the organization, external partners and consultants) are there to "get the work done" and after the project is completed, they return to their line units, start working on a new project or leave the organization for good. Hence, project experiences are neither fed into the new projects nor into the surrounding organization (Schindler & Eppler, 2003; Ekstedt et al., 1999). Another explanation to why a temporary organization is hostile to learning is the temporary constellation of people i.e. people and relationships differs from time to time, which makes it hard to learn from others (Brady et al., 2002).

Time pressure

A continuous time pressure is always present for a project team. To deliver a specific outcome with predefined objectives within a given time frame and use the right amount of resources are two of the main issues a project team has to deal with. One of the main reasons why time pressure occurs is the *conflict* between the project organization and the surrounding organization. The surrounding organization strives to sum up and terminate a project quickly and reallocate personnel to other newly established projects (Schindler & Eppler., 2003). As a result of this, there are project teams that deliver products without reflection, i.e. the time to discuss, capture and transfer learning to others is scarce. Hence, if this is done over a long period of time, the quality of project learning and the transferring of learning to the surrounding organization will be poor and, as a result, reduce the quality of the project processes and reduce the value for the customers (Keegan & Turner, 2001).

Customization and project novelty

Customization and project novelty are two barriers to project learning in complex product systems (CoPS) projects, e.g. concerning global telecommunication networks, aircraft systems and offshore oil and gas platforms. The customer base in this type of company usually has certain demands, i.e. the customer demands customized solutions with unique requirements and exclusive specifications. A good example can be derived from the aerospace industry – characterized by long project life cycles and advanced technology – which is facing difficulties to transfer knowledge within current projects and, also, between projects. Consequently, the skills the project members possess (e.g. technological and design skills) can become obsolete (Brady et al., 2002).

Uncertainty

When you enter and embrace a new project, a sense of uncertainty is always present for the project team due to the project's uniqueness (PMBOK™ Guide, 2008). One particular reason – according to Brady et al., (2002) - why uncertainty arises is the lack of standardized solutions when a new project is initiated. Thus, the project team is obligated to develop novel solutions for each project. For example, the customer requirements and the possible ways to handle these are unknown, or a customer has a different request which makes the

requirements more complex. As a result, the potential for learning between projects and making changes to project processes is reduced (Brady et al., 2002).

3.5 Lessons learned

The phrase "lessons learned" is mentioned several times in the PMBOK™ Guide, and is listed as an input and output in many of the PMI knowledge areas. LL information should, according to the PMBOK™ Guide, be transferred to the LL repository so that it can be used in future projects or phases. This includes information on issues, risks and techniques that worked well that can be applied to future projects. Essentially, it does not matter what kind of project it is or what size it is. The following chapter will examine the building blocks of the LL process and the tools available for use.

There is always something to learn. The real question is, if citing Terrell (1999), "*How can we ensure that we are truly learning the lessons and not just absorbing them*?"

LL can be seen as key project experiences – positive or negative – that can be transmitted to other future projects (Schindler & Eppler, 2003). Abramovici (1999) points out that LL should be gathered for all business projects. Tasks such as program and project phases, marketing bids, business reengineering tasks, subcontract negotiations or management phases and even larger tasks such as the yearly budget plan, will all profit from having LL captured, stored and used. Not to mention, management must support a LL process with a demand that everyone in the organization follows LL processes.

The National Aeronautics and Space Administration (NASA) has long experience of capturing and sharing knowledge in the form of LL. At NASA the codification approach to knowledge capturing and sharing has dominated the organization in the sense that the knowledge mostly is processed to take explicit forms.

In order to establish a successful and effective LL process, organizations should raise up certain requirements and apply them on all projects. These requirements include the processes of *capturing*, *analyzing*, *storing*, *disseminating* and *re-using* LL (Trevino & Anantmula, 2008). Similarly, Terrell (1999) states that an effective LL process should facilitate the project members to first observe and gather lessons (lesson observed), then understand and finally apply the corrective actions or observations that came up during the LL process (lesson learned).

3.5.1 Capturing lessons

While capturing lessons, it is important that the type and content of the lessons that need to be captured is clear. Also, the organization should identify the knowledge areas that involve the project management practices and processes that need improvement, and based on this document relevant lessons (Trevino & Anantmula, 2008). Further, important LL need to be documented and submitted in a timely manner (Survey of NASA's LL Process, 2001). While gathering lessons, it can help to keep in mind the knowledge one may need to implement

future projects. Also, all projects are subject to LL capturing, even the small and simple (Trevino & Anantamula, 2008).

Project managers should determine which method(s) to use for capturing LL, whether it is meetings, interviews, audits etc. Tacit knowledge is harder to obtain and some techniques would prove better than others for this purpose. Tacit lessons on projects are valuable and mapping techniques could help get to the root cause of problems. Organizations tend to capture LL at the end of a project, in what is called a post-project review. However, the best way is to collect lessons throughout the entire project life cycle and not just when the project is finished. Another important thing to bear in mind is that lessons should not just cover a specific kind of theme alone, e.g. technical knowledge (Trevino & Anantmula, 2008).

Upon the completion of a review session, facilitators should use templates to document the findings, to avoid the risks of manipulating the data. The data should be edited only if necessary for clarification (Trevino & Anantmula, 2008).

3.5.2 Analyzing lessons

Once lessons are collected, they have to be analyzed to ensure that they consist of relevant information, i.e., that they are key project experiences which are applicable to future projects (Trevino & Anantmula, 2008). Abramovici (1999) suggests that the facilitator of a review session should compile all the good and bad characteristics of a project into solutions for improving the project in the next phase, and for the next project.

Complex problems can be processed using mapping techniques showing the chains of causality. Other approaches to analyze LL are: using cause-effect diagrams; minding history; thinking and observing beyond project bounds and planning remedies (Trevino & Anantmula, 2008).

3.5.3 Storing lessons

After the lessons have been analyzed they should be stored for future reference. The lessons need to be accessible and therefore stored in a system with a wieldy, web-based and intuitive interface. The system can preferably be integrated with an existing project management storage system (Trevino & Anantmula, 2008).

The need for a knowledge storage system becomes greater as the organization is expanding and achieving global presence. The personnel need to be able to quickly locate a relevant LL by searching the system using keywords, also known as “triggers” (Trevino & Anantmula, 2008).

Huber (1999), who essentially agrees that LL should be stored in a database, emphasizes awareness that lessons are often too complex or too abstract to summarize in a single data file. He therefore stresses the importance that each LL should be supplemented with information which enables the database user to contact the people who were involved in the LL session.

Trevino & Anantmula (2008) further explain that social networks work better than a LL database. However, any information shared in social networks stays with people in the form of tacit knowledge. Therefore a conversion from tacit to explicit is necessary to ensure that the knowledge always is accessible and can be used whenever required.

3.5.4 Disseminating lessons

The distribution of information between the user and the information source can in essence only occur in two different ways, through a push or pull activity. The traffic between the user and the information source varies on the number, size and objective of the messages delivered.

Push

With push methods, the user is relieved from any direct handling of the information source, allowing them to focus on other efforts than to search for information. Lessons can be *broadcasted* – without being requested – to all members of an organization through bulletins. In an attempt to distribute lessons according to a user's needs, a dedicated list server can be used in *active casting* to distinguish needs based on the roles of individuals. Lessons that are considered general in such way that they do not rely on any preconditions to be applicable to some task, or can be applied to a whole category of tasks, can be integrated into an organization's body of knowledge (e.g. through training). Once incorporated into the organizational principles, there are no longer experiential lessons (Weber & Aha, 2003).

Pull

The pull methods, on the other hand, leave all the job of searching for information to the user, who will only seek after and gather information that is highly desirable. The approach in which users search for lessons using a knowledge repository or bulletins is referred to as passive distribution and is the most traditional pull method (Weber & Aha, 2003).

Problems with lesson distribution methods

Even though push methods allow users to devote attention to other things than searching for information, there are problems with them which limit their use as standalone tools in organizations (Weber & Aha, 2003). These can be read upon below.

- Distribution takes no account of targeted organizational processes.
- Users may not know or be reminded of the lesson repository, as they need to access a standalone tool to search for information. Also, users may not see the usefulness of lessons.
- Users may lack time and skills to retrieve and interpret lessons.
- Users may not be able to apply lessons adequately.

3.5.5 Making use of lessons

Not surprisingly, studies show that LL issues often surface when there is a need to improve project performance. Most commonly, these issues consist in LL being collected but never used again. One particular study of projects located in 40 countries showed that projects only

focused on LL related to cost management. The same study proved that after the LL were collected, they were stored away and never accessed or distributed (Trevino & Anantmula, 2008).

In a study conducted on the implementation of knowledge management initiatives in engineering firms, Carillo & Chinowsky (2006) identified eight barriers to capturing and using LL:

- Lack of time
- Lack of management support
- Employee resistance to sharing
- Poor information technology (IT) infrastructure
- 'Stove-piping'
- Accessibility of knowledge
- 'Not invented' here syndrome
- Lack of real-time integrated database

Trevino's & Anantmula's (2008) research showed similar results with the above. The top ten reasons for not completing LL in their study of firms were – in descending order – lack of time, lack of resources, lack of clear guidelines, lack of incentive, and lack of management support.

Project managers should be given enough time in the planning phase to search through a LL database for valuable information (Trevino & Anantmula, 2008). Pritchard (1997) believes that organizations awarding their project managers for using LL will more likely see their project managers document lessons and make sure that mistakes are not repeated.

Neal Whitten (1999) has not much for the practice of reviewing LL when it comes to learning from project to project. He argues that reviewing something usually yields little improvement. Instead he suggests that one should have to convince a review board of three members that one has appropriately applied the most significant LL to one's new project. And that can yield market improvements. He explains, "*If you cannot convince the review board, then you must replan and return to confront the review board until you can demonstrate the application of these lessons.*"

3.5.6 Tools and techniques for capturing lessons (pros/cons)

During the literature research, a number of techniques which aims to capture LL from projects were found. In essence, all methods are variations of each other in one way or another. However, the aim here is to briefly describe the relevant methods discussed in the literature.

- Post-project review or Post-mortem review
- Post-project appraisal
- After Action Review

Post-project review

A post-project review is a formal review which is conducted after the project is finished. It is stated by Anbari et al. (2008) that the post-project review enhances current and future project effectiveness in meeting project goals, disperse knowledge, utilize the right amount of resources and improve the project performance and methods. Moreover, if a post-project review is conducted properly, continuous learning will take place in the entire organization (von Zedtwitz, 2002).

To effectively conduct a post project review there is a need of visible commitment from senior management. The senior management team needs to be actively involved and highlight the importance of the data the project team gets from a post-project review session and stress the importance of learning from all projects, regardless if they were successful or unsuccessful (Anbari et al., 2008).

Moreover, the post-project review needs to be assessed according to well understood guidelines and procedures which should be available before the review. Collier et al. (1996) state that post-project reviews should act as a link to future projects. Hence, it helps an organization to develop a learning culture which is essential to improve from past experiences.

The process to conduct a post-project review

There is a five step process (Collier et al., 1996) to conduct a post-project review or post-project mortem. The process is comprised of five steps, each with its own purpose and outline, visualized in Figure 9.

Figure 9: The process of conducting a post- project review according to Collier et al. (1996)

The first step is to design an electronic *project survey*. The aim with this electronic survey is to gather subjective project information from the respondents. The results are then tabulated and evaluated.

The focus in the second step is to *collect objective project information*. Three types of metrics are captured: cost, schedule and quality. By collecting project information it will be easier to compare different projects with each other. Also, objective data will ease up the discussion as the information is based on actual facts rather than assumptions. Moreover, this will steer the focus to areas which have the biggest return on investment and the areas with the most essential problems.

The third step – *conduct a debriefing meeting* – is led by a chair and a facilitator. The chair provides technical support for the facilitator and should have knowledge about the project. The facilitator, however, is preferably an external person who has no connection to the project team. The facilitator's main tasks are to provide focus, direction and ensure that participants feel safe about sharing their views. The primary focus on the meeting is to gather positive and negative feedback from all project members. The survey results generated in the first step act as guidance for which areas that should be addressed during the meeting. However, new areas are often raised by the participants.

Project history day is a one day program where all project events and data are reviewed. Generally, the project history day is executed by a group of 6-8 people – usually project managers or other managerial staff. One of the main reasons for conducting a project history day is to get a better understanding and deeper insight of the project data. Hence, the root-cause of the problems is identified and captured.

The last phase – *Publish the results* – entails to publish a report in the form of an "open letter to the project teams". The report is summarized in four sections; (1) Project description – an overview of the project; (2) The good – a summary which shows all the positive findings e.g. developed tools, infrastructure improvements and process changes; (3) The bad – a summary of the three factors which hindered the team to reach the predefined goals; (4) The ugly – one key issue or problem is selected by the project team which need to be solved before any new project is initiated. The problem needs to have a concrete and distinct description so that everyone in the organization understands.

There are, however, disadvantages of post-project reviews. Turner et al. (2000) identified two problems with transmitting the learning to the rest of the organization at firms where post-project reviews are undertaken. In a project lasting for several years, valuable learning experiences – which take place at the beginning of a project – get lost because they are not captured until the post-project review at the very end. Secondly, while learning may be successfully captured in post-project reviews, firms fail to transmit it to the rest of the organization.

Post-Project Appraisal

A method to capture LL which has its origins from the 1980's is the post-project appraisal (PPA). The main goal of the PPA is to have the entire organization learn from a collection of past project experiences. It involves a large-scale evaluation of already finished projects (typically two years after the projects are completed), encapsulated in a report distributed throughout the entire organization. This method is carried out by an external post-project appraisal team with no biased opinion about the projects, which should ensure an objective viewpoint. The PPA team examines the whole project life cycle – from idea to final product – with the ambition to find elements which contributed to the project outcome.

Furthermore, after the large-scale examination of the project documentation, the PPA team carries out verbal interviews with all personnel which were involved in the project (on an average 40 people). The final report is then submitted to the business board and a corporate review committee. Afterwards, the report is released throughout the organization in the form of a case collection (Gulliver, 1987).

After Action Review

A simple and effective method that were adopted more than a decade ago by some organizations (e.g. British Petroleum, US Army, Israeli Air Force) in order to capture LL during a project (e.g. specific events) or after a project is the After Action Review (AAR). The AAR has its origins from the U.S military that used the method to capture lessons during or after a combat mission. In an AAR session with the U.S military, all participants are welcome to attend, from the lowest ranking solider to the highest commander (Department of the Army, 1993; Lipshitz et al., 2002).

Steps for conducting the AAR

According to the US Army and the US Agency International Development, there are four main questions the facilitator should raise up for discussion when carrying out an AAR:

What was supposed to happen?

The first step is about to discuss, in detail, what was supposed to happen. The facilitator asks the participants questions to gather all necessary information. Also, graphical accessories may be used to ensure everyone understands (USAID, 2006).

What actually happened?

The intent with the second question is to review all recent events. The facilitator guides the participants through the review as he or she asks open-ended questions to the participants. It is important that the facilitator ensures that all specific issues are revealed either they are the result of something good or bad (USAID, 2006; Department of the Army, 1993).

Why it happened – What we learned

"Why it happened" is a problem solving process where the participants find the root causes and propose solutions. There are three different techniques the facilitator can use to guide the participants through this question. The first technique the facilitator can use is displaying all the events – from start to finish – in a chronological order. This will make it easier for the participants to remember what actually happened. In the second technique there is a focus on critical events that occurred. This technique is suitable when there is a lack of time and when the facilitator wants to avoid that the discussion detours off from the core issues. The last technique is called "optional discussion guide" and it is practically a combination of the other two – used when only a few events have to be evaluated in detail (USAID, 2006).

What will we sustain or improve?

During the last question, the participants summarize and reflect on the previous questions. The main idea is to contribute with recommendations and actions to improve future projects. Furthermore, the participants identify where they are proficient, how they will stay proficient and where they need further training (Department of the Army, 1993).

Benefits with AARs

As stated by the USAID (2006), AARs help the organization as a whole and the individual participant to; *explore and correct its weaknesses, sustain its strengths and explore its opportunities*. With the AAR method, organizations can immediately recognize that they are out of scope or not fulfilling the performance standards. To conduct an AAR – which should not be longer than 90 minutes – it is vital that the participants can speak openly and honestly about the knowledge and experiences they have encountered. Thus, in order to have an open discussion, there is a need for mutual trust among the participants. Further, the discussion will help the participants to explore and capture what really happened. The participants should after an AAR session clearly understand what went well, what did not go well and what they learned from this. Thus, lessons are becoming LL (USAID 2006; Department of the Army 1993). Also, the AAR is suitable for gathering LL continuously (i.e. at each phase in the project life cycle) due to its simple and brief approach, which will reduce the risk to lose important knowledge (Mehrizi et al., 2008).

A summary of the methods read up on above is compiled in Table 7.

Table 7: Summary of methods for capturing of LL (Schindler & Eppler, 2003)

Parameter/Method	Post-project appraisal	Post-project review	After Action Review
Time of execution	Usually two years after the project completion	After project completion	During the project
Carried out by	External post-project appraisal unit	Chair, coordinator and facilitator	Facilitator
Participants	Project team and third parties	Project team	Project team. Sometimes third parties
Purpose	Capture LL and learn from mistakes. Also, transfer knowledge to third parties	Capture LL and learn from mistakes at the end of a project	Capture LL and learn from mistakes. Transfer knowledge inside the team
Benefits	Best practice generation for large scale projects. Improvements of forecasts and proposals	In-depth analysis of the project. Improve future project management methods and practices	Immediate reflection of own doings to improve future actions
Interaction mode	Extensive interviews with project members, document analysis	Team meetings	Team meetings
Codification	Booklets	Reports – "Open letter to the project team"	Flip charts

3.5.7 Tools and techniques for transferring lessons (pros/cons)

In order to disseminate LL effectively throughout the organization, a number of methods need to be taken into account. In this section we will present a number of methods an organization can use to prepare, structure and transfer LL.

- Micro Article
- Narrative/Storytelling
- Learning histories

Micro Articles

A micro article is a documentation approach to secure LL after a project. The micro-article was originally developed by the sociologist Helmut Wiklle in 1996, and is normally written by project members in an informal and entertaining way (Mehrizi et al., 2008). As the name indicates, it is meant to be a short article - maximum one page - that provides the reader with a light-weight summary of the main LL derived from the project (Köster, 2010).

According to Linz & Resch (2010), a micro article leaves a number of benefits to the capturing and transferring of LL. When a project member or manager is writing the micro-article, he or she is forced to think about which difficulties he or she discovered during the project. The author is also required to give suggestions and find solutions. Moreover, the project member composing the article is developing documentation skills, which is important in the transfer of his or her expertise in such a way that it is easy to assess and grasp for other project members in the organization.

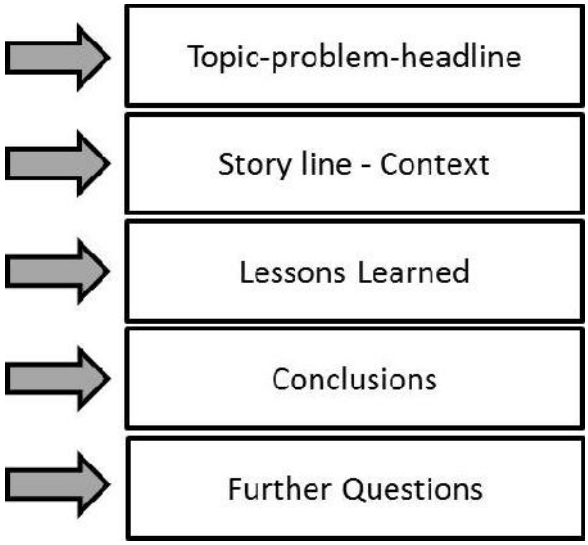


Figure 10: Structure of a micro article (Linz & Resch, 2010)

According to Linz & Resch (2010), a micro article can be summarized in five sections (see Figure 10). First of all, a micro article should have a header which is highlighting the topic and the problem. In the *Story line – context* section, the author explains the problem he encountered. In order to catch the reader's interest and ease the understanding, the story should be a mixture of hard facts and emotions. In the next section, the LL are summarized by the author. This is followed by a conclusion section, where the author shall answer the questions; *What should be done differently next time? What consequences does the LL imply on actions in the future?* In the last section, the author formulates thought-provoking questions, e.g. *what can help in the future to solve or avoid this problem?*

In comparison to other LL transfer methods, the micro-article stresses the importance of visualizing. A micro article has a high degree of visualization by using multimedia objects like video clips. The LL should therefore be presented in a genuine and entertainment manner (Köster, 2010). Another commendation provided by Linz & Resch (2010), is that the article should be standardized in order to make the activity more effective and thus less time-consuming for the project members to engage in. Moreover, it should be presented on the intranet in a database or in a paper-based form. There are, however, two issues an organization has to think about before implementing this method. First, organizations must allocate enough time to the project members to carry out such an activity. Secondly, organizational support is vital because the company needs to create rules to ensure that collective use among the employees is established.

Storytelling/Narrative

Storytelling or *narrative* has traditionally been a natural part of the organization in order to shape corporate culture and influence corporate behavior. Storytelling is by definition a social construction based on values, shared meanings and language. It is often presented textually, but oral and visual presentations occurs as well (James & Minnis, 2004). Several authors have conveyed the possible advantages of storytelling. It is stated by Stewart (1998) that stories effectively transfer tacit knowledge to people, and Tsoukas & Hatch (2001) point out that storytelling is a suitable tool for learning more complex lessons.

In a study by Williams (2008), it was revealed that LL in the participated organizations were quoted in a database. However, by telling stories behind the LL it became easier to explain how the situation actually occurred and what the underlying reasons were. In accordance with Stewart (1998), Williams (2008) further explains that storytelling is useful when it comes to transferring tacit knowledge, and a database is more suitable for explicit knowledge.

James & Minnis (2004) propose that storytelling has developed to become a powerful management tool, and they define four positive aspects of what storytelling can provide to an organization:

- Facilitate knowledge sharing
- Guide problem solving

- Decision making
- Generate commitment to change

Learning history

A documentation approach, which has the characteristics of storytelling, is the *learning history*. This concept was originally developed by a research team at Massachusetts Institute of Technology. A learning history is an authentic written story – usually between 20 to 100 pages long – containing all main project events, quotations from project members and comments from the "project historian", all structured in a chronological order. The main point with this method is, according to the founders Roth and Kleiner (1998), to more effectively capture and convert tacit knowledge to explicit knowledge.

The layout of the learning history is usually designed in the following way; it is presented in *two-side-by-side columns* where the right column includes the project members own quotations and the left column is loaded with evaluative comments and questions from the "project historian". Anonymity is emphasized when creating the story; the document should only refer to job titles (e.g. project manager). Between the columns there are additional boxes with comments regarding background and summary information from the project. Once compiled, the documents are validated by the involved project members. In addition, the documents are *not* handed out to the organization due to the fear of them being ignored. Instead, there are workshops or reading groups where the project members get together to have a reflective discussion about the project experiences for about two to three hours. Furthermore, as Roth and Kleiner (1998) put it, it is important to "build an atmosphere of innovation" where the potential pitfalls and challenges are valued and discussed.

3.6 Key success factors to project learning

Successful project learning is recognized by many authors as key to competitive advantage and increased innovativeness (Alavi & Leidner, 2001; Turner et al., 2000; Anbari et al., 2008). In this chapter we summarize the key success factors to enhance project learning found in the literature reviewed up until now. These factors refer to timing, structure, and resources. Further, we present new input concerning how to convert these success factors into actual deeds.

3.6.1 From single review to continuous project learning

Throughout the literature, several authors state that organizations executing a LL session solely at the end of the project life cycle reduce their ability to effectively capture and learn from project experiences (Kotnour, 2000; Lilly & Porter, 2003; Schindler & Eppler, 2003; Carrillo et al., 2004; Trevino & Anantmula, 2008; Turner et al., 2000). An example is found in an article by Kotnour (2000), in which he interviewed 43 project managers at a PMI chapter meeting. He found that the majority of the projects held a LL session when the project had finished. Moreover, three main disadvantages have been recognized when conducting a

LL session at the end of a project life cycle (Mehrizi et al., 2008; Kotnour, 2000; Bresnen et al., 2006; Lilly & Porter, 2003, Turner et al., 2000).

- The risk to lose valuable knowledge due to large time delay between project finish and the execution of the LL session.
- It is easy to focus only on events which affected the project negatively.
- Project members can be affected by the market outcome of the project i.e. whether the project was successful or not.

The best approach to capture LL is therefore to have regular LL sessions during the whole project life cycle. Several authors in the literature stress the need for *regular reviews*. Schindler & Eppler (2003) explain that it would be much easier to assemble the entire team, including temporary consultants, in a LL session if it is done during the project. Further, the same authors claim that regular reviews enhance project member's motivation.

Curiously, the literature tells little about *when* a LL session should be held. However, a few interesting opinions were found. Some authors share the opinion that a LL session should take place at each tollgate, cycle, completion of a major milestone or another major deliverable (Carrillo et al., 2004; Bresnen et al., 2006; Williams, 2008; Kotnour, 2000). Lilly & Porter (2003) illustrate three LL review sessions in a new product development process, shown in Figure 11. These three reviews are: mid-project review; post-implementation review; and post-market review. Also, the illustration shows feedback loops at each review which symbolize the actual procedure.

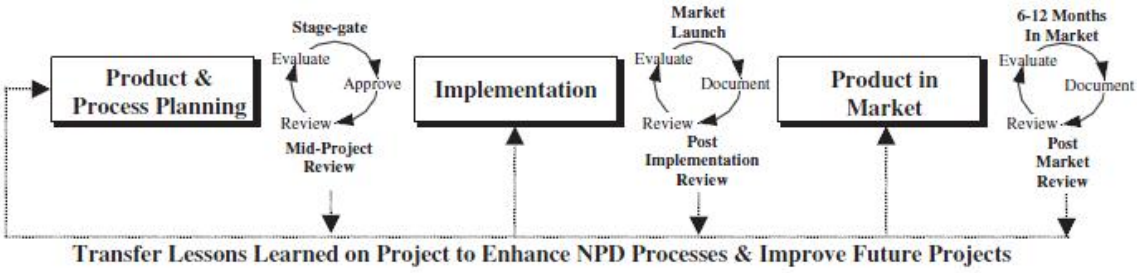


Figure 11: Multiple project reviews to capture LL (Lilly & Porter, 2003)

Mid-project review

To conduct a mid-project review, in which the project team captures and transfers lessons in a project with a long life cycle, may be beneficial for the project outcome. There are two main benefits that can be drawn from this:

- Opportunity to improve the current project and processes
- Reducing the problem with project member amnesia i.e. forgetting important events or lessons which were encountered in the beginning of the project.

Post market review

After the product has been out on the market for 6-12 months, a post market review is held. In a post-market review, the focus is exclusively on financial issues where the project team compares the actual financial outcomes with the estimated financial outcomes. The two main points here are to improve the forecasting of revenues and expenses and to improve decision making.

3.6.2 Multiple perspectives

In order to execute a successful LL session, it is of great importance to have a cross-section of personnel (Williams, 2008). Lilly & Porter (2003) state that the whole core development team should participate in a LL session, which will provide a variety of perspectives. Similarly, Terrell (1999) argues that all people – including stakeholders – who have been involved in the processes are great sources to LL. In the literature, there is little indication on which personnel should be participating in a LL session. However, Williams (2008) revealed in his empirical investigation that project management staff was participating 94,8% of the time, followed by technical staff and senior management (see Figure 12).

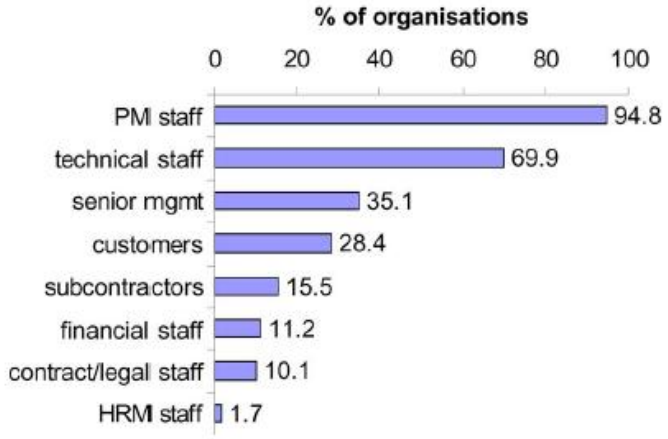


Figure 12: Personnel involved in a lesson learned session (Williams, 2008)

3.6.3 External facilitator

During a LL capture session it is of central importance to have an external facilitator, i.e. a person with strong facilitation skills who is not part of the project team. This role figures in most methods to capture LL, e.g. in the AAR and post-project review. In addition, the facilitator should be in charge over the whole debriefing process i.e. preparation, execution and documentation (Schindler & Eppler, 2003; Pitagorsky 2000; Department of the Army, 1993; Trevino & Anantmula, 2008; Collier et al., 1996; Gulliver, 1987).

According to the literature, there are some specific skills a facilitator should possess. Collier et al. (1996) stress that the external facilitator should provide focus, direction and ensure that

all participants feel open to share experiences. Then constructive and reflective dialogues among all the participants will arise. Another opinion is provided by Abramovici (1999), who explains that the facilitator should guide the discussion with a predefined checklist of subjects and guiding questions. Abramovici (1999) further explains that the facilitator has an important role, not just to get the positive and negative lessons, but to acquire solutions proposed by the participants, for input to future projects.

3.6.4 Support and guidelines

In order to learn from project experiences it is vital that the employees understand that project learning adds value to the organization. A learning culture cannot be achieved without organizational support. Many authors stress the importance of having not just project managers, but also senior management involved in and supporting a learning culture (Anbari et al., 2008; Trevino & Anantmula, 2008; Abramovici, 1999). Further, learning has to become a standard practice in project management, with organizational support through rules and guidelines (Linz & Resch, 2010; Ayas, 1996).

3.6.5 Knowledge application

The KM processes are essentially what builds up a functioning knowledge culture in which experiences are embraced and refined, to be injected like performance-enhancing substances, circulating through the organizational veins to ultimately become one with the organization's body of knowledge. These processes are represented by the creation, storage, transfer, and application of knowledge (Liebowitz, 2005; Alavi & Leidner, 2001). Fundamentally, once previous experiences has converged into knowledge and been applied, it is of value to the organization. Knowledge application accentuates change to culture, processes, and procedures. Therefore, it is essential that the organization knows how to apply knowledge. The LL processes are in essence based on the KM processes, but the terms used can differ, as LL practices in many respects emphasize "capture" and "analysis" rather than creation, and "re-use" or "transfer" rather than application (Trevino & Anantmula, 2008; Terrell, 1999). All processes are important to fulfill, and this is very well illustrated in the KM cycle (see figure 6) – the cycle has to remain closed, or else all processes are worthless. Organizations tend to fail in the transfer of knowledge. Organizations with a LL process collect and document lessons, but usually do not look at them in retrospect. One of the reasons for that is that the lessons are not possible to apply adequately (Weber & Aha, 2003). Thus, the organization should want to document only the relevant lessons (Trevino & Anantmula, 2008) that are applicable to future projects.

A lesson learned is defined in many ways in the literature. We choose to embrace one in particular, defined by NASA:

"A lesson learned is a knowledge or understanding gained by experience. The experience may be positive, as in a successful test or mission, or negative, as in a mishap or failure. Successes are also considered sources of LL. A lesson must be significant in that it has a real or assumed impact on operations; valid in that it is factually and technically correct; and

applicable in that it identifies a specific design, process, or decision that reduces or eliminates the potential for failures and mishaps, or reinforces a positive result." - (Survey of NASA's LL Process, 2001)

Within this definition lies a set of necessities for LL, conveyed through the phrases *knowledge*, *experience*, *impact on operations*, *technically correct*, and *applicable*.

This definition implies several requirements to the structure of a lesson, and suggestions to how it should be represented in a LL repository. As seen here and discussed above, application is a key issue.

In a study of LL, Weber & Aha (2003) derived a LL case representation based on this definition, emphasizing the distribution of lessons based on their applicability. To begin with, a case always has a *problem* and a *solution*. The case's problem describes the context in which the case occurred, and the case's solution describes how to solve that problem. In the CBR cycle (figure 7, p. 32), the problem is used to index and guide retrieval while the solution is reused to solve each new problem. Integrated with the elements in the LL definition – ease of interpretation and applicability – and the CBR processes, the representation in Table 8 was developed.

Table 8: The representation for LL (Weber & Aha, 2003)

Indexing elements (problem)	Applicable task
	Preconditions
Reuse elements (solution)	Lesson suggestion
	Rationale

To ensure a lesson's applicability it is indexed directly with the *task* (e.g. the task, decision or process) to which it is applicable, and described in terms of the final activity or action and the underlying process. Any conditions that influence when a lesson is applicable are stated in *preconditions*. The reuse part makes up a *lesson suggestion*, which captures any gained experience that should be repeated or avoided. At last, the *rationale* justifies the lesson by stating how it was learned. It consists of a set of sub-fields: type, what and why. The *type* distinguishes three possible origins of a lesson: success, failure, and advice. The *what* tells what happened and the *why* explains the cause (Weber & Aha, 2003). Table 9 shows an example of a LL taken from the US Navy LL System.

Table 9: Lesson learned example from the US Navy LL System (Weber & Aha, 2003)

Applicable task	**Action:** Assign air traffic controllers.
Preconditions	A civilian airport is used for military air traffic.
Lesson suggestion	Assign military air traffic controllers.
Rationale	**Type:** Failure **What?** Military traffic overloaded civilian controllers. **Why?** The rapid build-up of military flight operations at Mactan Intl Airport, Cebu quickly overloaded the civilian host nation controllers.

The lesson in Table 9 was created after an incident with overloaded flight controllers. The rationale tells us that this was a failure, and explains what that failure was and why it occurred. The lesson suggestion and solution to that problem would be to assign military air traffic controllers to support the civil controllers. The preconditions describes the context in which the incident occurred, and helps decide whether the lesson is applicable or not. The applicable task tells us that this lesson is applicable to the task of assigning air traffic controllers.

4. Result and analysis

This chapter constitutes the result of empirical data. Due to the importance of using quotes in analysis of qualitative data, the empirical data is mixed with the analysis. We analyze material gathered from interviews with project managers at Elekta and theoretical literature, and touch all aspects that could be of relevance for the research question in this thesis. Initially, to provide the reader with some understanding about certain issues addressed in the interviews (see Appendix 1), we will briefly present primary data that concerns Elekta's product creation process and the structure of the existing LL database.

4.1 Product Creation Process

Elekta runs their product realization in projects that are managed according to their Product Creation Process (PCP). It comprises a number of phases, tollgates, key elements, pre-defined milestones and documents. The product creation activities are called Key Elements and are structured in three areas: Business, Project and Product. All three Key Elements goes through four phases; Pre-Study, Definition, Realization and Product Delivery. Prior to each tollgate (T0, T1 … T5), the Key Elements shall be reviewed. The purpose is to evaluate if the project is ready to proceed into the next phase.

The Business activities involve continuous evaluation of the project's profitability, business uncertainty and long term results.

The Project activities includes preparing a pre-study report, project plans, market introduction plan, project closure report, perform a project risk analysis etc., and also refine these continually throughout the PCP. In the last phase of the project activities (i.e. Product Delivery) the project is evaluated through "LL" and project experiences are documented and communicated in the project closure report.

The Product activities involves everything concerning the technicalities surrounding the product development (e.g. design, prototyping, technical requirements, patent registration, instructions, production etc).

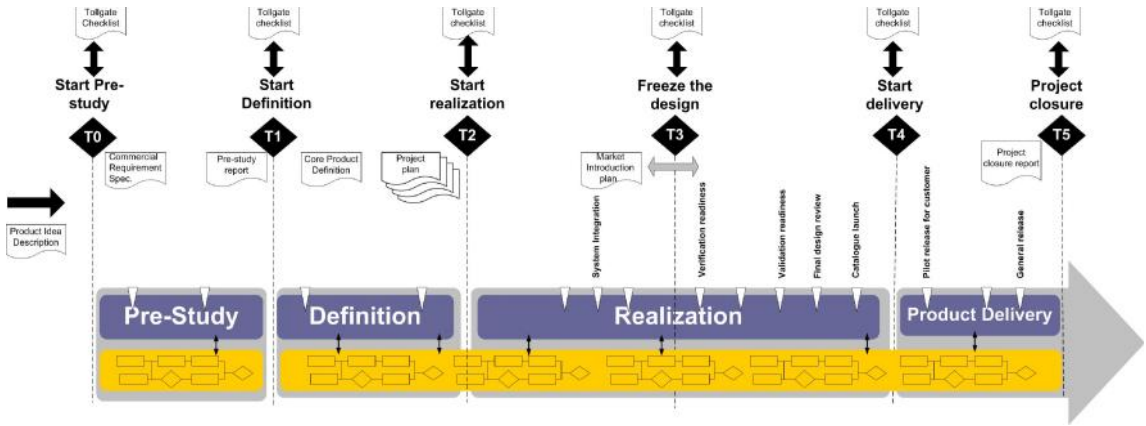


Figure 13: Elekta Product Creation Process.

The product creation process (PCP) at Elekta is divided into five different phases that can be distinguished from each other by different tollgates. In order to enter a new phase and continue in the PCP, the project manager needs to show compliance, in form of a tollgate checklist, to the PSG. Consequently, if the requirements – which are pre-determined – are fulfilled, the project enters the next phase. The project team follows its schedule and the processes in order to ensure the project deliverables are created and shipped on time.

4.2 Current lesson design

The lessons at Elekta can be assigned to many different group of categories, as shown in Table 10. Using many different groups might be helpful, but can complicate the classification of a lesson if every group of category is to be evaluated. The advantage is that a lesson can be filtered through any of these group of categories, depending on the user's need. The lesson in Table 10 was extracted from Elekta's database.

Table 10: Example of lesson in Elekta database

LessonId	265
LessonTitle	Check with the subcontractor early in the process that the agreement is acceptable by them. If a project fails later in the process due to the agreement, it is costly and time consuming to start again with a new supplier.
LessonDescription	
LessonProject	Pj063
ProjectName	MR Post kit
MeetingMoM	
ProjTypeName	General (HW, Embeded)
ProjClassName	Int.
ProdAreaName	LSS
LessonAreaName	Suppl
LessonOriginName	
LessonPhaseName	
LessonAreaProd	
LessonAreaProj	
LessonOriginGroup	
LessonPCPPhase	
LessonPMI_Area	
LessonType	Neg

4.3 Project management maturity

The first part of the literature review concerns project management improvement. We have described the five core project processes according to PMI standards and how they are integrated with the nine different *knowledge areas*, also defined by PMI. The reason for this is that the PMI standards are perhaps the most recognized globally, cited in numerous articles and books by acknowledged authors. The PMI standards furthermore appears in different

contexts in the Elekta project management office and is used as reference on many occasions. A matrix organization, such as Elekta, must continuously develop and improve its project management processes in order to deliver high quality products effectively (Wysocki, 2004). Measuring *project management maturity* is an effective way to determine how well the organization is performing its PM practices. As Crawford (2006) explains, in order for an organization to tackle its weak areas, it needs to identify its current project management maturity level. This is done using the PMMM. Needless to say, all organization's should strive to reach the highest level of maturity. We will not assess Elekta's maturity level, but wanted the interviewed project managers to give their own opinions regarding the company's maturity level. Some of them are more aware of the PMMM than others, which of course has an effect on the result. Nonetheless, it illustrates how different the perception is among the project managers within the same organization, and opens up an interesting topic for further discussion. The interviewed project managers will be referred to as Interviewee 1-6, and the term he/she or his/her will be used consistently to maintain confidentiality. Table 11 shows which position each interviewee holds and the total years of project experience.

Table 11: Interview participants (Elekta)

Interviewee	Position	Department	Project experience
Interviewee 1	Project Manager	Research & Development	>10 years
Interviewee 2	Project manager	Research & Development	> 10 years
Interviewee 3	System Engineer LSN	Research & Development	<5 years
Interviewee 4	Project manager	Research & Development	5-10 years
Interviewee 5	Project manager	Research & Development	5-10 years
Interviewee 6	Manager project management office	Research & Development	>10 years

Most interviewees agreed that the project management processes are in place with the corporate processes and that they are measured and controlled. Figure 14 shows the PMM levels as we presented it to the interviewees. We asked them to mark on the stairs where they believed Elekta's project management maturity is today. Their marks are projected in different colors.

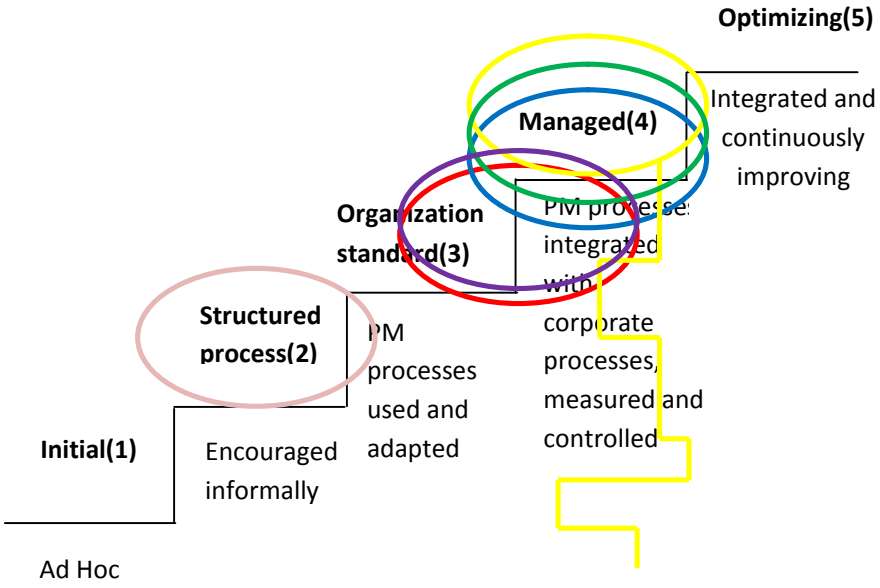


Figure 14: Project management maturity level indicated by interviewees. Interviewee 1-purple, 2-red, 3-green, 4-pink, 5-blue, 6-yellow

As we have acknowledged, most interviewees are familiar with the PMMM, but only half of them have knowledge of its purpose and how it is used. Those with a higher awareness of the PMMM (Interviewee 1, 2, 6) all stated that Elekta's PM processes lie around level 4, with two of them (Interviewee 1, 2) further explaining that the organization still is in the progress of succeeding level 4 maturity, and therefore positioned their marks at the tip of the fourth step. Interviewee 6 explained that the PMM is overall on level 4, but varies a little between departments, which is why Interviewee 6 symbolically chose to draw an irregular line cutting through the fourth step. Among the remaining interviewees with less knowledge of the PMMM, only Interviewee 4 thought that the PM processes were not fully integrated in the project organization. Notably, Interviewee 4 made an interesting comment about the difference between PM processes and project processes: "*When you look at LL and risk management – which I consider are pure project management processes and not appertained to the planning or execution of projects – I mark low. Knowingly to me, we do not have any well defined [PM] processes*". The same interviewee also adds that the work progress and methods for such *activities like the AAR are not managed in the processes*.

Although the interviewees with a better knowledge of the PMMM considered their organization's maturity level to have reached level 4, Interviewee 4's explanation indicates an awareness of the project management processes and hence his/her view that the organization is at level 2 maturity must not be rejected. As mentioned, Interviewee 6 explained that differences in maturity levels do occur between departments, adding that *System Verification has taken this further than any other line function*. If this is true, the other departments could *look at System Verification for tips on how to get their PM processes in shape*. However, since no actual assessment to evaluate the PMM has been made, the differences between departments is yet to be disclosed. If the organization chooses to assess their PMM, it needs to

make everyone aware of and understand the PMM by communicating the model so that there are no variations in the perception among employees.

4.4 Project learning

As we have stated before, in order to create a learning environment, the individuals making up the organization must acknowledge that knowledge adds value. This, as Trevino & Anantmula (2008) point out, is coherent with recognizing that valuable knowledge gained during projects tend to get lost. All interviewees admit that they either do not learn from projects at all or that they could improve a lot – adding that they mostly learn from their own projects. Thus, their self-perception indicates *high awareness of the value adding aspect of knowledge*. However, learning is not completely absent. Until now they have absorbed information via the AAR sessions, but – as more than one interviewee points out – you never go back to reflect on experiences. It is fair to say that in the current situation *lessons are "logged" rather than learned*. Today learning happens in *ad hoc* manners – an obstacle is reached or planning is carried out, and one may realize that this has been done before in an earlier project. Consequently, other project managers or someone else who was involved in that particular project are approached for advice.

A new project always carry risk that could be decreased by foreseeing barriers likely to be encountered on the way during the project life cycle. According to the interviewees, one strives to bring down risks in one way or another, either there are any tools for it or not. Normally, project plans are studied as a part of this. But project managers also approach one another to drain each other on information valuable to the planning of their own project. These processes are most intuitive, and not standardized or formalized in any way. These "heroic" efforts certainly corresponds to level 1 maturity in the PMMM. They exist solely on the premise that there is an "interest for survival", as Interviewee 2 phrased it. Consequently, a lot seems to be left to coincidence, individual ambition and personal experience. By establishing *mandatory procedures*, the organization can ensure that the teams at least attempt to transfer knowledge between projects.

4.5 Project reviewing

Knowledge has until now been captured using AARs. It is an outspoken method used at Elekta for gathering LL. Earlier, they had only done simpler follow-ups, often improvised and ad hoc. The overall response from the interviewees regarding the AAR is positive. With the AAR, the general perception is that meetings are *structured* and *approachable*. The AARs have been facilitated by someone external to the project in subject of a review, thus not the same person every time. Most reviews have been facilitated by the Process Engineering Manager at R&D who is also part of the project manager line. This person initiated the AARs at Elekta in the very beginning and oversees the activities concerning LL. This is in line with Schindler & Eppler's (2003) and Pitagorsky's (2000) – among others – opinion that the whole process of preparing, executing, and documenting should be appointed to the facilitator. The interviewees expressed an appreciation for the AARs as project managers are able to see how

things are perceived and understood by the individual project members. And by having a neutral facilitator, they assure that everyone will be able to share their own opinions.

The interviewees have no knowledge of other methods that can be used for collecting LL and do not document knowledge and lessons on their own. A couple of them take notes now and then or keep logbooks. What they all have in common though, is that they dig after knowledge at some point – either it is planned for or done intuitively. Colleagues often approach each other for tips and advice regarding different matters. This is probably the easiest and most straight forward way to transfer tacit knowledge. Nonaka (1994) refers to it as *socialization* (see 3.3.3) – tacit knowledge is shared and becomes new tacit knowledge. As Liebowitz (2005) further expounds, this knowledge is in one way or another converted to explicit knowledge through *externalization*, after which it is applied in some context. However, the exact transfer never happens twice. It is affected by each individual, the questions they ask, and how they perceive a certain problem, or with Liebowitz (2005) terms, affected by individual worldviews and values. As a consequence, it would be reasonable to expect that one individual could turn out to be more successful than another when absorbing knowledge in this manner. Thus, the quality of the transfer of knowledge between people in such a setting cannot be assured.

Explicit knowledge in the form of old project plans is also looked at when a new project is about to start. By reading between the lines, trends and patterns can be distinguished. "*There is data, but it is not data mined*", Interviewee 2 explained. Interviewee 6 emphasizes the importance of humility when undertaking something new. The interviewee admits that when he/she was about to take the managing role in a big project, he/she was not humble enough, and instead thought that his/her own past experiences would be enough in order to complete the assignment. The person in question adds that when entering a new project next time, he/she will be more open to listen, both method-wise and to how things have been done at Elekta in the past.

4.5.1 When reviewing?

In the beginning, the AARs had been carried out at the project's end, but more frequent reviewing was later acknowledged to be necessary. In a few more recent projects, AARs have been carried out after at least two or more tollgates. Several interviewees consider the period between T2 and T4 to be ideal for reviews. Interviewee 4 explained: "*This is usually where projects overrun. It could be due to a bad pre-study, but this is where problems are defined.*" The recap at T4 usually takes place after reaching the tollgate, since all focus just before T4 aims on getting the job done. Interviewee 2 explained: *"[Reviewing] could be a precondition for passing a tollgate. The benefit is that it would be done, the drawback is that it could be done in a rashly manner just to get it over with.*" For that reason there could be a lot to win – at least in T4 – by *waiting with reviewing until after the tollgate is reached*.

Further, T3 seems to be an appropriate occasion for reflection as things are still fresh in the minds of the project members. However, in the software line the development befalls in iterations, usually lasting a month to a month and a half, and normally used in the PCP realization phase. Thus, there is opportunity for more frequent capturing. Interviewee 4

explains that his intention in an upcoming project is to conduct a review after each software iteration in order to get feedback on how they estimate and plan and get to the root-cause of why goals are not reached. This will hopefully lead to better estimates in T2-T4.

Some interviewees add that *reviews should be carried out after any bigger or more difficult task*. Further, it should be part of the project and *defined in the project plan*, so that it is planned and carried out on structured occasions and in connection with certain activities, e.g. delivery etc. This view is shared by Linz (2010) and Ayas (1996), who advocate rules and guidelines so that learning can become a standard practice in project management.

Interviewee 3 had on an occasion been responsible for a small project lasting for 5 months. The team had a review after the project's end. Because of the countless activities and events taking place during a project's whole life cycle, the focus was able to stretch only 1-2 months back in time. It is not possible to reflect on the whole project in a couple of hours. Therefore there is need for *more follow-ups even in shorter projects*. There might not be time available to redo and make things right during the project, but the reviews would supply input to other projects. Interviewee 3 explains: "*We had recurring issues which we did not solve. They were brought up, but I think that we could have focused more on those issues, [and] made more people aware of them. [We] could have turned them into LL. Then we might have worked more [to solve those issues], because I believe that there are things that can be improved within the project as well. We had issues regarding the suppliers – how we cooperate within Elekta – and that issue came up in other projects too*." The issue brought up by Interviewee 3 concerned a reoccurring phenomena, which could entail that change was needed, e.g. to the processes of procurement management. This is typically an issue that needs to be captured and analyzed in order to establish a solution that can be applied to future projects.

4.5.2 Who should participate?

When having an AAR session, it is important that the right people is present, so that all important topics can be assessed. Project managers and technical staff from both the offices in Stockholm and Linköping usually make up the group of people participating in an AAR. Other functions that have not been participating in AARs, but who – according to the interviewees – favorably could bring a lot of value to LL are; *senior management* (e.g. representatives from the PSG), *customers* and *subcontractors* (see figure 15). All interviewees agreed that senior management – as owner of resources – should be represented in an AAR carried out at any larger tollgate, such as T4. At that time the project is often looked at as a whole, and the reflection stretches back as long as the participants can remember. It is important that senior management knows what is going well and what is not, and that they understand what the resources laid out imply both on the project as a whole and the people working with the project. This is coherent with the views of Anbari et al. (2008) and Trevino & Anantmula (2008) who are stressing the importance of having a senior management which supports a learning culture. Interestingly, four out of six interviewees (Interviewee 1, 2, 4, 5) thought that product management should participate more often in the AAR. They were referring to product management as being the customer in this regard, since product management is the sponsor of the project. Furthermore, subcontractors' views are appreciated

in an AAR, especially after a delivery or if there has been some sort of misunderstanding, and on occasions when there has been a more intensive relation with a manufacturer. Interviewee 3 pointed out that it is easy to blame others that are not present at a review: "*If the manufacturer is not present [in an AAR], it is easy to say 'Yes, but the long lead times…' or 'They didn't do as we said'*." Other thinkable functions such as finance, legal and human resources are not of particular importance in an AAR according to the interviewees. These functions are not directly involved in product development and thus their focus in an AAR might not be on project activities. Also, project members might not be aware of the financial influence on their project, as their job is utterly technical, and vice versa. This might lead to lack of interest in each other's business, or a lack of respect of one another's views and opinions, which is not desired. All functions – including finance, legal and human resources – could provide valuable input to LL. But each function's participation should be motivated by their involvement on implicit issues that arose during the project.

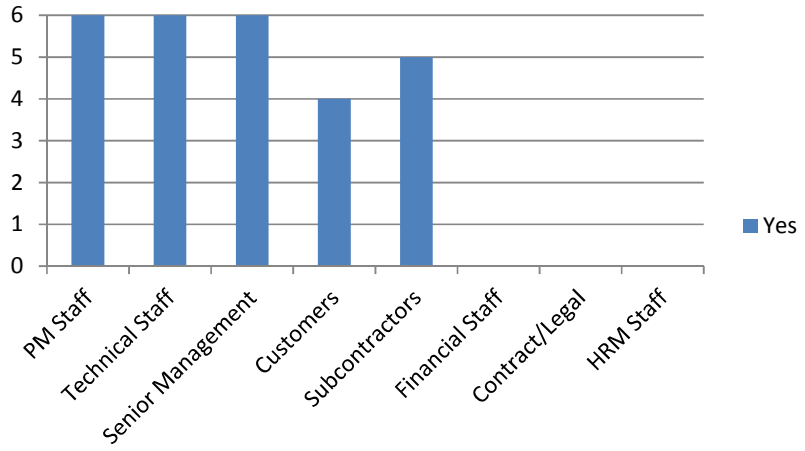


Figure 15: Personnel that *should* participate in a LL session

4.6 Lessons learned

The purpose of the AARs conducted at Elekta has been to define things in the project that went well and went bad. The outcome is documented in LL, with three different types of messages or – as they are named in the LL database – classes: recommendation (for upcoming projects); line activity (should be taken care of by the line organization); and action (an action that must be executed).

We asked the project managers to give their opinion on what the most positive things are with LL, to determine if they acknowledge LL to be of value to them and to the organization. There is no doubt that they share the opinion that by embracing LL, there are benefits to be gained such as avoiding that past mistakes happen again. "*To be able to make the right considerations and decisions in every aspect is valuable, and then one needs experience in the form of LL. Merely a theory is not enough. One has to know how things have worked and how things usually are*", interviewee 2 explained. Another opinion was that *LL are a great input to the planning*, in order to avoid being too optimistic.

4.6.1 Barriers to capturing and using lessons

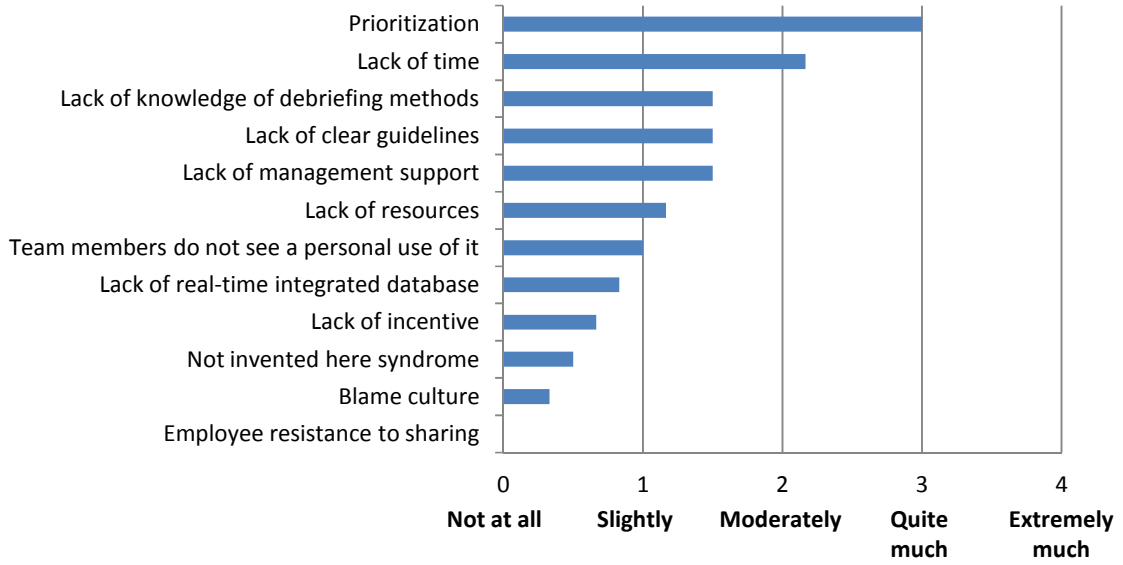


Figure 16: Barriers to capturing LL

When the interviewees were asked why they do not put more effort into the capturing and transferring of LL, the first thing they mentioned was *lack of time*. Interestingly, almost instantly, the majority switched over to say that the problem obviously is a matter of *prioritization*. Half of them said that if there is no requirement for it, e.g. written in the project plan, it will not be done. In section 3.5.5, a number of barriers – which were identified by Carillo & Chinowsky (2006) and Trevino & Anantmula (2008) – to capturing and using LL are listed. We had the interviewees rank how much each barrier affect the capture and use of LL at Elekta. Still, in the diagrams, "lack of time" was rated as a huge barrier, almost as substantial as "prioritization". Lack of time is certainly in many ways rather an excuse. It goes hand in hand with prioritization. If it was prioritized, people would allocate time to make sure that it is done. "*Lack of management support*" and "*lack of clear guidelines*" are two other barriers influencing the LL process in both ways – capture and transfer – somewhere in between "slightly " and "moderately". Support and guidelines are furthermore identified as key success factors in project learning (see 3.6.4). Linz (2010) and Ayas (1996) state that in order to make capture and transfer of LL a standard procedure in the company, there have to be *clear guidelines*.

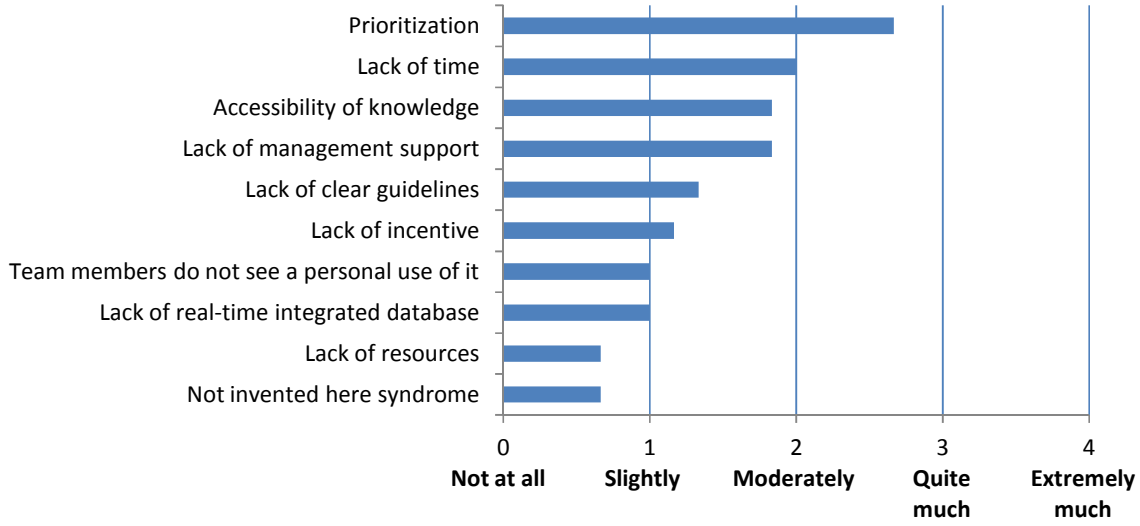


Figure 17: Barriers to transferring LL

Obviously, there is a feeling among the interviewees that knowledge is not accessible enough to foster transfer. Interviewee 2 thinks that the main problem is that there will not be any incitements until there is a good and effective way to disseminate LL, arguing *that they have neither received time nor guidance for using the database*. The feeling that the LL database is hidden and somewhat secret is shared among the interviewees. On the positive side, there does not seem to be any problem with the willingness to share knowledge among colleagues. The interviewees are confident that there is little or none resistance to sharing and absorbing the knowledge of others.

Worth mentioning is that Interviewee 1, who is working with improving project processes especially within change management, clarifies that his or her answers concern the PCP-projects, and that there are also global projects between all firms within Elekta which do not work with these sort of things. "*When you have started working with this you realize how valuable it is. […] They should work with this in the larger projects that really spell change.*"

4.6.2 Storing lessons

All interviewees agree that there should be a database providing the project organization with LL. "*As engineers, we like tools like databases, they fit in our environment*.", Interviewee 6 explained. But many agree that the database is not accessible for everyone and not easy to navigate through. This is coherent with the *lack of accessibility of knowledge*, perceived by the interviewees to be the third greatest barrier to using LL. When something is hard to do, one will hesitate. *But a database requires maintenance*, besides making it accessible and easy to navigate through.

Interviewee 6 had just recently gone through the LL database with a colleague, trying to gather information before entering a new phase in an ongoing project. By reading a heading, they could remember what had happened, what they did to solve it, what worked and what did not work. They could directly turn the lesson into an action and push it to the project. Two

hours later about 20 actions were formulated, which would be dug into further in order to see how they best could be applied in the new phase. Altogether, Interviewee 6 was satisfied with the outcome of the database review. However, Interviewee 4, who had gone through the database together with Interviewee 6, was not as satisfied. Interviewee 4 found the database to be rather hard to navigate through, which would further prevent people from searching through the database for information. The feeling is that the data is hard to interpret and use – it is hard to tell what the underlying cause was, what was good and what was bad. Interviewee 4 explained, *"[A lesson] says that having a system architect was great, but how should I interpret that without further knowledge about the project*? *In more recent projects you can ask those who were involved, but as the information gets older it becomes incomprehensive*." The reason for Interviewee 4's and Interviewee 6's different opinions regarding the lessons interpretability, can be explained by Interviewee 6's involvement in that project. Interviewee 6 had remembered certain issues that arose in that particular project by reading the heading, and was able to reflect on that. Interviewee 4 had not been involved in that project and therefore found the LL hard to interpret. This implies the importance of making the LL understandable to everyone, either they have been involved in a particular project that can be linked to a LL or not.

4.6.3 Categorization

Further, different individual preferences on how the database should be designed exist; any word should be searchable, the database should be accessible through a URL, and it should consist solely of clear recommendations. Moreover, lessons should be searchable by; project phase, project outcome, project type (e.g. new product, new feature, service pack, software), subcontractors, and documents (e.g. reports, PCP-process, checklists). Depending on the type of project, the staffing, planning, and execution is different. Therefore, a vision is that one should be able to find information based on the constellation of a project team (structure and functions).

Interviewee 6 has been involved in the categorization of lessons in the database. He or she has speculated quite a lot regarding the classification. An insight gained was that *the classification needs to be stringent and standardized*. One classification used in the database is the PMI knowledge areas. However, Interviewee 6 admits that he/she frequently forgets what the PMI standard says about these different categories, which impedes the ability to classify lessons on your own. Clearly, there is a need to *communicate guidelines on how to store lessons in the database*. Interviewee 6 means that those guidelines could be requirements on the formulation of a LL; this happened, what is the recommendation, what does that implicate for the next project? Interviewee 6 also insists that a recommendation should exist in every lesson, so that there would not be any need for using the classification "recommendation" anymore. "*The requirement [for a lesson] to enter the database should be that it actually generates a recommendation – handle it in the same way or handle it differently*."

4.6.4 Using lessons

Today, when the project is closed, the most valuable lessons gained from the project are copied from the database and put in the project closure report. This process could start with the project manager asking the facilitator of the database or the AAR for the lessons, whereupon those are emailed to the project manager who pastes them in the report. Unfortunately, that is where they stay.

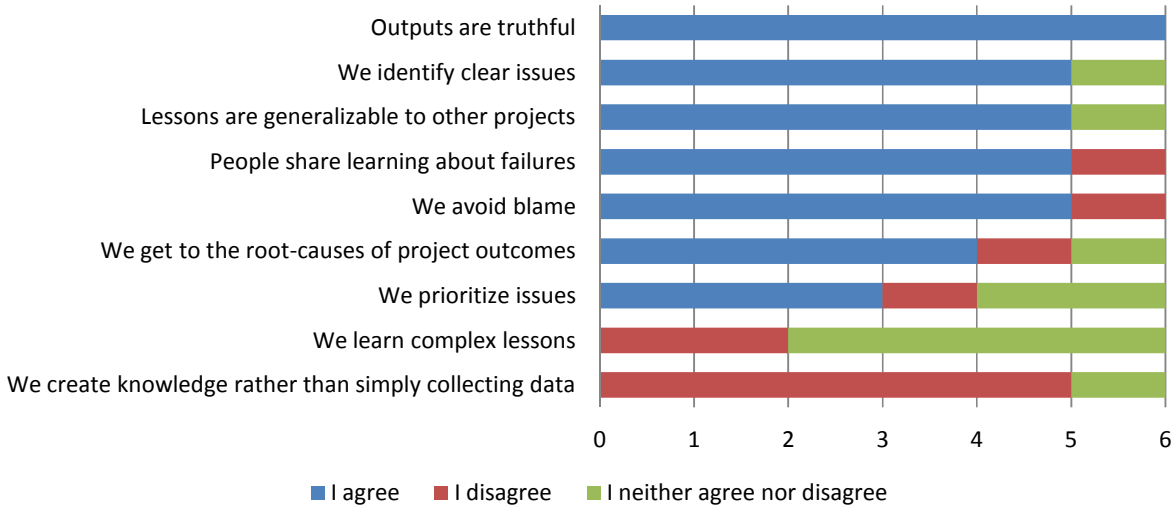


Figure 18: Quality of learning processes

We had the interviewees state how good their processes are for learning from projects and how useful the lessons that they learn are, based on issues taken from the literature. As indicated in the diagram above, the interviewees have mixed feelings regarding the learning of complex lessons. Interviewee 2 has experienced the learning of complex lessons and explains that the AAR brings forth a hypothesis to what should be done – it is easy to get satisfied very quickly – and a recommendation is concluded. "*It is easier said than done*", Interviewee 2 said, adding "*It is easy to draw simple conclusions that sound good. […] But was that really what went wrong, or is a part of it even missing in the words of the conclusion?*" As stated by Trevino & Anantmula (2008), mapping techniques and cause-effect diagrams can help in the processing of more complex problems. Also, Tsoukas & Hatch (2001) favor storytelling as a suitable method for learning more complex lessons.

Interviewee 1 adds that learning complex lessons is also about information that one has versus information that one does not have, e.g. the purchases one does not execute. This implicates the value of knowing not just about what happened, but about what did *not* happen.

Remarkably, almost all interviewees share the view that data – and not knowledge – is collected. These are of course only the interviewees' subjective views, and thus cannot fully determine the degree of success in the processes. However, the interviewees have experienced views of where the methods are failing them, and this is well illustrated in the diagram. LL

activities are meant to increase the participants understanding, and they obviously have views of where they feel their understanding is not being improved.

Recommendations and actions conveyed as LL are implicit outcomes from AARs at Elekta. The recommendations are meant to enhance future projects or project phases. Actions, on the other hand, are meant as direct interventions to project routines, processes and structure, and thus call for change. In the AAR report, the recommendations and actions are declared in the back. The question is, what happens to them once the report is finished and put aside? Are they stored in the database by a facilitator? If so, are they transmitted to all project staff? Who is responsible for the handling of the actions? The main question is; are the recommendations followed and are the actions executed?

Interviewee 3 said that the lessons are sometimes very clear, but despite that the problem could surface again. "*What I tend to remember the most are the things that never get sorted out between the projects. […]. I can see the projects that I managed two years ago, and compare with the project I had a half year ago, and the same issues can arise. You are surprised you landed there again. Other things you have learned might just roll on, you never check if it works*."

Only two of the interviewees (Interviewee 1 and 2) could say whether or not recommendations are followed. Interviewee 1 insisted that recommendations are not followed, and in the case that a similar project starts, recommendations are not embraced and transmitted to the new project. Interviewee 2 said that recommendations are followed in the sense that a conclusion has resulted from a recommendation in the AAR, but cannot say whether it is always right, it is too hard to analyze. Several interviewees had a feeling that the recommendations never get any further after the AAR, and insinuated that without anyone responsible it will not happen. There is clearly a confusedness around which person is responsible for taking the recommendations beyond the conference room. When we asked the interviewees what happened to the recommendations created in the latest AAR they participated in, they didn't give any clear answers. They did not know whether they were added to the database or not, or whether or not they themselves were responsible for taking the project team's LL to the database.

Similarly, all interviewees were unsure about the proceeding of the actions coming out from an AAR. According to some interviewees reflecting on recent AARs, the actions were handed over to the person who has been facilitating the database in the past, with the assumption that this person will take it from there, either it concerns updating work processes or disseminating information. In theory, actions should be communicated to the line. According to the interviewees the actions do not always come through to the line, and if they do they might not be prioritized. Actions concerning processes and procedures are documented in an improvement suggestion list – a list containing ideas on how to improve the PCP process – and compared to one another. Interviewee 1, currently working with process improvement, expressed a disappointment over the fact that actions seldom lead to change in processes, but believes that any suggestion backed up by a great amount of people is more likely to be prioritized.

It's clear that someone needs to be responsible for the process of taking the recommendations and actions to another level and making sure they are followed and executed. "*Someone should own this [process], someone should be measured [on how it develops]*.", Interviewee 6 suggested.

We referred to Pritchard (1997) earlier, who believed that by awarding project managers for using LL they would be more willing to document lessons and learn from them. We asked the interviewees what they think about rewards as incentives for using LL. The majority of the interviewees do not believe in rewards as incentive for learning lessons. Instead, they believe that the sole benefit of learning lessons should be enough as an incentive. But since all type of functions are involved in the knowledge gathering activities, it is important that the value of learning lessons is understood down to the individual project member. Interviewee 2 explained: "*As with time reporting – the consultants have use of it for obvious reasons, but the project members, however, do not see any use of it at all. They are told that time reporting is needed so that projects can be measured, but they never see any numerical values, and so there is no feedback*." In other words, unless learning lessons generates any clear benefits that can be communicated and shown to everyone, the learning will neither be effective nor exist at all.

Interviewee 3 thinks that the attitude towards learning lessons could change by just allocating time for learning and trigger people to search for lessons that can improve their work. Also, if it was *required* to look at lessons from other projects, then people would do it. It would be a part of the project. Not just a recommendation.

Interviewee 6 suggests that instead of rewards as incentive, someone should be measured on being responsible for owning that process. For example, the Project Management Office could have the objective – for a given time period – to show that a certain amount of everything that comes out from the projects is pushed back into the organization to create change.

Rewards in the form of bonuses, however, would call for a system to measure learning, with the risk of being complex and unfair.

4.6.5 When using lessons?

If referring to Weber & Aha (2003), information could either be dug after, pull, or transferred through dissemination, push. In a push, there's a receiver, but the receiver might not need the information at the moment. So once a tollgate is being reached, you would have to dig for information, depending on the characteristics of the project. Interviewee 1 draws an example where the database is reviewed for input to a new project or phase, and after that there is a session where the project members are able to ask questions to other project staff and thus create a dialogue in which knowledge is shared and absorbed. *If people can ask for the help that they need, they will get the right answers*, and no unnecessary or irrelevant information would have to circulate.

We asked the project managers at what times they would be looking at previous lessons for information and knowledge retrieval, to better understand how to design a knowledge process

model according to their needs. We can distinguish from the different interviews that retrieving knowledge is more suitable in certain phases or tollgates. Our study showed that there is clearly a need for knowledge retrieval in the planning phase, or more correctly worded, the definition phase. This is where the project plan is made, and the focus is on estimating the effort required for the realization of the project. All activities from realization to project closure are laid out, which comprise the PCP activities and the working- and sub-processes (design, verification, validation, manufacturing etc.). It is important for project managers to understand what has to be done, and to know about difficulties that have been encountered in previous similar projects. *Reviewing lessons from previous projects can thus provide a lot of important input in the definition phase*. That way a lot of problems can be anticipated on beforehand, and be tackled successfully or completely avoided.

The interviewees show interest of having knowledge retrieval already before entering the definition phase, that is before T1, in the pre-study phase. Then such an activity should be done before the tollgate so that risks can be evaluated based on previous information and knowledge. However, most project managers imply that it is most essential to retrieve LL sometime during the definition phase, between T1 and T2, because that is when cost, scope, and time is set and committed to.

As we stated earlier, Interviewee 6 who went through the LL database with a colleague in an effort to look for information that could be of importance for the planning of an upcoming project, experienced that it was very beneficial. They agreed that such an activity takes time and that is the reason for why it is not being prioritized. Their view was, however, that it is a shame that they do not do this more often. Further, though most of the other interviewees have heard that a database with lessons exists, they have never gone through it looking for information and said they would not even do it now after they have learned about it. This demonstrates that *an activity of this kind would demand some sort of restraint through guidelines* so that it becomes a given practice.

However, when we presented the idea of having such a task regulated in the project plan, interviewee 6 warned for the chance of turning such a practice into a must-do activity. He/she was referring to how project risks are handled in the organization at the moment, how everyone knows that a risk analysis has to be made, and once it is done everyone is satisfied and it is put away never to be looked at again. The essence here is that *it is not looked at as a useful tool to create value, it is done simply because it is required*. This implies that *it is of great importance to preach for the value of such an activity and make everyone aware of its benefits*. Then hopefully it will be embraced.

4.6.6 Responsibility

There seems to be a united consent to make each project responsible for its own collection of knowledge. Thus, the project managers should have the accountability for seizing lessons from their own projects for future use.

To have an external facilitator or project coordinator managing the knowledge gathering activity, whether it is an AAR or something else, seems to be the proper way to deal with it. All interviewees speak of the benefit of having someone else than the project manager in such a position, steering the discussions in the right direction, making sure that the project manager comes forth on the same grounds as his or her team members, and ensuring that the setup is consistent for all projects.

The interviewees seem to think that the responsibility for *transferring* knowledge between projects should lie on themselves as project managers. Project members should, however, be able to access the database consisting of lessons or any other knowledge repository at any time in order to search for information. Another view is that lessons calling for process improvements would require handling by a higher instance, someone that can communicate directly with the project managers and supervise any change in procedures. The Project Management Office (PMO) is suggested by project managers to be the most appropriate entity to be in charge of this. The manager for the PMO agrees to this and adds that someone within the PMO should own this process.

4.6.7 Lesson retrieval

We wanted to explore Neal Whitten's (1999) theory (explained in section 3.5.5) by presenting a process in which the project manager has to make a lesson implementation plan, showing how the most recent existing lessons will be applied to a new project. Additionally, the project manager will have to convince a review board of three managers that he/she can apply the lessons most adequately. If the project manager cannot convince the review board, then he/she must re-plan and return to confront them until he/she can demonstrate the application. Also, during periodic project reviews with higher management, the project manager will have to present progress status on the lesson implementation plan, as seen from his or her perspective.

There are similarities between this approach and how project risks are handled at Elekta – risks are defined at a tollgate, prioritized after likelihood and consequence, and reviewed by the PSG. The project is not let through unless the project manager gives clear indication on how to tackle the defined risks. Lessons could be handled in the same manner. This could be *added to the project plan* which, in turn, makes up the basis for the tollgate checklist. Then, in the project review, for example, one should explain how to act on a given amount of lessons. Further, if part of the project plan, the PSG could be responsible for approving the LL by signing and approving the complete project plan.

All project managers interviewed are positive to a process like this, and agree that *unless it becomes a requirement it will not be embraced by staff*. Also, no one believes that such a

process would require a lot of extra work. It is rather seen as conveying something good to the project, more to help than to push the project forward.

The interviewees indicate that *T2 would be the most important tollgate for such a review to take place*, as the investments starts and the organization counts on finishing the project. Another important tollgate mentioned is T4, which concerns roll out on market and delivery.

The difficulty lies in how to sort out the most recent or useful lessons. The interviewees talk about a handful of really important lessons to be evaluated for application. Once again, *this requires identified LL to be clear and understandable, and even suggest how one should act*. Concreteness needs to be emphasized so one can be able to reuse the information.

There are concerns, however, about which entity should be reviewing and approving compliance with LL. Some interviewees believe that the PSG might be too "heavy", requesting a smaller group to open up a discussion with, at least initially, and then perhaps take it to a higher level. Yet again, LL concerning more frequent, iterative tasks, might not be appropriate for the PSG to approve. Interviewee 6 had the idea of a committee, appropriately consisting of the main "stakeholders" – verification, software, hardware and system – where each responsible line manager reviews appropriate LL and make demands on the project accordingly. However, the interviewee hesitates on the notion that such a solution would result in the line leveraging on the project to a greater extent, which is not desirable. "*The project owns it, we are project-oriented. The project should be strong, we cannot have the line dictating all details because then we will be controlled by the line*.", Interviewee 6 explained. This might amplify the importance of having the project manager accountable for identifying those lessons that will be applied. Clearly, for this to work the responsible entity that approves an application of lessons must have a good understanding of the project and know which information is valuable for it. The PMO is well informed, wants a strong and effective project, and could therefore be an adequate option.

5. Benchmark interviews

The companies participating in this study all have clear processes for product development, consisting of phases and tollgates. Therefore, it is interesting to see how they handle reviewing and knowledge transfer in regards to their own product development process. Furthermore, this chapter will identify the selected companies' current needs, challenges and solutions.

Four companies were benchmarked – three from the automotive sector and one from the telecom sector (see Table 12). These companies are high tech firms managing their product development through capital intensive projects, and rely much on the success of each individual project when trying to stay competitive in an ever transmutable industry. Everyone who was interviewed has several years of experience within project management.

Table 12: Participating companies

Interviewee	Position	Project experience
Saab Automobile		
Jörgen Nylén	Vehicle Line Director	>10 years
Roger Johansson	Group Manager	>10 years
Volvo Car Corporation		
Olle Fast	Project Manager	> 10 years
Johan Lundmark	Project Manager	> 10 years
Ericsson		
Carl-Axel Bengtsson	Project Manager	>10 years
Scania		
Jan Palmér	Business Developer	5-10 years

The knowledge processes identified at each company is summarized in Table 13.

Table 13: Summary of knowledge activities

	SAAB	VOLVO	ERICSSON	SCANIA
Reviews and documentation	*Formal* After project closure Launch Team Release (production starts) gate with LL prerequisites Reflection goes all the way back to the start of construction and lessons to be transferred to the next project are identified.	*Formal* End of project Issues and other experiences that arise during the project is gathered in a "white book" at the project's end and presented to the Quality Department, where the project managers are interviewed to determine if they can show compliance with the tackling of problems and process changes that may be required.	*Formal* Mid-project LL session (Post-it notes), documented in project closure report End of project Project Closure report One-day workshop to break down issues that have arisen during the project *Informal* Every third month Helicopter (re)view – follow up and find issues	*Formal* End of Project LL session at "Start of production" After project closure At "Start of customer order production" >1 year after project's end. Retrospective with PQ
Transfer	*Formal* In predevelopment In connection with defining project risks - "Compare concepts with regards to LL."	*Formal* At start of project (Kick-off) The "White Books" constitutes the basis of what is transferred to new projects.	*Formal* In pre-study Look at previous lessons and what has been done in the past, through old project reports *Informal* Mid-project Another project team is invited to share their findings from a previous project during a half an hour session Start of project External people with experience from other projects invited to share knowledge when risks are defined	*Formal* Project Quarterly (PQ) Review on presented LL, follow up on existing projects. LL are communicated to project managers through PMO Retro > 1 year after project's end.

	SAAB	VOLVO	ERICSSON	SCANIA
Facilitator	Business Processes (department within technical development) documents and facilitates.	Quality department (assure procedures are updated and LL transferred to new projects)	Quality Department	LL session facilitated by project manager
Storage	Document handling system, updated by a full time employee, accessible to everyone. GM Database "Best Practice"	Document handling system	Document handling system, accessible for most people	Server LL together with project report and all existing info regarding the project
Other procedures to secure knowledge transfer			Emphasizes the importance of selecting people with various experience so that all competencies are represented 1-year mentorship program where experienced people share tips and advice with their mentees.	PMO has "pulse meetings" once a week with project managers and line managers to address current issues and coordinate direct actions

5.1 Collecting knowledge

What these four companies have in common is that they all conduct a formal review at the end of a project. Whether or not this is a post-project review that follows the characteristics we have described in section 3.5.6 is unclear. But conducting reviews after the project's end is fully in line with the "closing process" invoked by PMI (see 3.1.1). Only Ericsson has a formal LL review in the middle of a project, in addition to the review at the end. Thus, project members run less risk of getting project amnesia which could be of particular benefit to Ericsson, whose projects typically last 3-4 years (from pre-study to fully ramped up in production). The interviewee recently introduced a session for reflection in his current project, which appropriately would be conducted within three to four months intervals. These sessions are meant to provide input to the ongoing project, and will further be described in the next section.

Reflection is naturally appropriate after a tollgate has been reached, as there might be some time for the project team to stop and breathe for a short while before moving on. Demanding lessons to be collected before a tollgate is reached, however, is disadvantageous. Especially since the project intensity tends to be very high near these. Commonly, there are many things that need to be fulfilled at a tollgate, and the pressure of time would call for a postponement

of the tollgate to be able to reflect on LL. The interviewees from Saab emphasized the difficultness of having to postpone a tollgate to allocate time for a LL session. An abrupt stop at a tollgate could have a great effect on costs related to the project. Therefore such postponement is hardly ever encouraged.

Volvo project managers documents experiences in a "white book" which is delivered to the quality department for review at the end of a project. The interviewee's from Volvo explained, however, that when you start working as a project manager at Volvo, there are no formal guidelines on how to handle LL. The structure of the "white book" and its content consequently much depends on each individual effort.

5.2 Storing knowledge

Documents and reports are accessible through intranets. Only Saab had a specific LL database, promoted by GM and filled with best practices and solutions to technical problems. They had been collected over the years by the American automotive group. Although this might have been considered a treasure at GM, the database was never embraced by the Saab personnel. The Saab interviewees explained that corporate culture much influences the extent to which things like a database is embraced by an organization. There is a fear that such a database can have a locking impact on how people act and in some sense it can impede innovation. Therefore one needs to find the balance.

Volvo's quality department successfully collects and stores all documents concerning the projects. However, the Volvo interviewees insinuate a disappointment towards not being able to access that information easily today. They request a *simple way to access experiences* gained from other projects so that they can reuse that information as the project goes along.

Ericsson's document handling system is accessible for most employees, and contains thousands of project closure reports which are searched after for input as new projects start. "*It is hard to find lessons for new projects*.", the Ericsson interviewee said. "*Even though you have read through a report […] you will think 'This is good, I will mind this', but it is not until you have stepped on the mine that you actually realize what that meant. Once you learn from your own mistakes you tend to remember.*"

5.3 Transferring knowledge

All companies have *formal guidelines invoking exploration of previous experiences* (i.e. transfer of knowledge) *at the beginning of a project*. What format these experiences constitute differs, but *most commonly experiences are gathered in the form of LL at the end of a project*, *to later be reviewed in an early pre-study/pre-development phase of a new project*.

Scania's reuse of LL is managed by the steering group; 20-30 very experienced department managers representing each department (i.e. development, market, production, purchase), who meet on a quarterly basis to follow up on the current project portfolio and reflect on analyses done on completed projects with regards to LL. The managers then communicate their part of the LL to their own departments and their project managers.

Continuous improvements permeate the entire organization at Scania. This philosophy entails an approach to follow up on projects and evaluate possible issues continuously. Every Monday morning, the project management office meets with line managers and project managers to reflect on the work progress. These "pulse meetings" ensure that problems are brought to surface and being acted upon instantly. Since managers from all lines and projects are present, changes resulting from issues in one project can easily be levied to parallel projects. By allocating time for their employees to reflect continuously they do not have to wait until the project has done its LL at the end.

Most often at Ericsson there is little time even in between projects to reflect. Information is available and it is up to each project manager how much they want to absorb. The interviewee from Ericsson shared some of his more informal, self-initiated, procedures to ensure knowledge is fed into a project that is under way. In a project he is currently managing he has had two sessions – with approximately three months in between – where positive and negative things have been brought to surface to provide input and changes to the ingoing project. Also, *external project staff are invited on different occasions to share their experiences*; occasionally in the beginning of a project to provide input to risk analysis, and just recently, half way through the interviewee's current project, he invited people with experience from an earlier project to share their findings.

The other companies have little or no activity in regards to exploring or using previous knowledge as the project is under way. The Volvo interviewee's explain that they miss things that happen in between project start and project end. Then it is not evident how to reuse lessons in a structured way."*It is more up to you as project manager to know each other and say 'We have found this. Can you bring this with you?'*" At Volvo, problems that occur during the project are first documented when the "white book" is written at the very end of the project. Ongoing parallel projects therefore have little chance to benefit from another project's experiences, unless one through goodwill by word of mouth reports to colleagues working parallel so that they can take valuable information to their own projects. But this is also difficult since those who are working to solve a problem spend their entire time doing that, and thus have no time but to just briefly mention to others what the problem is about. Saab has reuse of LL defined as a tollgate requirement – "compare concepts with regards to LL". However this requirement is not always emphasized enough, according to the Saab interviewees. "*At the gate, one can ask 'Have you done a LL?' That is the criterion. 'Yes, I have done a LL.' But how does it help to give such an answer? It is the result of LL and later on the implementation that is important*", an interviewee explained. With that reasoning, if lessons are looked at to be implemented in a project, one should provide an explanation to *how* the lessons should be applied on the new project. The other interviewee from Saab added, "*Collecting experiences is not that hard. […] But to implement them in a new project, to make people learn from mistakes, that is the complicated part. For that, a total buy-in from top management is needed.*" He stresses on several times that higher management plays a crucial role to in efforts to prioritize learning. "*If there is a product development process where [learning from lessons] is a criteria for passing a gate, then it is up to management to put the project on hold until the criteria has been met. Management must be clear.*"

In many cases it winds up being a question of costs. When asked if they lack incitements for learning from projects and reuse LL, a Volvo interviewee said that "*not being opposed would have been enough*". What he meant was that it easily lands in a question of resources. You are encouraged to take action on things that come up during a project, but if it is not included in one's calculation it cannot cost anything. Consequently, one will not take it further. "*Sometimes I think we could benefit from being a little more pragmatic.*", the interviewee said.

The Ericsson interviewee believes that *knowledge transfer is much about how people is blended*. Teams should be assembled with a mix of fresh new thinkers and others with more extensive experience. Not to forget, to be able to pair the right persons together requires the project manager to have long experience of his or her organization. But besides that, the interviewee explained, it is important to look at references, ask questions and listen.

5.4 Summary of benchmark interviews

All participating organizations have the ambition to collect lessons at the end of a project for the purpose of learning them by applying them to new projects. Similarly all organizations have the ambition to do so in the early planning phases. Obviously, *this is a point in time when previous lessons are extremely valuable to take in to avoid making the same mistakes again.* However, if previous lessons are meant to be used as input to new projects, *there needs to be concrete plans on how these lessons can be applied.*

A project team could benefit from inviting staff from other projects to provide input on how to handle risks and to share findings from their previous project experiences.

In order to have an effective reflection to gather gained lessons from a project or project phase it is advantageously done *after a tollgate* to: avoid putting more stress to the project; avoid moving the tollgate; and to let project members recover and gain a little distance before having to look back.

Further, it appears that the reviewing and the handling of LL mainly are facilitated by personnel from other departments, such as Business Processes and Quality. On the other hand, this could make it hard for individual project managers to take part of the documentation concerning LL, as in the case with Volvo.

Reviewing of LL for application on projects could, as in Scania's case, be done by a group of much experienced people. Preferably they would have insight into all ongoing projects. Either the Project Steering Group or the Project Management Office would favorably be appropriate for such a task, since all major decisions concerning the projects lies with them.

What the participating organizations have in common is that they – to a certain extent – have *formal guidelines for collecting and transferring knowledge*. It is described in their product development processes and appears in project plans and tollgate checklists. More interestingly, although these requirements are conveyed formally, they tend – in some cases – to be left out and not followed. Why is that? In the case with Volvo, we have project

managers who feel that they are being worked against, indirectly, by a management that is; positive to the idea of having ambitious personnel wanting to improve their work in the best possible way they can; yet restricted in allowing the necessary resources for such initiatives. Of course, management needs to be reasonable with how much they can spend, and keep budgets in balance. But as addressed earlier in this thesis, management needs to acknowledge the value of having a learning corporate culture, and part of that is to *make sure that the personnel feel encouraged to go extra miles as a result of learning*. If continuously impeded, the personnel will take for granted that management will not be willing to let them go through with a certain idea or change the next time either. Because then one could ask why they should learn, or why they should allocate time in an already stressed project schedule to gather the project staff for a joint reflection on past experiences. As long as management refuses to let them act upon these experiences, there is little reason.

In general, a project never slows down. Instead, the intensity increases from the beginning until the very end. Thus, it is hard for the individual mind – while in the middle of this intensity that everyone in the project is experiencing – to suddenly slow down, let go of what you are doing, and reflect. An interviewee from Volvo said, "*You need some distance to it as well. When you are in the mid of something it is hard to allocate the time needed. There is always something that needs to be done, and all these musts become predominant*." Project managers inevitably argue that there is a lack of time. And we have on the other hand argued that *this is coherent with prioritization*, not least after the interviews with project managers at Elekta. Projects stay intensive. If there is no chance to gain time, it unavoidably becomes a question of prioritization. Then it is somewhat fair to say that the ball lies in the project manager's court. Generally, project managers have own mandate to distribute the time best they want. But with regards to not diminish the importance of management support, *project managers might need a "get-going" from higher instance.*

As can be seen in Table 13, Ericsson and Scania have other procedures to ensure that knowledge is being transferred. These do not take the form of traditional collecting-storing-transferring procedures, but rather emphasize direct actions and tacit processes. We have mentioned Scania's continuous improvement work. This is partly enabled through weekly meetings with the PMO. Thus, project activities are constantly being monitored, evaluated and improved. Ericsson's mentorship program is another example of an organization's effort to retain knowledge – with the majority being of tacit form – even though experienced employees eventually are being replaced. The mentor and mentee commonly come from different business areas. This might be an attempt to bridge gaps that might arise between departments. But the essential idea, nonetheless, is to have *experienced people passing down lessons to those less experienced.*

6 Conclusions

The conclusive chapter is derived from the theoretical framework (chapter 3), the result from interviews with project managers from Elekta (chapter 4) and the benchmarked organizations (chapter 5). This chapter initially presents identified factors that impede knowledge transfer at Elekta. With this in mind, a new lesson design template is introduced which is followed by a feedback model that takes the new lesson template into consideration. The chapter is then concluded with a plan for the model's implementation and future actions which will guide Elekta in the first steps toward becoming a learning organization.

This thesis has described the concept of KM processes and LL processes, and in section 3.6.5 their significant relation is described. Further, we acknowledged that these processes are illustrated in the KM cycle, linked to build a chain. It may sound like a cliché, but the chain is *only as strong as its weakest link*. Therefore, the organization needs to make sure that it can accomplish each process. After speaking to project managers at Elekta, we could identify certain issues regarding these processes. Not surprisingly, the *transfer* of knowledge is undoubtedly the weakest link in the chain of knowledge processes. Better is the fact that this is likewise acknowledged by all the interviewed project managers. It certainly simplifies future change and paves the way for process improvements.

Elekta has attributes similar to the ones described by Weber and Aha (2003) will indicate that the organization will profit from using a knowledge repository to support sharing of experiences: it much relies on innovativeness to stay competitive in a rapidly changing high tech industry; and as the organization is expanding and achieving global presence it becomes more difficult for members to interact. Elekta collects and store lessons, but they are not disseminated and used. A few factors that affect the transfer of lessons negatively has been identified from the interviews with project managers from Elekta. These can be read upon below.

- The lesson database is perceived to be inaccessible.
- Instead of creating knowledge we are collecting data.
- Lessons are hard to interpret for someone who was not involved in a project of which a lesson is referring to.
- There are no clear guidelines on how lessons should be learned.
- Management does not support learning enough.
- Project managers lack time to learn from lessons but neither prioritize such a task.

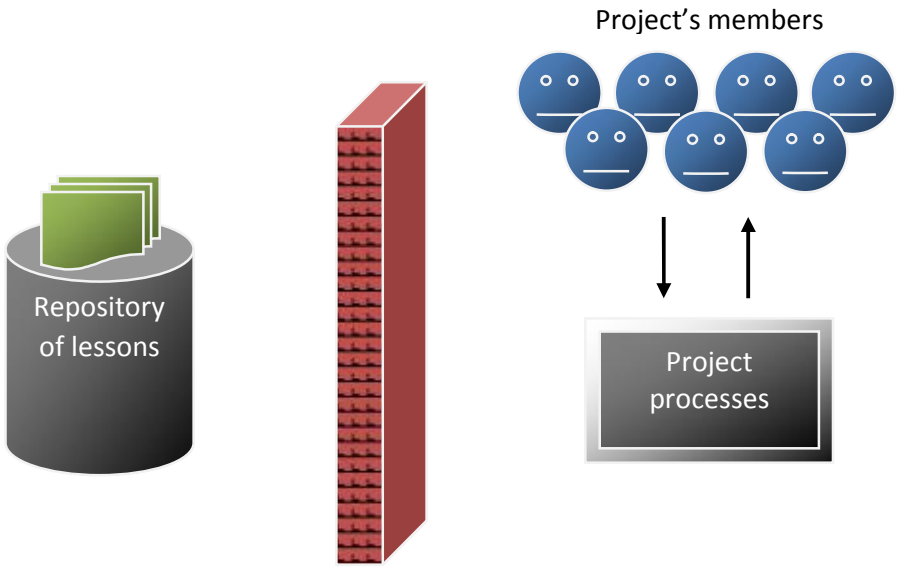


Figure 19: The lesson distribution barrier (Author's)

The problems listed above constitute a *barrier* between the lesson repository where all knowledge is stored, and the processes targeted by these lessons. The lessons are meant to improve the processes. Thus, this barrier must be broken by addressing all the problems listed above.

6.1 A new lesson design

Lessons are only learned, and thus transferred, if they can be *applied to future projects by changing a process, solving a problem, or guiding in decisions.* All lessons need to be analyzed before they are stored, to determine their applicability. It would therefore be appropriate to use a lesson template similar to the one Weber & Aha proposed in their study (see 3.6.5). This design will instantly tell the user for which task a lesson can be applied. And the precondition tells the user *when* the lesson is applicable.

The facilitator should preferably capture lessons in electronic format at the AARs to *reduce input time and improve turnaround of reviews*. The lessons can be documented either directly in the database or by using the template as an excel file. *Transferring lessons from an excel template to the database barely requires any extra time as an excel spreadsheet can be converted to an access database and transferred in just a few steps.* In addition, by documenting the lessons using a template there is less risk of manipulating data.

Table 14 illustrates how this lesson can be documented using the format in section 3.6.5.

Table 14: Lesson example in new format

LESSON				
Project:	Pj063	MR Post kit	Product Area:	LSS
Lesson nr:	265		Lesson Area:	Supplier
Time for use:	Post-T1		Project Type:	General (HW)
APPLICABLE TASK	**Action:**	Select subcontractor		
PRECONDITIONS	A subcontractor is needed for manufacturing of hardware			
LESSON SUGGESTION	Make sure agreement with subcontractor is settled before entering realization phase			
RATIONALE	**Type:**	Failure		
	What?	A new subcontractor was chosen later in the process which was costly and time consuming.		
	Why?	It was discovered that the subcontractor could not agree on terms.		
	WHYs	1st	2nd	3rd 4th 5th
		Project was not able to keep budget		
		Why?	*Project was delayed and required extra consultants*	
		Why delayed?	*Subcontractor was replaced late in process*	
			Why replaced?	*Initial subcontractor could not agree on terms*

Table 14 presents a lesson with much more substance than the previous one, which will *improve the lesson's interpretability.* All why-iterations done in the AAR could preferably be kept in the lesson when it enters the database to provide a better explanation of how the root-cause was found. It also increases the credibility of the suggested lesson.

Some or all existing categories could be used to classify the lesson. In the example above we have only used the main categories. An additional field for the responsible project manager could be added if desired, so that the user knows who to confront if more info about the event is needed. Since tasks like planning, staffing and execution is different depending on what type of project it is, the lessons should preferably also be categorized by the constellation of a project team, in terms of structure and functions.

Categorizing lessons according to PMI's different knowledge areas might be a good idea, even though it requires educating or at least reminding people of their implication. In consent with Trevino & Anantmula (2008), relevant lessons can be documented by identifying the knowledge areas that involve the PM practices that need improvement.

Ideally, the database should be searchable by any word. That would let the user find lessons not just by fixed categories, but by using any term that might come to mind when looking for a solution to a problem or any tips on how to carry out a task. A search on "delay" with the intention to recognize issues concerning delays, would result in finding lessons like the one in the example above that can provide hints on why projects get delayed and how delays can be prevented.

The new lesson template entails a different way to collect knowledge. One of the factors affecting the knowledge transfer is the fact that it is perceived that data is collected rather than knowledge. If recalling what Nonaka (1994) said regarding the difference between information and knowledge, knowledge is associated with human action. If lessons are collected and in addition analyzed and processed to actually determine *how* they can be applied to future projects, then knowledge is collected. And once knowledge is collected, knowledge – instead of just data – can be stored. This is essential.

6.2 Feedback model

The lesson database should provide input in different phases throughout the project life cycle. Lessons must be distributed either through a pull or push activity. As stated in section 3.5.4, a disadvantage of a push activity is that it takes no account of targeted processes. Essentially, if lessons were to be distributed through broadcasting, they would be delivered to people that have no use of them, because they affect processes that are not relevant at the time, or not relevant for the specific recipient. *A pull approach through passive distribution would be more effective.* Then the user can search for lessons that are desirable at the time, using a knowledge repository such as a lesson database. This approach was also requested by project managers at Elekta during the interviews.

The new lesson template suggestion entails that each lesson targets a process. Therefore we can establish a *feedback model* that will utilize lesson knowledge during process execution (e.g. planning, monitoring) to support decision-making.

The CBR cycle's sub-processes (see 3.3.5) and the LL sub-processes (see 3.5) are similar. "Retrieve" involves retrieving cases from a repository, comparable to a lesson database. "Reuse" is part of both the CBR and LL processes and involves the application of retrieved/disseminated knowledge to a new problem. The "revise" sub-process is what distinguishes them from each other: in CBR, revision aims to look for potential modifications to improve the reuse of knowledge that can be "retained", while in the LL processes, lessons are analyzed after the capturing from project members so that they can be stored in the lesson database. In the LL processes, any change to improve knowledge reuse is usually not stored – knowledge is derived from experience and is entered in the process solely by capturing. By adapting the "revise" sub-process in the LL processes, *lessons will be revised when necessary and keep the lesson database updated*.

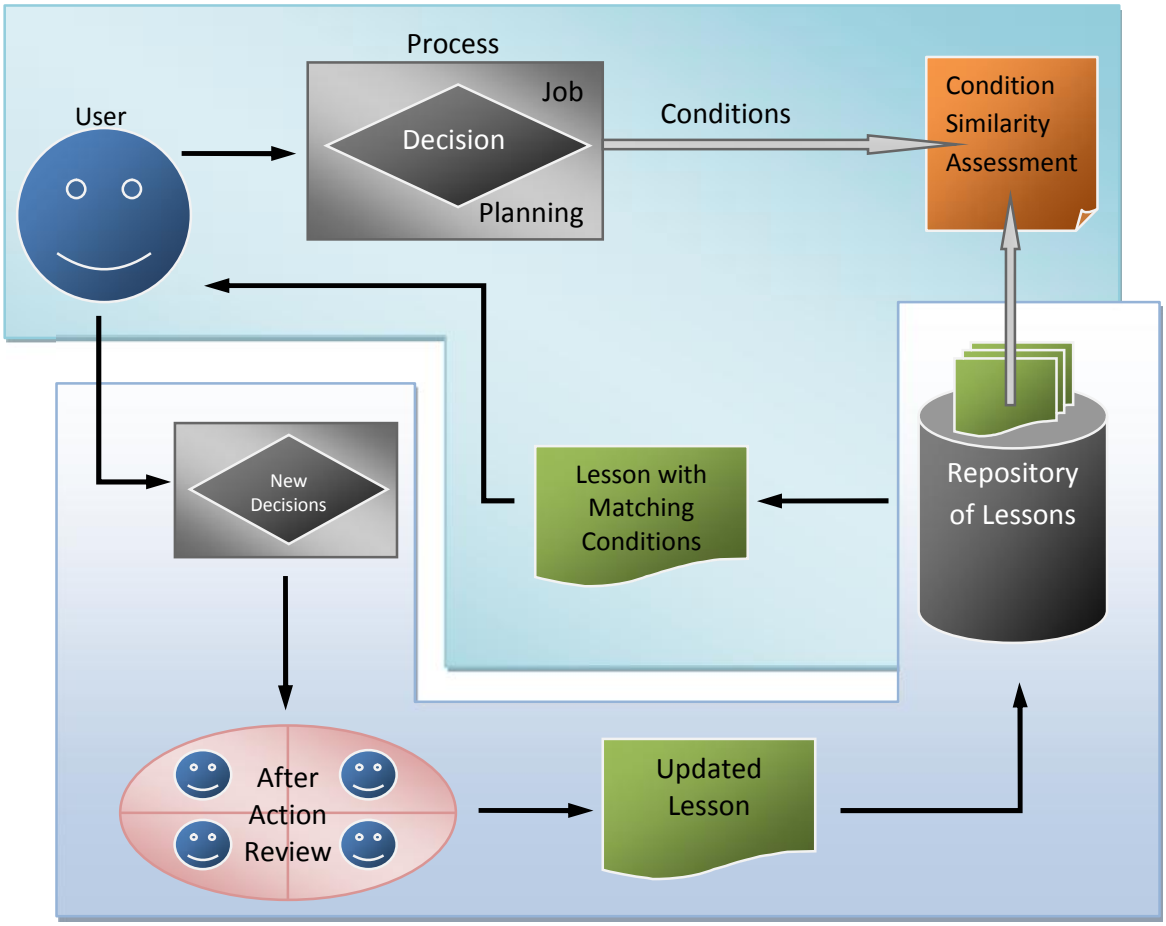


Figure 20: Lesson feedback model (Author's)

Figure 20 illustrates the feedback model. When a user is in a work process and faces a decision or problem, he/she can use the current task and conditions to assess their similarity to lessons stored in the database. If a lesson is regarded to be adequately similar to the current situation and applies to the current task, then the lesson is applicable to the decision or problem. Any process that has been impacted by a lesson has to be reviewed again – for example in the next AAR – and, if necessary, be revised and updated before it is retained by the database. The feedback model brings in ideas from the experiential learning cycle, in which competence is seen as the ability to test the implications of concepts in new situations. In the feedback model, concepts are developed and stored in a database where they later are matched with current tasks and tested in new situations.

6.3 Implementation of feedback model in PCP

The following chapter takes input from literature and interviews into consideration in order to establish the best structure of continuous reviewing and feedback of lessons throughout the entire project cycle. In other words, chapter 6.3 constitutes the implementation plan of the feedback model into Elekta's PCP.

6.3.1 Reviewing

A conclusion from the interviews at Elekta and the benchmarked organizations is that an AAR should be conducted *after* a tollgate has been reached. We identified three positive aspects with conducting an AAR after a tollgate rather than before, and these can be read upon below:

- Avoid putting more stress to the project. Let team focus on getting the job done.
- Avoid moving the tollgate due an already tight schedule.
- Let project members recover and gain a little distance before having to look back.

AARs should aim to capture gained experiences from the most recent project phase or go back as far as to when the last AAR was conducted. AARs should also review the specific processes that have been under influence of the lessons that were applied in the previous phase. At the AAR, the applied lessons should be revised and updated before they are retrieved and stored in the database together with new lessons.

Reviewing should take place after each new phase has been entered, preferably soon after the tollgate is passed so that project members will not have time to forget. Since it is requested to have input from lessons already in the pre-study phase, the first review should reflect that phase. Thus, the very first AAR should take place after T1. The most crucial period for reviewing is – according to project managers at Elekta – between T2 and T4. Reason for this is that projects tend to overrun during realization. An AAR should preferably be conducted after T2 to look back on previous actions, particularly from the definition phase, and after T4 to reflect on the entire realization phase. At the AAR conducted after T4, it is important that *product management* is present. If possible, there is a lot to gain from inviting external *subcontractors* to take part in this AAR since issues regarding manufacturing (e.g. transfer of design) might come up during the realization. Since the realization phase is quite long, an AAR should also be done after T3 to avoid that team members get project amnesia. After T5, a more extensive review should be carried out that looks back on the entire project, with focus on cost, schedule and quality. The review could preferably be done according to a post-project review (see 3.5.6). *Senior management* needs to be actively involved and highlight the importance of the data the project team gets from a post-project review session and seize the opportunity to stress the importance of learning from all projects. Management will be awakened by participating in reviewing activities, so that *the organization's members can acknowledge that management supports a learning culture.*

Moreover, Elekta should consider to introduce post-market reviews conducted 6-12 months after the product has been out on the market. This review should involve the core project team

and either the PMO or PSG. The purpose would be to compare actual financial outcomes with the estimated financial outcomes, with the aim of improving forecasting of revenues and expenses as well as decision-making.

6.3.2 Lesson feedback

Project managers at Elekta acknowledge that lessons are great input to the planning of projects. Further, a consistent theme at the four companies that were investigated in this study, is to feed back previous lessons in the pre-study phase of a project. Therefore it is of considerable value to review previous lessons for application in the definition phase. Lessons should be extracted from the database – preferably by the project manager – in accordance with the lesson feedback model. Possible lessons to be applied in new phase should be documented in the pre-study report or project plan (depending on which phase the project is in) along with a lesson implementation plan describing *how* the lessons will be utilized (e.g. with regards to cost, time, outcome). Thus, each lesson's implementation will have to be approved by the PSG as they sign the pre-study report/project plan. Furthermore, it will become a prerequisite for passing a tollgate. Lessons therefore have to be reviewed for implementation before a tollgate. In order to provide input in the definition phase, this consequently should take place near T1, and be documented in the pre-study plan. Further, to meet the requirements from the interviewed project managers at Elekta, review of previous lessons must be done before T2 to provide input to the realization phase, where cost, scope and time is set and committed to. Additional lessons that will be applied on the project should be added to the project plan with corresponding implementation plan. Same procedure applies to T4, which concerns roll out on market and delivery.

The new lesson template has been designed so that applicable lessons can be searched for at any time. However, *T1, T2 and T4 are the most important occasions for when lessons should be evaluated for application*, and *by making it a prerequisite for passing a tollgate it will be done in a timely manner.*

In the pre-study phase, a pre-study report, which should contain a number of pre-defined criteria such as project risk analysis, is created. Our proposal in this phase is to invite external project staff to share their experience from other projects. A common failure that was identified from the interviews was that projects tend to overrun between T2 and T4. One particular reason that came up was that the delay could be an effect of an insufficient pre-study. It was declared that Elekta's project managers intuitively approach one another to drain each other on information valuable to the planning of their own project. From now on, Elekta should embrace Ericsson's tactic and set up meetings so that everyone will be given the chance to ask each other questions and absorb any valuable knowledge that one's colleagues might possess. *By inviting other project staff for a discussion in the first phase, the project team will get valuable input to their assessment of potential risks and an opportunity to discuss lessons from past projects.*

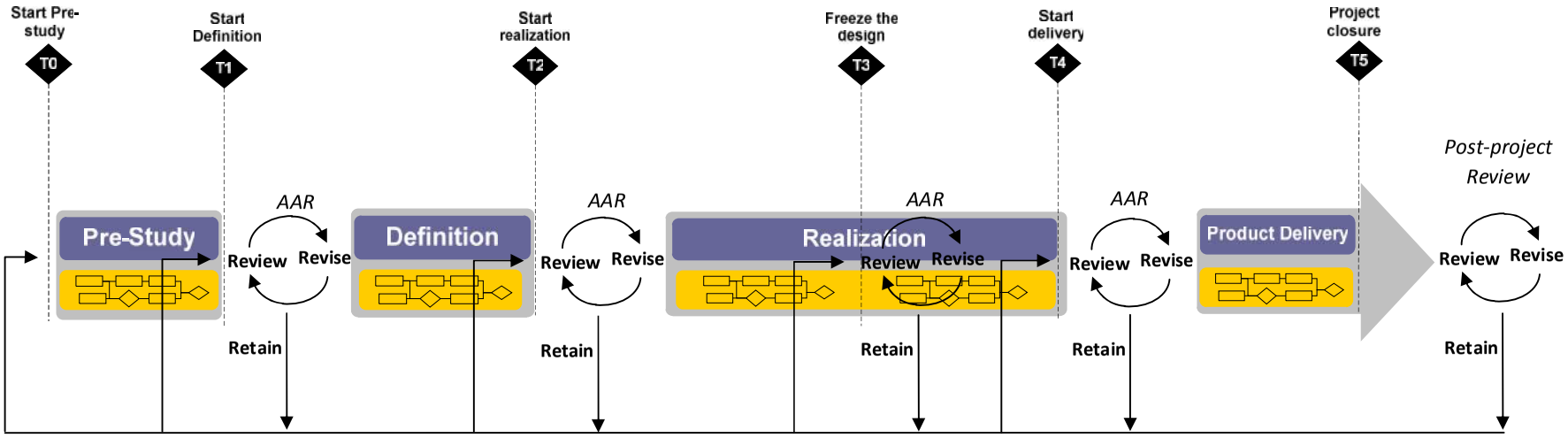


Figure 21: Lesson feedback model in PCP (Author's)

- Allocate time and prioritize project debriefings during the PCP
- When a new task or phase etc. is approached, go through the LL database. Hence, the storing, transfer and assimilation of lessons should be on-going.
- When a lesson from the database has been applied to a problem and improved with a new solution, update the database with the revised lesson.
- Document failures and their applicable solution in the lesson database using new lesson template.

6.3.3 Future actions

It was declared in the literature that learning has to become a standard practice in the project management processes. It is therefore essential to advocate clear guidelines so that the personnel know *how* to learn. Besides the traditional project goals, such as development of a new product, Elekta needs to have goals that strive to continuously increase the organization's knowledge base.

Our suggestion therefore is *to implement and incorporate learning objectives in the project plan*. Further, the *lesson feedback model must be described in the PCP.*

A few major barriers that we identified in the interviews were the lack of time, lack of prioritization and lack of clear guidelines. *By integrating learning objectives in the project plan, project members will have clear and formal guidelines to follow which, in turn, provide fundamental help to balance the conflict between time-pressure and prioritization*. Also, the learning objectives will be recognized as a strategic priority.

The following future actions which can be read upon below are the first steps towards becoming a learning project organization. These future actions are also prioritized which makes it easier for Elekta to choose the appropriate action.

1. Describe lesson feedback model in PCP Handbook.
2. Make database accessible to the entire project organization (e.g through a URL).
3. Test new excel lesson template in an AAR. Evaluate with participants. Make modifications.
4. Store lessons according to new lesson template. This entails remodeling of the access database according to new template, so that the excel template sheet easily can be converted to the database.
5. Add learning objectives in project plan. This includes template for documentation of applicable lessons.
6. Assign a facilitating entity to be responsible for reviewing, revising and retrieving via AARs.

Last but not least, Elekta needs to educate all project personnel in how to use the database to search for applicable lessons. This can be demonstrated through short seminars or workshops facilitated by the responsible entity. The lesson feedback model and its integration with the PCP should be part of the educational program.

7. Discussion

This chapter contains the project team's view on their contribution to science as well as further work recommendations. The authors also discuss the chosen methodology and finally share their personal reflections about the project.

7.1 Our contribution to science

As organizations more and more transforms into project-based organizations, it is of vital importance to learn from one project to the next. However, in practice, PBOs have difficulties to learn from past experiences and apply these experiences to new projects.

The pupose of this thesis project was to develop a process that can support Elekta in becoming a learning project organization. Our work was carried out with the intention to help Elekta turn into an organization that is skilled at creating, storing, transferring and applying past project experiences into future projects. In order to approach the research problem, we developed a feedback model for LL to enable systematic feedback of LL in past projects to future projects. Beyond this feedback model, we also proposed an implementation plan. The implementation plan explained how the feedback model will be best implemented in Elekta´s PCP.

The starting point for our study was to investigate the literature regarding our research problem. Our literature study gave us a broad understanding of project management, project management maturity, knowledge management, project learning and LL. The empirical research consisted of a case study at Elekta and at four other organizations. These case studies focused – as did the literature study – on how organizations capture, store, transfer and assimilate lessons from past projects. Our empirical research found features which, in turn, resulted in a feedback model and an implementation plan that incorporated all features for an effective LL process.

The most significant aspect about the developed feedback model is that it is so concrete, adaptable and understandable, which makes it easy for Elekta to use. The model incorporates all features for an effective LL process which, in turn, helps Elekta create a learning project environment.

The feedback model can be adapted to any project organization and therefore our work can be generalized to other project-based organizations. However, it should be noted that the feedback model needs to have some minor adjustments before it is generalizable. For example, other project organizations might not have AARs as a method to capture LL.

Furthermore, our implementation plan cannot be applied to other project organizations without justifications, since it was developed to fit Elekta's own product creation process. What we have seen from our benchmarking interviews is that organizations have similar ways of developing products, i.e. in a process where they utilize toll gates to help the project move forward in the product creation process. Thus, many of the recommendations are directly

transferable to other operations if other organizations are looking to adopt our implementation plan.

When reflecting on the conclusions of this thesis and comparing them with other solutions in this very field, we find some interesting similarities and deviations. First, in our research we have embraced all aspects concerning project management, project maturity, knowledge management, project learning and LL. Other researchers tend to focus on one or two aspects. For example, knowledge management and LL are often discussed together but they do not include any discussion concerning project management maturity and how it correlates with KM and LL.

The main reason why we discussed project management and project management maturity was to provide a thesis that had all aspects under the same umbrella. This was essential so the reader can understand how project management improvement and project learning goes hand in hand. For example, if an organization wants to reach the optimizing level (level 5) in the PMMM, they need to manage the whole LL process. Thus, the organization needs to have knowledge about both PMM and LL activities.

As we stress in the initial chapters of this thesis, an organization can assess its project management maturity to understand how well its project management practices and processes are performing. This thesis had no intention to assess the overall maturity of Elekta. However, Elekta's knowledge management processes were looked at in detail to get a better understanding of what is currently lacking in the processes, and what conditions are causing the shortfalls. Assessing Elekta's knowledge processes is in essence equal to assessing a minor part of Elekta's project management maturity. Although such work was not intended, our research clearly shows that certain processes can easily be categorized into different maturity levels. Moreover, we can acknowledge some of the benefits that the PMMM would bring to an organization. By localizing and identifying weaknesses and strengths regarding the knowledge transfer in Elekta's project organization, we found key points where actions can be directed to improve the knowledge processes and ultimately the projects' performance. Comparing Elekta's knowledge processes with other companies' resulted in propositions with the purpose of improving Elekta's project deliverables. And last but not least, through the execution of this thesis and the different elements involved, employees at Elekta has gained new insights and understanding of how the knowledge transfer processes are performed and what necessities that implies. By aspiring to teach them the means by which they can become a learning organization, we intend to initiate a cultural change among the employees.

A similarity from another author – Weber & Aha (2003) – is the new lesson template we lay out in this thesis. When comparing these two, there are similarities due to the fact that we have embraced their template in our study and advanced it. What is interesting with our lesson template is the adaptable approach and the aspect how you, as a user, can find the root cause by using the method were you ask the question "why?" until you find the root cause. It should be mentioned that Weber and Aha are two of few authors that have presented anything of significance within this area.

7.2 Reflections concerning the chosen methodology

Our chosen methodology in this thesis proved to be successful. The nature of this study made us take the decision to have a qualitative approach as we utilized the case study method. This research subject can be very abstract and difficult to comprehend, which made it difficult to choose another method. Based on the qualitative approach of this research, in-depth descriptions of situations have been provided, enabling the reader to better understand the phenomena that is investigated. Another advantage with a qualitative study is that the data and analysis is formed out of social conditions and gives a strong handle on what 'real life' is. Interesting quotes, insights and facts would never have come to light if we had used questionnaires or other more quantitative tools. When reflecting back on the results in this thesis, there is a need to add another data gathering method, which should be the observation technique. If we had the opportunity to participate in an AAR meeting at Elekta we believe more interesting information would have surfaced which could have provided a better understanding of how Elekta is performing their AARs in reality.

This thesis is considered to be reliable. In the empirics, the gathered data was always measured as we went back multiple of times to the source to check for the original information in order to secure reliability. During the interviews, one of us always asked the respondent questions while the other took notes. This was done in the same manner during all the interviews to ensure consistency. The interviews were also recorded on tape. Thus, there is no risk that some information was left out or that the interviews had different approaches or structures. This further ensures that our thesis is reliable. The validity was secured by triangulation, which means we used multiple sources and methods to collect information.

Another great lesson that we learned concerns the "pilot interview" which we performed with our supervisor before we carried out the first interview at Elekta. That gave us invaluable feedback which resulted in changing two of the questions on the interview sheet. Thanks to that change those we didn't lose any valuable and easily interpretable facts that could have been missed out otherwise.

As we described earlier in the thesis, the benchmarking interviews had an unstructured approach because we did not know how the organizations handled their LL activities. This interview technique turned out well for us and we got in-depth descriptions and other interesting insights regarding their LL processes. However, some difficulties arose later as those interviews were being processed. The first drawback with this kind of interview technique is the great amount of generated data which was very time-consuming for us to analyze. Another challenge was to steer the interview so that we could catch all important information that the respondent wanted to share. During these interviews, the respondent could sometimes start to talk about something which could be considered as off topic. The lesson we should embrace here for the future is to go through the questions in-depth before the interview and prepare for an eventual change of topic that might occur unintentionally during the interview. In other words, this kind of interview technique demands certain skills by the researcher and considerable preparations.

7.3 Further work recommendations

Even though we covered all the aspects concerning project management, knowledge management, project learning and LL, there is need for future research. The subject we have covered in this thesis is massive. There are a number of aspects that can be included in further studies. First of all, a suggestion for further research is to add more participating organizations in the study. Due to our limited time resources, we had to limit our research to four participating organizations. It can be interesting in future research to investigate how other organizations manage their LL process.

Further studies should also investigate, on a higher scale, how the relationship between respondents' views on how successful their organization's project management processes are and their characteristics. It would be interesting to in detail investigate what respondents think about their project management processes and moreover asses the organization's maturity level. In this thesis we had some problem with our questions regarding PMM because the respondents had different knowledge of PMM and how it is used to measure project success.

There is more to investigate regarding the relationship between PMM and LL processes. It would be interesting to see how organizations which are on level 4 or level 5 handle their LL activities. For example, when the respondents answer the question regarding the quality of the learning processes, it would be beneficial to compare how mature organizations versus less mature organizations feel about statements like "we get to the root cause of project outcomes" and "we learn complex lessons". However, in order to conduct a relevant study, it is required to have many more participating organizations.

7.4 Personal reflections

Why did I choose to research knowledge management? The question is relevant due to the absence of traditional engineering ingredients. Yet, I have studied industrial engineering and this is the research that will make my graduation. Knowledge management is a philosophy that provides tools for efficiency and innovation, tools that make us better and the organization that we operate within better. And this is in much the essence of industrial engineering. The journey that I have been part of when researching different areas of knowledge management has been both exciting and challenging. It is a fairly modern topic, despite the loads of articles and books written about it. The more one reads, the more one realizes how broad and deep the literature is. However, most often the literature did not provide me with the answers I was looking for. Often, the literature described the difficulties of LL and particularly the transfer of LL. I looked for examples of real scenarios, for solutions to the problems that were addressed, but they were rare. The interviews, however, gave more substance to the topic and moved the focus towards more important issues. Needless to say, I have gained valuable experience that will prove to be useful in my future professional career, no matter what industry I will work in or task I will undertake.

A crucial precondition for project learning is the need of top-management support in an organization. It is a must, and it has been said by the many authors referred to in this thesis. It is important that all employees in the organization have the same mindset and share the same

values. This is the meaning of corporate culture. During the project work I have to my delight seen the sincerity that the employees at Elekta, and at the other organizations as well, irradiate when discussing this topic. Hopefully our work has steered the crowd towards new and exciting challenges. With the contribution of this thesis and the skills Elekta´s employees possess, I certainly believe that Elekta has great potential to acquire the capabilities and the right tools to become a learning project organization.

References

Books

Aldrich, Howard (2007). *Organizations and Environments.* Stanford University Press.

Bryman, Alan (2008). *Social Research Methods*. Third Edition. Oxford University Press.

Creswell, John W (2009). *Research Design: Qualitative, Quantitative and Mixed Methods Approaches*. 3rd Edition. Sage Publications, Inc.

Dawson, Catherine (2002). *Practical Research Methods: A User-Friendly Guide to Mastering Research Techniques and Projects*", How To Books Ltd.

Denscombe, Martyn (2007). *The Good Research Guide: For small-scale social research projects*. 3rd Edition. Open University Press.

Diedrich, Andreas (2004). *Engineering Knowledge: How engineers and managers practice knowledge management*. BAS Publishing. Göteborg University, Göteborg.

Ekstedt E., R. A. Lundin, A. Soderholm, and H. Wirdenius (1999). *Neo-Industrial Organising: Renewal by Action and Knowledge Formation in a Project-Intensive Economy*. London: Routledge.

Höst M, Regnell B, Runeson P (2006). *Att genomföra examensarbete*. Studentlitteratur.

Kerzner, Harold (2009). *Project Management: A Systems Approach to Planning, Scheduling, and Controlling,* John Wiley & Sons, Inc, Hoboken, New Yersey. 10th edition.

Köster, Kathrin (2010). *International Project Management*, SAGE Publication Ltd, London

PMBOK™ Guide. *"A Guide to the Project Management Book of Knowledge",* Upper Darby, PA: Project Management Institute, 2008.

Wysocki, Robert K (2004). *Project Management Process Improvement*. Artech House.

Articles

Aamodt, A. "*Towards robust expert systems that learn from experience - an architectural framework*". In John Boose, Brian Gaines, Jean-Gabriel Ganascia (eds.): EKAW-89; Third European Knowledge Acquisition for Knowledge-Based Systems Workshop , Paris, pp 311-326. July 1989.

Abramovici, A. "*Gathering and using LL*", *PM Network.*, pp. 61–63, Oct. 1999.

Alavi, M. & Leidner, D. E. "*Review: Knowledge management and knowledge management systems: conceptual foundations and research issues*", MIS Quarterly, Vol. 25, No. 1, 2001.

Anbari, F. T., Carayannis, E.G. & Voetsch, R. J. "*Post-project reviews as a key project management competence*", Technovation, Vol.28, pp.633-643, 2008.

Arthur, M. B., DeFilippi, R. J. & Jones, C. "*Project-Based Learning as the interplay of Career and Company Non-Financial Capital*", Management Learning, vol. 32, pp. 99-117, 2001.

Ayas K. "*Professional project management: a shift towards learning and a knowledge creating structure*", International Journal of Project Management; Vol. 14(3), pp. 131–6, 1996.

Brady, T., Marshall, N., Prencipe, A. & Tell, F. "*Making sense of learning landscapes in project-based organizations*", presented at the 3rd Eur. Conf. Org. Knowl., Learn. Capabilities, Athens, Greece, 2002.

Bresnen, M., Newell, S., Edelman, L., Scarbrough, H. & Swan, J. "Sharing *Knowledge Across Projects, Limits to ICT-led Project Review Practices*", Management Learning, Vol. 37, No. 2, pp. 167-185, 2006.

Carrillo, P. & Chinowsky, P. "*Exploiting Knowledge Management: The Engineering and Construction Perspective*", Journal of Management in Engineering, 2006.

Carrillo, P., Robinson, H., Al-Ghassani, A. and Anumba, C. "*Knowledge management in UK construction: Strategies, resources and barriers*", Proj. Manage. J., vol. 35, pp. 46–56, 2004.

Collier, B., DeMarco, T. & Fearey, P. "*A defined process for project post-mortem review*," IEEE Softw., vol. 13, pp. 65–72, 1996.

Crawford, J. K. "*The Project Management Maturity Model*", Information Systems Management, Vol.23,No.4, pp. 50-58, 2006.

Davenport, T. H., & Prusak, L. "*Working knowledge: How organizations manage what they know*", Ubiquity, ACM IT Magazine, 1998.

Department of the Army. "*A leader's guide to after-action reviews*", Headquarters Department of the Army, 1993.

Fincher, A. & Levin, G. "*Project management maturity model*", Project Management Institute, pp. 1028-1035, 1997.

Garvin, D. A. "*Building a learning organization*", Harvard Business Review, July/August, pp. 78-91, 1993.

Gulliver, F. R. "*Postproject appraisals pay*," Harvard Business Review, vol. 65, no. 2, pp. 128–131, 1987.

Huber, G. P. "*Facilitating Project Team Learning and Contributions to Organizational Knowledge*", Creativity and Innovation Management, Vol. 8, No. 2, 1999, Pages 70-76.

James, C. & Minnis, W. "*Organizational storytelling: It makes sense*", Business Horizons, pp.23-32, 2004.

Keegan, A. & Turner, J. R. "*Quantity versus quality in project-based learning practices*" Manage. Learn., vol. 32, pp. 77–98, 2001.

Kolb, D.A. "*Experiential learning: experience as the source of learning and development*", Englewood Cliffs, NJ: Prentice Hall, 1984.

Koners, U. & Goffin, K. "*Learning from post-project reviews: A Cross- Case Analysis*", Journal of Product Innovation Management, vol. 24(3), pp. 242-258, 2007.

Koskinen, K. U., Pihlanto, P. & Vanharanta, H. "*Tacit knowledge acquistion and sharing in a project work context*", International Journal of Project Management, Vol. 21. Pages 281 – 290. 2003.

Kotnour, T. "*Organizational learning practices in the project management environment*", Int. J. Qual. Rel. Manage., vol. 17, pp. 393–406, 2000.

Liebowitz, J. "*Conceptualizing and implementing knowledge management*", In Love, P., Fong, P. & Irani, Z. (Eds.), Management of Knowledge in Project Environments. (pp. 1-18). Burlington, MA. Elsevier Ltd. 2005.

Lilly, B. & Porter, T. "*Improvement reviews in new product development*", R&D Management. Vol.33.No.3.pp 285-293. 2003.

Linz, A. & Resch, O. "*Double loop learning in work based settings*", In: OKCon, Vol. 575CEUR-WS.org, pp. 57-65, 2010.

Lipshitz, R., Popper, M. and Friedman, V. "A *multifacet model of organizational learning*", *J.* Appl. Behav. Sci., vol. 38, pp. 78–98, 2002.

Mehrizi, M. H. R., Tehrani, H. & Kazemi, M. "*Towards an integrated framework of knowledge management between project and organization level*" in The 9th European Conference on Knowledge Management: Eckm 2008, pp. 481-490.

Nonaka, I. "*A dynamic theory of organizational knowledge creation*", Organization Science, Vol. 5, No. 1, 1994.

Pennypacker, J. S. & Grant, K.P. "*Project Management Maturity: An Industry Benchmark*", Project Management Institute, vol.34, No.1, pp. 4-11, 2003.

Pitagorsky, G. "Lessons learned through process thinking and review", PM Network, 2000.

Pritchard, C. L. "*LL in the twenty-first century: Haven't we been here before*", Newton Square, PA: Project Management Institute, 1997.

Roth, G. & Kleiner, A. "*Developing organizational memory through learning histories*," Org. Dyn., vol. 27, pp. 43–59, 1998.

Runeson, P. & Höst, M. "*Guidelines for conducting and reporting case study research in software engineering",* Empir Software Eng., 2009.

Schindler, M & Damm, D. "*Security issues of a knowledge medium for distributed project work*", Int. J. Proj.Manage. vol 20, pp. 37-47, 2002.

Schindler, M. & Eppler, M. "*Harvesting project knowledge: A review of project learning methods and success factors*", Int. J. Proj. Manage., vol. 21, pp. 219–228, 2003.

Software Engineering Institute. *CMMI® for Development, Version 1.3,* Carnegie Mellon University, 2010.

Stewart, T. A. "*The cunning plots of leadership*". Fortune (7 September): 165-166. 1998.

Survey of NASA's LL Process. U.S Government Accountability Office, 2001.

Terrell, M. W. "*Implementing a LL process that works*," presented at the Proj. Manage. Inst. (PMI) Annu. Semin. Symp., Upper Darbay, PA, 1999.

Trevino, S. A. & Anantmula, V. S. "*Capitalizing from past projects: The value of lessons learned*", Western Carolina University, Project Management Institute, 2008.

Tsoukas, H. & Hatch, J.M. "*Complex thinking, complex practice: The case for a narrative approach to organizational complexity*" Hum. Relat., vol. 54, pp. 979–1013, 2001.

Turner, J. R., Keegan, A. & Crawford, L. "*Learning by experience in the project-based organisation*", presented at the Proj. Manage. Inst. (PMI) Res. Conf., Newtown Square, PA, 2000.

Turner, J. R. (Forewords. In P. Love, P. Fong & Z. Irani (Eds.), *Management of Knowledge in Project Environments.* Burlington, MA. Elsevier Ltd., 2005.

USAID. "After-action review: technical guidance", USAID, 2006.

von Zedtwitz, M. "*Organizational learning through postproject reviews in R&D*", R&D Management., vol. 32, pp. 255–268, 2002.

Weber, R. & Aha, D. W. "*Intelligent Delivery of Military LL*". Decision Support Systems, 34(3), pp. 287-304. 2003.

Whitten, N., "*Are you learning from project to project?*", PM Network, 1999.

Wiewiora, A., Trigunarsyah, B., Murphy, G., Gable, G. & Liang, C. ”*The Impact of Unique Characteristics of Projects and Project-Based Organisations on Knowledge Transfer*”, In 10th European Conference on Knowledge Management, 3-4 September 2009. Universitá Degli Studi Di Padova, Viceenza, Italy.

Williams, T. ”*How Do Organizations Learn Lessons From Projects – And Do they*”, IEEE Transactions On Engineering Management, Vol. 55, No.2, 2008.

Web

Practices, C. f. (2012). *Project Management Maturity Articles, Advancing Project Management Maturity.* Retrieved October 15, 2011, from Project Management Solotions: http://www.pmsolutions.com/uploads/pdfs/pmm_summary.pdf

Internal documents from Elekta instrument AB

Lessons learned database

After Action Review Reports

Product Creation Process poster

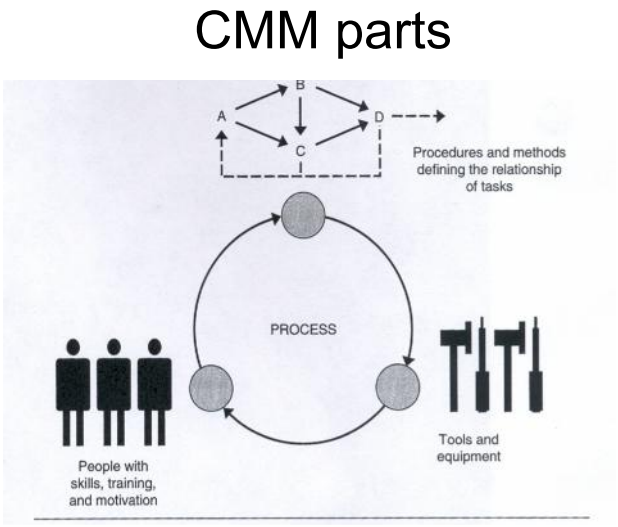
Appendix

The appendix consists of the interview sheet which was used for the interviews at Elekta and the benchmarked organizations.

KNOWLEDGE MANAGEMENT / LESSONS LEARNED INTERVIEW

Master's Thesis Project – Elekta Instrument AB

The experience curve, adapted by the Boston Consulting Group in the late 1960s for strategic purposes, shows that the more often a certain task is performed – whether it is the production of any good or service – the lower will be the cost of doing it. Thus, in order to improve it is essential to learn from past experiences. This also applies for projects. However, a challenge is that a project is a temporary organization that is dissolved once the project is completed. This means that projects much have to rely on the personal knowledge and experiences from the project members. New projects often have similar *components* and *attributes* as previously managed projects. The Capability Maturity Model (CMM) is a guide for measuring process and practice maturity, and emphasizes the need for organizations to continuously improve their project management processes.[1]



An illustration from original CMM, showing that "components & attributes" are equal to the three critical dimensions – "Procedures and methods", "Skills, training and motivation" and "Tools and equipment" – that an organization can focus on to improve its business.

This interview will investigate the attitude towards knowledge and the handling of lessons learned among personnel at Elekta Instrument AB for the purpose of understanding and improving knowledge transfer within the project organization. We ask you to reserve about 40 minutes of your time to discuss these questions with us. Your answers will be confidential.

[1] Wysocki, Robert K., *Project Management Process Improvement*, Artech House, 2004.

Thank you for your effort in helping us to improve your organization.

Demographics

What is your position at Elekta Instrument AB?_____

Which department do you work for?_____

How long experience do you have of projects (both at Elekta Instrument AB and elsewhere)?

< 5 years 5-10 years > 10 years

Are you a member of PMI or any other project management organization?

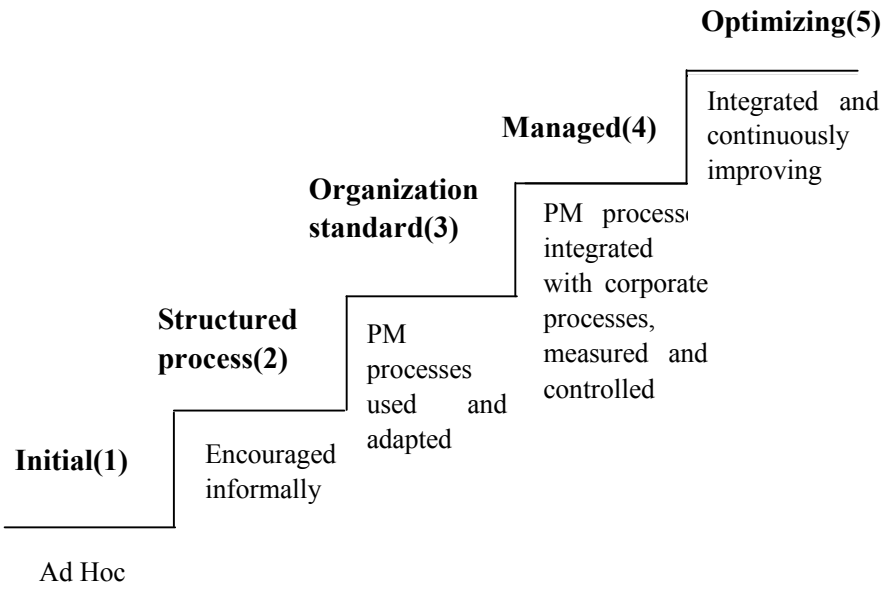
Yes No

If yes, please specify: _____

Introduction

1. When you manage a project, what is your aim(s) and goal(s) apart from the project's on goal?

2. How would you rate your organization's project management maturity? Circle one level.



3. How successful do you consider yourself in learning from projects?

Collecting lessons

4. Are there any *key* phases and activities during the project life cycle where knowledge can be captured?

Currently, Elekta is collecting lessons learned from each project as a way to capture knowledge from the projects. The following questions concern the use of lessons learned.

5. How often should lessons learned be collected during a project life cycle?

6. A) Which people should be involved in lessons learned?

Project Management Staff	Yes No
Technical Staff (Mek, Control, Software)	Yes No
Senior Management	Yes No
Customers	Yes No
Subcontractors	Yes No
Financial Staff	Yes No
Contract/Legal	Yes No
HRM Staff	Yes No
Others	Yes No

B) If others, please specify: _____

7. After Action Reviews are currently used at Elekta to gather lessons learned. Are there better methods than the one that is used today? (kanske låta respondenten välja mellan metoder?)

8. Do you use any other methods for collecting knowledge from projects?
   Yes No

   If yes, *which* methods are you using and *when* are you using these?

9. What are the most positive things with lessons learned?

10. What prevents you from putting more effort into capturing lessons learned?

11. A) In the literature, several barriers to collecting lessons learned are mentioned. Please mark on the given scale how much they affect the **capture** of lessons learned at Elekta.

Barrier	Not at all	Slightly	Moderately	Quite much	Extremely much
Lack of time	0	1	2	3	4
Prioritization	0	1	2	3	4
Lack of management support	0	1	2	3	4
Employee resistance to sharing	0	1	2	3	4
Not invented here syndrome (unwillingness to adopt someone else's idea)	0	1	2	3	4
Lack of real-time integrated database	0	1	2	3	4
Lack of incentive	0	1	2	3	4
Lack of resources (to carry out the exercises)	0	1	2	3	4
Lack of clear guidelines	0	1	2	3	4
Lack of knowledge of debriefing methods	0	1	2	3	4
Team members do not see a personal use of it	0	1	2	3	4
Blame culture	0	1	2	3	4

If you know of any other barriers, please specify: _____

B) In the literature, several barriers to disseminating and retrieving lessons learned are mentioned. Please mark on the given scale how much they affect the **use/learning** of lessons at Elekta.

Barrier	Not at all	Slightly	Moderately	Quite much	Extremely much
Lack of time	0	1	2	3	4
Prioritization	0	1	2	3	4
Lack of management support	0	1	2	3	4
Accessibility of knowledge (structure)	0	1	2	3	4
Not invented here syndrome (unwillingness to adopt someone else's idea)	0	1	2	3	4
Lack of real-time integrated database	0	1	2	3	4
Lack of incentive	0	1	2	3	4
Lack of resources (to carry out the exercises)	0	1	2	3	4
Lack of clear guidelines	0	1	2	3	4
Team members do not see a personal use of it	0	1	2	3	4

If you know of any other barriers, please specify: _____

Storing lessons

12. Is there a need for a "storage" of lessons learned at Elekta that is simple and easy to search through?

    Yes No

13. How should a storage of lessons learned be organized so that they are easy to find? How should they be categorized?

Retrieving lessons

14. How good are the processes at Elekta for learning from projects?

Quality of processes	I agree	I disagree
Lessons are generalizable to other projects		
Outputs are truthful		
We identify clear issues		
We prioritize issues		
We learn complex lessons		
We avoid blame		
People share learning about failures		
We create knowledge rather than simply collecting data		
We get to the root-causes of project outcomes		

15. How useful are the lessons you learn?

16. Are the recommendations defined in the AAR report followed?

    Yes No I do not know

17. Are the actions defined in the AAR report executed?

    Yes No I do not know

18. What do you think about rewards as incentive for learning lessons?

19. At which occasions would you be looking at lessons learned for information and knowledge retrieval?

20. Who should be responsible for the gathering, storing, and transferring of lessons learned? Circle one alternative.

    - A project coordinator
    - A specific department should be assigned to handle these activities
    - An external consultant
    - Other

    If other, please specify: _____

21. Read and give your opinion on the following case describing a learning process concept where the project manager is responsible for utilizing and implementing existing lessons learned into a new project.

    The project manager has to make a lessons implementation plan, showing how the most recent existing lessons will be applied to a new project. The project manager will have to convince a review board of 3 managers (e.g. Project Office Manager, VP R&D, Hardware Engineering Manager) that he/she can apply the lessons most adequately. If the project manager cannot convince the review board, then he/she must replan and return to confront them until he/she can demonstrate the application. Also, during periodic project reviews with higher management, the project manager will have to present progress status on the lessons implementation plan, as seen from his or her perspective.

Thank you for your contribution!